वार्षिक प्रतिवेदन
Annual Report
2014 - 15

AICRPDA

अखिल भारतीय समन्वित बारानी कृषि अनुसंधान परियोजना

All India Coordinated Research Project for Dryland Agriculture

ICAR-Central Research Institute for Dryland Agriculture

Hyderabad, India

वार्षिक प्रतिवेदन

ANNUAL REPORT
2014-15

हर कदम, हर डगर
किसानों का हमसफर
भारतीय कृषि अनुसंधान परिषद
Agrisearch with a human touch

अखिल भारतीय समन्वित बारानी कृषि अनुसंधान परियोजना

All India Coordinated Research Project for Dryland Agriculture

ICAR-Central Research Institute for Dryland Agriculture
Santoshnagar, Hyderabad - 500 059

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Preface

The All India Coordinated Research Project for Dryland Agriculture (AICRPDA) started in 1972 to conduct location specific research to address emerging issues in rainfed agriculture. The focus on research has been on developing simple, doable and profitable rainwater/ crop/ soil/ energy management practices/ technologies along with system based research on alternate land use and integrated farming systems modules.

This annual report of AICRPDA (2014-15) contains salient findings of on-station experiments and technologies assessed and upscaled under on-farm situations in major rainfed production systems. I hope the information contained in this report is useful to all the research institutes, agricultural universities and other stakeholders engaged in rainfed agriculture research and development.

My sincere thanks to Dr. S. Ayyappan, Director General, ICAR and Secretary, DARE and Dr. A.K. Sikka, DDG (NRM) for their kind guidance and encouragement in implementing this project successfully.

I acknowledge the contributions of the chief scientists and scientists from the net work centers and ORPs and also help extended by authorities of the respective State Agricultural Universities / ICAR Institutes/personnel from State Line Departments, NGOs, etc., particularly the farmers.

I wish to compliment Dr. G. Ravindra Chary, Project Coordinator (Dryland Research) I/c, for coordination, monitoring and evaluation of the technical program and Dr. K.A. Gopinath, Senior Scientist (Agronomy) and Er. Boini Narsimlu, Senior Scientist (SWC Engg) for compilation and synthesis of data generated from AICRPDA network centers.

I acknowledge Dr. (Smt) A. Girija, Dr. (Smt) D. Anantha Rao for technical help, Smt. N. Lakshmi Narasu for secretarial help and Sri P. Prakash Babu and Sri V. Venunath for administrative support.

(Ch. Srinivasa Rao)
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कार्यकारी सारांश

अखिल भारतीय समन्वित बारानी कृषि अनुसंधान परियोजना के 22 नेटवर्क केंद्र देश के वर्षा आधारित कृषि परिस्थितियों के विभिन्न जैव-भोतिक एवं सामाजिक-आर्थिक संरचनाओं सहित शुष्क, अर्ध-शुष्क, उप-आर्द्र जलवायु क्षेत्रों का प्रतिनिधित्व करता है। इस परियोजना का अधिदेश वर्षाजल प्रबंधन, समेकित पोषक प्रबंधन, ऊर्जा प्रबंधन, उन्नत किस्मों का मूल्यांकन, उत्पादन प्रणालियों पर आधारित, वर्षा आधारित चावल, मक्का, ज्वार, बाजरा, रागी, कपास, मूंगफली एवं सोयाबीन को वैकल्पिक भूमि उपयोग/कृषि प्रणालियां पर, केंद्र पर अनुसंधान के द्वारा स्थानीय प्रौद्योगिकियों का विकास करना है। परिणामी प्रौद्योगिकियों को बाद में 8 चालू अनुसंधान परियोजनाओं के माध्यम से किसानों के खेतों में मूल्यांकित किया गया। फार्म पर कुल 314 प्रयोगों का आयोजन किया गया जैसेकि वर्षाजल प्रबंधन-62, कृषि प्रणालियां-46, पोषक प्रबंधन-64, ऊर्जा प्रबंधन-32, उन्नत किस्मों का मूल्यांकन-70, खरपतवार प्रबंधन-5, वैकल्पिक भूमि उपयोग प्रणाली-14, समेकित कृषि प्रणाली-15 एवं संसाधान लक्षण-6 । चालू अनुसंधान परियोजना में, 114 प्रक्षेत्र जांचों/प्रदर्शनों का आयोजन किया गया जैसेकि वर्षाजल प्रबंधन-16, कृषि प्रणालियां-24, पोषक प्रबंधन-17, ऊर्जा प्रबंधन-13, उन्नत किस्मों का मूल्यांकन-23, खरपतवार प्रबंधन-5, वैकल्पिक भूमि उपयोग प्रणाली-3, समेकित कृषि प्रणाली-4 एवं प्रौद्योगिकी उन्नयन -14। प्रमुख उपलब्धियों को नीचे दिया गया है।

(क) वर्षाजल प्रबंधन

स्व-स्थाने नमी संरक्षण :

- फैजाबाद में, मेंढ़ की ऊंचाई को अधिकतम बढ़ाने एवं बोवाई की तिथि को आगे बढ़ाने से चावल में जल उत्पादकता वृद्धि पर प्रयोग किया गया जिसमें मेंढ़ की ऊंचाई 10 सेंटीमीटर बढ़ाने से 7960 एमजे प्रति हेक्टेयर का कुल निवेश ऊर्जा, 0.322 किलोग्राम प्रति एमजे का अधिकतम ऊर्जा उत्पादकता एवं 5.38 किलोग्राम प्रति हेक्टेयर -एमएम का वर्षाजल उपयोग क्षमता सहित अधिकतम अनाज उत्पादन (2323 किलोग्राम प्रति हेक्टेयर) दर्ज किया गया। बोवाई की तिथियों के मामले में, जुलाई के प्रथम सप्ताह (5 जुलाई) ने 7957 एमजे/हेक्टेयर का कुल निवेश ऊर्जा एवं 71613 एमजे/हेक्टेयर का उत्पादन ऊर्जा सहित अधिकतम चावल उत्पादन (2233 किलोग्राम प्रति हेक्टेयर दिया।
- विजयपुर में, अरहर एवं मूंगफली पर फसल अवशेषों से निश्चित कूंड़ कृषि के प्रभावों के मूल्यांकन पर किए गए अध्ययन में पता चला कि निश्चित कूंड़ों में अवशेष + ग्लेरिसिडिया के प्रति सथापन से औसत अधिकतम निवल आर्थिक प्रतिफल (59900/-रुपए प्रति हेक्टेयर) एवं 4.04 किलोग्राम प्रति हेक्टेयर-एमएम वर्षाजल उपयोग क्षमता सहित 1633 किलोग्राम प्रति हेक्टेयर का अरहर समतुल्य उत्पादन दर्ज किया गया।
- परभनी में, सोयाबीन + अरहर (4:2) अंतरासस्ययन प्रणाली के लिए वर्षाजल संरक्षण प्रक्रियाओं के मूल्यांकन पर किए गए प्रयोग में, बोवाई के 30 दिनों के बाद हर चार पंक्तियों के बाद सोयाबीन + अरहर (4:2) में कूंड़ खोदा गया, जिससे बिना कूंड़ (527 किलोग्राम प्रति हेक्टेयर) की तुलना में महत्वपूर्ण रूप से बेहतर उत्पादन (624 किलोग्राम प्रति हेक्टेयर) दर्ज किया गया।
- कोविलपट्टी में, कपास-मूंग का हेर-फेर, रोटोवेटर हल + चिसल हल से जल उपयोग क्षमता को बढ़ाने के लिए विभिन्न कर्षण पद्धतियों पर किए गए अध्ययन में, इस पद्धति से अधिक निवल प्रतिफल (17580 रुपए प्रति हेक्टेयर) एवं बी:सी अनुपात (1.54) प्राप्त हुआ जोकि पारंपरिक कर्षण की तुलना में 10 प्रतिशत अधिक है। वर्षाजल का 17.3 प्रतिशत अपवाह के रूप में नष्ट होने के बावजूद रोटोवेटर हल + चिसल हल से 2.36 किलोग्राम प्रति हेक्टेयर-एमएम का अधिकतम वर्षाजल उपयोग क्षमता दर्ज किया गया।
- एस.के. नगर में, अरंड़ में हाईड्रोजेल (Hydrogel) के मूल्यांकन अध्ययन में, 7.5 किलोग्राम प्रति हेक्टेयर की दर से प्रयोग ने अरंड़ का महत्वपूर्ण रूप से अधिक बीज एवं डंठल का उत्पादन (1377 एवं 991 किलोग्राम प्रति हेक्टेयर) दिया जोकि नियंत्रण की तुलना में अधिक निवल प्रतिफल (33451 रुपए प्रति हेक्टेयर), बी:सी अनुपात (3.19) एवं वर्षाजल उपयोग क्षमता (2.21 किलोग्राम प्रति हेक्टेयर-एमएम) सहित क्रमश: 87.1 एवं 72.2 प्रतिशत अधिक था।
- बंगलोर में, वर्तमान अम्ला बागीचों (3200 एम^2) में विभिन्न संरक्षण तकनीकों द्वारा वर्षाजल प्रबंधन पर किए गए अध्ययन से पता चला कि अन्य संरक्षण तकनीकियों की तुलना में ट्रेंच व क्रिसेंट बांदों ने अधिक उत्पादन (16949 किलोग्राम प्रति हेक्टेयर) एवं निवल प्रतिफल (162290/- रुपए प्रति हेक्टेयर) दिया।

बाह्य-स्थान वर्षाजल प्रबंधन :

- वारणासी में, बिना सिंचाई (1228 किलोग्राम प्रति हेक्टेयर का उत्पादन, 15540/- रुपए प्रति हेक्टेयर का निवल प्रतिफल एवं 2.03 का बी:सी अनुपात) की तुलना में मटर में पुष्पण स्तर पर सिंचित वर्षाजल से अतिरिक्त सिंचाई देने पर 1462 किलोग्राम प्रति हेक्टेयर का अधिकतम

बीज उत्पादन, 20090/- रुपए प्रति हेक्टेयर का निवल प्रतिफल एवं 2.2 का बी:सी अनुपात दिया।

- बिस्वनाथ चरिअली में, आलू पर सिंचित वर्षाजल की क्षमता पर किए गए अध्ययन में पता चला कि कृषि तालाब में सिंचित वर्षाजल से रोपण के 25, 60 एवं 80 दिनों पर तीन सिंचाइयों + 2 टन प्रति हेक्टेयर की दर से वर्माकंपोस्ट से अन्य उपचारों की तुलना में अधिक कंद उत्पादन (23.39 टन प्रति हेक्टेयर) सहित 109370/- रुपए का निवल प्रतिफल दिया।
- अकोला में, सोयाबीन को संचित वर्षाजल से अतिरिक्त सिंचाई पर किए गए अध्ययन से पता चला कि क्रांतिक स्तरों पर संचित कृषि तालाब जल से दो संरक्षण छिड़काव सिंचाइयों एवं इसके बाद एक संरक्षण सिंचाई ने सोयाबीन का अधिक बीज उत्पादन (1021 किलोग्राम प्रति हेक्टेयर) दिया। एक सिंचाई एवं बीना संरक्षण सिंचाई की तुलना में दो संरक्षण सिंचाइयों से जल उपयोग क्षमता (1.79 किलोग्राम प्रति हेक्टेयर-एमएम) एवं बी:सी अनुपात (2.20) भी अधिक हुई।
- परभनी में, सोयाबीन में जलग्रहण भंडारण-नियंत्रण (Command) संबंधों पर किए गए अध्ययन से पता चला कि शाखा विन्यास स्तर पर संचित वर्षाजल से एक संरक्षण सिंचाई ने बिना सिंचाई (586 किलोग्राम प्रति हेक्टेयर) की तुलना में 64.57 प्रति उत्पादन वृद्धि सहित अधिक बीज उत्पादन (965 किलोग्राम प्रति हेक्टेयर) दिया।

(ख) सस्ययन प्रणालियां

अंतर सस्ययन प्रणालियां

- राख धैंसर में, लोबिया के 2 पंक्तियों सहित मक्का के जोड़ी पंक्तियों से 2340 किलोग्राम प्रति हेक्टेयर का मक्का समतुल्य उत्पादन (एमईवाई), 1.26 का भूमि समतुल्य अनुपात (एलईआर) एवं 1.53 का बी:सी अनुपात सहित अधिकतम मक्का समतुल्य उत्पादन हुआ। अन्य सभी प्रणालियों की तुलना में मक्का का दो पंक्ति + लोबिया के 3 पंक्तियों से 2150 किलोग्राम प्रति हेक्टेयर का मक्का समतुल्य उत्पादन एवं 1.34 का बी:सी अनुपात प्राप्त हुआ।
- विजयपुर में, उथली काली मृदा में पुनर्वसु (06-22 जुलाई) के दौरान अकस्मिक योजना के लिए विभिन्न फसलों के मूल्यांकन में, अन्य फसलों एवं फसल प्रणालियों की तुलना में अरहर + मूंगफली (2:4) ने 77395/- रुपए प्रति हेक्टेयर का निवल आर्थिक प्रतिफली एवं 15.4 किलोग्राम प्रति हेक्टेयर-एमएम का वर्षाजल उपयोग क्षमता सहित महत्वपूर्ण रूप से अधिक बाजरा समतुल्य उत्पादन (6400 किलोग्राम प्रति हेक्टेयर) दिया। पुश्य नक्षत्र (22 जुलाई - 03 अगस्त) के दौरान, अन्य फसलों एवं फसल प्रणालियों की तुलना में बाजरा + अरहर (2:1) के अतंर सस्ययन ने 71966/- रुपए प्रति हेक्टेयर का निवल प्रतिफल एवं 16.8 किलोग्राम प्रति हेक्टेयर -एमएम का वर्षाजल उपयोग क्षमता सहित महत्वपूर्ण रूप से अधिक बाजरा समतुल्य उत्पादन (5904 किलोग्राम प्रति हेक्टेयर) दिया।
- बिस्वनाथ चरिअली में, तिल आधारित अंतर सस्ययन प्रणालियों के मूल्यांकन में, 30:20:20 किलोग्राम एनपीके प्रति हेक्टेयर प्रयोग सहित तिल + मूंग (2:2) ने अन्य अंतर सस्ययन प्रणालियों की तुलना में 1300 किलोग्राम प्रति हेक्टेयर का अधिकतम तिल समतुल्य उत्पादन, 47758/- रुपए प्रति हेक्टेयर का निवल प्रतिफल एवं 3.22 किलोग्राम प्रति हेक्टेयर-एमएम का वर्षाजल उपयोग क्षमता दर्ज किया गया।
- परभनी में, विभिन्न अंतर सस्ययन प्रणालियों पर किए गए अध्ययन से पता चला कि अन्य अंतर सस्ययन प्रणालियों की तुलना में कपास + सोयाबीन (1:1) ने अधिकतम बीज कपास समतुल्य उत्पादन (1658 किलोग्राम प्रति हेक्टेयर), निवल प्रतिफल (32644/- रुपए प्रति हेक्टेयर) एवं बी:सी अनुपात (1.97) दिया।
- बंगलोर में, निप्पड़ अरंड़ (Nipped castor) में अंतर फसलों के निष्पादन पर, किए गए अध्ययन से पता चला कि अरंड़ + रागी (1:2) ने 60377/- रुपए प्रति हेक्टेयर का अधिक निवल प्रतिफल, 3.41 का बी:सी अनुपात एवं 2.73 किलोग्राम प्रति हेक्टेयर-एमएम का वर्षाजल उपयोग क्षमता सहित महत्वपूर्ण रूप से अधिक अरंड़ समतुल्य उत्पादन (2135 किलोग्राम प्रति हेक्टेयर) दर्ज किया गया।

दोहरी सस्ययन प्रणालियां

- बिस्वनाथ चरिअलि में, दोहरी सस्ययन प्रणालियों पर आधारित मक्का के मूल्यांकन मे, मक्का-आलू प्रणाली से 123865/- रुपए प्रति हेक्टेयर निवल आर्थिक प्रतिफल सहित 10300 किलोग्राम प्रति हेक्टेयर का अधिकतम मक्का समतुल्य उत्पादन हुआ, इसके बाद अन्य सस्ययन प्रणालियों की तुलना में मक्का-राजमा प्रणाली से 9944 किलोग्राम प्रति हेक्टेयर का मक्का समतुल्य उत्पादन एवं 11922/- रुपए प्रति हेक्टेयर का निवल आर्थिक प्रतिफल प्राप्त हुआ। इसी प्रकार, विभिन्न बीज दरों सहित वर्षा आधारित मध्य निम्नभूमि परिस्थितियों के अंतर्गत खरीफ चावल से रबी दलहनों (मटर, मसूर एवं लैथिरस (Lathyrus) के निरंतर सस्ययन के मूल्यांकन में, 150 प्रतिशत सिफारिश की गई बीज दर एवं चावल की कटाई के 15 दिन पहले रिले (Relayed) की गई लैथिरस, ने अधिकतम बीज उत्पादन (425 किलोग्राम प्रति हेक्टेयर) एवं कड़बी उत्पादन (982 किलोग्राम प्रति हेक्टेयर) दिया।

(ग) पोषक प्रबंधन

स्थाई खाद जांच:

- बंगलोर में, रागी-मूंगफली सस्ययन प्रणाली में समेकित पोषक प्रबंधन ने सूचित किया कि अन्य उपचारों की तुलना में 10 टन प्रति हेक्टेयर अहाता खाद + प्राप्त एनपीके + जैव-उर्वरकों ने अधिक निवल प्रतिफल (23674/- रुपए प्रति हेक्टेयर), बी:सी अनुपात (1.82) एवं वर्षाजल उपयोग क्षमता (1.42 किलोग्राम प्रति हेक्टेयर-एमएम) सहित अधिक मूंगफली के फलियों का उत्पादन (1024 किलोग्राम प्रति हेक्टेयर) दिया। जबकि, 10 टन प्रति हेक्टेयर अहाता खाद + 100 प्रतिशत नाइट्रोजन, फासफोरस + 150 प्रतिशत पोटाश + जैव उर्वरक के अंतर्गत प्लॉटों में मृदा जैविक कार्बन (0.52%), उपलब्ध नाइट्रोजन (216 किलोग्राम प्रति हेक्टेयर), P_2O_5 (108 किलोग्राम प्रति हेक्टेयर) अधिक थे।
- अनंतपुर में, 50 प्रतिशत सिफारिश किया गया उर्वरक + 4 टन प्रति हेक्टेयर की दर से अहाता खाद के प्रयोग से अधिक मूंगफली के फलियों का औसत उत्पादन (937 किलोग्राम प्रति हेक्टेयर) दर्ज किया गया। 50 प्रतिशत सिफारिश किया गया उर्वरक + 4 टन प्रति हेक्टेयर के अंतर्गत वाले प्लॉटों में भी मृदा जैविक कार्बन अधिक (0.55 प्रतिशत) था। 100 प्रतिशत सिफारिश किया गया उर्वरक + 50 किलोग्राम प्रति हेक्टेयर की दर से $ZnSO_4$ (3 वर्ष में एक बार) के प्रयोग से अधिक मृदा उपलब्ध फासफोरस (107 किलोग्राम प्रति हेक्टेयर) एवं आभासी घनत्व (1.42 Mg/m^3) दर्ज किया गया।
- बिस्वनाथ चरिअलि में, सभी उपचारों की तुलना में अहू चावल (ahu rice) में 75 प्रतिशत सिफारिश किया गया उर्वरक (अजैविक) + 5 टन प्रति हेक्टेयर की दर से वर्मीकंपोस्ट के प्रयोग ने अधिकतम अनाज उत्पादन (1783 किलोग्राम प्रति हेक्टेयर) सहित अधिक भूसा उत्पादन (5146 किलोग्राम प्रति हेक्टेयर), वर्षाजल उपयोग क्षमता (1.79 किलोग्राम प्रति हेक्टेयर-एमएम) एवं बी:सी अनुपात (2.28) दिया। इसी प्रकार रबी के दौरान, तोरिआ में 75 प्रतिशत सिफारिश किया गया उर्वरक (अजैविक) + 5 टन प्रति हेक्टेयर की दर से वर्मीकंपोस्ट के प्रयोग से अधिक बीज उत्पादन (1163 किलोग्राम प्रति हेक्टेयर), वर्षाजल उपयोग क्षमता (20.58 किलोग्राम प्रति हेक्टेयर-एमएम), निवल प्रतिफल (21263/- रुपए प्रति हेक्टेयर) एवं बी:सी अनुपात (3.36) दर्ज किया गया।

समेकित पोषक प्रबंधन

- राख धैंसर में, उर्वरक द्वारा 100 प्रतिशत एनपीके जोकि अजैविक से 75 प्रतिशत नाइट्रोजन + वर्मीकंपोस्ट (2437 किलोग्राम प्रति हेक्टेयर) से 25 प्रतिशत नाइट्रोजन के प्रयोग से महत्वपूर्ण रूप से अधिक बाजरा अनाज उत्पादन (2586 किलोग्राम प्रति हेक्टेयर) दिया। उर्वरकों द्वारा 100 प्रतिशत एनपीके के प्रयोग से क्रमश: 2.92, 29492/-रुपए प्रति हेक्टेयर एवं 3.92 का अधिकतम बी:सी अनुपात, निवल प्रतिफल एवं वर्षाजल उपयोग क्षमता प्राप्त हुआ।
- अकोला में, अन्य उपचारों की तुलना में ग्लेरिसिडिया + अजैविक माध्यम से 50 प्रतिशत नाइट्रोजन + जैव उर्वरक + 25 किलोग्राम पोटाश प्रति हेक्टेयर द्वारा 50 प्रतिशत नाइट्रोजन के प्रयोग से सोयाबीन का महत्वपूर्ण रूप से अधिकतम बीज उत्पादन (542.5 किलोग्राम प्रति हेक्टेयर) दर्ज किया गया। हरे पत्तों का खाद + अजैविक माध्यम से 50 प्रतिशत नाइट्रोजन + जैव उर्वरक + 25 किलोग्राम पोटाश प्रति हेक्टेयर द्वारा 50 प्रतिशत नाइट्रोजन के प्रयोग से 20083/- रुपए का अधिकतम निवल प्रतिफल प्राप्त हुआ। अन्य उपचारों की तुलना में ग्लेरिसिडिया + अजैविक माध्यम से 50 प्रतिशत नाइट्रोजन + जैव उर्वरक + 25 किलोग्राम पोटाश प्रति हेक्टेयर द्वारा 50 प्रतिशत नाइट्रोजन के प्रयोग से अधिकतम एसवाईआई (0.33) देखा गया।
- आग्रा में, बाजरा में समेकित पोषक प्रबंधन पर किए गए अध्ययन में, अहाता खाद द्वारा 50 प्रतिशत सिफारिश किया गया नाइट्रोजन + अजैविक उर्वरकों के माध्यम से 50 प्रतिशत नाइट्रोजन के प्रयोग से अन्य उपचारों की तुलना में 3103 किलोग्राम प्रति हेक्टेयर का अधिकतम अनाज उत्पादन, 27337/- रुपए प्रति हेक्टेयर, 2.48 का बी:सी अनुपात एवं 13.41 किलोग्राम प्रति हेक्टेयर-एमएम का वर्षाजल उपयोग क्षमता दर्ज किया गया।
- बंगलोर में, रागी-मूंगफली सस्ययन प्रणाली में समेकित पोषक प्रबंधन पर किए गए प्रयोग से पता चला कि 10 टन प्रति हेक्टेयर का अहाता खाद + सिफारिश किए गए एनपीके + जैव उर्वरकों के प्रयोग ने निवल प्रतिफल (23674/- रुपए प्रति हेक्टेयर), बी:सी अनुपात (1.82) एवं वर्षाजल उपयोग क्षमता (1.42 किलोग्राम प्रति हेक्टेयर-एमएम) सहित अधिक मूंगफली का फली उत्पादन (1024 किलोग्राम प्रति हेक्टेयर) दिया। इसके बाद सिफारिश किए गए एनपीके (701 किलोग्राम प्रति हेक्टेयर) की तुलना में बहि-स्थाने हरा खाद (7.5 टन प्रति हेक्टेयर) + 75 प्रतिशत नाइट्रोजन एवं फासफोरस + 100 प्रतिशत पोटाश + जैव उर्वरक (995 किलोग्राम प्रति हेक्टेयर) का स्थान रहा। अन्य उपचारों की तुलना में 10 टन प्रति हेक्टेयर का अहाता खाद + सिफारिश किया गया एनपीके + जैव उर्वरकों के प्रयोग ने अधिक पलाल उत्पादन दिया।

पर्ण छिड़काव

- अरजिया में, टस्सलिंग (Tasseling) एवं अनाज भराव स्तर से पहले 0.5 प्रतिशत की दर से $ZnSO_4$ + 2 प्रतिशत की दर से एनपीके (घुलनशील) के छिड़काव ने अन्य उपचारों की तुलना में महत्वपूर्ण रूप से अधिक

मक्का अनाज उत्पादन (2510 किलोग्राम प्रति हेक्टेयर), निवल प्रतिफल (30507/- रुपए प्रति हेक्टेयर) एवं बी:सी अनुपात (2.85) दिया।

- विजयपुर में, रबी ज्वार के लिए पोषकों के पर्ण छिड़काव पर किए गए अध्ययन में, बोवाई के 45 एवं 75 दिनों के बाद सिफारिश किए गए उर्वरकों का प्रयोग + KNO_3 (1 प्रतिशत छिड़काव) छिड़काव ने 1821 किलोग्राम प्रति हेक्टेयर का अधिकतम अनाज उत्पादन दिया, जबकि नियंत्रण से 611 किलोग्राम प्रति हेक्टेयर का न्यूनतम उत्पादन प्राप्त हुआ। जबकि, बोवाई के 45 दिनों के बाद 250 ग्राम प्रति हेक्टेयर की दर से थियोरिआ (Thiourea) छिड़काव से अधिक कड़बी (Stover) का उत्पादन प्राप्त हुआ।
- कोविलपट्टी में, वर्टीसोलों में कपास में पर्ण पोषकों पर किए गए प्रयोग में, सिफारिश किए गए उर्वरक (60:30:30 किलोग्राम एनपीके प्रति हेक्टेयर) + वर्ग निर्माण (Square formation) एवं पुष्पण स्तर पर 1.25 प्रतिशत कॉटन प्लस का पर्ण छिड़काव ने अन्य उपचारों की तुलना में बेहतर निवल प्रतिफल (28237/- रुपए प्रति हेक्टेयर), बी:सी अनुपात (1.88) एवं वर्षाजल उपयोग क्षमता (5.72 किलोग्राम प्रति हेक्टेयर-एमएम) सहित महत्वपूर्ण रूप से अधिक बीज कपास उत्पादन (1723 किलोग्राम प्रति हेक्टेयर) दिया।
- परभनी में, उर्वरक प्रबंधन एवं पर्ण छिड़काव पर किए गए अध्ययन में, सिफारिश किए गए उर्वरक (120:60:60 किलोग्राम एनपीके प्रति हेक्टेयर) + 1 एवं 2 प्रतिशत की दर से KNO_3 का पर्ण छिड़काव (बोवाई के 35 एवं 65 दिनों के बाद) ने अन्य उपचारों की तुलना में अधिकतम बीज कपास उत्पादन (1237 किलोग्राम प्रति हेक्टेयर), निवल प्रतिफल (12705/- रुपए प्रति हेक्टेयर), बी:सी अनुपात (1.33) एवं वर्षाजल उपयोग क्षमता (4.38 किलोग्राम प्रति हेक्टेयर-एमएम) दिया।
- एस के नगर में, मक्का पर पोषकों के पर्ण प्रयोग के प्रभावों पर किए गए अध्ययन में, 0.5 प्रतिशत की दर से $ZnSO_4$ + 0.5 प्रतिशत की दर से $FeSO_4$ के छिड़काव ने अन्य उपचारों की तुलना में अधिक निवल प्रतिफल (18626/- रुपए प्रति हेक्टेयर), बी:सी अनुपात (3.44) एवं वर्षाजल उपयोग क्षमता (2.07 किलोग्राम प्रति हेक्टेयर-एमएम) सहित अनाज एवं डंटल उत्पादन (क्रमश: 1394 एवं 3815 किलोग्राम प्रति हेक्टेयर) दिया।

(घ) ऊर्जा उत्पादन

- इंदौर में, सोयाबीन में संसाधन संरक्षण पर कर्षण के प्रभाव पर किए गए प्रयोग में, कम कर्षण + 4 टन प्रति हेक्टेयर का भूसी + हांथ से की गई निकौनी के परिणामस्वरूप अन्य उपचारों की तुलना में निवल आर्थिक प्रतिफल (27364/- रुपए प्रति हेक्टेयर), बी:सी अनुपात (2.89) एवं वर्षाजल उपयोग क्षमता (1.67 किलोग्राम प्रति हेक्टेयर-एमएम) सहित अधिकतम अनाज उत्पादन (1408 किलोग्राम प्रति हेक्टेयर) दिया।
- बिस्वनाथ चरिअलि में, मूंगफली में कर्षण एवं पोषक प्रबंधन पर किए गए जांचों में, दो बार हैरा चलाना + पावर टिल्लर से एक संक्षोदन (Pulverization) ने मूंगफली का अधिकतम फली उत्पादन (2863 किलोग्राम प्रति हेक्टेयर) एवं बी:सी अनुपात (2.24) दिया, इसके बाद कम कर्षण + रोटावेटर से अन्य उपचारों की तुलना में अधिक 2164 किलोग्राम प्रति हेक्टेयर का फली उत्पादन एवं 1.69 का बी:सी अनुपात दिया। पारंपरिक कर्षण (तीन से चार बार की जुताई के बाद लेडरिंग) द्वारा अधिकतम क्षेत्र क्षमता (28.50 घंटे प्रति हेक्टेयर) दर्ज की गई एवं न्यूनतम कर्षण(एक हैरो) से अधिकतम ऊर्जा उपयोग क्षमता (2.5) दर्ज किया गया।
- आग्रा में, बाजरा पर कर्षण एवं बोवाई उपकरणों के प्रभाव पर किए गए अध्ययन में, अन्य उपकरणों की तुलना में एमबी हल 2829 किलोग्राम प्रति हेक्टेयर का अधिकतम अनाज उत्पादन, 22391/- रुपए प्रति हेक्टेयर का निवल प्रतिफल, 2.20 का बी:सी अनुपात एवं 12.51 किलोग्राम प्रति हेक्टेयर-एमएम का वर्षाजल उपयोग क्षमता सहित बेहतर सिद्ध हुआ। विभिन्न बोवाई उपकरणों में, रेस्ड बेड प्लांटर एवं रिडजर सीडर ने समान लकिन अन्य उपकरणों की तुलना में महत्वपूर्ण रूप से अधिक उत्पादन (2783-2862 किलोग्राम प्रति हेक्टेयर) दिया। एमबी हल से 13.13 एवं 0258 किलोग्राम प्रति एमजे की अधिकतम ऊर्जा उपयोग क्षमता एवं ऊर्जा उत्पादकता प्राप्त की गई, इसके बाद डिस्क हल (12.66 एवं 0.256 किलोग्राम प्रति एमजे) द्वारा प्राप्त हुआ।
- एस के नगर में, ग्वार में विभिन्न कर्षण प्रक्रियाओं पर किए गए अध्ययन में, रोटो टिल ड्रिल उपचार से अधिक निवल प्रतिफल (15534/- रुपए प्रति हेक्टेयर), बी:सी अनुपात (4.09) एवं वर्षाजल उपयोग क्षमता (0.75 किलोग्राम प्रति हेक्टेयर-एमएम) सहित ग्वार का अधिकतम बीज उत्पादन (468 किलोग्राम प्रति हेक्टेयर) दर्ज किया गया। यह स्ट्रिप टिल ड्रिल (420.6 किलोग्राम प्रति हेक्टेयर) एवं रेस्ड बेड प्लांटर (406.9 किलोग्राम प्रति हेक्टेयर) के समान था लेकिन जीरो टिल ड्रिल (381.3 किलोग्राम प्रति हेक्टेयर) एवं नियंत्रण से महत्वपूर्ण रूप से बेहतर था।

(ङ) उन्नत किस्मों का मूल्यांकन

- चयनकी के ज्वार किस्म जांच में, 20 प्रविष्टियों में, सीएसएच-14 ने 2818 किलोग्राम प्रति हेक्टेयर का अनाज उत्पादन एवं 7.0 किलोग्राम प्रति हेक्टेयर-एमएम के वर्षाजल उपयोग क्षमता सहित अच्छा निष्पादन दिया जबकि सीएसवी-20 (किस्म) ने 2237 किलोग्राम प्रति हेक्टेयर का अनाज उत्पादन एवं 5.5 किलोग्राम प्रति

हेक्टेयर-एमएम के वर्षाजल उपयोग क्षमता दर्ज किया।

- बल्लोवाल सांकुरी में, दोहरे उपयोग के लिए जांचे गए, लोबिया के पांच किस्मों में, यूपीसी 9202 द्वारा अधिकतम बीज (1313 किलोग्राम प्रति हेक्टेयर) साथ ही साथ चार उत्पादन (301 क्विंटल प्रति हेक्टेयर) दर्ज किया गया। इसके बाद बीज के लिए सीएल 367 एवं चारा के लिए आईटी 38956-1 का स्थान था। यूपीसी-9202 से 2.87 के बी:सी अनुपात सहित 41062/- रुपए का अधिकतम निवल प्रतिफल प्राप्त हुआ।
- बिस्वनाथ चरिअलि में, मध्यम अवधि के अधिक उत्पादन देने वाले चावल के किस्मों के मूल्यांकन ने सूचित किया कि मूल्यंकित किए गए 13 किस्मों में टीटीबी-404 किस्म, 4225 किलोग्राम प्रति हेक्टेयर का अनाज उत्पादन, 50704/- रुपए का निवल प्रतिफल, 5.48 का बी:सी अनुपात एवं 3.24 किलोग्राम प्रति हेक्टेयर का-एमएम का वर्षाजल उपयोग क्षमता सहित बेहतर पाया गया।
- राजकोट के मूंगफली किस्म जांचों में, जेएसपी-51 जीनरूप ने अधिकतम फली उत्पादन (1250 किलोग्राम प्रति हेक्टेयर) एवं निवल प्रतिफल (32216/- रुपए प्रति हेक्टेयर) दिया जबकि सोमनाथ (सी) जीनरूप से अधिक पलाल उत्पादन (5608 किलोग्राम प्रति हेक्टेयर) दर्ज किया गया इसके बाद अन्य जीनरूपों की तुलना में जेएसपी-55 (5139 किलोग्राम प्रति हेक्टेयर) एवं जेएसपी-58 (5104 किलोग्राम प्रति हेक्टेयर) का स्थान था।

(च) वैकल्पिक भूमि उपयोग प्रणालियां

- राख धैंसर में, विभिन्न कृषि-बागवानी-चारा प्रणालियों पर किए गए अध्ययनों से पता चला कि खरीफ के दौरान वन-कृषि-चारा प्रणाली के अंतर्गत ल्यूकेना पेड़ों के वीथियों (Alleys) में उगाए गया मिश्रित चारा, सभी अन्य प्रणालियों की तुलना में अधिक लाभदायक प्रणाली पाई गई, जिसमें 2.58 के बी:सी अनुपात सहित 21580/- रुपए प्रति हेक्टेयर का अधिकतम निवल प्रतिफल पाया गया। जबकि, विभिन्न प्रणालियों के अंतर्गत चारा उपचारों के मामले में, कृषि चारागाह, वन-कृषि-चारागाह एवं कृषि-बागवानी-चारागाह के अंतर्गत ल्यूकेना एवं ओनला पेड़ों के वीथियों में क्रमश: 31418, 27828 एवं 25951 किलोग्राम प्रति हेक्टेयर का शुद्ध मिश्रित चारा का उत्पादन दर्ज किया गया।
- सोलापुर में, नीम + अकेसिआ निलोटिका + सेंचोरस सिलिआरिस + स्टाइलो प्रणाली ने अधिकतम निवल प्रतिफल (173996/- रुपए प्रति हेक्टेयर) एवं बी:सी अनुपात (9.65) सहित अत्यधिक नीम की ऊंचाई (355 सेंटीमीटर), लकड़ी का उत्पादन (85.54 घन फीट प्रति हेक्टेयर), अकेसिआ निलोटिका का उत्पादन (184.64 घन फीट प्रति हेक्टेयर), स्टाइलो घास का उत्पादन (6.37 टन प्रति हेक्टेयर) दर्ज किया। इसके बाद का श्रेष्ठ उपचार नीम+बाकन(लिमबारा) + सेंचोरस सिलिआरिस + स्टाइलो था जिसने अधिकतम निवल प्रतिफल (118904/- रुपए प्रति हेक्टेयर) एवं बी:सी अनुपात (6.91) सहित अत्यधिक नीम की लकड़ी का उत्पादन(54.10 घन फीट प्रति हेक्टेयर), अंतर फसल पेड़ प्रजातियों का लकड़ी का उत्पादन (138.40 घन फीट प्रति हेक्टेयर), स्टाइलो घास का उत्पादन (5.38 टन प्रति हेक्टेयर) दर्ज किया गया।
- परभनी में, चौब आधारित कृषि-बागवानी प्रणाली में, चौब में अंतर फसलों का उत्पादन मूंग(1361 किलोग्राम प्रति हेक्टेयर), उड़द (1349 किलोग्राम प्रति हेक्टेयर), सोयाबीन(1430 किलोग्राम प्रति हेक्टेयर) एवं सनई (1421 किलोग्राम प्रति हेक्टेयर) था। अकेले चौब (3 मीटर x 3 मीटर) ने 1837 किलोग्राम प्रति हेक्टेयर का बेहतर उत्पादन दर्ज किया । इसके बाद चौब+सोयाबीन (1:6) (1430 किलोग्राम प्रति हेक्टेयर) का था।

(छ) समेकित कृषि प्रणाली

- बिस्वनाथ चरिअलि में, वास भूमि (Homestead) कृषि के अंतर्गत विभिन्न अवयवों के आर्थिक विश्लेषणों ने स्प्ष्ट किया कि रोपण फसलों में नारियल ने 57800/- रुपए अधिकतम निवल प्रतिफल एवं 5.0 का बी:सी अनुपात दिया। जबकि पशुधन अवयवों में, मत्स्यकी ने 2200245/- रुपए का अधिकतम निवल प्रतिफल एवं 5.0 का बी:सी अनुपात दिया । पशुओं के स्थानी नस्लों के मामले में 1.2 का न्यूनतम बी:सी अनुपात पाया गया।
- राजकोट में समेकित कृषि प्रणाली पर किए गए प्रयोग में, कपास कृषि किसानों की प्रक्रिया की तुलना में समेकित कृषि प्रणाली (कपास, अरहर, ज्वार, मक्का एवं लोबिया शामिल) से 112272/-रुपए प्रति हेक्टेयर का अत्यधिक निवल प्रतिफल दर्ज किया गया। कपास कृषि की किसानों की प्रक्रिया के अंतर्गत 165 श्रम दिन प्रति हेक्टेयर प्रति वर्ष की तुलना में आईएफएस मॉडल के अंतर्गत रोज़गार निर्माण 365 श्रम दिन प्रति हेक्टेयर प्रति वर्ष था।
- जगदलपुर में बंडेड मध्यभूमि (मल) एवं निम्नभूमि (गबहर) परिस्थितियों के लिए समेकित कृषि प्रणाली पर किए गए अध्ययन में पता चला कि मध्यभूमि में 2250 घन मीटर क्षेत्र वाले तालाब में मत्स्य पालन से 12673/- रुपए की अतिरिक्त आय प्राप्त हुई। जबकि निम्नभूमि में 1650 घन मीटर क्षेत्र वाले तालाब से 9534/-रुपए प्राप्त हुए।
- वारणासी में, समेकित पशु आधारित प्रणालियों (चावल + दो भैंस + मत्स्य) ने 7300 किलोग्राम प्रति हेक्टेयर का चावल समतुल्य उत्पादन सहित अधिकतम निवल प्रतिफल (65850/- रुपए प्रति हेक्टेयर) एवं बी:सी अनुपात(1.65) दिया जबकि कृषि-बागवानी प्रणाली

(ओनला + मूंग) ने 3560 किलोग्राम प्रति हेक्टेयर का चावल समतुल्य उत्पादन सहित 59000/- रुपए प्रति हेक्टेयर का निवल प्रतिफल एवं 4.7 का बी:सी अनुपात दर्ज किया।

- कोविलपट्टी में, ज्वार + लोबिया (0.4 हेक्टेयर) + मक्का + मूंग (0.1), कपास + उड़द (0.6 हेक्टेयर) + ग्वार (0.1 हेक्टेयर) + चारा फसल (0.4 हेक्टेयर) + बकरी इकाई (10+1) एवं एक दुधारू पशु, शामिल समेकित कृषि प्रणाली पर किए गए अध्ययन में पता चला कि समेकित कृषि प्रणाल में औसत प्रणाली उत्पादकता एवं औसत प्रणाली आय क्रमश: 12870 किलोग्राम प्रति हेक्टेयर एवं 116098/- रुपए प्रति हेक्टेयर थे, जबकि पारंपरिक प्रणाली में यह मूल्य 1071 एवं 1045 किलोग्राम प्रति हेक्टेयर थे। औसत रोज़गार निर्माण केवल सस्ययन से एवं समेकित कृषि प्रणाली से क्रमश: 174 एवं 410 श्रम दिवस प्रति वर्ष थे।

चालू अनुसंधान परियोजना (ओ आर पी)

क. वर्षाजल प्रबंधन

- अरजिया में, मक्का + उड़द एवं मूंगफली + तिल में अतिरिक्त/प्राण रक्षा सिंचाई का फार्म पर प्रदर्शन में नियंत्रण (780 किलोग्राम प्रति हेक्टेयर) की तुलना में मक्का + उड़द (2:2) अंतर सस्ययन प्रणाली में संरक्षण सिंचाई ने बेहतर मक्का समतुल्य उत्पादन (1450 किलोग्राम प्रति हेक्टेयर) दिया। नियंत्रण (660 किलोग्राम प्रति हेक्टेयर) की तुलना में मूंगफली + तिल (6:2) अंतर सस्ययन प्रणाली में भी बेहतर मूंगफली का फली समतुल्य उत्पादन (1150 किलोग्राम प्रति हेक्टेयर) दिया। मक्का + उड़द (2:2) अंतर सस्ययन प्रणाली की तुलना में मूंगफली + तिल (6:2) अंतर सस्ययन प्रणाली ने बेहतर निवल प्रतिफल (28708/- रुपए प्रति हेक्टेयर) एवं बी:सी अनुपात (3.13) दिया।
- सोलापुर में, रबी ज्वार के उत्पादन पर स्व-स्थाने नमी संरक्षण उपायों के मूल्यांकन में पता चला कि मेढ़ों एवं कूंड़ों के निर्माण ने किसानों की प्रक्रिया (863 किलोग्राम प्रति हेक्टेयर) की तुलना में 1040 किलोग्राम प्रति हेक्टेयर का अनाज उत्पादन, 2660 किलोग्राम प्रति हेक्टेयर का कड़बी उत्पादन एवं 1.98 का बी:सी अनुपात दिया।

ख. सस्ययन प्रणालियां

- अरजिया में, ज्वार + मूंग (2:1) अंतर सस्ययन प्रणाली की उपयुक्ता के बारे में प्रक्षेत्र पर मूल्यांकन में, ज्वार + मूंग (2:1) अंतर सस्ययन से अधिकतम ज्वार का अनाज उत्पादन (1367 किलोग्राम प्रति हेक्टेयर) एवं मूंग (65 किलोग्राम प्रति हेक्टेयर), 18485/- रुपए प्रति हेक्टेयर का निवल प्रतिफल एवं 2.53 का बी:सी अनुपात प्राप्त हुआ। यह ज्वार एवं मूंग के मिश्रित सस्ययन की तुलना में प्राप्त 1183 किलोग्राम प्रति हेक्टेयर का ज्वार उत्पादन, 48 किलोग्राम प्रति हेक्टेयर का मूंग उत्पादन, 13870/- रुपए प्रति हेक्टेयर का निवल प्रतिफल एवं 2.18 का बी:सी अनुपात से अधिक था।
- हिसार में, पट्टीदार (Strip) सस्ययन प्रणालियों पर किए गए प्रदर्शन में, एकल बाजरा (940 किलोग्राम प्रति हेक्टेयर) की तुलना में बाजरा + मूंगबीन (8:4) अंतर सस्ययन प्रणाली से बेहतर बाजरा समतुल्य उत्पाद (2412 किलोग्राम प्रति हेक्टेयर) दर्ज किया गया। मूंगबीन के पट्टीदार सस्ययन ने बाजरा के उत्पादन क्षमता को 18.7 प्रतिशत तक कम कर दिया जबकि एकल बाजरा की तुलना में बाजरा समतुल्य उत्पादन 25.6 प्रतिशत अधिक था।
- सोलापुर में, दोहरे सस्ययन प्रणालियों पर किए गए प्रदर्शनों में, 1290 किलोग्राम प्रति हेक्टेयर का अनाज एवं 3190 किलोग्राम प्रति हेक्टेयर का रबी ज्वार का कड़बी उत्पादन से 2.30 का बी:सी अनुपात सहित बेहतर पाया गया। खरीफ उथली रबी ज्वार अनुक्रम के अंतर्गत रबी मौसम में 1020 किलोग्राम प्रति हेक्टेयर का अनाज एवं 2633 किलोग्राम प्रति हेक्टेयर का रबी ज्वार का कड़बी उत्पादन से 2.15 का न्यूनतम बी:सी अनुपात प्राप्त हुआ।

ग. पोषक प्रबंधन

पोषक प्रबंधन

- अरजिया में, स्थान विशेष पोषक प्रबंधन पर आधारित उर्वरक मात्रा ने किसानों की प्रक्रिया (1030 किलोग्राम प्रति हेक्टेयर) की तुलना में अधिकतम ज्वार उत्पादन (1513 किलोग्राम प्रति हेक्टेयर), निवल प्रतिफल (14948/- रुपए प्रति हेक्टेयर) एवं बी:सी अनुपात (2.25) दिया। नाइट्रोजन एवं फासफोरस की सिफारिश की गई मात्रा (1273 किलोग्राम प्रति हेक्टेयर के उत्पादन से 10898/- रुपए प्रति हेक्टेयर का निवल प्रतिफल, 1.92 का बी:सी अनुपात) ने इसका अनुकरण किया।
- बल्लोवाल सांकुरी में, मक्का में पोषक प्रबंधन का प्रक्षेत्र पर मूल्यांकन में, 75 प्रतिशत अजैविक + जैविक माध्यम द्वारा नाइट्रोजन के प्रयोग से 3601 किलोग्राम प्रति हैकटेयर का अधिकतम मक्का अनाज उत्पादन दर्ज किया गया। जो क्रमश: 50 प्रतिशत अजैविक + 50 प्रतिशत जैविक (3508 किलोग्राम प्रति हेक्टेयर), एवं 100 प्रतिशत अजैविक + 100 प्रतिशत जैविक (3261 किलोग्राम प्रति हेक्टेयर) के संयोग द्वारा नाइट्रोजन के प्रयोग की तुलना में 3, 8 एवं 10 प्रतिशत अधिक था एवं जिससे 27792/- रुपए प्रति हेक्टेयर का निवल प्रतिफल एवं 1.91 का बी:सी अनुपात प्राप्त हुआ।
- बंगलोर में, रागी + अरहर प्रणाली में पोषक प्रबंधन के मूल्यांकन में, जैविक माध्यम द्वारा 50 प्रतिशत नाइट्रोजन + अजैविक माध्यम द्वारा 50 प्रतिशत नाइट्रोजन एवं

100 प्रतिशत फासफोरस एवं पोटाश + 12.5 किलोग्राम का $ZnSO_4$ + 10 किलोग्राम का बोरक्स के प्रयोग से बेहतर वर्षाजल उपयोग क्षमता (5.79 किलोग्राम प्रति हेक्टेयर-एमएम), निवल प्रतिफल (38068/- रुपए प्रति हेक्टेयर) एवं बी:सी अनुपात (2.49) सहित अधिकतम रागी अनाज समतुल्य उत्पादन (2446 किलोग्राम प्रति हेक्टेयर) दर्ज किया गया। इसके बाद रागी + अक्काड़ी (क्रमश: 1280 किलोग्राम प्रति हेक्टेयर, 3.21 किलोग्राम प्रति हेक्टेयर-एमएम,10228/- रुपए प्रति हेक्टेयर एवं 1.67) के किसानों की प्रक्रिया की तुलना में सिफारिश की गई उर्वरकों का स्थान था।

पर्ण छिड़काव

- अनंतपुर में, कपास के पुष्पण एवं पुष्पण के 20 दिनों के बाद, 2 प्रतिशत $ZnSO_4$; 1 प्रतिशत $MgSO_4$; 0.15 प्रतिशत बोरॉन एवं 1 प्रतिशत 19:19:19 के पर्ण छिड़काव ने पत्तों में होने वाले लाल रंग के रोग को 51 प्रतिशत कम किया एवं इसके परिणामस्वरूप 11 प्रतिशत तक उत्पादन में सुधार हुआ। सूक्ष्म पोषक छिड़काव ने अधिकतम बीज कपास उत्पादन (908 किलोग्राम प्रति हेक्टेयर), निवल प्रतिफल (7605/- रुपए प्रति हेक्टेयर), वर्षाजल उपयोग क्षमता (2.49 किलोग्राम प्रति हेक्टेयर-एमएम) एवं 1.7 का बी:सी अनुपात दिया।
- सोलापुर में, बोवाई के 30 एवं 45 दिनों के बाद 1 प्रतिशत पोटाशियम के प्रयोग ने किसानों की प्रक्रिया (550 किलोग्राम प्रति हेक्टेयर) की तुलना में 14300/- रुपए प्रति हेक्टेयर का निवल प्रतिफल एवं 2.05 का बी:सी अनुपात सहित 760 किलोग्राम प्रति हेक्टेयर का बेहतर चना (किस्म विजय) दिया।

घ. ऊर्जा प्रबंधन

- अनुतपुर में, मूंगफली की बोवाई के लिए अनंता अक्वा प्लांटर के मूल्यांकन में, अनंता अक्वा प्लांटर ने किसानों की प्रक्रिया की तुलना में 1.12 का बी:सी अनुपात एवं 2.2 किलोग्राम प्रति हेक्टेयर-एमएम सहित अधिकतम फली एवं पलाल उत्पादन (451 एवं 1201 किलोग्राम प्रति हेक्टेयर) दिया।
- बल्लोवाल सांकुरी में, बोवाई से तुरंत पहले रोटावेटर से एक जुताई एवं कल्टीवेटर से एक जुताई ने 3165 किलोग्राम प्रति हेक्टेयर का गेहूं का अनाज उत्पादन दिया जो कल्टीवेटर से तीन जुताई (खरीफ फसल की कटाई के तुरंत बाद 2 आड़ा जुताई एवं 1 बोवाई से पहले) की तुलना में 19 प्रतिशत अधिक था।
- सोलापुर में, टू बाउल फर्टी-सीड ड्रिल ने चार वर्ष (2011 से 2014) में 2.40 का बी:सी अनुपात सहित अधिकतम ज्वार अनाज उत्पादन (910 किलोग्राम प्रति हेक्टेयर) एवं कड़बी उत्पादन (2260 किलोग्राम प्रति हेक्टेयर) सहित श्रेष्ठ पाया गया।

ड. उन्नत किस्मों का मूल्यांकन

- अनंतपुर में, चार स्थानों पर मूल्यांकित किए गए चार उन्नत मूंगफली के किस्मों में, स्थानी किस्म (365 किलोग्राम प्रति हेक्टेयर) की तुलना में के-9 (501 किलोग्राम प्रति हेक्टेयर) श्रेष्ठ पाया गया इसके बाद धरणी (499 किलोग्राम प्रति हेक्टेयर) एवं के-6 (491 किलोग्राम प्रति हेक्टेयर) का स्थान था।
- बल्लोवाल सांकुरी में, मक्का किस्मों के मूल्यांकन में, पीएमएच 1 संकर ने 4008 किलोग्राम प्रति हेक्टेयर का अधिकतम अनाज उत्पादन, 42701/- रुपए प्रति हेक्टेयर का निवल प्रतिफल एवं 2.38 का बी:सी अनुपात दिया । इसके बाद 3844 किलोग्राम प्रति हेक्टेयर का अनाज उत्पादन, 40392/- रुपए प्रति हेक्टेयर का निवल प्रतिफल एवं 2.31 का बी:सी अनुपात सहित पीएमएच 2 का स्थान था।
- हिसार में, उन्नत ग्वार किस्मों के प्रक्षेत्र प्रदर्शन में, एचजी 365 (524 किलोग्राम प्रति हेक्टेयर) 8553/- रुपए प्रति हेक्टेयर का निवल प्रतिफल एवं 1.47 का बी:सी अनुपात की तुलना में एचजी 563 ने थोड़ा अधिक अनाज उत्पादन (550 किलोग्राम प्रति हेक्टेयर), निवल प्रतिफल (9886/- रुपए प्रति हेक्टेयर) एवं बी:सी अनुपात (1.54) दर्ज किया।

च. समेकित कृषि प्रणाली

- अनंतपुर में, मूंगफली की कृषि एवं भेड़ (5) पालन युक्त समेकित कृषि प्रणाली का प्रक्षेत्र मूल्यांकन में, केवल मूंगफली (16135 किलोग्राम प्रति हेक्टेयर) की कृषि की तुलना में समेकित कृषि प्रणाली मॉड्ल ने उत्पादकता 32320 किलोग्राम प्रति हेक्टेयर) प्रणाली को बेहतर बनाया।

राष्ट्रीय जलवायु समुत्थान कृषि नवप्रवर्तन

वर्ष 2011 से भारतीय चारागाह एवं चारा अनुसंधान संस्थान, झांसी में शामिल 23 अखिल भारतीय समन्वित बारानी कृषि अनुसंधान परियोजना केंद्रों पर निक्रा का प्रौद्योगिकी प्रदर्शन अवयव (टीडीसी), केंद्र एवं प्रक्षेत्र दोनों पर कार्यान्वित किया जा रहा है। 2014-15 के दौरान, वर्षाजल संग्रहण (स्व-स्थाने एवं बहि-स्थाने) एवं प्रभावी उपयोग, सूखा सहीष्णु फसल प्रणालियां, समुत्थान फसल प्रबंधन प्रक्रियाएं एवं बेहतर ऊर्जा प्रबंधन जैसे हस्तक्षेपों द्वारा मौसम प्रतिकूलताओं से जूझने के लिए सही समय की आकस्मिक फसल योजना का कार्यान्वयन एवं तैयारी पर जोर दिया गया। 15 विभिन्न राज्यों के 24 जिलों के 33 गांवों में फैले 898 हेक्टेयर के 3611 किसानों के खेतों में जोखिम समुत्थान हस्तक्षेपों को प्रदर्शित किया गया। मौसम में देरी के दौरान सही समय की आकस्मिक उपायों (लघु अवधि के किस्मों आदि का प्रस्तुती) एवं मौसमी सूखा से जूझने के उपायों (संग्रहित वर्षाजल से अतिरिक्त सिंचाई, पर्ण छिड़काव युक्त फसल/मृदा प्रबंधन प्रक्रियाएं) के प्रदर्शन प्रभाव

से उत्पादन में 22 प्रतिशत एवं वर्षाजल उपयोग क्षमता में 5 किलोग्राम प्रति हेक्टेयर-एमएम तक की वृद्धि हुई।

जनजाति उप-योजना (टी.एस.पी.)

वर्ष 2011 से राजस्थान, झारखंड, मध्य प्रदेश, उड़ीशा, असम, छत्तीसगढ़ एवं गुजरात में शामिल 8 जिलों के 22 गांवों में एक्रीप-बारानी कृषि (एक्रीपडा) के 7 नेटवर्क केंद्रों द्वारा जनजाति उप-योजना कार्यक्रम का कार्यान्वयन किया जा रहा है। वर्षाजल प्रबंधन के विषय में उन्नत वर्षा आधारित प्रौद्योगिकियां, सूखा सहीष्णुता, उन्नत प्रबंधन प्रक्रियाएं, सस्यन प्रणालियां, पर्ण छिड़काव युक्त समेकित पोषक प्रबंधन प्रक्रियाएं, अत्याधुनिक यंत्रों से युक्त कृषि यांत्रिकीकरण एवं जनजाति पुरूष एवं महिला दोनों के लिए सबसे प्रमुख आवश्यकता आधारित प्रशिक्षण एवं क्षमता निर्माण कार्यक्रम पर टी.एस.पी. के गांवों में प्रमुख हस्तक्षेपों पर जोर दिया जा रहा है। गांव में निर्माण किए गए भौतिक संपदाओं में वर्षाजल संग्रहण संरचनाएं, बेहतर उपकरण, बेहतर नस्ल आदि शामिल हैं। वर्षा आधारित फसल की उत्पादकता में 20 प्रतिशत तक की वृद्धि, लाभ में 25 प्रतिशत तक की वृद्धि एवं डेरी, सुअर पालन, कुक्कट पालन, मशरूम की खेती, वर्मीकंपोस्ट की इकाइयां आदि जैसे जीविकोपार्जन हस्तक्षेपों द्वारा लाभार्थियों के जीविकोपार्जन को सुधारा गया।

मॉनीटरी एवं मूल्यांकन

इस अवधि के दौरान सभी अखिल भारतीय समन्वित बारानी कृषि अनुसंधान परियोजना (एक्रीपडा) केंद्रों का तकनीकी, भौतिक एवं आर्थिक लक्ष्यों की मॉनीटरी एवं मूल्यांकन किया गया। परियोजना समन्वयन एकक से डॉ. सीएच. श्रीनिवास राव परियोजना समन्वयक (एक्रीपडा), डॉ. जी. रविन्द्रा चारी, प्रभारी परियोजना समन्वयक (एक्रीपडा) एवं डॉ. के.ए. गोपीनाथ, वरिष्ठ वैज्ञानिक (सस्यविज्ञान) ने एक्रीपडा के केंद्रों का दौरा कर 2014-15 में जारी तकनीकी कार्यक्रमों, आधारिक सुविधाओं, प्रशासन एवं बजट संबंधी पहलुओं का मूल्यांकन किया। दौरों के दौरान ही परियोजना समन्वयक, एक्रीपडा या निदेशक क्रीडा या राज्य कृषि विश्वविद्यालयों के अधिकारियों द्वारा सुधार/कोई आवश्यक कार्रवाई के लिए हरेक दौरे की कार्यवाही निकाली गई। दिनांक 9-10 मई, 2014 के दौरान एनएएससी, नई दिल्ली में एक्रीपडा-क्रीडा एवं राष्ट्रीय कृषि विज्ञान अकादमी (एनएएएस) - हैदराबाद शाखा द्वारा संयुक्त रूप से दो दिवसीय विचारमंथन सत्र का आयोजन किया गया जिसमें एक्रीपडा के अंतर्गत चलाए जा रहे वर्षा आधारित कृषि अनुसंधान कार्यों की समीक्षा की गई। इसके अलावा, 26-29 दिसंबर, 2014 के दौरान एक्रीपडा केंद्र, इंदौर पर XXIV द्विवार्षिक कार्यशाला के दौरान तकनीकी, भौतिक एवं आर्थिक लक्ष्यों की समीक्षा भी की गई।

संपर्क एवं सहयोग

परियोजना समन्वयन एकक, एक्रीपडा एवं नेटवर्क केंद्र अपनाने योग्य वर्षा आधारित प्रौद्योगिकियों का उन्नयन, प्राथमिक एवं द्वितीयक पणधारियों में क्षमता निर्माण के लिए, संबंधित राज्य कृषि विश्वविद्यालयों, भा.कृ.अनु.प. के संस्थानों, राज्य संबंधी विभागों, कृषि विज्ञान केंद्रों, गैर सरकारी संगठनों, किसानों एवं बारानी अनुसंधान को प्राथमिकता देने वाले अन्य पणधारियों से निरंतर सहयोग/संपर्क के विकास द्वारा निकट संबंध बनाए रखने का प्रयास जारी है। केंद्र भी विभिन्न संगठनों जैसेकि आई.डब्ल्यु.एम.पी., महात्मा गांधी रोज़गार गारंटी अधिनियम, राष्ट्रीय कृषि विकास योजना, राष्ट्रीय खाद्यान्न सुरक्षा मिशन, राष्ट्रीय बागवानी मिशन, एन.एल.एम. आदि राज्य एवं राष्ट्रीय कार्यक्रमों से समाभिरूपता में अपनाने योग्य वर्षा आधारित प्रौद्योगिकियों से जुड़े विभिन्न संगठनों से भी संपर्क स्थापित किए हुए है। केंद्र प्रिंट एवं इलेक्ट्रानिक माध्यमों द्वारा बेहतर बारानी प्रकियाओ, कृषि-सलाहों, आकस्मिक योजनाओं आदि के प्रसार में प्रमुख भूमिका निभा रहा है।

प्रकाशन

वर्ष के दौरान 77 अनुसंधान लेख, 120 सम्मेलनों में प्रस्तुत किए गए लेख, 55 पुस्तक/बुलेटिन/रिपोर्ट एवं 64 लोकप्रिय लेख के रूप में कुल 316 प्रकाशनों का योगदान दिया। वर्ष 2014-15 के दौरान वैज्ञानिकों के द्वारा 29 रेडियो वार्ता, 23 दूरदर्शन पर वार्ता एवं 55 व्याख्यान दिए गए।

मानव संसाधन विकास, वर्षा आधारित प्रौद्योगिकियों का प्रभाव एवं उन्नयन

केंद्र प्राथमिक एवं द्वितियक पणधारियों के ज्ञान/कौशल के विकास के लिए मानव संसाधन विकास एवं क्षमता निर्माण की गतिविधियों में निरंतर प्रयत्नशील है। कार्यक्रम/गतिविधियों में मौसम पूर्व एवं मध्य मौसमीय प्रशिक्षण, कृषि दिवस, प्रदर्शन दौरे आदि शामिल हैं। इन प्रौद्योगिकियों की शक्ति एवं सीमाओं के मूल्यांकन के लिए अनंतपुर एवं बंगलोर केंद्रों द्वारा चालू अनुसंधान परियोजना गांवों में वर्षा आधारित प्रौद्योगिकियों का प्रभाव विश्लेषण किया जा रहा है। केंद्रों से वर्षा आधारित प्रौद्योगिकियों का निष्पादन एवं सीमाओं के बारे जानकारी प्राप्त की गई। दिनांक 12 सितंबर, 2014 को अनंतपुर, 15 अक्तूबर, 2014 को फैजाबाद, 21 अक्तूबर, 2014 को बंगलोर एवं 13 जनवरी, 2015 को परभनी के एक्रीपडा केंद्रों पर एक दिवसीय जिला स्तरीय पणधारी परामर्श कार्यशाला के दौरान इन प्रौद्योगिकियों के उन्नयन की संभावनाओं की समीक्षा की गई।

बजट

वर्ष 2014-15 के लिए एक्रीपडा के 22 केंद्रों के लिए कुल 1485.24 लाख रूपए एवं 8 चालू अनुसंधान परियोजना केंद्रों के लिए 213.37 लाख रुपए आबंटित किए गए।

Executive Summary

The All India Coordinated Research Project for Dryland Agriculture (AICRPDA) has a network of 22 centers representing arid, semi-arid, sub-humid, humid and per-humid climates with diverse bio-physical and socio-economic settings of the rainfed agro-ecologies of the country. The project has a mandate to generate location specific technologies through on-station research focusing on rainwater management, cropping systems, nutrient management, energy management, evaluation of improved varieties, alternate land use/farming systems in rainfed rice, maize, sorghum, pearlmillet, fingermillet, cotton, groundnut and soybean based production systems. The resultant technologies are subsequently assessed on farmers' fields through 8 Operational Research Projects (ORPs). A total of 314 on-station experiments were conducted *viz.* rainwater management-62; cropping sytems-46; nutrient management-64; energy managment-32; evaluation of improved varities-70; weed managment-5; alternate land use systems-14; integrated arming systems-15 and resource characterization-6. In ORPs, 114 on-farm trials/demonstrations were conducted viz. rainwater management-16; cropping sytems-24; nutrient management-17; energy managment-13; evaluation of improved varieties-23; weed managment-5; alternate land use systems-3; integrated farming systems-4 and technology upscaling-14. The salient achievements are given below.

A. Rainwater management

In-situ moisture conservation

- At Faizabad, in an experiment on enhancing water productivity in rice by optimizing bund height and date of sowing, maximum grain yield (2323 kg/ha) with total input energy of 7960 MJ/ha and maximum energy productivity of 0.322 kg/MJ and RWUE of 5.38 kg/ha-mm were recorded with 10 cm bund height. In case of sowing dates, sowing in first week of July (5th July) gave maximum rice grain yield (2233 kg/ha) with 7957 MJ/ha of total input energy and 71613 MJ/ha of output energy.
- At Vijayapura, in a study to assess the effect of set furrow cultivation with crop residues on pigeonpea and groundnut, set furrow with residue incorporation (RI) + glyricidia recorded pigeonpea equivalent yield (PEY) of 1633 kg/ha with mean maximum NMR (Rs.59900/ha) and RWUE of 4.04 kg/ha-mm followed by set furrow with silt + residue incorporation + glyricidia (1556 kg/ha).
- At Parbhani, in an experiment on evaluation of rainwater conservation practices for soybean + pigeonpea (4:2) intercropping system, opening of furrow in soybean + pigeonpea (4:2) was carried out after every four rows 30 DAS, recorded significantly higher yield (624 kg/ha) compared to no furrow opening (527 kg/ha).
- At Kovilpatti, in a study on different tillage methods for improving water use efficiency in cotton-greengram rotation, rotovator ploughing + chisel ploughing recorded the highest grain yield of greengram (908 kg/ha), with higher net returns (Rs.17580/ha) and B:C ratio (1.54) which was 10% higher than the conventional tillage. Rotovator ploughing + chisel ploughing recorded the highest rainwater use efficiency of 2.36 kg/ha-mm inspite of 17.3% of rainwater being lost as runoff.
- At SK Nagar, in a study on evaluation of hydrogel in castor, application of hydrogel @ 7.5 kg/ha gave significantly higher seed and stalk yield of castor (1377 and 991 kg/ha) which was 87.1 and 72.2% higher than control (736 kg/ha) with higher net returns (Rs.33451/ha), B:C ratio (3.19) and RWUE (2.21 kg/ha-mm).
- At Bangaluru, in a study on rainwater management through different conservation techniques in the existing amla orchards (3200 m^2), trench-cum-crescent bund gave higher yield (16949 kg/ha) and net returns (Rs.162290/ha) compared to other conservation techniques.

Ex-situ rainwater management

- At Varanasi, supplemental irrigation from harvested rainwater at flowering stage in pea gave maximum seed yield of 1462 kg/ha, net returns of Rs.20090/ha and B:C ratio of 2.2 as compared to no irrigation (1228 kg/ha, Rs.15540/ha and 2.03, respectively).
- At Biswanath Chariali, in a study on efficiency of harvested rainwater on potato, three irrigations at 25, 60 and 80 days after planting from the harvested water in farm pond + vermicompost @ 2 t/ha gave higher tuber yield (23.39 t/ha) with net returns of Rs.109370/ha compared to other treatments.
- At Akola, in a study on supplemental irrigation from harvested rainwater to soybean, two protective sprinkler irrigations from stored farm pond water at critical stages gave higher seed yield of soybean (1021 kg/ha) followed by one protective irrigation. The water use efficiency (1.79 kg/ha-mm) and B: C ratio (2.20) was also higher with two protective irrigations over one and no protective irrigation.
- At Parbhani, in a study on catchment-storage-command relationship in soybean, one protective irrigation given from harvested rainwater at branching gave higher seed yield (965 kg/ha) with 64.57% increase in yield over no irrigation (586 kg/ha).

B. Cropping systems

Intercropping systems

- At Rakh Dhiansar the highest maize equivalent yield (MEY) was obtained with paired rows of maize with 2 rows of cowpea with the MEY and LER of 2340 kg/ha and 1.26, respectively with the highest B:C ratio of 1.53. It was followed by two rows of maize + 3 rows of cowpea with MEY of 2150 kg/ha and B:C ratio of 1.34 compared to all other systems.
- At Vijayapur, in an assessment of different crops for contingency planning during *Punarvasu* (06-22 July) in shallow black soils, growing of pigeonpea + groundnut (2:4) gave significantly higher pearlmillet equivalent yield (6400 kg/ha) with NMR of Rs.77395/ha and RWUE of 15.4 kg/ha-mm as compared to other crops and cropping systems. During *Pushya nakshatra* (22 July–03 August), intercropping of pearlmillet + pigeonpea (2:1) gave significantly higher pearlmillet equivalent yield (5904 kg/ha) with net returns of Rs.71966/ha and RWUE of 16.8 kg/ha-mm as compared to other crops and cropping systems.
- At Biswanath Chariali, in an evaluation of sesame based intercropping systems, sesame + greengram (2:2) with application of 30:20:20 kg NPK/ha recorded maximum sesame equivalent yield of 1300 kg/ha, net returns of Rs.47758/ha and RWUE of 3.22 kg/ha-mm compared to other intercropping systems.
- At Parbhani, in a study on different intercropping systems, cotton + soybean (1:1) system gave maximum seed cotton equivalent yield (1658 kg/ha), net returns (Rs.32644/ha) and B:C ratio (1.97) compared to other intercropping systems.
- At Bangalore, in a study on the performance of intercrops in nipped castor, castor + fingermillet (1:2) recorded significantly higher castor equivalent yield (2135 kg/ha) with higher net returns of Rs.60377/ha, B:C ratio of 3.41 and RWUE of 2.73 kg/ha-mm.

Double cropping systems

- At Biswanath Chariali, in an evaluation of maize based double cropping systems, maximum maize equivalent yield (MEY) of 10300 kg/ha was obtained with maize-potato system with NMR of Rs.123865/ha followed by maize-rajmah system with MEY of 9944 kg/ha and NMR of Rs.119220/ha as compared to other cropping systems. Similarly, in an evaluation of relay cropping of *rabi* pulses (pea, lentil and lathyrus) with *kharif* rice under rainfed medium lowland situation with different seed rates, lathyrus relayed with 150% recommended seed rate (RSR) and 15 days before harvesting of rice gave maximum seed yield (425 kg/ha) and stover yield (982 kg/ha).

C. Nutrient management

Permanent manurial trials

- At Bangalore, INM in fingermillet–groundnut cropping system indicated that application of 10 t/

ha FYM + rec. NPK + bio-fertilizers recorded higher groundnut pod yield (1024 kg/ha) with higher net returns (Rs.23674/ha), B:C ratio (1.82) and RWUE (1.42 kg/ha-mm) compared to other treatments. However, the soil organic C (0.52%), available N (216 kg/ha), P_2O_5 (108 kg/ha) and K_2O (126 kg/ha) were highest in the plots under 10 t/ha FYM + 100% NP + 150% K + biofertilizers.

- At Anantapur, higher groundnut mean pod yield (937 kg/ha) was recorded with application of 50% RDF + FYM @ 4 t/ha. The soil organic C was also higher (0.55%) in the plots under 50% RDF + FYM @ 4 t/ha. Higher soil available phosphorous (107 kg/ha) and lower bulk density (1.42 Mg/m^3) was recorded with application of 100% RDF + $ZnSO_4$ @ 50 kg/ha (once in 3 years).
- At Biswanath Chariali, *ahu* rice gave maximum grain yield (1783 kg/ha) with higher straw yield (5146 kg/ha), RWUE (1.79 kg/ha-mm) and B:C ratio (2.28) with application of 75% RDF (inorganic) + vermicompost @ 5 t/ha over all other treatments. Similarly during *rabi*, in toria the higher seed yield (1163 kg/ha), RWUE (20.58 kg/ha-mm), net returns (Rs. 21263/ha) and B:C ratio (3.36) were recorded with 75% RDF (inorganic) + vermicompost @5 t/ha.

Integrated nutrient management

- At Rakh Dhiansar, significantly higher pearlmillet grain yield (2586 kg/ha) was obtained with application of 100% NPK through fertilizer which was at par with application of 75% N through inorganic + 25% N through vermicompost (2437 kg/ha). The maximum B:C ratio, net returns and RWUE of 2.92, Rs.29492/ha and 3.92, respectively were obtained with application of 100% NPK through fertilizers.
- At Akola, significantly highest seed yield (542.5 kg/ha) of soybean was recorded with the application of 50% N through glyricidia + 50% N through inorganics + biofertilizers + 25 kg K_2O/ha compared to other treatments. The highest net returns of Rs.20083/ha was obtained with the application of 50% N through green leaf manure + 50% N through inorganics + biofertilizers + 25 kg K_2O/ha. Highest SYI (0.33) was observed with the application of 50% N through glyricidia + 50% N through inorganics + biofertilizers + 25 kg K_2O/ha compared to other treatments.
- At Agra, in a study on INM in pearlmillet, the highest grain yield of 3103 kg/ha, net returns of Rs.27337/ha, B:C ratio of 2.48 and RWUE of 13.41 kg/ha-mm were recorded with application of 50% RDN through FYM + 50% N through inorganic fertilizer compared to other treatments.
- At Bangalore, in a n experiment on INM in fingermillet-groundnut cropping system, application of 10 t/ha FYM + rec. NPK + biofertilizers recorded higher groundnut pod yield (1024 kg/ha) with net returns (Rs.23674/ha), B:C ratio (1.82) and RWUE (1.42 kg/ha-mm) followed by *ex-situ* green manure (7.5 t/ha) + 75% N & P + 100% K + biofertilizers (995 kg/ha) as compared to recommended NPK (701 kg/ha). Application of 10 t/ha FYM + rec. NPK + biofertilizers gave higher haulm yield (2267 kg/ha) compared to other treatments.

Foliar spray

- At Arjia, spray of $ZnSO_4$ @ 0.5% + NPK (soluble) @ 2% before tasseling and at grain filling stage, gave significantly higher maize grain yield (2510 kg/ha), net returns (Rs.30507/ha) and B:C ratio (2.85) compared to other treatments.
- At Vijayapur, in a study on foliar spray of nutrients for *rabi* sorghum, application of RDF + KNO_3 (1% spray) sprays at 45 & 75 DAS gave maximum grain yield of 1821 kg/ha, while the control gave lowest yield of 611 kg/ha. However, spraying of thiourea @ 250 g/ha at 45 DAS resulted in production of higher stover yield (3511 kg/ha).
- At Kovilpatti, in an experiment on foliar nutrition in cotton in Vertisols, RDF (60:30:30 kg NPK/ha) + foliar spray of 1.25% cotton plus at square formation and flowering stages recorded significantly higher seed kapas yield (1723 kg/ha), with higher net returns (Rs.28237/ha), B:C ratio (1.88) and RWUE (5.72 kg/ha-mm) compared to other treatments.
- At Parbhani, in a study on fertilizer management and foliar spray, application of RDF (120:60:60 kg NPK/

ha) + foliar spray of KNO_3 @ 1 & 2% (35 & 65 DAS) gave maximum seed cotton yield (1237 kg/ha), net returns (Rs.12705/ha), B:C ratio (1.33) and RWUE (4.38 kg/ha-mm) compared to other treatments.

- At SK Nagar, in a study on the effect of foliar application of nutrients on maize, spray of $ZnSO_4$ @ 0.5% + $FeSO_4$ @ 0.5% gave significantly higher grain and stalk yield (1394 and 3815 kg/ha), respectively with higher net returns (Rs.18626/ha), B:C ratio (3.44) and RWUE (2.07 kg/ha-mm) compared to other treatments.

D. Energy management

- At Indore, in an experiment on effect of tillage on resource conservation in soybean, low tillage + 4 t/ha of straw + hand weeding resulted in highest seed yield (1408 kg/ha) with higher NMR (Rs.27634/ha), B:C ratio (2.89) and RWUE (1.67 kg/ha-mm) compared to other treatments.
- At Biswanath Chariali, in a trial on tillage and nutrient management in groundnut, two harrowings + one pulverization by power tiller gave higher pod yield of groundnut (2863 kg/ha) and B:C ratio (2.24) followed by minimum tillage + rotavator with pod yield of 2164 kg/ha and B:C ratio of 1.69 as compared to other treatments. The maximum field efficiency (28.50 hr/ha) was recorded by conventional tillage (three to four ploughing followed by laddering) and maximum energy use efficiency (2.5) was recorded with minimum tillage (one harrowing).
- At Agra, in a study on the effect of tillage and sowing implements on pearlmillet, MB plough was found superior with highest grain yield of 2829 kg/ha, net returns of Rs.22391/ha, B:C ratio of 2.20 and RWUE of 12.51 kg/ha-mm over other implements. Among different sowing implements, raised bed planter and ridger seeder gave similar but significantly higher yield (2783-2862 kg/ha) compared to other implements. The highest energy use efficiency and energy productivity of 13.13 and 0.258 kg/MJ was obtained with MB plough followed by disc plough (12.66 and 0.256 kg/MJ).
- At SK Nagar, in a study on different tillage practices in clusterbean, the highest seed yield of clusterbean (468 kg/ha) with higher net returns (Rs.15534/ha), B:C ratio (4.09) and RWUE (0.75 kg/ha-mm) was recorded with treatment roto till drill. It was at par with strip till drill (420.6 kg/ha) and raised bed planter (406.9 kg /ha) but significantly superior to zero till drill (381.3 kg/ha) and control.

E. Evaluation of improved varieties

- In a sorghum varietal trial at Chianki, among 20 entries, CSH-14 performed better with grain yield of 2818 kg/ha and RWUE of 7.0 kg/ha-mm while CSV-20 (check) recorded grain yield of 2237 kg/ha with RWUE of 5.5 kg/ha-mm.
- At Ballowal Saunkhri, among the five cultivars of cowpea tested for dual purpose, highest seed (1313 kg/ha) as well as fodder yield (301 q/ha) was recorded by UPC 9202 followed by CL 367 for seed and IT 38956-1 for fodder. The highest net returns of Rs.41062/ha with a B:C ratio of 2.87 was obtained with UPC-9202.
- At Biswanath Chariali, evaluation of medium duration high yielding rice varieties indicated that TTB-404 was found better among 13 varieties with grain yield of 4225 kg/ha, net returns of Rs.50704/ha, B:C ratio of 5.48 and RWUE of 3.24 kg/ha-mm.
- In a groundnut varietal trial at Rajkot, genotype JSP-51 gave maximum pod yield (1250 kg/ha) and net returns (Rs.32216/ha), while higher haulm yield (5608 kg/ha) was recorded by Somnath (C) genotype, followed by JSP-55 (5139 kg/ha) and JSP-58 (5104 kg/ha) compared to other genotypes.

F. Alternate land use systems

- At Rakh Dhiansar, in a study on different agri-horti-pastoral systems, mixed fodder grown in the alleys of *Leucaena* trees under silvi-agri-pastoral system during *kharif* was most remunerative system as compared to all other systems which recorded the highest net returns of Rs.21580/ha with a B:C ratio of 2.58. However, in case of fodder treatments under various systems, pure mixed fodder, in the alleys of *Leucaena*

and aonla trees recorded the yield of 31418, 27828 and 25951 kg/ha under agri-pastoral, silvi-agri-pastoral and agri-horti-pastoral systems, respectively.

- At Solapur, neem + *Acacia nilotica* + *Cenchrus ciliaris* + stylo system recorded highest neem height (335 cm), wood yield (85.54 cubic ft/ha), *Acacia nilotica* wood yield (184.64 cubic ft/ha), stylo grass yield (6.37 t/ha) with highest net returns (Rs.173996/ha) and B:C ratio (9.65). The next best treatment was neem + *bakan* (Limbara) + *Cenchrus ciliaris* + stylo treatment which recorded highest neem wood yield (54.10 cubic ft/ha), intercrop tree species wood yield (138.40 cubic ft/ha), stylo grass yield (5.38 t/ha) with highest net returns (Rs.118904/ha) and B:C ratio (6.91).
- At Parbhani, in drumstick based agri-horti system, the yield of intercrops in drumstick was greengram (1361 kg/ha), blackgram (1349 kg/ha), soybean (1430 kg/ha) and sunhemp (1421 kg/ha). The drumstick sole (3 m x 3 m) recorded the higher yield of 1837 kg/ha followed by drumstick + soybean (1:6) (1430 kg/ha).

G. Integrated farming system

- At Biswanath Chariali, the economic analysis of various components under the homestead farming showed that coconut, among the plantation crops, gave the highest net returns of Rs.57800 and B:C ratio of 5.0, while among the livestock components, fishery gave the highest net returns of Rs.2200245 and B:C ratio of 5.0. The lowest B:C ratio of 1.2 was found in case of local breed of cattle.
- In an experiment on integrated farming system at Rajkot, higher net returns of Rs.112272/ha were recorded with integrated farming system (field crops including cotton, pigeonpea, sorghum, maize and cowpea with one milch cow) compared to farmer's practice of cotton cultivation. The employment generation under IFS module was 365 man-days/ha/yr compared to 165 man-days/ha/yr under farmer's practice of cotton cultivation.
- In a study on integrated farming system for bunded midland (*Mal*) and lowland (*Gabhar*) situations at Jagdalpur, fish rearing in farm ponds in midlands gave additional income of Rs. 12673 with pond area of 2250 m^3 while in lowlands Rs. 9534 was obtained with pond area of 1650 m^3.
- At Varanasi, integrated animal based systems (rice + two buffalo + fish) gave highest net returns (Rs.65850/ha) and B:C ratio (1.65) with rice equivalent yield of 7300 kg/ha while agri-horti-system (aonla + greengram) recorded net returns of Rs.59000/ha and B:C ratio of 4.7 with rice equivalent yield of 3560 kg/ha.
- At Kovilpatti, in a study on integrated farming system, involving sorghum + cowpea (0.4 ha), maize + greengram (0.1 ha), cotton + blackgram (0.6 ha) + clusterbean (0.1 ha) + fodder crops (0.4 ha) + goat unit (10 + 1) and one milch animal, the mean system productivity and mean system income in IFS were 12870 kg/ha and Rs.116098/ha whereas in conventional system the values were 1071 and 10445 kg/ha. The mean employment generation was 174 and 410 man days/year due to cropping alone and IFS, respectively.

Operational Research Project (ORP)

a. Rainwater management

- At Arjia, in an on-farm demonstration of supplemental / protective irrigation in maize + blackgram and groundnut + sesame systems, protective irrigation gave higher maize equivalent yield (1450 kg/ha) in maize + blackgram (2:2) intercropping system as compared to control (780 kg/ha). It also gave higher groundnut pod equivalent yield (1150 kg/ha) in groundnut + sesame (6:2) intercropping system as compared to control (660 kg/ha). Groundnut + sesame (6:2) intercropping system gave higher net return (Rs.28708/ha) and B:C ratio (3.13) as compared to maize + blackgram (2:2) intercropping system.
- At Solapur, in an assessment of *in-situ* moisture conservation measures on the yield of *rabi* sorghum, opening of ridges and furrows gave higher grain yield of 1040 kg/ha, stover yield of 2660 kg/ha and B:C ratio of 1.98 as compared to farmers' practice (863 kg/ha).

b. Cropping systems

- At Arjia, in on-farm assessment of suitability of sorghum + greengram (2:1) intercropping system, maximum grain yield of sorghum (1367 kg/ha) and greengram (65 kg/ha), net returns of Rs. 18485/ha and B:C ratio of 2.53 were attained with sorghum + greengram (2:1) intercropping compared to mixed cropping of sorghum and greengram which gave a sorghum yield of 1183 kg/ha, greengram yield of 48 kg/ha, net returns of Rs.13870/ha and B:C ratio of 2.18.
- At Hisar, in a demonstration on strip intercropping systems, pearlmillet + mungbean (8:4) intercropping system recorded higher pearlmillet equivalent yield (2421 kg/ha) as compared to sole pearlmillet (940 kg/ha). Strip cropping of mungbean reduced the potential yield of pearlmillet to the extent of 18.7% whereas pearlmillet equivalent yield was 25.6% higher compared to sole pearlmillet.
- At Solapur, in demonstrations on double cropping systems, blackgram-sorghum sequence was found superior with a maximum B:C ratio of 2.30 from a yield of 1290 kg/ha of grain and 3190 kg/ha of stover of *rabi* sorghum. The lowest B:C ratio of 2.15 was attained under *kharif* fallow-*rabi* sorghum sequence with a sorghum grain yield of 1020 kg/ha and stover yield of 2633 kg/ha in the *rabi* season.

c. Nutrient management

Integrated nutrient management

- At Arjia, fertilizer dose based on site specific nutrient managemnet (SSNM) gave the highest sorghum yield (1513 kg/ha), net returns (Rs.14948/ha) and B:C ratio (2.25) closely followed by recommended dose of NP (net returns of Rs.10898/ha, B:C ratio of 1.92 from a yield of 1273 kg/ha) as compared to farmers' practices (1030 kg/ha).
- At Ballowal Saunkhri, in an on-farm assessment of nutrient management in maize, maximum maize grain yield of 3601 kg/ha was recorded with application of N through combination of 75% inorganic + 25% organic source, which was 3, 8 and 10% higher over application of N through combination of 50% inorganic + 50% organic (3508 kg/ha), 100% inorganic source (3321 kg/ha), and 100% organic source (3261), respectively, with maximum net returns of Rs.27792/ha and B:C ratio of 1.91.
- At Bangalore, in an assessment of nutrient management in fingermillet + pigeonpea system, application fo 50% N through organic source + 50% N & 100% PK through inorganic + 12.5 kg $ZnSO_4$ + 10 kg borax/ha recorded maximum fingermillet grain equivalent yield (2446 kg/ha) with higher RWUE (5.79 kg/ha-mm), net returns (Rs.38068/ha) and B:C ratio (2.49) followed by RDF alone compared to farmers' practice of fingermillet + *akkadi* (1280 kg/ha, 3.21 kg/ha-mm, Rs.10228/ha and 1.67, respectively).

Foliar spray

- At Anantapur, foliar spray of 2% $ZnSO_4$; 1% $MgSO_4$; 0.15% boron and 1% 19:19:19 at flowering and 20 days after flowering of cotton reduced the reddening of leaves by 51% and resulted in yield improvement by 11%. The micronutrient spray gave highest seed cotton yield (908 kg/ha), net returns (Rs.7605/ha), RWUE (2.49 kg/ha-mm) and B:C ratio of 1.7.
- At Solapur, application of 1% potassium sulphate at 30 and 45 days after sowing gave higher chickpea (cv.Vijay) yield of 760 kg/ha as compared to farmer's practice (550 kg/ha), with highest net returns and B:C ratio of Rs.14300/ha and 2.05.

d. Energy management

- At Ananatpur, in an assessment of Ananta Aqua planter for groundnut sowing, Ananta Aqua planter gave highest pod and haulm yield (451 and 1201 kg/ha) with the B:C ratio of 1.12 and RWUE of 2.2 kg/ha-mm compared to farmers' practice.
- At Ballowal Saunkhri, one ploughing with rotavator and one ploughing with cultivator just before sowing gave wheat grain yield of 3165 kg/ha, which was 19% higher as compared to 4 ploughings with cultivator (2 cross ploughings just after harvesting of *kharif* crop and 1 before sowing). The net returns of Rs.36768/ha and B:C ratio of 2.56 was obtained with rotavator as compared to the net returns of Rs.27948/ha and B:C ratio of 2.18 in case of cultivator.

- At Solapur, two bowl ferti-seed drill was found superior with maximum sorghum grain yield (910 kg/ha) and stover yield (2260 kg/ha), with a B:C ratio of 2.40 in four years (2011 to 2014). The yield increased by 17% as compared to farmer's method (local seed drill).

e. Evaluation of improved varieties

- At Anantapur, among the four improved groundnut varieties evaluated at four locations, K9 (501 kg/ha) was found superior followed by Dharani (499 kg/ha) and K-6 (491 kg/ha) compared to local variety (365 kg/ha).
- At Ballowal Saunkhri, in an evaluation of maize cultivars, PMH 1 hybrid gave maximum yield of 4008 kg/ha, net returns of Rs.42701/ha and B:C ratio of 2.38 followed by PMH 2 with grain yield of 3844 kg/ha, net returns of Rs.40392/ha and B:C ratio of 2.31.
- At Hisar, in an on-farm demonstration of improved clusterbean varieties, HG 563 recorded marginally higher yield (550 kg/ha), net returns (Rs.9886/ha) and B:C ratio (1.54) as compared to HG 365 (524 kg/ha), net returns of Rs. 8553/ha and B:C ratio of 1.47.

f. Integrated farming system

- At Anantapur, in an on-farm assessment of integrated farming system (IFS) involving groundnut cultivation and rearing of ramlands (5), the IFS module improved system productivity (32320 kg/ha) compared to groundnut cultivation alone (16135 kg/ha).

National Innovations on Climate Resilient Agriculture (NICRA)

The technology demonstration component (TDC) of NICRA, both on-station and on-farm, is being implemented at 23 AICRPDA centres including IGFRI, Jhansi since 2011. During 2014-15, the emphasis was on real time contingency crop plan implementation and preparedness to cope with weather aberrations with interventions such as rainwater harvesting (*in-situ* and *ex-situ*) and efficient use, drought tolerant cropping systems, resilient crop management practices, and efficient energy management. The risk resilient interventions were demonstrated in 3611 farmers' fields covering 898 ha in 33 villages in 24 districts across 15 states. The demonstratin of real time contingency measures during delayed onst of monsoon (introduction of short duration varieties etc.) and to mitigate seasonal drought (crop/soil management practices including supplemental irrigation with harvested rainwater, foliar sprays etc) impacted yield enhancement by up to 22%, and RWUE by up to 5 kg/ha-mm.

Tribal Sub-Plan (TSP)

The TSP program is being implemented by 7 network centers of AICRP-Dryland Agriculture (AICRPDA) in 22 villages in Rajasthan, Jharkhand, Madhya Pradesh, Odisha, Assam, Chhattisgarh and Gujarat covering 8 districts since 2011. The major interventions in TSP villages is being focused on improved rainfed technologies in thematic areas of rainwater management, drought tolerance, improved management practices, cropping systems, integrated nutrient management practices including foliar spray, farm mechanization with improved machinery and most important the need based trainings and capacity building programs both for tribal men and women. The physical assets created in the villages included rainwater harvesting structures, improved implements, improved breeds etc. The livelihood of the beneficiaries were improved through enhancing productivity of rainfed crops by up to 20%, profitability by up to 25% and livelihood interventions such as dairy, piggery, poultry, mushroom cultivation, vermicompost units etc.

Monitoring and Evaluation

During the period the technical, physical and financial targets were monitored and evaluated across AICRPDA network centers. Dr. Ch. Srinivasa Rao, Project Coordinator (AICRPDA), Dr. G. Ravindra Chary, Project Coordinator I/C (AICRPDA), and Dr. K.A. Gopinath, Senior Scientist (Agronomy) from Project Co-ordination Unit, AICRPDA visited centers and assessed the ongoing technical programme 2014-15, infrastructure facilities, administrative and budgetary aspects. The proceedings of each visit were brought out during the visits itself for improving /any necessary action by Project Coordinator, AICRPDA or Director, CRIDA or by the SAU authorities.

The rainfed agriculture research being carried out under AICRPDA network was reviewed during a two-day brainstorming session jointly organized by AICRPDA-CRIDA and National Academy of Agricultural Sciences (NAAS)-Hyderabad Chapter during 9-10 May, 2014 at NASC, New Delhi. Further, technical, physical and financial targets were also reviewed during the XXIV biennial workshop held at AICRPDA Centre, Indore during 26-29 December, 2014.

Linkages and Collaboration

The PC Unit, AICRPDA and the Network Centers have been continuously striving to develop collaboration/ linkages with respective State Agricultural Universities, ICAR Institutes, State line Departments, KVKs, NGOs, farmers and other stakeholders to prioritized dryland research, for upscaling doable rainfed technologies and capacity building of primary and secondary stakeholders. The network centers also established linkages with various organizations to upscale doable rainfed technologies in convergence with ongoing state and national programmes like IWMP, MGNREGA, RKVY, NFSM, NHM, NLM etc. The centers have been playing key role in dissemination of improved dryland practices, agro-advisories, contingency plans etc through print and electronic media.

Publications

Overall, 316 publications were contributed by AICRPDA team comprising of 77 research papers, 120 papers in conferences, 55 books/bulletins/reports and 64 popular articles during the year. The scientist gave 29 Radio talks, 23 Television talks and 55 lectures delivered during 2014-15.

HRD, impacts and upscaling of rainfed technologies

The centers are regularly engaged in HRD and capacity building activities for enhancing the knowledge base/skill development of primary and secondary stakeholders. The programs/activities include pre and in-seasonal trainings, field days, exposure visits etc. The impact analysis of rainfed technologies is being done in ORP adopted villages by Anantapur and Bangalore centres for assessing the strengths and limitations of these technologies. The performance and limitations of the rainfed technologies emanated from the centers and the scope for upscaling of these technologies were reviewed during one day District Level Stakeholder Consultation Workshops at AICRPDA Centres, Anantapur on 12th September, 2014, Faizabad on 15th October, 2014, Bangalore on 21st October, 2014, and at Parbhani on 13th January, 2015.

Budget

The total budget allocated for 22 network centers of AICRPDA for the period 2014-15 was Rs.1485.24 lakhs and Rs. 213.37 lakhs was allocated for 8 Operational Research Project centers.

1. Introduction

Rainfed agriculture, which is totally rain dependent, accounts for 55.3% (about 78 m ha) of the net cultivated area in India and plays an important role in country's economy. It supports 82% of rural poor and contributes to 40 % of national food basket. Monsoon, management and market along with other abiotic and biotic stresses and socio economic status of the farmers are the major factors affecting rainfed agriculture and livelihood of small and marginal farmers. Further, climate change/variability and unabated land degradation are the twin problems that are impacting productivity, profitability and sustainability of rainfed production systems.

To meet the emerging challenges, continued and renewed research efforts are made through a network of 22 centers of All India Coordinated Research Project for Dryland Agriculture (AICRPDA) to develop location-specific doable rainfed technologies focusing higher rainwater productivity, profitability and sustainability. The prioritized research programs are rainwater management, cropping systems, nutrient management, energy management, evaluation of improved varieties, alternate land use and integrated farming systems.

Mandate

Main / Sub-centres

- To optimize the use of natural resources, i.e., rainfall, land and water, and minimize soil and water loss and degradation of environment;
- To evolve simple technologies to substantially increase crop productivity and viability;
- To increase stability of crop production over years by providing improvements in natural resources management, crop management systems and alternate crop production technologies matching weather aberrations;
- To develop alternate and sustainable land use systems; and
- To evaluate and study transferability of improved dryland technology to farmers' fields.

ORP Centres

- Evaluate the performance of each component of dryland technology under the farmers' management.
- Provide feedback to main centres for refinement of the recommendations and to achieve first hand working experience in the development of micro-watersheds so that they may serve as models for extension agencies.

The agroecological setting of AICRPDA network centers are given in Table 1. The project is unique in its multi-disciplinar y approach and on-farm participatory research along with outreach programs like on-farm technology assessment/ refinement and demonstrations. The assessment and refinement of location specific technologies are carried out at 8 Operational Research Projects (viz., Anantapur, Arjia, Ballowal Saunkhri, Bangalore, Hisar, Indore, Ranchi and Solapur) by conduct on-farm participatory research in farmers' fields. Adopting the paradigm of agro-ecosystems based research, the 22 main centers are now undertaking research in 8 production systems, viz., rainfed rice (6 centers), sorghum (2 centers), pearlmillet (3 centers), fingermillet (1 center), maize (3 centers), cotton (3 centers), groundnut (2 centers) and soybean (2 centers) with Project Coordination unit at CRIDA, Hyderabad. The location of centers, ORPs and Organogram of AICRPDA shown in Fig.1.1 and Fig.1.2.

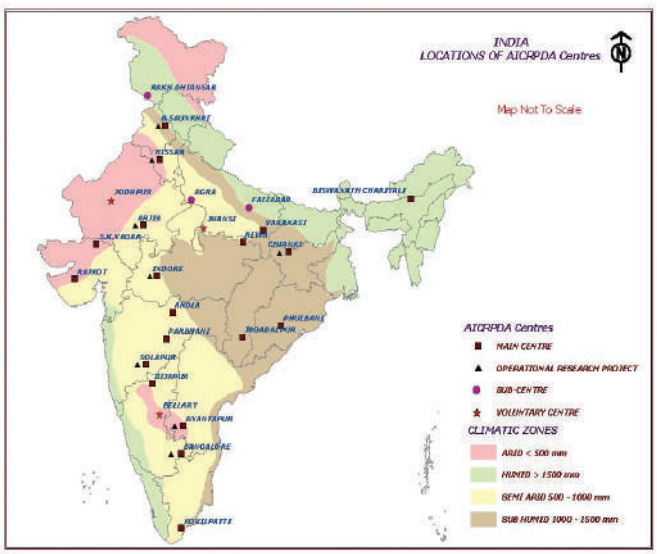


Fig.1.1. Location of AICRPDA Network Centers

Table 1.1: Agroecological Setting of AICRPDA Network Centres

Name of the Centre	SAU / ICAR Institute/ Others (Hqrs)	Agro-Climatic Zone (NARP) / Agro-ecosub region (AESR)	Climate**	Major rainfed crop based production system
Agra (SC)	RBSC, Agra	South – western semiarid zone in Uttar Pradesh (4.1)	Semiarid (Hot dry)	Pearlmillet
Akola (MC)	PDKV, Akola	Western Vidarbha Zone in Maharashtra (6.3)	Semiarid (Hot moist)	Cotton
Anantapur (MC & ORP)	ANGRAU, Hyderabad	Scarce rainfall zone (Rayalaseema) in Andhra Pradesh (3.0)	Arid (Hot)	Groundnut
Arjia (MC & ORP)	MPUAT, Udaipur	Southern zone in Rajasthan (4.2)	Semiarid (Hot dry)	Maize
B.Saunkhri (MC & ORP)	PAU, Ludhiana	Kandi region in Punjab (9.1)	Subhumid) (Hot dry)	Maize
Bangalore (MC & ORP)	UAS_B, Bangalore	Central, eastern and southern dry zone in Karnataka (8.2)	Semiarid (Hot moist)	Fingermillet
Bellary (VC)	CSWCRTI, Dehradun	Northern dry zone in Karnataka (3.0)	Arid (Hot)	*Rabi* Sorghum
Bijapur (MC)	UAS_D, Dharwad	Northern dry zone in Karnataka (6.1)	Semiarid (Hot dry)	*Rabi* Sorghum
Biswanth Chariali (MC)	AAU, Jorhat	North bank plain zone of Assam (15.2)	Humid (hot)	Rice
Chianki (MC & ORP)	BAU, Ranchi	Western plateau zone of Jharkhand (11.0)	Subhumid (Hot moist)	Rice
Faizabad (SC)	NDUAT, Faizabad	Eastern plain zone in Uttar Pradesh (9.2)	Subhumid (Hot dry)	Rice
Hisar (MC & ORP)	CCSHAU, Hisar	South-western dry zone in Haryana (2.3)	Arid (Hyper)	Pearlmillet
Indore (MC&ORP)	RVSKVV, Gwalior	Malwa plateau in Madhya Pradesh (5.2)	Semiarid (Hot moist)	Soybean
Jagdalpur (MC)	IGAU, Raipur	Basthar Plateau zone in Chattisgarh (12.1)	Subhumid (Hot moist)	Rice
Jhansi (VC)	IGFRI, Jhansi	Bundhelkhand zone in Uttar Pradesh (4.4)	Semiarid (Hot moist)	*kharif* Sorghum
Jodhpur (VC)	CAZRI, Jodhpur	Arid Western zone of Rajasthan (2.1)	Arid (Hyper)	Pearlmillet
Kovilpatti (MC)	TNAU, Coimbatore	Southern zone of Tamil Nadu (8.1)	Semiarid (Hot dry)	Cotton
Parbhani (MC)	MAU, Parbhani	Central Maharastra Plateau Zone in Maharashtra (6.2)	Semiarid (Hot moist)	Cotton
Phulbani (MC)	OUAT, Bhubaneswar	Eastern Ghat Zone in Orissa (12.1)	Subhumid (Hot moist)	Rice
Rajkot (MC)	JAU, Junagarh	North Saurashtra zones in Gujarat (5.1)	Semiarid (Hot dry)	Groundnut
Rakh Dhiansar (SC)	SKUAS_T, Jammu	Low altitude subtropical zone in Jammu and Kashmir (14.2)	Semiarid (Moist dry)	Maize
Ranchi (MC & ORP)	BAU, Ranchi	Western plateau zone of Jharkhand (4.1)	Semiarid (Hot dry)	Rice
Rewa (MC)	JNKVV, Jabalpur	Keymore plateau and Satpura Hill zone in Madhya Pradesh (10.3)	Subhumid (Hot dry)	Soybean
S.K.Nagar (MC)	SDAU, Dantewada	Northern Gujarat in Gujarat (2.3)	Semiarid/Arid (Hot dry)	Pearlmillet
Solapur (MC & ORP)	MPKV, Rahuri	Scarcity zone in Maharashtra (6.1)	Semiarid (Hot dry)	*Rabi* Sorghum
Varanasi (MC)	BHU, Varanasi	Eastern Plain and Vindhyan Zone in Uttar Pradesh (4.3 / 9.2)	Semi arid (Hot moist) Subhumid (Hot dry)	Rice

MC- Main Centre; SC - Sub Centre; VC - Voluntary Centre; ORP – Operational Research Project

**: Climate details as per AESR given by NBSS & LUP (ICAR)

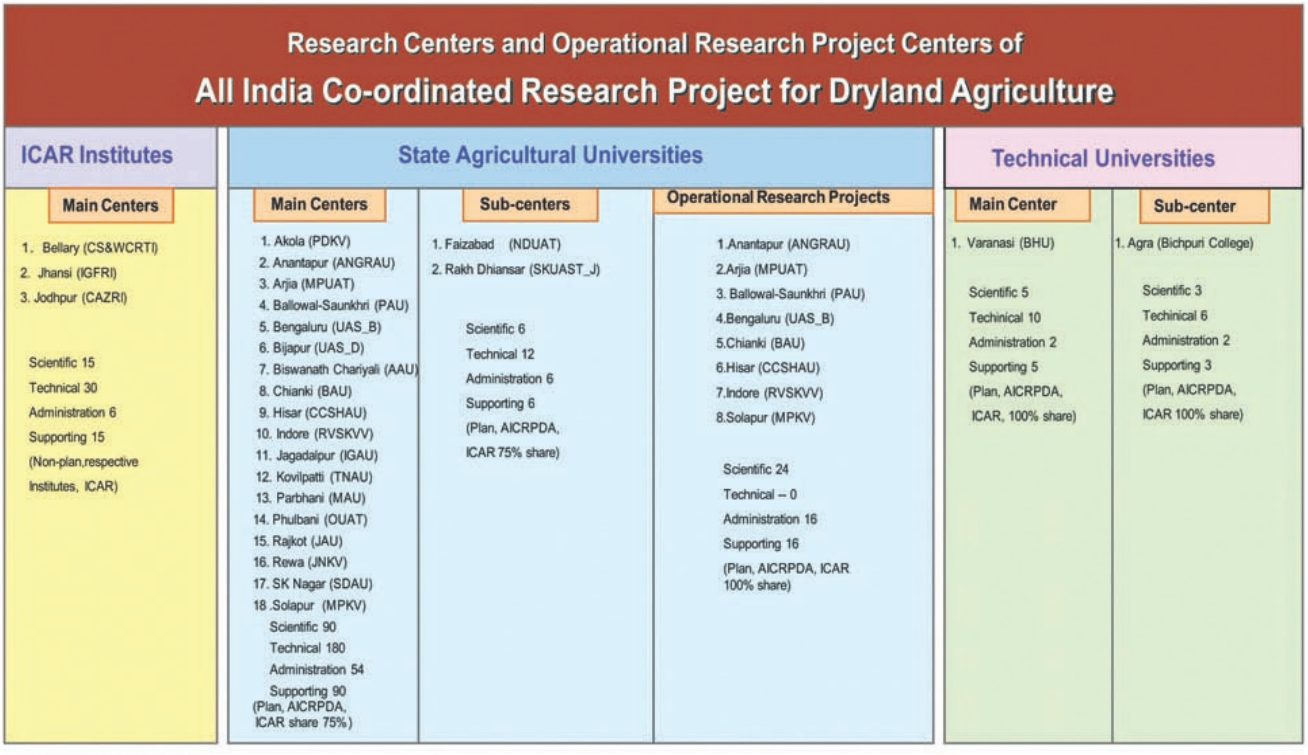


Fig.1.2. Organogram of AICRPDA Network Centers

During 2014-15, in total, 314 on-station experiments were conducted across the centres. The abstract of the number of experiments, production system-wise, ceter-wise and theme-wise, both under on-station and on-farm are given in Table 1.2 and 1.3, respectively.

Table 1.2: On-station experiments at main/sub-centers during 2014-15

Production System/ Center	RWM	CS	INM	EM	PVS	IWM	ALU	IFS	RC	Total
Rice based production system										
Biswanath Chariali	2	6	3	1	8	0	1	1	3	25
Chianki	0	1	2	2	5					10
Faizabad	1		4	1	1	1	1			9
Jagadalpur	3		3	4	2		3		1	16
Phulbani	1		2		5					8
Varanasi	3		1	1	2		1	2		10
Total	10	7	15	9	23	1	6	3	4	78
Maize based production system										
Arjia	5	1	4		5	2	1			18
Ballowal Saunkhri	3	2	2	3	5		1	2		18
Rakh Dhiansar		2	2	1				1		6
Total	8	5	8	4	10	2	2	3		42
Fingermillet based production system										
Bangalore	6	2	3		3					14
Total	6	2	3		3					14

Production System/ Center	RWM	CS	INM	EM	PVS	IWM	ALU	IFS	RC	Total
Pearlmillet based production system										
Agra	2	4	2	2						10
Hisar	4	2	4	1	1		1	1		14
SK Nagar	2	1	6	1	5			1		16
Total	8	7	12	4	6		1	2		40
Sorghum based production system										
Bijapur	3	7	3	2	5		4			24
Solapur	5		2	1	3			2	1	14
Total	8	7	5	3	8	0	4	2	1	38
Soyabean based production system										
Indore	4	3	2	2	3	2				16
Rewa	2	5	3	1	5			1		17
Total	6	8	5	3	8	2	0	1	0	33
Groundnut based production system										
Anantapur	3	2	5	4	4			1		19
Rajkot	4	2	2	1	5			1	1	16
Total	7	4	7	5	9			2	1	35
Cotton based production system										
Akola	2	4	4	1	2		1			14
Kovilpatti	2	1	3	1				1		8
Parbhani	5	1	2	2	1			1		12
Total	9	6	9	4	3		1	2		34
Grand Total	62	46	64	32	70	5	14	15	6	314
% Expts	17.9	13.3	18.4	9.2	20.2	1.4	4.0	4.3	1.7	

Table 1.3: On-farm trial in ORP adopted villages during 2014-15

ORP/ Centers	RWM	CS	INM	EM	PVS	ALU	IFS	TU	HRD	Others	Total
Anantapur	1	3	3	2	2		2			1	14
Arjia	2	4	2	1	4	1		2	1	1	18
Ballowal Saunkhri	3	3	3	2	1	2		1			15
Bangalore	2	5	2	4	3				1	1	18
Chianki	1				6		1				8
Hisar	3	3	3		6						15
Indore	2				1		1	2	1		7
Solapur	2	6	4	4					1	2	19
Total	16	24	17	13	23	3	4	5	4	5	114
% of Total	14.0	21.1	14.9	11.4	20.2	2.6	3.5	4.4	3.5	4.4	

RWM- Rainwater management; IFS- Integrated farming system; EM- Energy management; INM- Integrated nutrient management; CS- Inter cropping/double cropping/ sequence cropping/relay cropping system; PVS- Participatory varietal selection; ALU- Alternate land use; IWM- Integrated weed management; LA- Livelihood activities; TU- Technology Upscaling; DEMO- Demonstration; RC- Resource characterization; OFT-On farm trials; Others: HRD-Human resource development; FLDs-Frontline demonstrations technology up-scaling; PP- Package of practices; RC- Resource characterization

2. Resource Characterization

2.1 Climate and soils

The AICRPDA network centres are located in diverse agro-ecological settings i.e arid, semiarid (dry and mosit), subhumid (dry and moist) and humid climates and dominant soil types viz. Inceptisols, Vertisols, Alfisols, Aridisols and Oxisols. The mean annual rainfall across network centres ranges from 412 mm to 1990 mm; while PET from 455 mm to 1681 mm, water surplus from 0 mm to 609 mm, water deficit from 0 mm to 655 mm, mean annual maximum temperature from 27.8^{0}C to 42.4^{0}C and mean annual minimum temperature from 26.7^{0}C to 16.4^{0}C (Table 2.1).

Table 2.1: Climate characteristics across AICRPDA network centres

AICRPDA Centre	Climate	Mean annual rainfall (mm)	PET (mm)	Water surplus (mm)	Water deficit (mm)	Air temperature (^{0}C)		Sun-shine (hr/day)	Wind speed (km/hr)
						Max	Min		
Agra	Semiarid (Hot dry)	665	598	0	152	35.3	26.7	-	-
Akola	Semiarid (Hot moist)	824	604	0	49	32.8	24.2	-	-
Anantapur	Arid (Hot)	544	641	0	312	34.0	21.5	8.2	10.8
Arjia	Semiarid (Hot dry)	656	1681	125	655	42.4	17.4	7.4	-
Ballowal Saunkhri	Subhumid (Hot dry)	1011	739	0	155	30.5	16.4	7.9	2.3
Bangalore	Semiarid (Hot moist)	926	503	0	60	27.8	19.3	4.5	10.7
Vijayapura	Semiarid (Hot dry)	595	622	0	228	31.0	21.6	6.7	9.4
Biswanath Chariali	Humid (Hot)	1990							
Chianki	Subhumid (Hot moist)	1179	455	597	0	30.4	22.7	4.3	4.3
Faizabad	Subhumid (Hot dry)	1051	1482	255	69	30.8	19.1	7.3	-
Hisar	Arid (Hyper)	412	769	0	459	37.5	26.3	9.7	5.9
Indore	Semiarid (Hot moist)	958	616	70	0	30.7	22.5	4.7	16.3
Jagdalpur	Subhumid (Hot moist)	1297							
Kovilpatti	Semiarid (Hot dry)	723	812	0	631	36.7	24.7	6.6	14.5
Parbhani	Semiarid (Hot moist)	901							
Phulbani	Subhumid (Hot moist)	1580	478	609	0	36.6	23.5	7.5	6.8
Rajkot	Semiarid (Hot dry)	590	738	0	157	33.7	24.5	5.7	17.7
Rakh Dhiansar	Semiarid (Moist dry)	860	700	-	0	29.0	17.3	5.0	-
Rewa	Subhumid (Hot dry)	1088	688	173	74	31.4	19.1	8.4	4.6
Sardar Krishi Nagar	Semiarid/ Arid (Hot dry)	670	572	161	88	30.2	18.7	8.3	5.2
Solapur	Semiarid (Hot dry)	732	589	0	67	32.3	22.3	4.6	8.6
Varanasi	Semi arid (Hot moist) Subhumid (Hot dry)	1049	577	190	0	34.4	26.6	5.8	5.2

Across the network centres, the length of growing period (LGP) i.e. moisture availability period varies from 60 days to 270 days. Over years, due to continuous monocropping of predominant rainfed crops/cropping systems, the locations are identified with multiple nutrient stresses (Table 2.2).

Table 2.2: Soil characteristics across AICRPDA network centres

AICRPDA Centre	Soil characteristics		
	Dominant soil type	LGP (days)	Limiting nutrients
Agra	Inceptisols	90-120	N, K, Mg, Zn, B
Akola	Vertisols	120-150	N, P, S, ZN, B
Anantapur	Alfisols	60-90	N, K, Mg, Zn, B
Arjia	Vertisols	90-120	N, Mg, Zn, B
Ballowal Saunkhri	Inceptisols	120-150	N, K, S, Mg, Zn
Bangalore	Alfisols	120-150	N, K, Ca, Mg, Zn, B
Vijayapura	Vertisols	90-120	N, Zn, Fe
Biswanath Chariali	Inceptisols	240-270	K, Zn, B
Chianki	Inceptisols	150-180	N, Zn, B
Faizabad	Inceptisols	150-180	N, Zn, B
Hisar	Inceptisols/Aridisols	60-90	N, Mg, B
Indore	Vertisols	120-150	N, Zn, S
Jagdalpur	Inceptisols	180-210	N, P
Kovilpatti	Vertisols	90-120	N, P
Parbhani	Vertisols	120-150	N, Zn, Fe
Phulbani	Alfisols / Oxisols	180-210	N, Ca, Mg, Zn, B
Rajkot	Vertisols	90-120	N, P, S, Zn, Fe, B
Rakh Dhiansar	Inceptisols	150-210	N, K, Ca, Mg, Zn, B
Rewa	Vertisols	150-180	N, Zn
Sardar Krishi Nagar	Aridisols / Entisols	60-90	N, K, S, Ca, Mg, Zn, B
Solapur	Vertisols	90-120	N, P, Zn
Varanasi	Inceptisols	120-150/ 150-180	N, Zn, B

2.2 Experienced Rainfall during 2014 across AICRPDA network centres

At the network centres of AICRPDA, the daily weather data are recorded for eight parameters *viz.*, air temperature (^{O}C), wind speed (km/hr), PET (mm), rainfall (mm), sun-shine (hr/day) etc. The water surplus (mm) and water deficit (mm) from this information is also calculated for interpretation of the experimental results.

The data on rainfall received at different AICRPDA centres during 2014 are given in Table 2.3.

Rice based production system

At Biswanath Chariali, the onset of monsoon was delayed by 2 weeks (19th June). A rainfall of 1812.3 mm was received which was deficit by 52.5 mm compared to normal (1864.8 mm). During south-west monsoon (*kharif*) a rainfall of 1088.8 mm was received against a normal rainfall of 1182.2 mm. The rainfall during *rabi* was deficit by 18.2 mm compared to normal rainfall of 120 mm (Fig. 2.1).

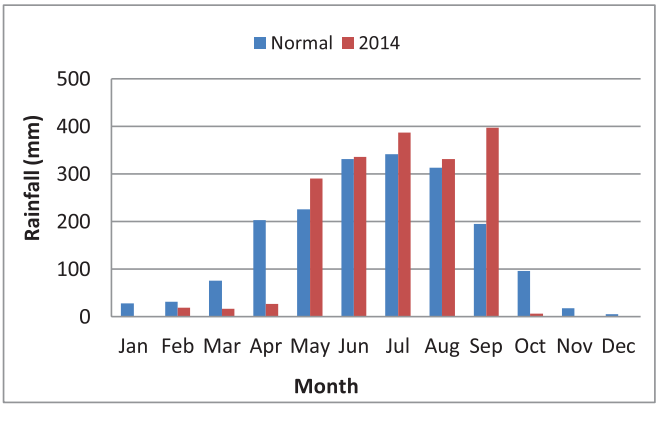


Fig. 2.1: Normal and actual (2014) monthly rainfall at Biswanath Chariali

At Chianki, the onset of monsoon was delayed by 2 weeks (22nd June). A rainfall of 556.9 mm was received which was deficit by 623.4 mm compared to normal (1180.3 mm) (Fig. 2.2). During *kharif* (June–September),

404 mm of rainfall was received which was deficit by 634 mm compared to normal of 1038 mm. During *rabi* season, it was 13 mm which was deficit by 52.9 mm compared to normal of 65.9 mm and in summer, rainfall was 64.5 mm which was excess by 21.8 mm as against normal of 42.7 mm.

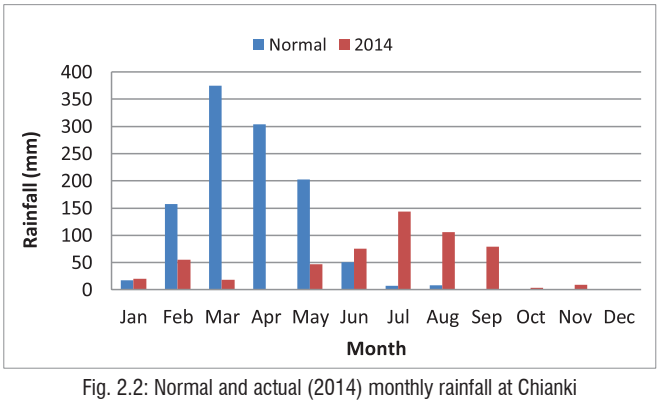


Fig. 2.2: Normal and actual (2014) monthly rainfall at Chianki

At Faizabad, the onset of monsoon was timely (23rd June, normal onset of monsoon is 21st June). A rainfall of 669.4 mm was received which was deficit by 370.7 mm (35.6%) compared to normal (1040.1 mm) (Fig. 2.3). During south-west monsoon (*kharif*), 417.6 mm rainfall was received which was deficit by 497.3 mm (54.4%) compared to normal of 914.9 mm. In north-east monsoon (October - December), 116.9 mm rainfall was received which was excess by 51.3 mm (78.2%) compared to normal (65.6 mm) and during summer, 45.5 mm of rainfall was received which was excess by 12.3 mm (37%) compared to normal rainfall of 33.2 mm.

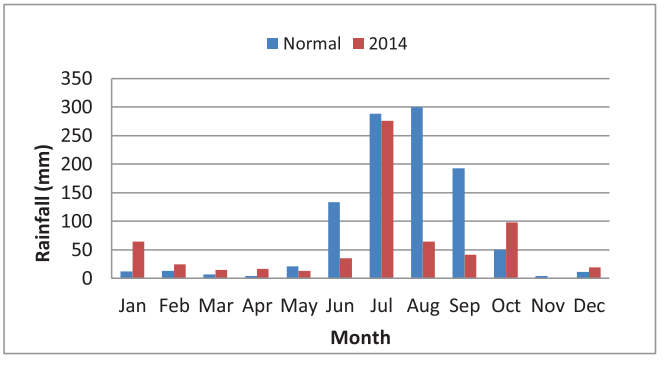


Fig. 2.3: Normal and actual (2014) monthly rainfall at Faizabad

At Jagdalpur, the onset of monsoon was delayed by 45 days (17th July). A total rainfall of 1437.7 mm was received which was excess by 125.5 mm compared to normal of 1404.4 mm (Fig. 2.4). During south-west monsoon (*kharif),* there was 1147.9 mm rainfall which was excess of 26.4 mm (2.4%) as against normal rainfall of 1121.5 mm. During north-east monsoon (October - December), 114 mm of rainfall was received which was same as that of normal (114.8 mm). During summer, 175.8 mm of rainfall was received which excess by 29.7 mm (20.3%) was compared to normal 146.1 mm.

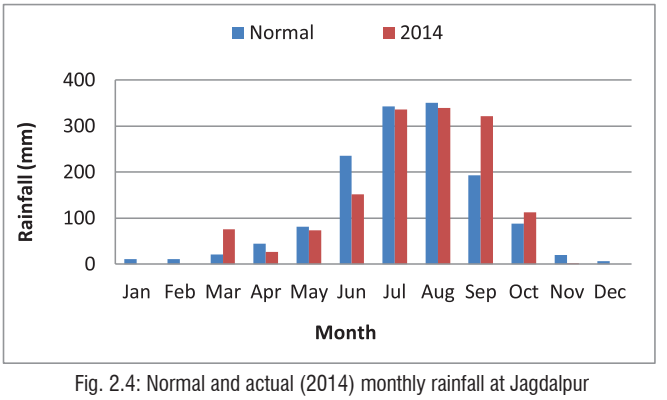


Fig. 2.4: Normal and actual (2014) monthly rainfall at Jagdalpur

At Phulbani, the onset of monsoon was delayed by 8 days during second week of June (18th). A rainfall of 1569.3 mm was received during 2014 which was excess by 162 mm than normal rainfall of 1407.3 mm. Out of total rainfall of 1569.3 mm, 1305.7 mm was received during *kharif* season (June- September) and was excess by 15.2 mm (13.5%) than normal of 1150.5 mm. In *rabi* season, there was 13.9% deficit rainfall (107.4 mm) than normal of 124.7 mm and in summer, it was by 24.37 mm excess (22.5%) than normal of 108.4 mm (Fig. 2.5).

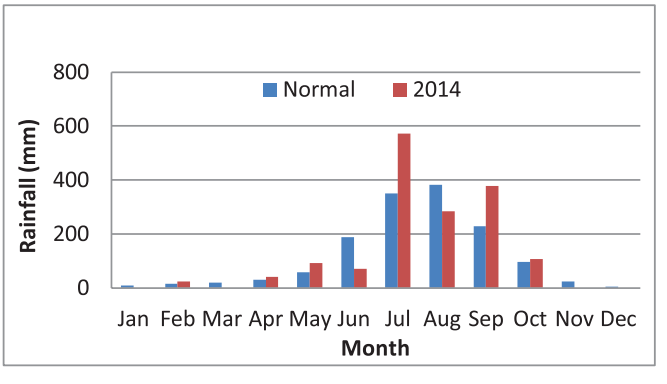


Fig. 2.5: Normal and actual (2014) monthly rainfall at Phulbani

At Varanasi, the onset of monsoon was timely during 2nd week of June (16th June). A rainfall of 696.1 mm was received which was deficit by 249 mm compared to normal (945 mm) (Fig. 2.6), during south-west monsoon (*kharif).* During north-east monsoon (October - December), 84.8 mm of rainfall was received which was excess by 24 mm compared to normal (60.9 mm). During summer, 35.7 mm of rainfall was received which was excess by 3.4 mm compared to normal (32.3 mm).

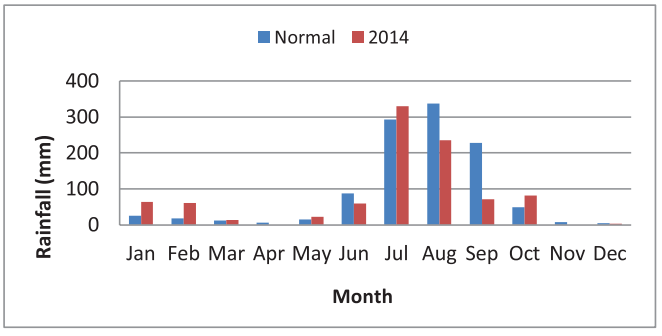


Fig.2.6: Normal and actual (2014) monthly rainfall at Varanasi

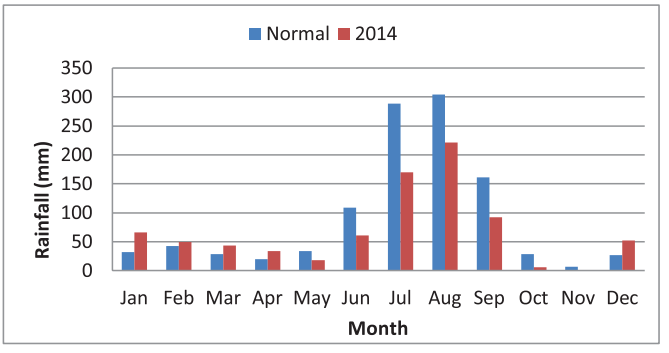


Fig. 2.8: Normal and actual (2014) monthly rainfall at Ballowal Saunkhri

Maize based production system

At Arjia, the onset of monsoon was delayed by 9 days (11th July). A rainfall of 870 mm was received which excess by 212.3 mm compared to normal 567.7 mm (Fig. 2.7). During south-west monsoon (June to September) 711.6 mm rainfall was received which was excess by 97.1 mm (15.8%; during north-east monsoon (October-December), there was no rain against normal of 20.2 mm. During summer (March - May), 83.8 mm of rainfall was received which was excess by 68.7 mm compared to normal (15.1 mm).

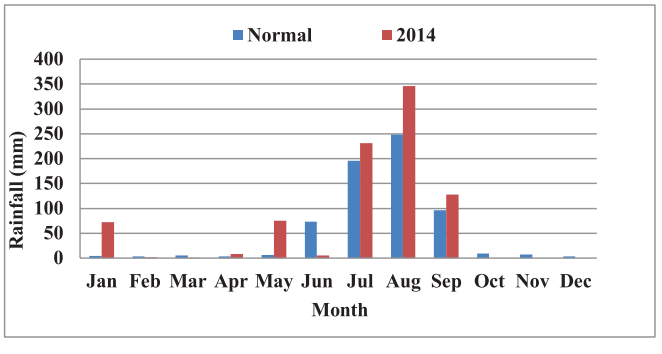


Fig. 2.7: Normal and actual (2014) monthly rainfall at Arjia

At Ballowal Saunkhri, the annual rainfall recorded during the year 2014 was 812.7 mm, which was 24.8% less than the normal rainfall of 1081 mm (mean of 25 years). Out of the total rainfall, 545 mm was received during the *kharif* season (June to September) as against normal of 862 mm. In *rabi*, 57.8 mm rainfall was received which was 4.1 mm deficit than normal of 61.9 mm. In summer season, the rainfall was 94.7 mm and was excess by 12.6 mm as against normal of 82.1 mm (Fig. 2.8).

At Rakh Dhiansar, the onset of monsoon was delayed by 5 days (first week of July). A rainfall of 728.7 mm was received which was deficit by 157.1 mm compared to normal (885.8 mm) (Fig. 2.9), during *kharif* season. During *rabi* (October - December), 15 mm of rainfall was received which was deficit by 32.6 mm compared to normal (47.6 mm). During summer (March -May), 145.2 mm of rainfall was received which was excess by 31.1 mm compared to normal (114.1 mm).

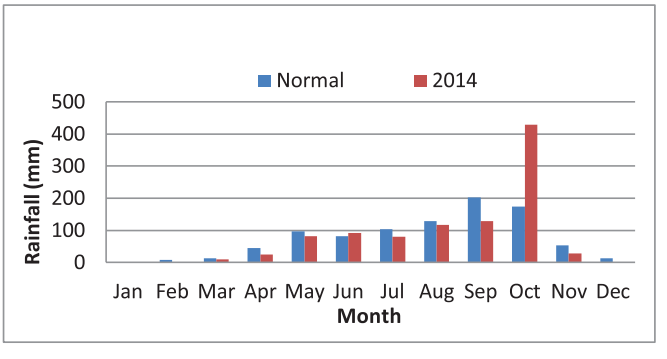


Fig. 2.9: Normal and actual (2014) monthly rainfall at Rakh Dhiansar

Fingermillet based production system

During 2014, the onset of monsoon was delayed by 6 days (8th of June). A rainfall of 992.3 mm was received which was excess by 69.2 mm (7.5%) compared to normal (923.1 mm) (Fig. 2.10). During *kharif* season (June–Sep), 417.6 mm was recorded which was deficit by 99.3 mm (19.2%) against normal of 516.9 mm. In *rabi* season, it was 457.8 mm which was excess by 216.7 mm (90%) than the normal of 241.1 mm, and in summer, 116.9 mm was recorded which was deficit by 38.9 mm (25%) than normal rainfall of 155.8 mm.

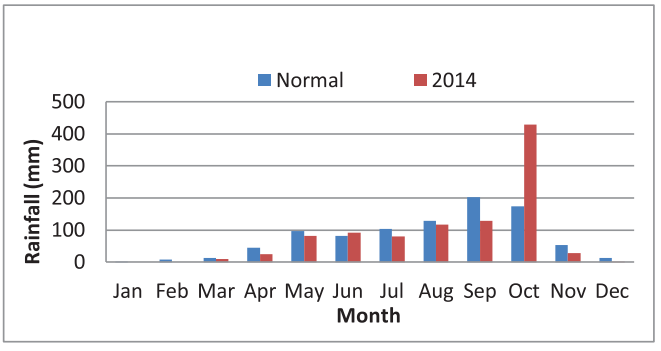


Fig. 2.10: Normal and actual (2014) monthly rainfall at Bangalore

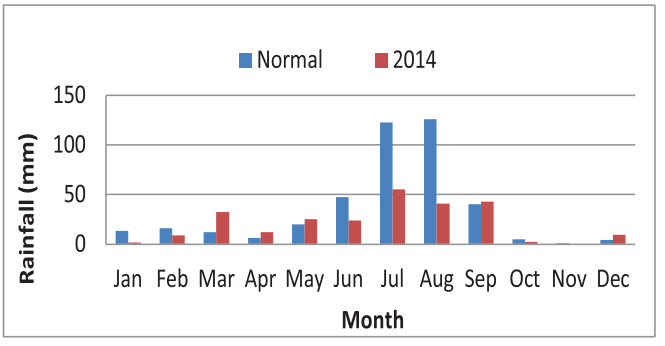


Fig. 2.12: Normal and actual (2014) monthly rainfall at Hisar

Pearlmillet based production system

At Agra, the onset of monsoon was delayed by 15 days (17th July). A rainfall of 480.7 mm was received which was deficit by 181.8 mm compared to normal (662.5 mm). During south-west monsoon (*kharif*), 363.1 mm rainfall was received which was deficit by 224 mm (38.2%) as against normal of 587.1 mm. During *rabi* (October-December), 5.2 mm rainfall was received which was deficit by 23.3 mm compared to normal (28.5 mm). During summer (March-May), 19.6 mm of rainfall was received which was deficit by 3.8 mm compared to normal (23.4 mm) (Fig 2.11).

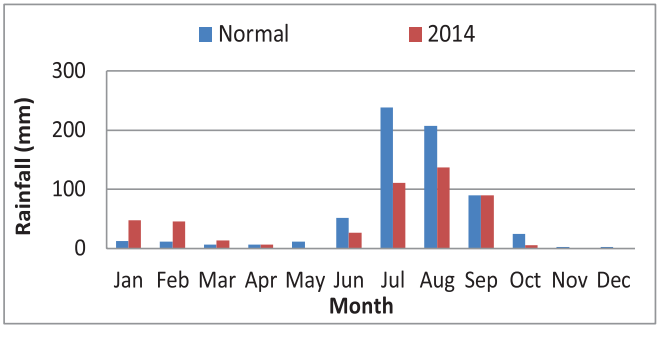


Fig. 2.11: Normal and actual (2014) monthly rainfall at Agra

At Hisar, the onset of monsoon was delayed by 4 weeks (29th July) and a rainfall of 253.7 mm was received which was deficit by 158.3 mm (38.4%) compared to normal (412 mm) (Fig. 2.12). During *kharif* season, 162.4 mm rainfall was received which was deficit by 173.4 mm (51.6%) than normal of 335.8 mm. In *rabi*, 11.7 mm rainfall was received which was 2.5 mm excess than normal of 9.2 mm and in summer rainfall was excess by 31.8 mm (69.8%) than normal of 38 mm.

At SK Nagar, the onset of monsoon was delayed by 21 days (16th July). A rainfall of 622.9 mm was received which was deficit by 15.1 mm compared to normal (638 mm) (Fig. 2.13). During south-west monsoon (*kharif*), 622.9 mm was received which was excess by 27.1 mm than normal rainfall of 598.1 mm; during *rabi* (October-December), and summer (March-May) there were no rains compared to normal rainfall of 27.1 and 8.8 mm, respectively.

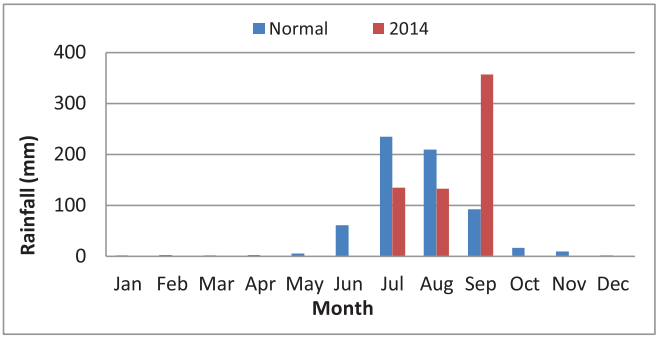


Fig. 2.13 : Normal and actual (2014) monthly rainfall at SK Nagar

Sorghum based production system

At Vijayapura, a rainfall of 736.8 mm was received which was excess by 141.7 mm (23.8%) compared to normal (595.1 mm). Out of total rainfall in 2014 (736.8 mm), *kharif* season (June- Sep) recorded 511.1 mm which was excess by 122.5 mm (31.5%) than seasonal normal of 388.6 mm. During *rabi*, it was 96.3 mm which was deficit by 37.9 mm (28.2%) than normal rainfall of 134.2 mm and in summer 123 mm was recorded and was excess by 57.4 mm (87.5%) than normal rainfall of 65.6 mm (Fig. 2.14).

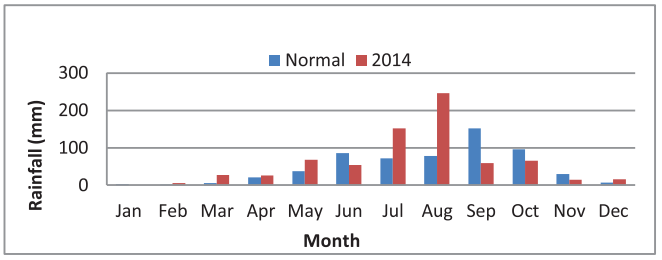


Fig. 2.14: Normal and actual (2014) monthly rainfall at Vijayapura

At Solapur, a rainfall of 609.1 mm was received which was deficit by 112.2 mm (15.6%) compared to normal of 721.3 mm. During *kharif,* 362.3 mm rainfall was recorded, which was deficit by 172.8 mm (32.3%) than normal of 535.1 mm; *rabi* season recorded 93.5 mm which was deficit by 32 mm (25.5%) than normal rainfall of 125.5 mm and in summer, 131.9 mm rainfall was received, 79.3 mm excess rainfall (150.8%) as against normal of 52.6 mm (Fig. 2.15).

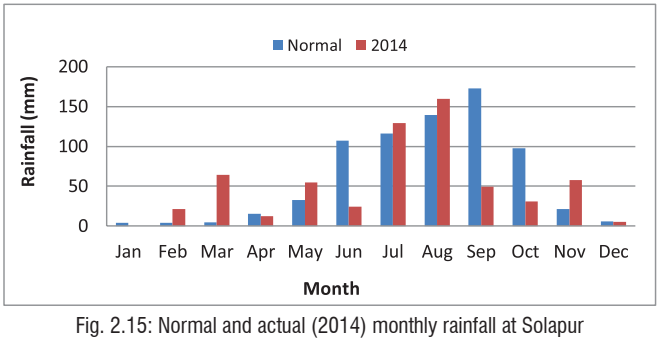


Fig. 2.15: Normal and actual (2014) monthly rainfall at Solapur

Soybean based production system

At Indore, annual rainfall of 879.8 mm was received which was deficit by 78.2 mm compared to normal (958 mm) (Fig. 2.16). During south-west monsoon (*kharif*), the rainfall received was 718.2 mm compare to normal (854.5 mm) which was deficit by 136.3 mm (15.9%). During *rabi* (October - December), 37.2 mm rainfall was received which was deficit by 27.3 mm (42.3%) compared to normal (64.5 mm). During summer, 26.6 mm rainfall was received which was deficit by 4.05 mm (13.2%) compared to normal (30.6 mm).

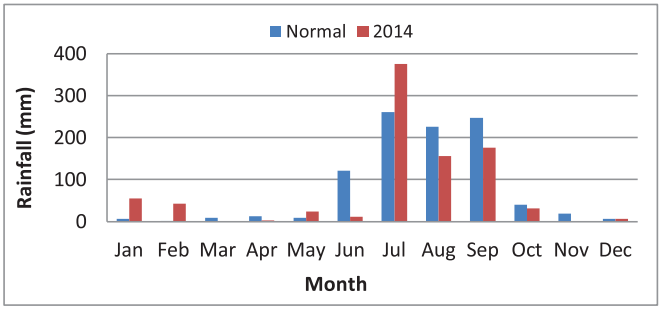


Fig. 2.16: Normal and actual (2014) monthly rainfall at Indore

Groundnut based production system

At Anantapur, the onset of monsoon was delayed by 10 days (15th June). A rainfall of 375.2 mm was received which was deficit by 194.6 mm (34.2%) compared to normal (569.8 mm) during 2014. Out of total rainfall, 216.2 mm was received in *kharif* season which was 135.9 mm deficit (38.6%) than normal of 352.1 mm. In *rabi*, it was 83.2 mm and was deficit by 60.8 mm (42.2%) than normal of 144 mm and in summer season, 75.8 mm rainfall was received which was excess by 4.3 mm (6%) than normal of 71.5 mm (Fig. 2.17).

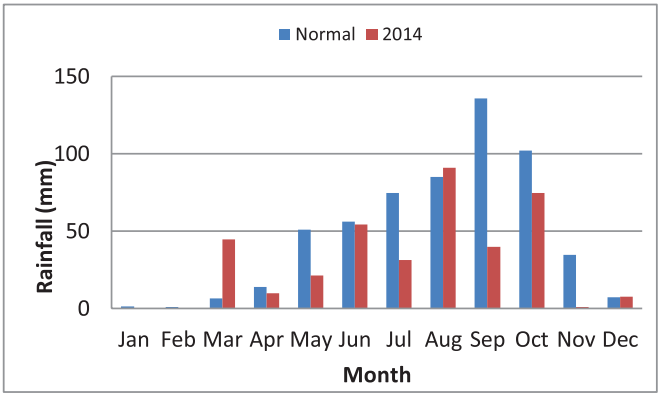


Fig. 2.17 : Normal and actual (2014) monthly rainfall at Anantapur

At Rajkot, the onset of monsoon was delayed by 25 days (10th July). A rainfall of 491.9 mm was received which was deficit by 98.5 mm as compared to normal rainfall of 590.4 mm (Fig. 2.18). During south-west monsoon (*kharif*), 481.9 mm rainfall was received which was deficit by 76.03 mm (13.6%) than normal of 557.9 mm. During *rabi* (October - December), 10 mm rainfall was received which was deficit by 14.5 mm as compared to normal 24.8 mm and in summer, there were no rains as against normal of 6 mm.

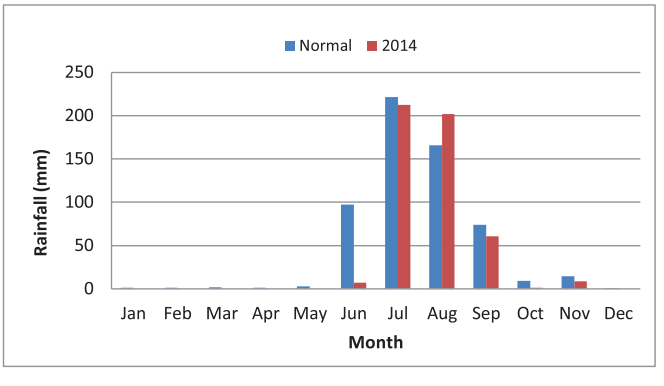


Fig. 2.18: Normal and actual (2014) monthly rainfall at Rajkot

Cotton based production system

At Akola, the onset of monsoon was during second week of July (11th July). A rainfall of 661.3 mm was received which was deficit by 150.6 mm (18.5%) compared to normal (811.9 mm) (Fig. 2.19). Out of total rainfall received, 570.1 mm was received during kharif season which was deficit by 117.9 mm compared to normal of 688 mm. During rabi (October - December), 23 mm of rainfall was received which was deficit by 59 mm compared to normal (82 mm). During summer (March - May), 39.6 mm of rainfall was received which was excess by 16.8 mm compared to normal rainfall (22.8 mm).

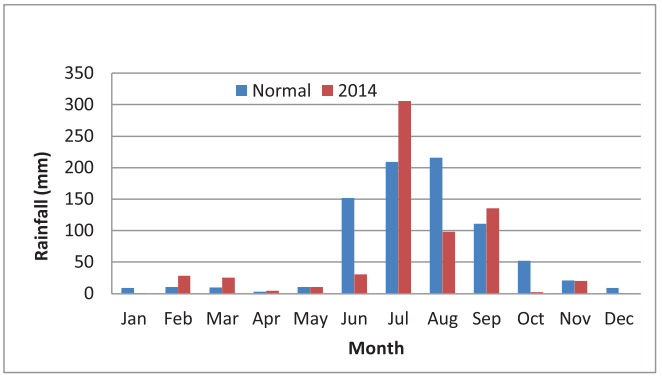


Fig. 2.19: Normal and actual (2014) monthly rainfall at Akola

At Kovilpatti, a rainfall of 666.8 mm was received which was deficit by 55.8 mm (7.7%) compared to normal rainfall 722.6 mm. During *kharif* (June to September), 170.8 mm rainfall was received which was excess by 20.6 mm than normal of 150.2 mm; in *rabi* season (October – December), 301.2 mm rainfall received which was deficit by 89.7 mm than normal of 390.9 mm and during summer (March to May 2014), 177.7 mm rainfall was received which was also excess by 36.8 mm than normal of 140.9 mm (Fig. 2.20).

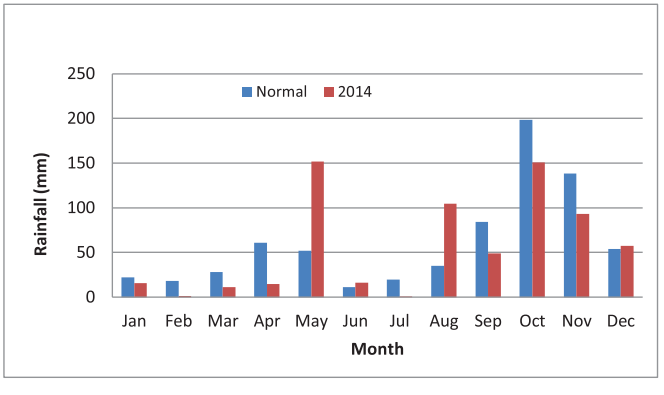


Fig. 2.20: Normal and actual (2014) monthly rainfall at Kovilpatti

At Parbhani, the onset of monsoon was delayed by 19 days (9th July). A rainfall of 569.7 mm was received which was deficit by 393.3 mm (40.8%) compared to normal of 963 mm (Fig. 2.21). During *kharif* season, 398.1 mm rainfall was recorded which was deficit by 402.4 mm (50.3%) than normal rainfall of 800.5 mm; *rabi* season received 37.6 mm and was deficit by 72.9 mm (66%) than normal of 110.5 and the summer season received 109.6 mm which was excess by 73.1 mm (200.3%) as against normal of 36.5 mm.

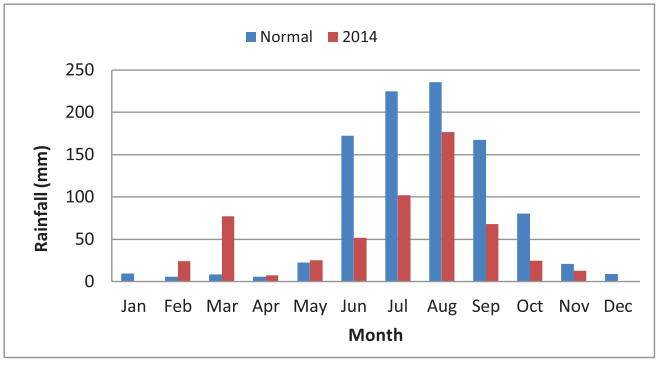


Fig. 2.21: Normal and actual (2014) monthly rainfall at Parbhani

The production system wise and centre-wise resource characterization, salient achievements and other activities are presented in the following chapters.

Table 2.3: Production system wise rainfall (mm) received at AICRPDA centers during 2014

Centre	June			July			August			September			October			November			December		
Rice based production system																					
	N	A	D (%)	N	A	D (%)	N	A	D (%)	N	A	D (%)	N	A	D (%)	N	A	D (%)	N	A	D (%)
Biswanath Chariali	331.6	335.4	1.1	341.9	386.9	13.2	313.4	331.5	5.8	195.3	397.3	103.4	96.3	6.2	-93.6	17.8	0	-100	5.9	0.8	-86.4
Chianki	157.3	75.6	-51.9	374.6	143.2	-61.8	303.8	106.2	-65.0	202.3	79.0	-60.9	50.8	4.0	-92.1	7.2	9	25	7.9	0	-100
Faizabad	133.4	35.6	-73.3	288.3	275.8	-4.3	300.1	64.7	-78.4	193.1	41.5	-78.5	50.5	97.8	93.7	4	0	-100	11.1	19.1	72.1
Jagdalpur	235.5	151.3	-35.8	342.6	336	-1.9	350.5	338.9	-3.3	192.9	321.7	66.8	88.2	112.4	27.4	20.2	1.6	-92.1	6.4	0	-100
Phulbani	188.7	69.8	-63.0	350.4	573.0	63.5	383.2	284.9	-25.7	228.2	378	65.6	95.7	107.4	12.2	24	0	-100	5.03	0	-100
Varanasi	86.8	59.3	-31.7	293.3	330.3	12.6	336.9	234.9	-30.3	227.5	71.6	-68.5	49.1	82.0	67.0	7.2	0	-100	4.6	2.8	-39.1
Maize based production system																					
Arjia	73.5	5.4	-92.7	195.6	231.7	18.5	248.8	346.5	39.3	96.6	128.0	32.5	9.6	0	-100	6.8	0	-100	3.8	0	-100
Ballowal Saunkhri	108.4	61.1	-43.6	288.1	170.3	-40.9	304.3	221.2	-27.3	161.2	92.4	-42.7	28.2	5.8	-79.4	6.9	0	-100	26.8	52	94.0
Rakh Dhiansar	90.8	13.1	-85.6	323.8	130.3	-59.8	333.9	201.7	-39.6	137.3	383.6	179.4	19.3	12.2	-36.8	6.4	2.8	-56.3	21.9	0	-100
Fingermillet based production system																					
Bangalore	81.7	92.0	12.6	103.0	80.8	-21.6	129	116.4	-9.8	203.2	128.4	-36.8	173.9	428.2	146.2	53.9	28.6	-46.9	13.3	1.0	-92.5
Pearlmillet based production system																					
Agra	51.5	26.4	-48.7	238.6	110.5	-53.7	207.2	137.0	-33.9	89.8	89.2	-0.7	24.6	5.2	-78.9	2	0	-100	1.9	0	-100
Hisar	47.4	23.7	-50.0	122.4	55.2	-54.9	125.6	41.0	-67.4	40.4	42.5	5.2	4.9	2.5	-49.0	0.1	0	-100	4.2	9.2	119
SK Nagar	61.2	0.0	-100	234.6	134.4	-42.7	209.8	132.2	-37.0	92.5	356.3	285.2	16.6	0	-100	9.4	0	-100	1.1	0	-100
Sorghum based production system																					
Vijayapura	86	54.4	-36.7	72.9	151.6	108.0	78.1	245.7	214.6	151.6	59.4	-60.8	96.2	65.3	-32.1	30.6	15.0	-51.0	7.4	16.0	116.2
Solapur	107.1	24.1	-77.5	115.8	129.2	11.6	139.6	159.7	14.5	172.7	49.3	-71.5	97.9	30.6	-68.7	21.6	57.7	167.1	6.0	5.2	-13.3
Soybean based production system																					
Indore	120.8	11.0	-90.9	260.8	375.4	43.9	225.4	155.6	-31.0	247.5	176.2	-28.8	39.7	31.4	-20.9	18.3	0	-100	6.5	5.8	-10.8
Rewa	119.8	30.4	-74.6	308.8	266.2	-13.8	337.4	268.2	-20.51	199.1	154..2	-22.6	31.9	154.2	383.4	9.7	0	-100	8.5	21	147.1
Groundnut based production system																					
Anantapur	56.3	54.2	-3.7	74.7	31.2	-58.2	85.2	90.8	6.6	135.9	40.0	-70.6	102.1	74.6	-26.9	34.6	1.0	-97.1	7.3	7.6	4.1
Rajkot	97.2	7.0	-92.8	221.2	212.6	-3.9	165.6	201.6	21.7	73.9	60.7	-17.9	9.3	1.2	-87.1	14.6	8.8	-39.9	0.5	0	-100
Cotton based production system																					
Akola	151.7	30.2	-80.1	209.2	306	46.3	216	98.4	-54.4	111.1	135.5	22.0	52.3	2.0	-96.2	20.5	20.1	-2.0	9.2	0.9	-90.2
Kovilpatti	11.1	16.0	44.1	19.8	1.0	-94.9	35.1	104.8	198.6	84.2	49.0	-41.8	198.6	150.8	-24.1	138.5	93.2	-32.7	53.8	57.2	6.3
Pharbani	172.4	51.5	-70.1	225.0	102.0	-54.7	235.8	176.5	-25.1	167.3	68.1	-59.3	80.4	24.6	-69.4	20.9	13.0	-37.8	9.2	0	- 100

N: Normal; A: Actual; D: Deficit

3.1 Rice Based Production System

3.1.1 Rainwater management

In a study on lining materials for rainwater storage in farm pond at Biswanath Chariali, lining with polythene sheets was found to be most effective with availability of water throughout the year. Seepage and percolation loss was highest in no lining condition followed by cow dung + soil plaster, cement + soil plaster and polythene sheet lining material (Fig. 3.1).

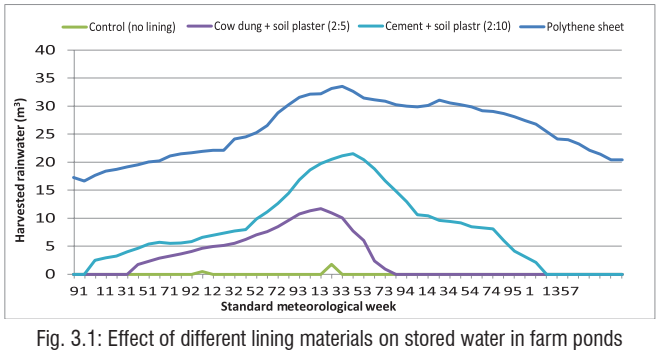
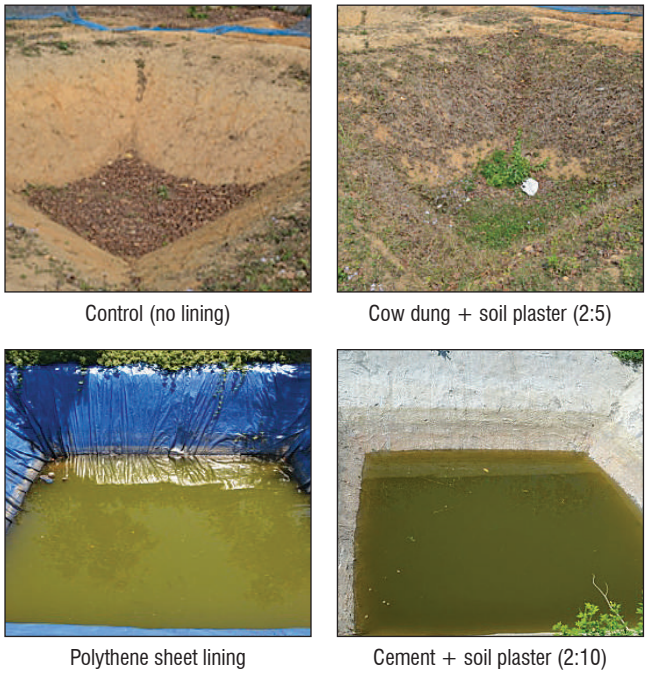


Fig. 3.1: Effect of different lining materials on stored water in farm ponds



Control (no lining) | Cow dung + soil plaster (2:5) | Polythene sheet lining | Cement + soil plaster (2:10)

At Biswanath Chariali, tuber yield of potato was highest (23.39 t/ha) with net returns of Rs. 109370/ha with three irrigation at 25, 60 and 80 days after planting (DAP) from the harvested water in farm pond + vermicompost @ 2 t/ha followed by three irrigation at 25, 60 and 80 DAP + no organics. The higher mean tuber yield (22.55 t/ha) and stalk yield (16.98 t/ha) were recorded with the same treatment of three irrigation at 25, 60 and 80 DAP + vermicompost @ 2 t/ha as compared to other treatments (Table 3.1).

Table 3.1: Efficiency of harvested rainwater on potato under rainfed condition – Biswanath Chariali

Treatment	Yield (t/ha)			Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)	Total irrigation applied (mm)	Irrigation potential (ha) of harvested tank
	Tuber (2014-15)	Mean tuber yield (2 yrs)	Stalk						
Control + no organics	9.51	8.71	6.48	85140	450	1.01	139.44	0.00	-
Control + vermicompost @ 2 t/ha	12.25	12.11	8.46	95140	15110	1.16	179.62	0.00	-
One irrigation at 25 DAP + no organics	13.81	14.20	9.69	87140	37150	1.43	94.29	78.36	0.324
One irrigation at 25 DAP + vermicompost @ 2 t/ha	15.92	15.67	11.29	97140	46140	1.47	110.89	75.36	0.337
Two irrigation at 25 and 60 DAP + no organics	18.16	22.01	12.98	89140	74300	1.83	80.79	156.59	0.162
Two irrigation at 25 and 60 DAP + vermicompost @ 2 t/ha	18.65	22.54	13.43	99140	68710	1.69	82.29	158.44	0.160
Three irrigation at 25, 60 and 80 DAP + no organics	22.00	20.99	15.86	91140	106860	2.17	72.95	233.38	0.109
Three irrigation at 25, 60 and 80 DAP + vermicompost @ 2 t/ha	23.39	22.55	16.98	101140	109370	2.08	77.38	234.09	0.108

A total rainfall of 68.2 mm was received during the crop growing period; DAP = Days after planting

Three irrigations at 25, 60 and 80 DAP + vermicompost @ 2 t/ha

Control

At Faizabad, in an experiment involving improvement in rice by optimizing bund height and date of sowing, grain yield was maximum (2323 kg/ha) with total input energy of 7960 MJ/ha and maximum energy productivity of 0.322 kg/MJ and RWUE of 5.38 kg/ha-mm with 10 cm bund height. However, minimum total input energy (7955 MJ/ha) and output energy (58568 MJ/ha) was recorded in 5 cm bund height. In case of sowing dates, sowing in first week of July (5th July) gave maximum rice grain yield (2233 kg/ha) with 7957 MJ/ha of total input energy and 71613 MJ/ha of output energy. The maximum rainwater use efficiency (7.38 kg/ha-mm) was recorded when sowing was delayed by one week (12th July) (Table 3.2).

Table 3.2: Enhancing water productivity in rice by optimizing bund height and date of sowing - Faizabad

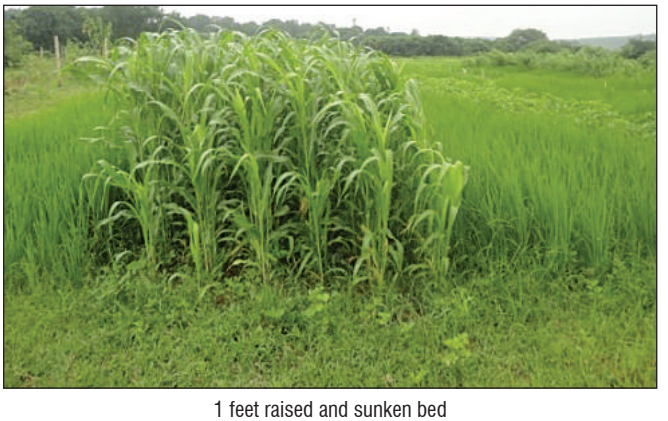
Treatment	Grain yield (kg/ha)	Mean grain yield (3 yrs)	Straw yield (kg/ha)	Mean straw yield (3 yrs)	Total input energy (MJ/ha)	Energy productivity (kg/MJ)	Output energy (MJ/ha)			RWUE (kg/ha-mm)
							Grain	Straw	Total	
Bund height (cm)										
5.0	1900	2139	2451	2679	7955	0.268	27930	30638	58568	4.58
7.5	2182	2374	3033	3134	7957	0.298	32075	37913	69988	5.09
10.0	2323	2511	3252	3377	7960	0.322	34148	40650	74798	5.38
CD at 5%	242	248	224	230	-	-	-	-	-	-
Date of sowing										
Normal (5th July)	2233	2481	3103	3322	7957	0.311	32825	38788	71613	5.98
One week delay (12th July)	2162	2352	2918	3044	7957	0.295	31781	36475	68193	7.38
Two week delay (19th July)	2010	2192	2613	2753	7957	0.275	29547	32663	62210	6.07
CD at 5%	218	231	202	221	-	-	-	-	-	-

At Jagdalpur, in an experiment on *in-situ* moisture conservation under upland situation, 1 feet sunken/raised bed gave higher grain yield (2440 kg/ha) and RWUE (1.97 kg/ha-mm) of upland rice, maize and fingermillet as compared to ½ feet sunken and raised bed. However, higher seed yield of cowpea (4517 kg/ha) was recorded in raised bed by ½ feet excavation. The highest RWUE (3.74 kg/ha-mm) was achieved by cowpea with ½ feet raised bed (Table 3.3).

Table 3.3: Evaluation of raised and sunken bed technique of *in-situ* moisture conservation under upland situation - Jagdalpur

Treatment	Rice				Cowpea			
	Grain yield (kg/ha)		RWUE (kg/ha-mm)		Seed yield (kg/ha)		RWUE (kg/ha-mm)	
	2014	Mean (2 years)	2014	Mean (2 years)	2014	Mean (2 years)	2014	Mean (2 years)
½ feet sunken/raised bed	2170	2155	1.75	1.78	4517	4658	3.74	3.90
1 feet sunken/raised bed	2440	2465	1.97	2.04	4236	4317	3.41	3.56
Flat bed	1970	1895	1.59	1.56	3630	3454	2.93	2.85
	Maize				Fingermillet			
½ feet sunken/raised bed	4015	3983	3.24	3.29	2480	1760	2.00	1.44
1 feet sunken/raised bed	4226	4250	3.41	3.51	2820	1950	2.27	1.59
Flat bed	3461	3318	2.79	2.74	1970	1367	1.59	1.12

1/2 feet raised and sunken bed



1 feet raised and sunken bed

At Phulbani, supplemental irrigation with continuous furrow method, from the harvested rainwater in farm pond, gave higher yields, net returns and energy use efficiency in case of all vegetables compared to skip furrow method. However, both the irrigation methods were found to be better than no irrigation. Higher radish equivalent yield (REY) of 23656 kg/ha was obtained with yambean under continuous furrow method. Yambean gave 57.8% increase in REY under continuous furrow method compared to no irrigation (Table 3.4).

Table 3.4: Crop yield and economics with supplemental irrigation methods - Phulbani

Treatment		Yield (kg/ha)		Cost of cultivation (Rs)	NMR (Rs/ha)	B:C ratio	Energy use efficiency (kg/MJ)	RWUE (kg/ha-mm)	REY (kg/ha)	% increase in REY over 'no irrigation'
Crop	Irrigation method	2014	Mean (2 years)							
Radish	Continuous furrow	19297	21121	40000	114374	3.86	7.17	16.65	19297	29.6
	Skip furrow	17599	18813	37000	103792	3.81	7.06	15.87	17599	18.1
	No irrigation	14906	16005	34000	85245	3.51	4.01	22.62	14906	0.0
Cauliflower	Continuous furrow	5596	5643	50000	89907	2.80	5.34	4.42	17488	46.8
	Skip furrow	4957	4957	47000	76915	2.64	4.64	4.08	15489	30.0
	No irrigation	3813	3438	44000	51336	2.17	3.31	4.98	11917	0.0

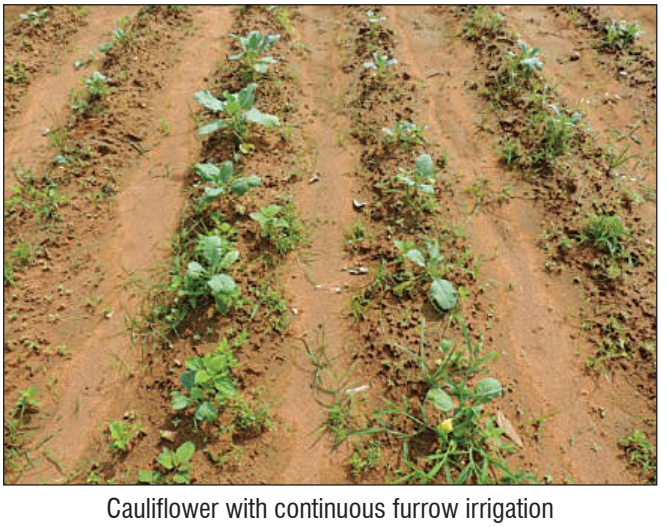
Treatment		Yield (kg/ha)		Cost of cultivation (Rs)	NMR (Rs/ha)	B:C ratio	Energy use efficiency (kg/MJ)	RWUE (kg/ha-mm)	REY (kg/ha)	% increase in REY over 'no irrigation'
Crop	Irrigation method	2014	Mean (2 years)							
Yambean	Continuous furrow	9463	11215	50000	139250	3.79	8.76	7.47	23656	57.8
	Skip furrow	7505	8965	47000	103108	3.19	7.86	6.17	18763	25.2
	No irrigation	5997	6964	44000	75933	2.73	4.60	7.83	14992	0.0
Okra	Continuous furrow	4824	5401	42000	78597	2.87	4.14	3.81	15075	28.2
	Skip furrow	4063	4676	39000	62570	2.60	3.63	3.34	12696	8.0
	No irrigation	3763	4080	35000	59072	2.69	2.87	4.91	11759	0.0

REY: Radish equivalent yield

Radish with no irrigation

Radish with continuous furrow irrigation

Yambean with skip furrow irrigation



Cauliflower with continuous furrow irrigation

At Varanasi, in an evaluation of foliar nutrition for drought coping, foliar spray with 2% KCL + Zn + Bo gave highest grain yield of rice (2111 kg/ha), with higher net returns (Rs.24059/ha), B:C ratio (2.58) and RWUE (3.02 kg/ha-mm) followed by foliar spray of 2% urea (2042 kg/ha) while absolute control gave lowest grain yield (1518 kg/ha) (Table 3.5).

Table 3.5: Effect of foliar sprays for mitigating drought in rice - Varanasi

Treatment	Yield (kg/ha)			Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Grain yield (2014)	Mean (2 years)	Straw yield				
Control	1517	1647	3026	13000	15058	2.16	2.07
Water spray	1823	1705.	3514	14200	19249	2.36	2.49
Foliar spray of 2% KCl	1852	1834	3229	14500	18799	2.30	2.53
Foliar spray of 2% KNO_3	1914	1979	3483	14500	20218	2.40	2.62
Foliar spray of 2% Thiourea	2042	1945	3709	14500	22527	2.56	2.80
Foliar spray of 2% KCl with Zn + Bo	2211	2127	3598	15200	24059	2.58	3.02
CD at 5%	68	-	154	-	1009	0.07	0.09

At Varanasi, in an evaluation of foliar sprays for drought coping, foliar spray with 2% KCl + Zn + Bo gave highest seed yield of lentil (1175 kg/ha), with higher net returns (Rs.29125/ha), B:C ratio (3.43) and RWUE (8.96 kg/ha-mm) followed by foliar spray of 2% urea with 1123 kg/ha while absolute control gave lowest yield (847 kg/ha) (Table 3.6).

Table 3.6: Yield and economics of lentil under drought management practices - Varanasi

Treatment	Yield (kg/ha)		Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Seed	Stalk				
Control	847	1673	12000	17663	2.47	6.46
Water spray	942	1850	12000	20973	2.75	7.19
Foliar spray of 2% KCl	946	1856	12000	21119	2.76	7.22
Foliar spray of 2% KNO_3	1099	2090	12000	26494	3.21	8.39
Foliar spray of 2% Thiourea	1123	2090	12000	27309	3.28	8.57
Foliar spray of 2% KCl with Zn + Bo	1175	2140	12000	29125	3.43	8.96
CD at 5%	69	96	-	2424	0.20	0.53

In an evaluation of high value crops (bottle gourd, okra & chilli) under supplemental irrigation from harvested rainwater at Varanasi, bottle gourd gave of yield 12200 kg/ha with RWUE of 17.23 kg/ha-mm and B:C ratio of 3.05 followed by okra (4800 kg/ha). Two irrigation each of 5 cm were given at flowering and fruiting stages of the crops (Table 3.7).

Table 3.7: Performance of crops under supplemental irrigation - Varanasi

Crop	Yield (kg/ha)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
Bottle gourd	12200	40000	82000	3.05	17.23
Okra	4800	20000	28000	2.4	6.78
Chilli	36000	20000	16000	1.8	1.69

Performance of high value crops under supplemental irrigation

At Varanasi, in a study on efficient utilization of harvested rainwater for growing pea, supplemental irrigation at flowering stage gave maximum seed yield of 1462 kg/ha, net returns Rs.20090/ha and B:C ratio of 2.2 as compared to no irrigation (1228 kg/ha, Rs.15540/ha and 2.03, respectively). Among pea varieties, AP-3 recorded highest yield of 1406 kg/ha, NMR of Rs.17430/ha and B:C ratio of 1.98 while Malvia-15 gave pea yield of 1259 kg/ha (Table 3.8).

Table 3.8: Effect of variety and supplemental irrigation on yield of pea - Varanasi

Treatment	Seed yield (kg/ha)		Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	2014	Mean (2 yrs)				
Variety						
Malvia-15	1259	1416	15115	16360	2.08	18.0
AP-3	1406	1902	17720	17430	1.98	20.1
CD at 5%	NS	-	-	-	-	-
Supplemental irrigation						
No Irrigation	1228	1395	15160	15540	2.03	17.6
Irrigation at flowering	1462	1730	16460	20090	2.2	20.9
Irrigation at podding	1308	1853	16346	16354	2.0	18.8
CD at 5%	NS	-	-	-	-	-

3.1.2 Cropping systems

At Biswanath Chariali, in an evaluation of maize based double cropping systems, maximum maize equivalent yield (MEY) of 10300 kg/ha was obtained with maize-potato system with NMR of Rs.123865/ha followed by maize-rajmah system with MEY of 9944 kg/ha and NMR of Rs.119220/ha as compared to other cropping systems. Higher B:C ratio (3.61) was recorded with maize-rajmah cropping system compared to other systems (Table 3.9).

Table 3.9: Evaluation of maize based double cropping systems under rainfed upland situation - Biswanath Chariali

Treatment	Yield (kg/ha)		MEY (kg/ha)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Maize	Rabi crops					
Maize – toria	6770	502	7840	33788	93931	2.78	11.20
Maize – lathyrus	7060	461	7943	28788	95288	3.31	11.35
Maize – pea	6600	609	7833	30153	94077	3.12	11.19
Maize – lentil	6800	467	8747	33763	105003	3.11	12.50

Treatment	Yield (kg/ha)		MEY (kg/ha)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Maize	Rabi crops					
Maize – linseed	7000	439	7915	32943	94876	2.88	11.31
Maize – buckwheat	6750	977	7727	30573	92636	3.03	11.04
Maize – mustard	6940	590	8219	33638	98559	2.93	11.74
Maize – niger	6540	891	8434	31513	101157	3.21	12.05
Maize- maize	6810	3090	9381	51700	112706	2.18	14.21
Maize – rajmah	7150	958	9944	32663	119220	3.65	14.21
Maize – horsegram	6870	481	8072	30409	97005	3.19	11.53
Maize –potato	7100	5110	10300	62558	123865	1.98	14.71

MEY: Maize equivalent yield

At Biswanath Chariali, in an evaluation of sesame based intercropping systems with two fertility levels, maximum sesame equivalent yield of 1300 kg/ha, net returns of Rs.47758/ha and RWUE of 3.22 kg/ha-mm were recorded by F1S2 treatment combination (30:20:20 kg NPK/ha with sesame + greengram (2:2) followed by F1S3 (30:20:20 kg NPK/ha with sesame + blackgram (1:1)) with SEY of 1280 kg/ha, net returns of Rs.47232/ha, and RWUE of 3.17 kg/ha-mm. However, the highest LER (1.74), MAI (27218) and B:C ratio (3.82) were recorded under sesame + blackgram (1:1) intercropping system with 30:20:20 kg NPK/ha as compared to other treatment combinations (Table 3.10).

Table 3.10: Effect of fertility levels on yield and economics of sesame based intercropping systems – Biswanath Chariali

Treatment	Yield (kg/ha)		SEY (kg/ha)	LER	MAI	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Main crop	Inter crop							
F_1S_1	492	465	1050	1.38	14456	17142	35358	3.06	2.60
F_1S_2	646	540	1300	1.71	26988	17242	47758	3.77	3.22
F_1S_3	582	770	1280	1.74	27218	16768	47232	3.82	3.17
F_1S_4	572	510	1030	1.43	15486	16668	34832	3.09	2.55
F_2S_1	401	417	902	1.18	6880	17045	28055	2.65	2.24
F_2S_2	459	433	981	1.29	11026	17113	31937	2.87	2.43
F_2S_3	308	447	710	1.12	3803	16530	18970	2.15	1.76
F_2S_4	341	382	686	1.01	339	16748	17552	2.05	1.70
F_3S_1	429	341	838	1.11	4152	17358	24542	2.41	2.08
F_3S_2	518	371	963	1.28	10533	17442	30708	2.76	2.39
F_3S_3	541	328	837	1.17	6081	16615	25235	2.52	2.07
F_3S_4	348	281	601	1.19	4798	16778	13272	1.79	1.49

S_1: sesame + greengram (1:1); S_2: sesame + greengram (2:2); S_3: sesame + blackgram (1:1); S_4: sesame + blackgram (2:2); F_1= 30:20:20 kg NPK/ha; F_2= 15:35:10 kg NPK/ha; F_3= 30:35:20 kg NPK/ha; LER: Land equivalent ratio; SEY: Sesamum equivalent yield; MAI: Monetary advantage index.

Sesame intercropped with greengram (2:2) with 30:20:20 kg NPK/ha

Sesame (Sole)

In an experiment to evaluate the effect of planting time and varieties of potato under rainfed condition at Biswanath Chariali, highest tuber yield of 8626 kg/ha, NMR of Rs.152055/ha and B:C ratio of 4.61 were recorded when planting was done on 16th October, while lowest tuber yield of 6955 kg/ha, NMR of Rs.114455/ha and B:C ratio of 3.72 were recorded when planting was done on 16th November. Among varieties, Kufri Pokhraj recorded maximum of tuber yield (9022 kg/ha), NMR (Rs.44585/ha) and B:C ratio (1.98) as compared to other varieties (Table 3.11).

Table 3.11: Effect of planting time and varieties of potato on crop yield and economis – Biswanath Chariali

Treatment	Tuber yield (kg/ha)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
Date of planting					
1st October	7929	42045	136355	4.24	2549
16th October	8626	42045	152055	4.61	1470
1st November	8367	42045	146255	4.47	1427
16th November	6955	42045	114455	3.72	1186
CD at 5%	1303	-	-	-	-
Variety					
Local (red eyed)	7104	38454	32586	1.85	609
Local (white eyed)	7782	39865	37955	1.95	668
Recommended variety (*Kufri Pokhraj*)	9022	45635	44585	1.98	774

Kufri pokhraj

Local variety (Red eyed)

At Biswanath Chariali, in an evaluation of relay cropping of *rabi* pulses (pea, lentil and lathyrus with *kharif* rice under rainfed medium lowland situation with different seed rates, lathyrus relayed with 150% recommended seed rate (RSR) and 15 days before harvesting of rice gave maximum seed yield (425 kg/ha) and stover yield (982 kg/ha) followed by lathyrus relayed with 150% RSR at rice harvest with seed yield of 163 kg/ha. However, the performance of pea and lentil was poor compared to lathyrus (Table 3.12).

Table 3.12: Relay cropping of *rabi* pulses with *kharif* rice under rainfed medium lowland situation - Biswanath Chariali

Treatment	Seed yield (kg/ha)	Stalk yield (kg/ha)
Pea relayed with 100% RSR at 15 DBHR	129	244
Pea relayed with 150% RSR at 15 DBHR	137	280
Pea relayed with 100% RSR at rice harvest	111	229
Pea relayed with 150% RSR at rice harvest	131	265
Lentil relayed with 100% RSR at 15 DBHR	42	160
Lentil relayed with 150% RSR at 15 DBHR	61	212
Lentil relayed with 100% RSR at rice harvest	38	150
Lentil relayed with 150% RSR at rice harvest	40	147
Lathyrus relayed with 100% RSR at 15 DBHR	157	365
Lathyrus relayed with 150% RSR at 15 DBHR	425	982
Lathyrus relayed with 100% RSR at rice harvest	140	311
Lathyrus relayed with 150% RSR at rice harvest	163	353

RSR: Recommended seed rate; DBHR: Days before harvesting of rice

Lathyrus with 150% seed rate as relay crop in rice

Lentil with 100% seed rate as relay crop in rice

At Biswanath Chariali, intercropping of ginger + pigeonpea (ICPL-88039) gave higher ginger equivalent yield of 5405 kg/ha, LER (2.09), MAI (220920), NMR (Rs.522600/ha), B:C ratio (5.15) and RWUE (3.4 kg/ha-mm) compared to ginger + pigeonpea (local) and ginger (sole) (Table 3.13).

Table 3.13: Performance of ginger + pigeonpea intercropping system - Biswanath Chariali

Treatment	Yield (kg/ha)		GEY (kg/ha)	LER	MAI	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Rhizome yield (ginger) (kg/ha)	Intercrop (pigeonpea)							
Ginger + local (LDV)	4440	1410	5145	1.92	192912	126000	491400	4.90	3.0
Ginger + ICPL-88039 (SDV)	4950	910	5405	2.09	220920	125000	522600	5.15	3.4
Ginger (Sole)	4950	-	3120			175000	199400	2.14	2.1

GEY: Ginger equivalent yield; LDV: Long duration variety; SDV: Short duration variety

Ginger + pigeonpea(cv.LDV)

Ginger + pigeonpea (ICPL88039)

Ginger sole

At Biswanath Chariali, in a study on modeling crop growth parameters and yield of rice varieties, Gitesh variety of rice gave higher grain (5198 kg/ha) and straw yield (7873 kg/ha) compared to other varieties (Table 3.14a). In another study on modeling crop growth parameters and yield of potato, D_3 (26th Nov) planting recorded higher tuber yield (10752 kg/ha) of *Kufri* Jyoti variety, while D_2 (19th Nov) recorded higher tuber yield (12780 kg/ha) of Pokhraj variety (Table 3.14b).

Table 3.14a: Modelling crop growth parameters and yield of rice varieties - Biswanath Chariali

Parameters	Kanaklata	Gitesh	Luit
Duration of variety (in days)	135	150	100
Sowing date	19th June, 2014	23rd June, 2014	19th July, 2014
Harvesting date	14th Nov, 2014	6th Dec, 2014	5th Nov, 2014
No. of effective tillers/ m^2	194	153	181
Straw yield (kg/ha)	5133	7873	4113
Grain yield (kg/ha)	3820	5198	4033

Table 3.14b: Modelling crop growth parameters and yield of potato varieties - Biswanath Chariali

Treatment	*Kufri* Jyoti				Pokhraj			
	Days to maturity	Tuber dry wt. (kg/ha)	Tuber yield (kg/ha)	Mean tuber yield (kg/ha)	Days to maturity	Tuber dry wt. (kg/ha)	Tuber yield (kg/ha)	Mean tuber yield (kg/ha)
D_1 (12th Nov, 2013)	89	1401	9216	10582	91	10392	11260	9779
D_2 (19th Nov, 2013)	86	1514	9960	11708	89	6478	12780	11740
D_3 (26th Nov, 2013)	84	1635	10752	11767	83	15128	10940	10272
D_4 (3rd Dec, 2013)	82	1155	7596	9455	78	5078	8500	8352

At Varanasi, in a field experiment on planting technique and weed management practices on ridge-furrow planting of pigeonpea + rice intercropping system, normal planting (onset monsoon) with 100% population of both crops (rice + pigeonpea) & one hand weeding at 30 DAS recorded highest pigeonpea equivalent yield (PEY) of 2358 kg/ha with B:C ratio of 3.58, net returns of Rs.80619/ha and RWUE of 3.13 kg/ha-mm followed by 150% population of pigeonpea + 100% rice population & one hand weeding (PEY yield of 2186 kg/ha) (Table 3.15).

Table 3.15: Effect of planting method and weed management practices on ridge-furrow planting of pigeonpea + rice intercropping systems - Varanasi

Treatment		Yield (kg/ha)		PEY (kg/ha)	LER	MAI	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
		Rice	Pigeonpea							
P_1	W_1	1703	365	1817	1.07	5120	25000	59280	2.64	2.49
	W_2	2212	468	2358	1.07	6562	25000	80619	3.58	3.13
	W_3	1664	452	1805	1.08	6334	25000	58735	2.61	2.47
	W_4	2042	460	2186	1.07	6448	25000	75873	3.37	2.99
	W_5	1747	463	1891	1.08	6486	25000	62637	2.78	2.59
P_2	W_1	1017	542	1186	1.17	7601	25000	30898	1.37	1.63
	W_2	1312	605	1501	1.15	8474	25000	45045	2.00	2.05
	W_3	1165	571	1343	1.15	8004	25000	37937	1.69	1.84
	W_4	1415	581	1596	1.13	8148	25000	49365	2.19	2.18
	W_5	1187	525	1351	1.14	7359	25000	38288	1.70	1.85
P_3	W_1	840	349	949	1.13	4893	25000	20225	0.90	1.30
	W_2	1098	349	1208	1.10	4893	25000	31840	1.42	1.65
	W_3	958	346	1067	1.11	4855	25000	25496	1.13	1.46
	W_4	1143	368	1258	1.10	5159	25000	34097	1.52	1.72
	W_5	958	352	1068	1.12	4931	25000	25572.82	1.14	1.46
CD at 5%		152.72	55.96	155.53	0.02	783	-	6999	0.31	0.21

P_1: Normal planting (onset of monsoon); P_2: Staggered planting (rice-sown in time & pigeonpea at 30 DAS); P_3: Pruning of normal planted pigeonpea at 60 DAS; W_1: Control; W_2: 100% population of both crops + hand weeding; W_3: 150% population of pigeonpea + 100% of rice + no weeding; W_4: 150% population of pigeonpea + 100% of rice + hand weeding; W_5: 100% population (P + R) + pendimethalin @ 1.0 kg a.i/ha as pre-emergence.

Timely planting (pigeonpea + rice) with ridge furrow planting system

Timely rice sowing in furrow & pigeonpea planted on ridges after 30 days

In a field experiment on rice + okra intercropping system at Varanasi, rice variety NDR-97, intercropped with okra variety VRO-5 recorded highest okra equivalent yield of 9310 kg/ha and net return of Rs.109006/ha with B:C ratio of 5.2 (Table 3.16).

Okra + rice intercropping system

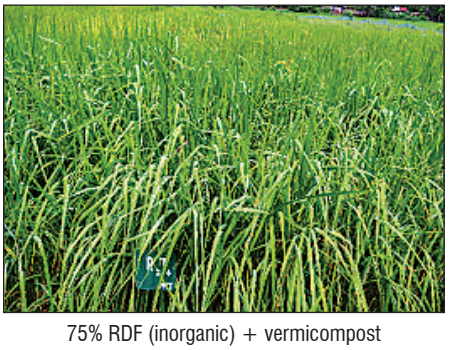
Table 3.16: Performance of rice + okra intercropping system - Varanasi

Treatment	Yield (kg/ha)		OEY (kg/ha)	LER	MAI	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Okra	Rice							
Okra Anamika	8510	-	5869	1.00	-	26000	59100	3.3	8.1
HRB-55 (Varsha)	10907	-	7529	1.00	-	26000	83067	4.2	10.4
VRO-5	11183	-	7713	1.00	-	26000	85833	4.3	10.6
HUR-105	-	1683	1683	1.00	-	14000	10408	1.7	2.3
HUR-3022	-	1530	1763	1.00	-	14000	11568	1.8	2.4
NDR-97	-	1942	1942	1.00	-	14000	14154	2.0	2.7
Okra Anamika + HUR-105	8240	1142	6824	1.62	27914	26000	72954	3.8	9.4
Okra Anamika + HUR-3022	9160	1040	7357	1.70	33055	26000	80680.	4.1	10.2
Okra Anamika + NDR-97	8493	1570	7427	1.93	39391	26000	81698	4.1	10.2
HRB-55 + HUR-105	11200	1133	8857	1.77	44495	26000	102433	4.9	12.2
HRB-55 + HUR-3022	10973	1052	8619	1.69	40540	26000	98982	4.8	11.9
HRB-55 + NDR-97	10883	1542	9047	2.01	52764	26000	105188	5.1	12.5
VRO-5 + HUR-105	10913	1037	8563	1.51	33230	26000	98165	4.8	11.8
VRO-5 + HUR-3022	11030	790	8397	1.39	27044	26000	95755	4.7	11.6
VRO-5 + NDR-97	11200	1487	9311	1.77	47319	26000	109007	5.2	12.8
CD at 5%	386	0.08	386	0.078	4482	-	5593	0.2	0.53

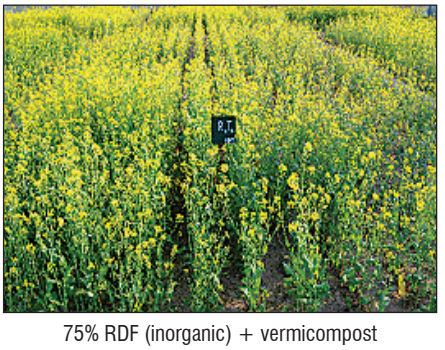
OEY:Okra equivalent yield

3.1.3 Nutrient management

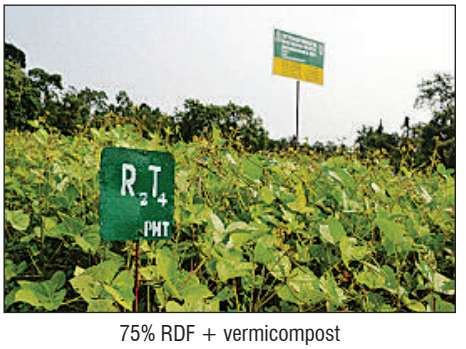
In a permanent manurial trail at Biswanath chariali, *ahu* rice gave maximum grain yield of rice (1783 kg/ha) with straw yield (5146 kg/ha), RWUE (1.79 kg/ha-mm) and B:C ratio of 2.28 with application of 75% RDF (inorganic) + vermicompost @ 5 t/ha over all other treatments. Similarly during *rabi*, in toria the higher seed yield (1163 kg/ha), stalk yield (2623 kg/ha), RWUE (20.58 kg/ha-mm), net returns (Rs.21263/ha) and B:C ratio of 3.36 were recorded with 75% RDF (inorganic) + vermicompost @ 5 t/ha. However, in greengram the maximum seed yield (1156 kg/ha), stalk yield (3187 kg/ha), RWUE (2.85 kg/ha-mm), net returns (Rs.30901/ha) and B:C ratio (2.94) were recorded with the application of 75% RDF + vermicompost @ 3 t/ha as compared to other treatments. Similar trend was observed with mean seed yield of rice, greengram and toria over years (Table 3.17a & b).



75% RDF (inorganic) + vermicompost @ 5 t/ha in rice



75% RDF (inorganic) + vermicompost @ 5 t/ha in toria



75% RDF + vermicompost @ 3 t/ha in greengram

Table 3.17a: Permanent manurial trial in rice–greengram-toria system under rainfed situation - Biswanath Chariali

Treatment	*Ahu* rice (*kharif*)				Greengram (*kharif*)				Toria (*rabi*)			
	Grain yield (kg/ha)	Mean grain yield (3 yrs)	Straw yield (kg/ha)	RWUE (kg/ha-mm)	Seed yield (kg/ha)	Mean seed yield (2 yrs)	Stalk yield (kg/ha)	RWUE (kg/ha-mm)	Seed yield (kg/ha)	Mean seed yield (5 yrs)	Stalk yield (kg/ha)	RWUE (kg/ha-mm)
Control	782	698	2021	0.78	623	680	1725	1.54	512	357	1235	9.06
100% (RDF)	1115	1057	3133	1.12	827	887	2231	2.05	746	651	1824	13.20
75% RDF + vermicompost @ 3 t/ha	1778	1353	5112	1.78	1156	1205	3187	2.85	1145	781	2531	20.27
75% RDF (inorganic) + vermicompost @ 5 t/ha	1783	1382	5146	1.79	1103	1189	3091	2.73	1163	823	2623	20.58
75% RDF (inorganic) + *in-situ Sesbania aculeata*	1165	1047	3195	1.17	832	864	2185	2.06	1025	700	2315	18.14
50% RDF + vermicompost @ 3 t/ha	1282	1097	3237	1.28	998	1038	2546	2.47	1053	646	2387	18.64
50% RDF (inorganic) + vermicompost @ 5 t/ha	1336	1123	3428	1.33	1014	1056	2833	2.51	1068	644	2411	18.90
50% RDF + *in-situ Sesbania aculeata*	1068	930	2811	1.07	825	849	2157	2.04	916	595	2032	16.21
Vermicompost @ 3 t/ha	914	916	2925	0.92	792	875	1956	1.95	588	450	1416	10.41
Vermicompost @ 5 t/ha	1023	980	3217	1.03	813	889	2179	2.01	617	482	1555	10.92
In-situ Sesbania aculeata	897	824	2492	0.89	708	724	1988	1.75	610	450	1519	10.80
CD at 5%	432	304	526	-	350	283	402	-	217	160	238	9.06

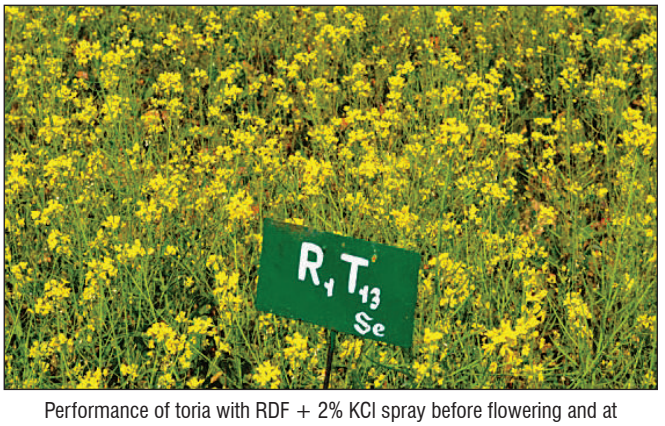
Table 3.17b: Economics of rice-greengram-toria cropping system - Biswanath Chariali

Treatment	Rice			Greengram			Toria		
	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio
Control	7523	2297	1.31	11982	12938	2.07	7484	5316	1.71
100% (RDF)	8716	5434	1.62	13473	19607	2.46	8126	10524	2.30
75% RDF + vermicompost @ 3 t/ha	8759	14021	2.48	15339	30901	2.94	8236	18689	3.27
75% RDF (inorganic) + vermicompost @ 5 t/ha	8853	13977	2.58	15463	28657	2.85	9012	21263	3.36
75% RDF (inorganic) + *in-situ* Sesbania aculeata	8876	5774	1.65	13229	20051	2.52	7823	17602	3.25
50% RDF + vermicompost @ 3 t/ha	8654	7166	1.83	14512	25408	2.75	8175	18150	3.22
50% RDF (inorganic) + vermicompost @ 5 t/ha	8670	7690	1.88	14927	25633	2.72	8251	18449	3.24
50% RDF + *in-situ* Sesbania aculeata	8662	5018	1.58	12834	20166	2.57	7682	15218	2.98
Vermicompost @ 3 t/ha	8756	3384	1.38	13321	18359	2.38	7586	7114	1.94
Vermicompost @ 5 t/ha	8912	4318	1.48	13678	18842	2.37	7539	7886	2.05
In-situ Sesbania aculeata	8550	2420	1.28	12540	15780	2.26	7814	7436	1.95

At Biswanath Chariali, recommended dose of fertilizer + 2% KCl spray before flowering and at siliqua formation gave maximum toria yield of 782 kg/ha with higher stalk yield (1816 kg/ha), net returns (Rs.11745/ha), B:C ratio (1.99) and RWUE of 111.71 kg/ha-mm as compared to other foliar treatments. However, the maximum mean seed yield of 757 kg/ha was recorded with recommended dose of fertilizer + 2% KNO_3 spray before flowering over other foliar treatments (Table 3.18).

Table 3.18: Effect of foliar application of chemicals on yield and economics in toria - Biswanath Chariali

Treatment	Yield (kg/ha)		Stalk yield (kg/ha)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Seed (2014)	Mean (2 yrs)					
Control	304	301	812	7829	1291	1.17	43.42
100% NPK (RDF)	577	561	1336	9886	7424	1.75	82.43
RDF + water spray	586	582	1358	10157	7423	1.73	83.71
RDF + 0.5% selenium spray before flowering	598	591	1413	10235	7705	1.75	85.43
RDF + 0.5% selenium spray at siliqua formation	619	603	1632	10287	8283	1.81	88.43
RDF + 0.5% selenium spray before flowering and at siliqua formation	623	609	1646	10426	8264	1.79	89.00
RDF + 1% KNO_3 spray before flowering	646	635	1667	10766	8614	1.80	92.28
RDF + 1% KNO_3 spray at siliqua formation	642	631	1651	10698	8562	1.80	91.71
RDF + 1% KNO_3 spray before flowering and at siliqua formation	657	642	1656	10792	8918	1.83	93.86
RDF + 2% KNO_3 spray before flowering	776	757	1762	11779	11501	1.98	110.86
RDF + 2% KNO_3 spray at siliqua formation	709	693	1726	11584	9686	1.84	101.28
RDF + 2% KNO_3 spray before flowering and at siliqua formation	721	704	1748	11651	9979	1.86	103.00
RDF + 2% KCl spray before flowering and at siliqua formation	782	749	1816	11915	11745	1.99	111.71
CD at 5%	198	206	265	-	-	-	-



Performance of toria with RDF + 2% KCl spray before flowering and at siliqua formation

Toria without foliar spray

In an INM trial on rice based cropping systems at Biswanath Chariali, recommended dose of fertilizer gave significantly higher grain yield of rice (783 kg/ha), mean grain yield (644 kg/ha), straw yield (1226 kg/ha) with maximum net returns of Rs. 12149/ha, B:C ratio of 2.44 and rainwater use efficiency of 88.06 kg/ha-mm, followed by application of 50% N (inorganic) + 50% N (vermicompost) + P & K as compared to other nutrient management treatments (Table 3.19).

Table 3.19: Effect of integrated nutrient management on rice yield and economics - Biswanath Chariali

Treatment	Yield (kg/ha)			Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Grain (2014)	Mean (2 yrs)	Straw				
Control	171	177	224	4987	88	1.01	3.89
RDF	783	644	1226	8426	12149	2.44	88.06
25% N (inorganic) + 75% N (vermicompost)	244	244	516	8326	220	1.03	12.92
50% N (inorganic) + 50% N (vermicompost)	330	304	671	8255	995	1.12	25.00
75% N (inorganic) + 25% N (vermicompost)	351	351	652	8169	1606	1.19	27.92
50% N (inorganic) + 50% N (vermicompost) + P & K	431	319	766	8356	3419	1.41	39.03
100% N (vermicompost)	249	227	389	6544	881	1.13	13.75
CD at 5%	18	98	33	-	-	-	-

In an INM trial on cereal legume rotation at Chianki, application of 50% NPK + 50% *Mahua* cake recorded maximum pigeonpea equivalent yield (982 kg/ha) followed by application of 50% NPK + 50% *Karanj* cake with PEY of 912 kg/ha. The maximum sorghum grain yield (704 kg/ha) and pigeonpea seed yield (778 kg/ha) were also recorded with application of 50% NPK + 50% *Mahua* cake as compared to other treatments. The porosity (29.41%), water holding capacity (26.21%) and OC (1.76%) were highest with application of 25% NPK + 25% FYM + 25% *Karanj* cake + 25% *Mahua* cake compared to other treatments (Table 3.20a).

Table 3.20: Effect of integrated nutrient management on sorghum - pigeonpea rotation - Chianki
a. Yield and soil properties

Treatment	Yield (kg/ha)						Bulk density (mg/m³)	Porosity (%)	Water holding capacity (%)	OC (%)	EC (dS/m)
	Sorghum		Pigeonpea		PEY						
	2014	Mean (4 yrs)	2014	Mean (4 yrs)	2014	Mean (4 yrs)					
Control	392	1174	502	1142	571	1226	1.67	34.37	22.38	1.67	0.36
100% NPK	521	1585	655	1336	755	1520	1.69	34.73	23.47	1.42	0.34
50% NPK + 50% FYM	633	1530	552	1249	830	1484	1.73	37.40	25.35	1.62	0.43
100% *Karanj* cake	655	1455	672	1316	895	1492	1.66	35.26	23.47	1.31	0.34
50% NPK + 50% *Karanj* cake	624	1502	810	1326	912	1563	1.68	34.32	22.58	1.64	0.30
100% *Mahua* cake	594	1414	709	1244	846	1432	1.67	36.47	24.25	1.35	0.46
50% NPK + 50% *Mahua* cake	704	1526	778	1289	982	1472	1.57	35.87	23.14	1.55	0.44
25% NPK + 25% FYM + 25% *Karanj* cake + 25% *Mahua* cake	483	1504	722	1290	740	1517	1.60	39.41	26.21	1.76	0.46
Initial value	-	-	-	-	-	-	1.58	36.65	22.24	1.72	0.37
CD at 5%	168	-	99	-	161	-	NS	NS	NS	NS	NS

PEY: Pigeonpea equivalent yield

The available soil N and K status was higher with 100% NPK through inorganics while available P and B contents were higher with 50% NPK + 50% *Mahua* cake and 25% NPK + 25% FYM + 25% *Karanj* cake + 25% *Mahua* cake, respectively (Table 3.20b).

b. Nutrient status of soil under cereal-legume rotation - Chianki

Treatment	Avail. N (kg/ha)	Avail. P (kg/ha)	Avail. K (kg/ha)	Boron (ppm)
Control	172	24	160	0.778
100% NPK	206	26	175	0.717
50% NPK + 50% FYM	198	24	170	0.734
100% *Karanj* cake	195	23	165	0.777
50% NPK + 50% *Karanj* cake	198	24	174	0.823
100% *Mahua* cake	192	24	166	0.829
50% NPK + 50% *Mahua* cake	198	26	168	0.825
25% NPK + 25% FYM + 25% *Karanj* cake + 25% *Mahua* cake	199	26	174	0.834
Initial value	186	25	153	0.812

At Chianki, in an INM trial in rice-linseed cropping system, application of 25% NPK each through FYM + *Karanj* cake + *Mahua* cake recorded highest linseed yield of 659 kg/ha. After harvest of linseed higher soil available N (237.58 kg/ha) was recorded with 100% NPK, while available K was recorded higher (148.74 kg/ha) with 25% NPK each through FYM + *Karanj* cake + *Mahua* cake as compared to other treatments (Table 3.21 a & b). However, different treatments had no significant effect on bulk density, porosity, water holding capacity, EC, pH and organic C.

Table 3.21: Integrated nutrient management in linseed in rice-linseed cropping system - Chianki

a. Yield and soil properties

Treatment	Seed yield (kg/ha)	Bulk density (mg/m^3)	Porosity (%)	Water holding capacity (%)	EC (dS/m)	OC (%)	pH
Control	386	1.57	31.78	21.38	1.49	0.47	6.79
100% NPK	555	1.74	31.85	20.88	1.50	0.49	6.78
50% NPK + 50% FYM	496	1.54	34.62	21.69	1.37	0.47	6.68
100% *Karanj* cake	450	1.56	32.72	21.47	1.38	0.49	6.77
50% NPK + 50% *Karanj* cake	590	1.58	32.97	21.45	1.58	0.47	6.78
100% *Mahua* cake	509	1.55	32.57	21.59	1.45	0.48	6.59
50% NPK + 50% *Mahua* cake	540	1.57	33.67	21.79	1.62	0.50	6.63
25% NPK + 25% FYM + 25% *Karanj* cake + 25% *Mahua* cake	659	1.58	33.66	21.82	1.69	0.47	6.60
Initial value	-	1.55	33.85	21.28	1.35	0.46	6.68
CD at 5%	81	NS	NS	NS	NS	NS	NS

b. Nutrient status of soil under rice-linseed cropping system - Chianki

Treatment	Available N (kg/ha)	Available P (kg/ha)	Available K (kg/ha)	Boron (ppm)
Control	220	37	140	0.88
100% NPK	237	42	144	0.87
50% NPK + 50% FYM	234	40	144	0.88
100% *Karanj* cake	228	39	144	0.81
50% NPK + 50% *Karanj* cake	237	36	147	0.73
100% *Mahua* cake	234	38	145	0.79
50% NPK + 50% *Mahua* cake	236	37	145	0.87
25% NPK + 25% FYM + 25% *Karanj* cake + 25% *Mahua* cake	236	39	148	0.88
Initial value	224	38	143	0.78

At Faizabad, in an INM trial in pigeonpea based intercropping systems, pigeonpea + blackgram recorded maximum pigeonpea equivalent yield of 2347 kg/ha with RWUE of 5.92 kg/ha-mm, NMR of Rs.70170/ha and B:C ratio of 2.20 over other intercropping systems. In case of nutrient management, RDF + *Rhizobium* + PSB + FYM @ 25 t/ha + Harit vardan @ 5 kg/ha gave maximum pigeonpea equivalent yield of 2148 kg/ha, RWUE of 5.42 kg/ha-mm, NMR of Rs.31270/ha and B:C ratio of 1.98 over other nutrient management treatments (Table 3.22a). The higher organic carbon content (0.35%), available N, P and K (158.7, 18.6 and 241.2 kg/ha) were recorded with pigeonpea + blackgram intercropping system, while application of RDF + *Rhizobium* + PSB+ FYM @ 5 t/ha+ Harit-Vardan @ 5 kg/ha recorded higher available N and K_2O (159.2 and 240.1 kg/ha, respectively) (Table 3.22b).

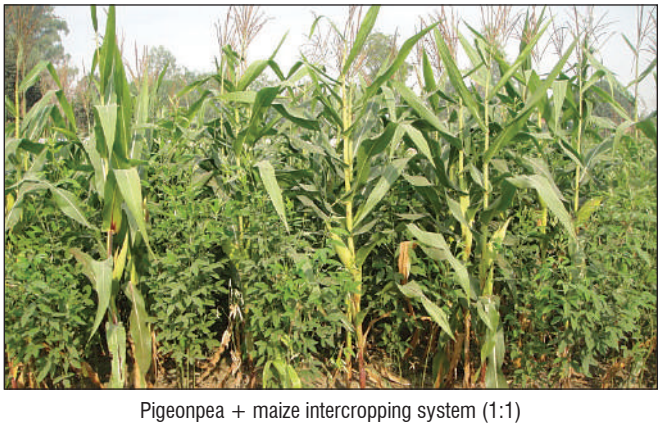
Table 3.22: Influence of integrated nutrient management on pigeonpea based cropping systems under rainfed condition – Faizabad

a. Yield and economics

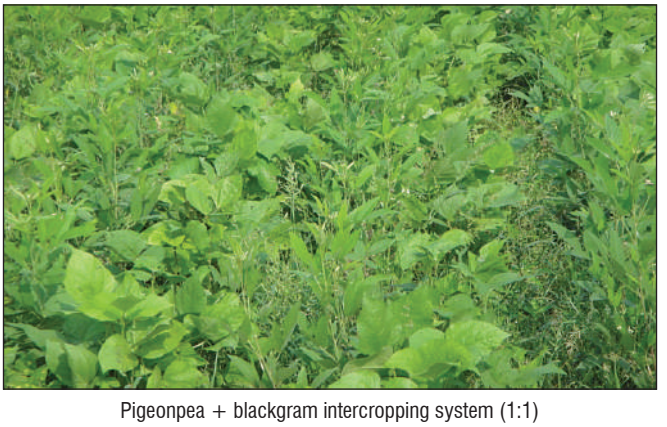
Treatment	Pigeonpea yield (kg/ha)		Blackgram yield (kg/ha)		Maize yield (kg/ha)		PEY (kg/ha)		RWUE (kg/ha-mm)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio
	2014	Mean (3 yrs)	2014	Mean (3 yrs)	2014	Mean (3 yrs)	2014	Mean (3 yrs)				
Intercropping system												
Pigeonpea sole	1403	1551	-	-	-	-	1403	1551	3.54	25989	32418	1.25
Pigeonpea + blackgram	1582	1713	764	617	-	-	2347	2121	5.92	31891	70170	2.20
Pigeonpea + maize	1097	1207	-	-	2532	2577	1859	1926	4.69	33092	47796	1.44
CD at 5%	156	108	-	-	-	-	172	129	-	-	-	-
Nutrient management												
RDF	1128	1258	492	436	2254	2240	1541	1414	3.89	29402	34119	1.16
RDF + Rhizobium + PSB	1276	1417	606	536	2472	2444	1758	1827	4.44	29480	46978	1.59
RDF + Rhizobium + PSB + FYM @ 5 t/ha	1470	1603	710	624	2891	2859	2032	2081	5.13	31145	57219	1.84
RDF + Rhizobium + PSB + FYM @ 5 t/ha + Harit-Vardan @ 5 kg/ha	1569	1685	776	679	2936	2921	2148	2165	5.42	31270	62197	1.98
CD at 5%	181	135	-	-	-	-	194	175	-	-	-	-

b. Soil nutrient status in pigeonpea based intercropping systems - Faizabad

Treatment	Organic carbon (%)	Available N (kg/ha)	Available P_2O_5 (kg/ha)	Available K_2O (kg/ha)
Intercropping system				
Pigeonpea sole	0.32	155.53	16.77	234.36
Pigeonpea + blackgram	0.35	158.73	18.58	241.22
Pigeonpea + maize	0.33	153.19	16.72	234.33
CD at 5%	0.02	5.43	1.68	5.39
Nutrient management				
RDF	0.31	151.85	15.58	232.88
RDF+ Rhizobium + PSB	0.31	153.67	17.31	234.76
RDF + Rhizobium + PSB+ FYM @ 5 t/ha	0.36	158.57	18.37	238.77
RDF + Rhizobium + PSB+ FYM @ 5 t/ha + Harit-Vardan @ 5 kg/ha	0.35	159.19	18.17	240.12
CD at 5%	0.03	6.27	1.94	6.23



Pigeonpea + maize intercropping system (1:1)



Pigeonpea + blackgram intercropping system (1:1)

At Faizabad, in an INM trial in rainfed maize, application of 75% NPK + FYM @ 6 t/ha + $ZnSO_4$ @ 25 kg/ha as soil application + $FeSO_4$ @10 kg/ha as soil application gave maximum grain yield (5085 kg/ha), mean grain yield (4895 kg/ha), RWUE (18.99 kg/ha-mm) and NMR (Rs.30168/ha), followed by 75% NPK + FYM @ 6 t/ha + $ZnSO_4$ @ 25 kg/ha as soil application with grain yield of 4902 kg/ha and RWUE of 18.50 kg/ha-mm (Table 3.23). The higher B:C ratio of 1.22 was recorded with application of 100% NPK + $ZnSO_4$ @ 25 kg/ha as soil application + $FeSO_4$ @ 10 kg/ha as soil application followed by application of 100% NPK + $ZnSO_4$ @ 25 kg/ha as soil application (1.21) as compared to other treatments (Table 3.23).

Table 3.23: Effect of integrated nutrient management on rainfed maize - Faizabad

Treatment	Grain yield (kg/ha)		RWUE (kg/ha-mm)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio
	2014	Mean (2 yrs)				
Control	2690	2794	10.55	20914	14578	0.69
100% RDF (80:40:30 kg NPK /ha)	4024	4003	15.35	23484	26591	1.13
75% NPK alone	3538	3462	13.35	22435	20904	0.93
75% NPK + *Azotobacter*	3714	3755	14.31	22535	24350	1.08

Treatment	Grain yield (kg/ha)		RWUE (kg/ha-mm)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio
	2014	Mean (2 yrs)				
75% NPK + PSB	3620	3674	13.98	22545	23315	1.03
100% NPK + $ZnSO_4$ @ 25 kg/ha as soil application	4435	4463	17.04	25102	30542	1.21
100% NPK + $FeSO_4$ @10 kg/ha as soil application	4416	4399	16.86	25104	29854	1.19
100% NPK + $ZnSO_4$ @ 25 kg/ha as soil application + $FeSO_4$ @ 10 kg/ha as soil application	4719	4678	17.95	26354	32169	1.22
75% NPK + FYM @ 6 t/ha	4492	4360	16.93	26935	27912	1.04
75% NPK + FYM @ 6 t/ha + $ZnSO_4$ @ 25 kg/ha as soil application	4902	4799	18.50	28210	31810	1.13
75% NPK + FYM @ 6 t/ha+ $FeSO_4$ @ 10 kg/ha as soil application	4867	4725	18.08	27060	31103	1.14
75% NPK + FYM @ 6 t/ha + $ZnSO_4$ @ 25 kg/ha as soil application + $FeSO_4$ @ 10 kg/ha as soil application	5085	4895	18.99	28330	33109	1.17
CD at 5%	494	298	-	-	-	-

At Faizabad, maximum seed yield (1397 kg/ha) and stalk yield (1933 kg/ha) were obtained with application of 50 kg DAP/ha as basal + 50 kg DAP/ha as foliar spray in 2 splits at 45 and 60 DAS + PSB as compared to other treatments. Application of 50 kg DAPS/ha as basal + 50 kg DAP as foliar in 2 splits at 45 and 60 DAS was the next best treatment (Table 3.24).

Table 3.24: Effect of basal and foliar application of diammonium phosphate (DAP) on chickpea - Faizabad

Treatment	No. of pods/ plant	No. of seeds/ pod	Test weight (g)	Seed yield (kg/ha)		Stalk yield (kg/ha)	RWUE (kg/ha-mm)
				2014	Mean (2 yrs)		
Control	30.0	1.0	170.5	687	818	932	6.38
100 kg DAP/ha as basal	33.7	1.0	176.9	981	1145	1351	9.11
100 kg DAP/ha as basal + PSB	37.3	1.1	171.8	1103	1305	1517	10.24
75 kg DAP/ha as basal + 25 kg DAP/ha as foliar at 45 DAS	37.4	1.1	182.3	1126	1319	1558	10.45
75 kg DAP/ha as basal + 25 kg DAP/ha as foliar spray at 45 DAS + PSB	38.0	1.2	187.5	1268	1490	1748	11.77
50 kg DAP/ha as basal + 50 kg DAP/ha as foliar in 2 splits at 45 & 60 DAS	38.4	1.3	187.5	1293	1504	1794	12.01
50 kg DAP/ha as basal + 50 kg DAP/ha as foliar spray in 2 splits at 45 & 60 DAS + PSB	39.8	1.3	192.2	1397	1655	1933	12.97
25 kg DAP/ha as basal + 75 kg DAP/ha as foliar spray in 3 splits at 45, 60 & 75 DAS	36.6	1.1	182.7	1143	1336	1565	10.61

Treatment	No. of pods/ plant	No. of seeds/ pod	Test weight (g)	Seed yield (kg/ha)		Stalk yield (kg/ha)	RWUE (kg/ha-mm)
				2014	Mean (2 yrs)		
25 kg DAP/ha as foliar spray at 45 DAS	31.0	1.1	173.4	840	970	1129	7.80
50 kg DAP/ha as foliar spray in 2 splits at 45 & 60 DAS	32.4	1.2	175.6	914	1060	1242	8.49
75 kg DAP/ha as foliar spray in 3 splits at 45, 60 & 75 DAS	36.6	1.1	180.5	995	1176	1374	9.24
100 kg DAP/ha as foliar spray in 4 splits at 45, 60, 75 & 90 DAS	36.5	1.1	181.0	1066	1256	1477	9.90
CD at 5%	1.8	NS	3.8	1.23	-	2.66	-

In a study on foliar and soil application of micronutrients in rice at Faizabad, application of 100% RDF + 2 foliar spray of 10 kg $ZnSO_4$/ha + 5 kg $FeSO_4$/ha + 10 kg Borax/ha + 10 kg Sulphur/ha gave maximum grain yield (2272 kg/ha) and straw yield (3033 kg/ha) compared to other treatments. Similarly, the mean maximum grain and straw yields (2588 and 3525 kg/ha, respectively) were recorded with the same treatment (Table 3.25).

Table 3.25: Effect of foliar and soil application of micronutrients on yield of paddy - Faizabad

Treatment	No. of panicles/ m^2	No. of grains/ panicle	Test weight (g)	Grain yield (kg/ha)		Straw yield (kg/ha)		RWUE (kg/mm-ha)
				2014	Mean (2 yrs)	2014	Mean (2 yrs)	
100% RDF as basal	284.2	67.2	21.2	1619	1879	2210	2566	3.60
100% RDF as basal + 3 water sprays	294.2	66.2	21.4	1763	2024	2427	2833	3.88
75% RDF + FYM @ 2.5 t/ha	273.9	64.6	21.3	1573	1782	2174	2471	3.43
50% RDF + FYM @ 5 t/ha	273.0	64.3	21.3	1483	1693	2057	2383	3.25
50% RDF + 3 foliar sprays of 20 kg urea/ha	273.8	66.7	21.7	1751	2027	2400	2807	3.88
50% RDF + 3 foliar sprays of 20 kg urea/ha + 10 kg $ZnSO_4$/ha	326.0	67.9	22.3	2075	2378	2850	3303	4.56
100% RDF + 30 kg $ZnSO_4$/ha as soil application	308.4	66.4	22.5	1885	2130	2594	3137	4.10
100% RDF + 2 foliar sprays of 5 kg $FeSO_4$/ha	316.5	67.6	21.9	1973	2257	2705	3124	4.33
100% RDF + 2 foliar sprays of 10 kg borax/ha	314.0	67.6	21.8	1971	2245	2711	3123	4.31
100% RDF + 2 foliar sprays of 10 kg sulphur/ha	311.0	67.0	21.8	1954	2227	2656	3078	4.28
100% RDF + 2 foliar sprays of 20 kg urea/ha + 10 kg $ZnSO_4$/ha	334.8	68.4	22.5	2128	2439	2900	3393	4.68
100% RDF + 2 foliar sprays of 10 kg $ZnSO_4$/ ha + 5 kg $FeSO_4$/ha + 10 kg borax/ha +10 kg Sulphur/ha	345.0	70.0	23.4	2272	2588	3033	3525	4.97
CD at 5%	7.62	1.94	0.96	142	-	250		-

In an INM trial on groundnut-onion cropping system at Jagdalpur, application of 100% general recommended dose (GRD) + lime @ 3 q/ha + $MgSO_4$ @ 15 kg/ha + FYM 5 t/ha in furrow (T_{10}) was recorded higher groundnut pod yield (3102 kg/ha), RWUE (2.5 kg/ha-mm) and net returns (Rs.85584/ha) as compared to other nutrient management practices (Table 3.26). However, the buildup of N and solublization of P was observed under the same

treatment i.e. T_{10}. The higher agronomic and recovery efficiencies of primary nutrients were recorded under T_7 (50% GRD + $ZnSO_4$ @ 25 kg + FYM @ 5 t/ha in furrow), whereas higher physiological efficiency was recorded under T_6 (50% GRD + FYM @ 5 t/ha in furrow). The treatment T_8 (i.e. 100% GRD + lime @ 3 q/ha + FYM @ 5 t/ha in furrow) registered higher B:C ratio (2.23) as compared to other treatments (Table 3.26 a & b).

Table 3.26a: Performance of groundnut under nutrient management practices - Jagdalpur

Treatment	Pod yield (kg/ha)	RWUE (kg/ha-mm)	NMR (Rs/ha)	B:C ratio	Agronomic efficiency (kg/kg)			Recovery efficiency (kg/kg)			Physiological efficiency (kg/kg)		
					N	P	K	N	P	K	N	P	K
T_1	2235	1.8	60916	2.14	-	-	-	-	-	-	-	-	-
T_2	2388	1.9	63400	1.98	5.1	2.5	5.1	0.5	0.06	0.17	10.9	43	29
T_3	2637	2.1	72364	2.19	13.4	6.7	13.4	0.9	0.12	0.31	14.9	54	43
T_4	2544	2.0	65652	1.82	10.3	5.1	10.3	0.7	0.08	0.24	14.3	62	44
T_5	2704	2.2	71068	1.92	15.6	7.8	15.6	1.2	0.13	0.44	13.3	59	36
T_6	2680	2.1	72916	2.13	29.7	14.8	29.7	1.6	0.17	0.45	18.7	85	66
T_7	2834	2.3	78052	2.21	39.9	19.9	39.9	2.5	0.28	0.81	16.2	72	49
T_8	3062	2.5	84560	2.23	27.5	13.8	27.5	1.7	0.18	0.61	16.4	76	45
T_9	2773	2.2	74216	2.02	17.9	9.0	17.9	1.2	0.13	0.43	14.8	72	42
T_{10}	3102	2.5	85584	2.22	28.9	14.4	28.9	1.9	0.22	0.75	15.2	67	39

GRD: General recommended dose; T_1: Control; T_2: GRD (30:60:30); T_3: GRD (30:60:30) + $ZnSO_4$ @ 25 kg; T_4: GRD (30:60:30) + FYM @ 5 t/ha in furrow; T_5: GRD (30:60:30) + FYM @ 5 t/ha in furrow + $ZnSO_4$ @ 25 kg; T_6: 50% GRD + FYM @ 5 t/ha in furrow; T_7: 50% GRD + $ZnSO_4$ @ 25 kg + FYM @ 5 t/ha in furrow; T_8: 100% GRD +Lime @ 3 q/ha + FYM 5 t/ha in furrow; T_9: 100% GRD + $MgSO_4$ @ 15 kg/ha + FYM 5 t/ha in furrow; T_{10}: 100% GRD + Lime @ 3 q/ha + $MgSO_4$ @ 15 kg/ha + FYM 5 t/ha in furrow

Table 3.26b: Balance sheet of N (kg/ha) as influenced by INM in groundnut under midland of Bastar - Jagdalpur

Treatment	Initial Avail. N	Applied N		Total N	N uptake	Apparent N balance	Real N balance	Depletion/ build up of N
		fertilizer	Manure					
	1	2	3	4=1+2+3	5	6 = 4 - 5	7	8 = 7 – 6
T_1	229	0	0	229	117	112	231	119
T_2	229	30	0	259	131	128	238	110
T_3	229	30	0	259	144	115	237	122
T_4	229	30	28	287	139	148	249	102
T_5	229	30	28	287	152	135	250	116
T_6	229	15	28	272	141	131	247	117
T_7	229	15	28	272	154	118	246	129
T_8	229	30	28	287	168	119	257	139
T_9	229	30	28	287	154	133	253	121
T_{10}	229	30	28	287	174	113	258	146

Table 3.26c: Balance sheet of P (kg/ha) as influenced by INM in groundnut under midland of Bastar - Jagdalpur

Treatment	Initial Avail. P	Applied P		Total P	P uptake	Apparent P balance	Real P balance	Solublization (+) or fixation (-) of P
		fertilizer	Manure					
	1	2	3	4= 1+2+ 3	5	6 = 4 - 5	7	8 = 7 – 6
T_1	18.2	0	0	18.2	23	-4.8	15.1	19.9
T_2	18.2	26.4	0	44.6	27	17.6	17.9	0.3
T_3	18.2	26.4	0	44.6	31	13.6	17.5	3.9
T_4	18.2	26.4	9	53.6	28	25.6	26.2	0.6
T_5	18.2	26.4	9	53.6	31	22.6	25.4	2.8
T_6	18.2	13.2	9	40.4	28	12.4	16.5	4.1
T_7	18.2	13.2	9	40.4	32	8.4	15.3	6.9
T_8	18.2	26.4	9	53.6	34	19.6	27.6	8.0
T_9	18.2	26.4	9	53.6	31	22.6	24.5	1.9
T_{10}	18.2	26.4	9	53.6	36	17.6	27.8	10.2

Similarly, higher bulb yield of onion and net return was recorded under T_{10} (100% GRD + lime @ 3 q/ha + $MgSO_4$ @ 15 kg/ha + FYM 5 t/ha in furrow). The higher agronomic, recovery and physiological efficiencies of primary nutrients were recorded under T_7 (50% GRD + $ZnSO_4$ @ 25 kg + FYM @ 5 t/ha in furrow) whereas, treatment with 100% GRD + $ZnSO_4$ @ 25 kg (T_3) registered higher B:C ratio (7.43) as compared to other treatments. Treatment with 100% GRD without FYM recorded negative balance of N however, full GRD coupled with lime and FYM (T_8) application recorded higher buildup of N except control (T_1). In general, fixation of P was not observed in any of the treatments as far as P balance is concerned (Table 3.27)

Table 3.27: Effect of INM in on onion productivity under midland farming situation - Jagdalpur

Treatment	Bulb yield (kg/ha)	NMR (Rs/ha)	B:C ratio	Agronomic efficiency			Recovery efficiency			Physiological efficiency		
				N	P	K	N	P	K	N	P	K
T_1	18000	149900	4.98	-	-	-	-	-	-	-	-	-
T_2	28100	244900	6.78	135	168	101	0.37	0.27	0.46	368	615	217
T_3	31800	280275	7.43	184	230	138	0.51	0.34	0.56	362	677	246
T_4	31500	275300	6.93	180	225	135	0.48	0.33	0.47	377	683	285
T_5	32500	283675	6.86	193	242	145	0.55	0.34	0.60	351	705	242
T_6	28300	246300	6.71	275	343	206	0.73	0.48	0.70	376	714	294
T_7	29000	251675	6.57	293	367	220	0.74	0.51	0.74	395	721	297
T_8	34100	299950	7.31	215	268	161	0.59	0.37	0.60	362	720	267
T_9	31600	275745	6.85	181	227	136	0.48	0.32	0.48	376	712	280
T_{10}	34600	304395	7.32	221	277	166	0.60	0.39	0.61	369	719	272

In an INM trial in direct seeded rice at Jagdalpur, application of full dose of NPK + FYM + $ZnSO_4$ @ 25 kg/ha + lime 3 q/ha (T_8) recorded higher grain yield (4226 kg/ha) and rainwater use efficiency (3.41 kg/ha-mm). However, the maximum net returns and B:C ratio were recorded with the application of 50% NPK (T_9). Application of half dose of NPK with FYM @ 5 t/ha + $ZnSO_4$ @ 25 kg/ha and lime @ 3 q/ha (T_{12}) resulted in higher agronomic and recovery efficiencies of primary nutrients as compared to other treatments (Table 3.28).

Table 3.28: Effect of integrated nutrient management on productivity, economics and nutrient use efficiencies of direct seeded rice under rainfed midland situation - Jagdalpur

Treatment	Grain yield (kg/ha)	RWUE (kg/ha-mm)	NMR (Rs/ha)	B:C ratio	Agronomic efficiency			Recovery efficiency			Physiological efficiency		
					N	P	K	N	P	K	N	P	K
T_1	2658	2.14	21689	1.40	-	-	-	-	-	-	-	-	-
T_2	4053	3.27	37226	1.91	14.0	23.3	34.9	0.27	0.20	0.62	51.6	114	55.9
T_3	2863	2.31	21755	1.19	-	3.4	5.1	-	0.09	0.15	27.8	38	33.8
T_4	3798	3.06	35245	1.97	11.4	-	28.5	0.26	-	0.65	44.3	123	43.6
T_5	3952	3.19	37005	2.02	12.9	21.6	-	0.23	0.19	-	56.3	114	57.5
T_6	4072	3.28	33988	1.48	14.1	23.6	35.4	0.29	0.19	0.64	49.4	124	55.0
T_7	4170	3.36	34357	1.43	15.1	25.2	37.8	0.31	0.22	0.56	48.3	114	67.5
T_8	4226	3.41	33348	1.29	15.7	26.1	39.2	0.37	0.23	0.87	42.4	114	45.1
T_9	3937	3.17	37598	2.15	25.6	42.6	64.0	0.44	0.31	0.95	57.7	137	67.5
T_{10}	3977	3.21	34655	1.65	26.4	44.0	66.0	0.54	0.35	0.90	48.8	126	73.4
T_{11}	4111	3.31	35531	1.61	29.1	48.4	72.7	0.61	0.41	0.93	48.0	117	77.7
T_{12}	4183	3.37	34739	1.46	30.5	50.8	76.3	0.66	0.45	0.93	45.9	112	81.8
CD at 5%	630	-	-	-	-	-	-	-	-	-	-	-	-

T_1: Control; T_2: 100% NPK; T_3: 100% PK; T_4: 100% NK; T_5: 100% NP; T_6: 100% NPK + FYM @ 5 t/ha; T_7: 100% NPK + FYM @ 5 t/ha + $ZnSO_4$ @ 25 kg; T_8: 100% NPK + FYM @ 5 t/ha + $ZnSO_4$ @ 25 kg/ha + Lime @ 3 q/ha; T_9: 50% NPK; T_{10}: 50% NPK + FYM @ 5 t/ha; T_{11}: 50% NPK + FYM @ 5 t/ha + $ZnSO_4$ @25 kg/ha; T_{12}: 50% NPK + FYM @ 5 t/ha + $ZnSO_4$ @ 25 kg/ha + Lime @ 3 q/ha

The soil organic C content was highest (0.66%) with T_8 (100% NPK + FYM @ 5 t/ha + $ZnSO_4$ @ 25 kg/ha + lime @ 3 q/ha and T_{10} (50% NPK + FYM @ 5 t/ha) compared to other treatments. T_8 treatment also recorded high N and K whereas the available P content was higher in the plots under T_5 (100% NP) (Table 3.29).

Table 3.29: Effect of integrated nutrient management in direct seeded rice on soil fertility under rainfed midland situation of Bastar plateau - Jagdalpur

Treatment	pH	Org. C	Avail. N (kg/ha)	Avail. P (kg/ha)	Avail. K (kg/ha)	Avail. Zn (ppm)	Avail. Cu (ppm)	Avail. Mn (ppm)	Avail. Fe (ppm)
Initial	6.4	0.64	240	24.4	168.4	1.03	1.78	26.8	32.6
T_1	6.5	0.57	229	23.3	157	1.04	1.56	25.3	31.2
T_2	6.0	0.62	235	27.4	162	0.94	1.53	27.0	34.4
T_3	6.2	0.59	245	26.9	173	1.02	1.62	27.4	33.1
T_4	6.4	0.64	239	26.1	172	0.97	1.68	26.5	30.7
T_5	6.6	0.64	243	28.7	164	0.94	1.60	25.9	32.5
T_6	6.2	0.65	250	27.2	174	0.97	1.80	24.6	29.9
T_7	6.3	0.64	245	26.8	164	1.01	1.67	26.1	31.6
T_8	6.7	0.66	257	28.6	179	1.02	1.71	24.1	28.4
T_9	6.0	0.58	243	26.4	169	0.96	1.70	26.8	30.1
T_{10}	6.1	0.66	244	25.1	173	0.97	1.73	25.1	31.3
T_{11}	6.4	0.63	247	27.7	170	1.00	1.69	24.7	29.8
T_{12}	6.6	0.62	240	26.3	166	0.98	1.66	24.2	28.6

During *rabi*, the higher seed, stalk yield and net returns of field pea were recorded under GRD as compared to control. However, higher B:C ratio was recorded under control as compared to GRD. All the parameters recorded higher values under treatment T_8 (100% NPK + 5 t FYM + $ZnSO_4$ @ 25 kg/ha + lime 3 q/ha) (Table 3.30).

Table 3.30: Effect of integrated nutrient management in direct seeded rice on productivity, economics and agronomic efficiency of field pea under midland situation of Bastar plateau - Jagdalpur

Treatment	Seed yield (kg/ha)			Straw yield (kg/ha)			NMR (Rs/ha)		B:C ratio		Agronomic efficiency		
	Control	GRD	Mean	Control	GRD	Mean	Control	GRD	Control	GRD	N	P	K
T_1	1083	1313	1198	2205	2161	2183	22984	26098	2.42	1.96	9.2	4.6	7.7
T_2	1202	1430	1316	2116	2329	2223	26556	29595	2.80	2.23	9.1	4.6	7.6
T_3	1225	1478	1351	2185	1914	2050	27239	31025	2.87	2.33	10.1	5.1	8.4
T_4	1054	1237	1145	1843	2113	1978	22108	23810	2.33	1.79	7.3	3.7	6.1
T_5	1116	1338	1227	1720	1927	1824	23993	26844	2.53	2.02	8.9	4.4	7.4
T_6	1184	1434	1309	2264	2095	2180	26017	29724	2.74	2.23	10.0	5.0	8.3
T_7	1187	1448	1317	2046	2084	2065	26118	30125	2.75	2.27	10.4	5.2	8.7
T_8	1243	1529	1386	2302	2338	2320	27797	32567	2.93	2.45	11.4	5.7	9.5
T_9	1119	1259	1189	1708	2142	1925	24066	24477	2.53	1.84	5.6	2.8	4.7
T_{10}	1034	1274	1154	1869	2170	2020	21531	24927	2.27	1.87	9.6	4.8	8.0
T_{11}	1068	1289	1178	1917	2268	2093	22525	25372	2.37	1.91	8.9	4.4	7.4
T_{12}	1142	1319	1231	2104	2023	2064	24751	26281	2.61	1.98	7.1	3.6	5.9

In an experiment on fertilizer scheduling in maize + cowpea (2:2) intercropping system at Phulbani, proportion of plants and respective dose applied to respective crops gave higher maize equivalent yield (3283 kg/ha), cowpea yield (690 kg/ha) and maximum RWUE of 3.05 kg/ha-mm. However, the highest maize yield (2056 kg/ha) was recorded with fertilizer dose of main crop (maize) to main crop only and no fertilizer to inter-crop followed by proportion of plants and respectibve dose applied to respective crops (2005 kg/ha). The higher mean yield of maize (1691 kg/ha) was recorded with fertilizer dose of main crop (maize) to main crop only and no fertilizer to inter-crop, whereas higher cowepea mean yield (815 kg/ha) was recorded with proportion of plants and respective dose applied to respective crops (Table 3.31).

Table 3.31: Fertilizer scheduling in maize + cowpea (2:2) intercropping system - Phulbani

Treatment	Yield (kg/ha)				MEY (kg/ha)	RWUE (kg/ha-mm)
	Maize		Cowpea			
	2014	Mean (4 years)	2014	Mean (4 years)		
Proportion of plants and respective dose applied to respective crops	2005	1678	690	815	3283	3.05
Proportion of plants and fertilizer is mixed and applied uniformly	1944	1554	634	694	2928	2.89
As per area covered by individual crops and respective dose applied to respective crop	1727	1379	653	779	2901	2.75
As per area covered by individual crops and fertilizer is mixed and applied uniformely	1685	1403	648	677	2764	2.71
Fertilizer dose of main crop (maize) to main crop only and no fertilizer to inter-crop	2056	1691	633	619	2941	2.98
Fertiliser dose of main crop to both main and inter-crop	1949	1494	671	687	2852	2.97
CD at 5%	268	-	84	-	-	-

The higher organic carbon conent of 0.354% and available phosphorus (22.9 kg/ha) were recorded with proportion of plants and respective dose applied to respective crops. However, available N (312.5 kg/ha) and available K (163.7 kg/ha) was highest in the plots under fertlizer dose of main crop to both main and intercrops (Table 3.32).

Table 3.32: Soil chemical properties in maize + cowpea intercropping system under variable fertilizer schedules - Phulbani

Treatment	pH	EC (dS/m)	OC (%)	Avail. N (kg/ha)	Avail. P_2O_5 (kg/ha)	Avail. K_2O (kg/ha)
Proportion of plants and respectibve dose applied to respective crops	6.26	0.14	0.354	280.0	22.9	157.3
Proportion of plants and fertilizer is mixed and applied uniformly	6.14	0.19	0.256	265.0	19.6	145.2
As per area covered by individual crops and respective dose applied to respective crop	6.07	0.29	0.284	212.5	17.3	161.3
As per area covered by individual crops and fertilizer is mixed and applied uniformely	6.14	0.16	0.315	250.0	20.3	115.6
Fertilizer dose of main crop (maize) to main crop only and no fertilizer to inter-crop	6.00	0.22	0.296	287.5	20.9	159.9
Fertiliser dose of main crop to both main and inter-crop	6.05	0.19	0.334	312.5	22.4	163.7

In a study on nutrient management in groundnut at Phulbani, application of 100% RDF + Ca + S + B gave maximum pod yield (1343 kg/ha), haulm yield (2286 kg/ha) and RWUE (1.52 kg/ha-mm) as compared to all other treatments. The increase in pod and haulm yield was 22.61 and 14.29%, respectively with 100% RDF + Ca + S + B over recommended dose of NPK (20:40:20 kg/ha) (Table 3.33a). The higher organic carbon content (0.463%) was recorded with application of 100% RDF + Ca + S; however higher available N and K_2O were recorded with application of 100% RDF + Ca + S + B (Table 3.33b).

Table 3.33a: Nutrient management in groundnut under rainfed condition - Phulbani

Treatment	Pod yield (kg/ha)		Haulm yield (kg/ha)	% increase in pod yield over RDF	Harvest index (%)	RWUE (kg/ha-mm)
	2014	Mean (2 yrs)				
RDF NPK (20:40:20 kg/ha)	1095	1259	2000	-	35.38	1.24
100% RDF + Ca through PMS @ 5 q/ha	1214	1447	2138	10.87	36.22	1.38
100% RDF + S through gypsum @ 30 kg S/ha	1205	1447	2148	10.00	35.94	1.36
100% RDF + B through Borax @ 12.5 kg/ha	1114	1323	2171	1.74	33.91	1.26
100% RDF + Ca +S	1314	1579	2114	20.00	38.33	1.49
100% RDF + Ca + B	1190	1452	2110	8.70	36.06	1.35
100% RDF + S + B	1152	1452	2129	5.22	35.11	1.30
100% RDF + Ca + S + B	1343	1615	2286	22.61	37.01	1.52
CD at 5%	207	1259	211	-	-	-

Table 3.33b: Soil chemical properties under different nutrient management practices of groundnut - Phulbani

Treatment	pH	EC (dS/m)	OC (%)	Avail. N (kg/ha)	Avail. P_2O_5 (kg/ha)	Avail. K_2O (kg/ha)
RDF NPK (20:40:20 kg/ha)	5.7	0.15	0.393	250.0	31.7	144.6
100% RDF + Ca through PMS @ 5 q/ha	6.1	0.22	0.453	212.5	25.2	133.7
100% RDF + S through gypsum @ 30 kg S/ha	6.0	0.19	0.395	287.5	43.1	149.2
100% RDF + B through Borax @ 12.5 kg/ha	5.8	0.18	0.413	212.5	52.0	139.8
100% RDF + Ca +S	6.0	0.19	0.463	237.5	48.5	135.7
100% RDF + Ca + B	6.1	0.17	0.396	275.0	26.2	147.8
100% RDF + S + B	5.9	0.18	0.385	285.0	32.2	134.8
100% RDF + Ca + S + B	6.0	0.25	0.453	375.0	26.9	154.6

In a permanent manurial trial in rice-lentil system at Varanasi, 50% RDF + 50% N through FYM gave maximum rice yield (1380 kg/ha), net returns (Rs.7910/ha) and B:C ratio (1.5), and 2170 kg/ha mean rice yield over 27 years with 68% sustainability, followed by 100% N recommended fertilizer with grain yield of 1250 kg/ha, NMR of Rs.6185/ha, B:C ratio of 1.4 and mean rice yield over 28 years was 2050 kg/ha with 66% sustainability (Table 3.34). During *rabi*, the lentil crop failed due to moisture stress and severity of wilt-nematode disease complex.

Table 3.34: Performance of rice as influenced by conjunctive use of organic & inorganic source of nutrients -Varanasi

Treatment	Yield (kg/ha)			Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Grain (2014)	Mean grain yield (27 yrs)	Straw				
Control	840	1290	2100	14000	2380	1.2	1.2
100% N (FYM)	1320	2050	2500	18000	6140	1.3	1.9
100% RDF	1250	2010	2530	17000	6185	1.4	1.8
50% RDF (Soil) + 50% N (Foliar)	1180	1740	2400	16500	5410	1.3	1.7
50% RDF	1100	1620	2580	16000	5110	1.3	1.6
50% RDF + 50% N (FYM)	1380	2170	2700	17500	7910	1.5	1.9
50% N (FYM)	1220	1750	2500	16000	6690	1.4	1.7
Farmers practice (20 kg N/ha)	1165	1590	2400	15500	6192.5	1.4	1.6

3.1.4 Energy management

In a trial on tillage and nutrient management in groundnut at Biswanath Chariali, higher pod yield of groundnut (2863 kg/ha) and B:C ratio (2.24) were recorded with two harrowings + one pulverization by power tiller, followed by minimum tillage followed by rotavator with pod yield of 2164 kg/ha and B :C ratio of 1.69. Among nutrient management practices, recommended dose of fertilizer recorded higher pod yield (2087 kg/ha) and B:C ratio (1.63) as compared to other treatments. The maximum field efficiency (28.50 hr/ha) and energy use efficiency (2.5) were recorded by conventional tillage (three to four ploughing followed by laddering) and minimum tillage (one harrowing), respectively (Table 3.35).

Table 3.36: Effect of tillage and nutrient management on groundnut - Biswanath Chariali

Treatment	Number of pods/ plant	Number of branches/ plant	Pod Yield (kg/ha)	B:C ratio	Field efficiency (hr/ha)	Energy (MJ/ha)	Energy use efficiency
Tillage							
Minimum tillage (one harrowing)	65	17	1516	1.18	4.25	538	2.5
Two harrowings + one pulverization by power tiller	96	23	2863	2.24	15.33	1316	2.0
Conventional tillage (three to four ploughing followed by laddering)	60	15	1761	1.38	28.50	3376	0.5
Minimum tillage followed by rotavator	92	22	2164	1.69	12.75	1614	1.2
Rotavator	57	17	1005	0.78	8.50	1076	0.8
CD at 5%	5.4	2.2	234	-	-	-	-
Nutrient management							
Recommended dose of fertilizer (RDF)	74	20	2087	1.63	-	-	-
50% RDF + 50% organic (vermicompost)	74	18	1873	1.46	-	-	-
75% RDF + 25% organic (vermicompost)	75	18	1626	1.27	-	-	-
CD at 5%	NS	1.46	210		-	-	-

At Chianki, in an experiment to study the performance of *rabi* crops in zero tilled condition under medium land situation, chickpea recorded maximum wheat equivalent yield (WEY) of 1989 kg/ha followed by wheat, safflower and pea with WEY of 1312, 1044 and 1007 kg/ha, respectively. However, higher RWUE of 16.40 kg/ha-mm was recorded by wheat followed by safflower and chickpea with RWUE of 9.43 and 9.24 kg/ha-mm, respectively (Table 3.37).

Table 3.37: Performance of *rabi* crops in zero tilled condition under medium land situation - Chianki

Crop	Yield (kg/ha)	Wheat equivalent yield (kg/ha)	RWUE (kg/ha-mm)
Wheat	1312	1312	16.40
Pea	655	1007	8.19
Chickpea	739	1989	9.24
Niger	258	535	3.23
Safflower	754	1044	9.43
Mustard	358	688	4.48
Toria	224	430	2.80
Linseed	447	584	5.59
CD at 5%	132	111	-

At Chianki, in an experiment on tillage and nutrient management in maize, maximum grain yield (2149 kg/ha) was recorded with off seasonal tillage + ½ conventional tillage + 2 hand weedings + 50% nutrient through organic source + 50% nutrient through inorganic (M_2S_2) followed by off seasonal tillage + conventional tillage + 2 hand weedings + 100% nutrient through inorganic source (M_1S_3) (1861 kg/ha) (Table 3.38).

Table 3.38: Effect of tillage and nutrient management in maize – Chianki

Treatment	Grain yield (kg/ha)	Plant height (cm)	Cob length (cm)	Cob girth (cm)	No. of rows/cob	100 seed weight (g)
M_1S_1	1518	194.8	17.86	12.80	11.3	20.13
M_1S_2	1858	200.8	18.65	12.14	14.6	22.23
M_1S_3	1861	208.9	20.14	13.51	13.7	23.24
M_2S_1	1752	214.7	23.47	12.04	15.0	21.47
M_2S_2	2149	207.1	21.13	13.06	13.4	24.60
M_2S_3	1807	218.7	20.47	13.60	12.8	22.79
M_3S_1	1444	219.5	18.23	11.21	14.4	22.14
M_3S_2	1723	220.1	24.25	23.14	13.8	19.28
M_3S_3	1840	223.4	21.47	13.60	15.4	24.16

M_1: Off seasonal tillage + conventional tillage + 2 hand weeding; M_2: Off seasonal tillage + ½ conventional tillage + 2 hand weeding; M_3: Off seasonal tillage + ½ conventional tillage + herbicide + 1 hand weeding; S_1: 100% nutrient through organic source; S_2: 50% nutrient through organic source + 50% nutrient through inorganic source; S_3: 100% nutrient through inorganic source

In a trial on tillage management in rice at Faizabad, sub soiling (35 cm) with sub soiler in cross pass + 2 harrowings recorded higher grain yield (1599 kg/ha), straw yield (2587 kg/ha), total input energy (10174 MJ/ha), total energy output (59869 MJ/ha) with RWUE of 4.43 kg/ha-mm as compared to other treatments. Deep ploughing (30 cm) with MB plough + 2 harrowing was the next best treatment (Table 3.39).

Table 3.39: Tillage management in rice - Faizabad

Treatment	Grain yield (kg/ha)		Straw yield (kg/ha)		Total input energy (MJ/ha)	Energy productivity (kg/MJ)	Total energy output (MJ/ha)	RWUE (kg/ha-mm)
	2014	Mean (3 yrs)	2014	Mean (3 yrs)				
Deep ploughing (30 cm) with MB plough + 2 harrowings	1506	1789	2140	2437	8936	0.200	56886	4.21
Sub soiling (35 cm) with sub soiler in cross pass + 2 harrowings	1599	1882	2350	2587	10174	0.185	59869	4.43
Shallow ploughing with rotavator	1339	1594	2830	2433	7534	0.211	49668	3.75
Shallow ploughing with cultivator	1022	1246	1428	1749	7612	0.163	40170	2.89
Shallow ploughing with disc harrow	1244	1480	1760	2037	7616	0.178	47214	3.48
Farmers` practice (two cross operation of cultivator)	976	1156	1185	1532	7612	0.152	36147	2.74
CD at 5%	157	113	-	-	-	-		-

In a study on effect of reduced tillage and nutrient management on maize productivity under midland farming situation at Jagdalpur, summer ploughing + conventional tillage + 2 hand weedings recorded maximum grain yield of 3930 kg/ha. In case of nutrient management, 100% recommended fertilizer recorded maximum grain yield (4880 kg/ha) (Table 3.40).

Table 3.40: Effect of tillage and nutrient management on maize productivity and soil nutrient status under midland farming situation - Jagdalpur

Treatment	Grain yield (kg/ha)		Available N (kg/ha)	Available P (kg/ha)	Available K (kg/ha)
	2014	Mean (2 yrs)			
Tillage					
Summer ploughing + conventional tillage + two hand weedings	3930	3600	238	19	183
Reduced tillage + 2 hand weedings	3670	3500	243	20	194
Reduced tillage + herbicide application + one hand weeding	3610	3350	247	21	196
CD at 5%	NS	-	NS	NS	NS

Treatment	Grain yield (kg/ha)		Available N (kg/ha)	Available P (kg/ha)	Available K (kg/ha)
	2014	Mean (2 yrs)			
Nutrient management					
Control	1130	1090	227	15	188
50% RDF + FYM @ 8 t/ha	2440	2340	234	17	195
75% RDF + FYM @ 8 t/ha	4810	4750	248	18	187
100% RDF	4880	4890	237	16	201
CD at 5%	1188	-	9.34	1.14	NS

At Varanasi, in a study on tillage and nutrient management of low till farming strategies for resource conservation and improving soil quality in rice (NDR-97), higher yield of 1514 kg/ha, NMR of Rs.7510/ha, B:C ratio of 1.6 and RWUE of 2.37 kg/ha-mm was recorded with compartment bunding. Among tillage practices, conventional tillage + weed control + interculture recorded 1374 kg/ha of grain yield, NMR of Rs. 6000/ha, B:C ratio of 1.35 and RWUE of 2.15 kg/ha-mm and low tillage with the same weed control options gave lower grain yield of 1082 kg/ha and net returns of Rs.2763/ha, B:C ratio of 1.2 with RWUE of 1.69 kg/ha-mm. In case of nutrient management, 50% N through inorganic + 50% N through organic sources proved to be the best with maximum yield of 1319 kg/ha, net returns of Rs. 6374/ha, B:C ratio of 1.41 and RWUE of 2.07 kg/ha-mm. The maximum output energy (99890 MJ/ha) was recorded with compartment bunding (Table 3.41).

Table 3.41: Tillage and nutrient management in rice - Varanasi

Treatment	Yield (kg/ha)			Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)	Energy (MJ/ha)		Energy use efficiency
	Seed/ grain yield in 2014	Mean seed/ grain yield (2 yrs)	Stover/ stalk yield					Input	Output	
Bunding										
Compartmental bunding	1514	2553	4313	16600	7510	1.6	2.37	12012	99890	8.32
Without bunding	960	2230	3610	14600	1125	1.0	1.50	11700	79092	6.76
CD at 5%	182	-	223							
Tillage										
Conventional tillage + weed control + interculture	1374	2525	4153	16000	6000	1.3	2.15	12499	81247	6.5
Minimum tillage + weed control + interculture	1254	2392	3984	15200	4975	1.3	1.96	11856	90146	7.60
Low tillage + weed control + interculture	1082	2257	3748	14800	2763	1.2	1.69	11213	83369	7.44
CD at 5%	NS	-	NS							
Nutrient management										
100% N through inorganic	1305	2436	4059	14088	6865	1.4	2.04	13067	92246	7.06
50% N through inorganic + 50% N through organic	1319	2463	4071	14788	6374	1.4	2.07	11856	92667	7.82
100% N through organic	1087	2284	3754	15300	2339	1.2	1.70	10645	83551	7.85
CD at 5%	NS	-	NS	-	-	-	-			

Rice with bunding

Rice without bunding

3.1.5 Evaluation of improved varieties

Evaluation of medium duration high yielding rice varieties at Biswanath Chariali indicated that TTB-404 was found better among 13 varieties with grain yield of 4225 kg/ha, net returns of Rs.50704/ha, B:C ratio of 5.48 and RWUE of 3.24 kg/ha-mm. The yields of all other varieties were less than Komal (local) (3957 kg/ha) (Table 3.42).

Table 3.42: Performance of medium duration high yielding rice varieties - Biswanath Chariali

Variety	Yield (kg/ha)			NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Grain (2014)	Mean grain yield (2 yrs)	Straw			
TTB 404	4225	4583	4535	50704	5.48	3.24
Sahabhagi	3459	3660	3769	41511	4.49	2.65
IR 36	3813	4226	4123	45751	4.95	2.92
Bihari Ahu	3156	3768	3466	37875	4.09	2.42
Dehangi	3698	3974	4008	44379	4.80	2.83
Satyaranjan	3457	4088	3767	41482	4.48	2.65
Basundhara	3876	4178	4186	46510	5.03	2.97
Naveen	3525	4113	3835	42300	4.57	2.70
Abhisek	3875	4188	4185	46503	5.03	2.97
Komal (local)	3957	4384	4267	47483	5.13	3.03
Chandrama	3260	4008	3570	39122	4.23	2.50
Jaya	3388	4159	3698	40654	4.40	2.60
Baismuthi/ Basanti (local)	3526	3938	3836	42317	4.57	2.70

Cost of cultivation: Rs.9250/ha

At Biswanath Chariali, in an evaluation of 13 genotypes of pigeonpea, BAC 1 recorded maximum seed yield of 1986 kg/ha, 2258 kg/ha of mean seed yield over 4 years with net returns of Rs.59567/ha, B:C ratio of 11.91 and RWUE of 2.48 kg/ha-mm over other genotypes (Table 3.43).

Table 3.43: Evaluation of pigeonpea genotypes for rainfed upland situation – Biswanath Chariali

Genotype	Seed yield (kg/ha)		NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	2014	Mean (4 yrs)			
Asha	1623	1783	48694	9.74	2.03
Bahar	1845	2045	55361	11.07	2.30
ICPH-2740	1753	1959	52577	10.52	2.19

Genotype	Seed yield (kg/ha)		NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	2014	Mean (4 yrs)			
MAL-13	1855	2075	55641	11.13	2.32
BAC-3	1854	1960	55626	11.13	2.32
ICPH-2671	1652	1879	49564	9.91	2.06
Maruti	1789	2051	53680	10.74	2.23
TS-3R	1758	-	52751	10.55	2.20
ICPL-88039	1726	1996	51768	10.35	2.16
ICPL-11305	1845	-	55358	11.07	2.30
T-21	1875	2078	56264	11.25	2.34
BAC-1	1986	2258	59567	11.91	2.48
BAC-2	1970	2219	59106	11.82	2.46

At Biswanath Chariali, out of 11 sesame genotypes evaluated, BSC 5 (Bihpuria local) gave maximum seed yield (1025 kg/ha), B:C ratio (5.13) and RWUE (2.58 kg/ha-mm), while ST-1 gave lowest seed yield of 856 kg/ha with B:C ratio of 4.28 and RWUE of 2.15 kg/ha-mm (Table 3.44).

Table 3.44: Evaluation of sesame genotypes for rainfed upland situations of Assam - Biswanath Chariali

Genotype	Yield (kg/ha)			NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Seed (2014)	Mean seed yield (3 years)	Stalk			
ST-1	856	908	1245	34245	4.28	2.15
PT-1	863	903	1195	34502	4.31	2.17
ST 1683	985	1141	1099	39418	4.93	2.48
BSC (Kaliabor)	1025	1138	1342	41014	5.13	2.58
BSC 2 (Biswanath)	987	1073	1489	39486	4.94	2.48
BSC 3 (Bahua bhati)	860	1010	1179	34386	4.30	2.16
BSC 4 (Nagaon local)	945	1095	1136	37808	4.73	2.38
BSC 5 (Bihpuria local)	1025	1247	1457	41014	5.13	2.58
BSC 6 (Naokata Ahutil)	958	1117	1378	38329	4.79	2.41
BSC 7 (Naokata Salitil)	876	950	1181	35022	4.38	2.20
S1 (RARS, Diphu)	979	1152	1276	39147	4.89	2.46

In an evaluation of 21 early maturing mustard genotypes under rice-mustard sequence cropping at Biswanath Chariali, YSC-1 genotype gave higher seed yield (1126 kg/ha), mean seed yield (1060 kg/ha), stalk yield (1352 kg/ha), NMR (Rs.33767/ha), B:C ratio (4.82) and RWUE (135.6 kg/ha-mm) over all other genotypes. YSC-2 was the next best genotype with seed yield of 1063 kg/ha (Table 3.45).

Table 3.45: Evaluation of early maturity mustard genotypes under rice-mustard crop sequence of Assam - Biswanath Chariali

Variety	Yield (kg/ha)			NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Seed (2014)	Mean seed yield (3 years)	Stalk yield			
Pusa Bahar	785	765	1011	23562	3.37	94.6
TS-36	853	812	1079	25580	3.65	102.7
JT-90-1	752	732	978	22571	3.22	90.6
Binoy	857	867	1083	25721	3.67	103.3
Pusa Mahak	786	759	1012	23580	3.37	94.7

Variety	Yield (kg/ha)			NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Seed (2014)	Mean seed yield (3 years)	Stalk yield			
TS-46	852	842	1078	25569	3.65	102.7
JD-6	752	733	978	22570	3.22	90.6
NPJ-135	859	845	1085	25774	3.68	103.5
TS-59	769	753	995	23072	3.30	92.7
TS-38	816	879	1042	24469	3.50	98.3
Agrani	729	749	955	21869	3.12	87.8
Pusa Bijoy	748	752	974	22444	3.21	90.1
PM-21	796	789	1022	23869	3.41	95.9
TS-67	792	786	1018	23763	3.39	95.4
Pusa Jagannath	802	812	1028	24069	3.44	96.7
TS-66	775	752	1001	23260	3.32	93.4
Pusa Bold	965	995	1191	28954	4.14	116.3
YSC-1	1126	1060	1352	33767	4.82	135.6
YSC-2	1063	1008	1289	31895	4.56	128.1
Mustard Local	856	804	1082	25690	3.67	103.2
Sonali Local	813	825	1039	24398	3.49	98.0

In an evaluation of 10 niger genotypes under rice-*rabi* crop sequence cropping at Biswanath Chariali, NB-1 genotype gave higher seed yield (575 kg/ha), mean seed yield (598 kg/ha), stalk yield (815 kg/ha), NMR (Rs.5755/ha), B:C ratio (1.44) and RWUE (40.0 kg/ha-mm) over all other genotypes (Table 3.46).

Table 3.46: Evaluation of niger genotypes under rice-*rabi* crop sequence of Assam - Biswanath Chariali

Variety	Yield (kg/ha)			NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Seed (2014)	Mean seed yield (2 yrs)	Stalk yield			
NB-1	575	598	815	5755	1.44	40.0
NG-1	485	582	756	5155	1.29	35.8
BNC-1	392	541	725	4853	1.21	33.7
BNC-2	469	523	632	3922	0.98	27.2
BNC-3	492	512	709	4693	1.17	32.6
BNC-4	456	496	732	4922	1.23	34.2
BNC-5	521	478	696	4561	1.14	31.7
JNC 6	475	505	761	5214	1.30	36.2
GA 10	514	534	715	4754	1.19	33.0
Phulbani local	487	571	754	5139	1.28	35.7

Niger cv.NB-1

Niger cv NG-1 (Control)

In a varietal evaluation of buck wheat at Biswanath Chariali, out of 4 varieties, BWC-3 recorded higher grain yield (1212 kg/ha), mean grain yield (1058 kg/ha), stalk yield (1362 kg/ha), net returns (Rs.12124/ha), B:C ratio (2.42) and RWUE (79.2 kg/ha-mm) as compared to other varieties (Table 3.47).

Table 3.47: Varietal evaluation of buck wheat - Biswanath Chariali

Variety	Yield (kg/ha)			NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Grain (2014)	Mean grain yield (2 yrs)	Straw			
BWC-1	1125	985	1275	11252	2.25	73.5
BWC-2	1105	992	1255	11052	2.21	72.2
BWC-3	1212	1058	1362	12124	2.42	79.2
BWC-4	1113	986	1263	11132	2.23	72.8

In a sorghum varietal trial at Chianki, among 20 entries of sorghum, CSH-14 performed better with grain yield of 2818 kg/ha and RWUE of 7.0 kg/ha-mm while CSV-20 check recorded grain yield of 2237 kg/ha with 5.5 kg/ha-mm of RWUE (Table 3.48).

Table 3.48: Evaluation of sorghum varieties - Chianki

Entry	Days to 50% flowering	Days to maturity	Plant height (cm)	1000 grain weight (g)	Grain yield (kg/ha)	RWUE (kg/ha-mm)
CSH-14	68	93	208.9	40.0	2818	7.0
CSH-13	70	94	257.7	38.3	2629	6.5
CSV-15	75	103	225.4	41.3	2522	6.2
CSV-18	83	108	274.5	39.7	2378	5.9
C-43	74	104	175.5	40.3	2063	5.1
CSH-16	68	99	192.4	38.3	2017	5.0
CSV-27	79	101	236.9	43.7	2015	5.0
RS-29	83	103	253.7	40.7	2012	5.0
CSV-1955	74	109	261.4	40.0	1995	4.9
CSV-21-F	68	105	287.1	42.7	1978	4.9
CSH-22SS	79	104	255.1	42.7	1939	4.8
CSV-26	83	105	235.6	40.3	1928	4.8
CSH-20MF	60	98	220.9	39.3	1855	4.6
CSV-29	75	97	206.3	39.7	1850	4.6
SPV-462	71	95	221.1	43.3	1799	4.5
CSV-22	57	105	287.7	40.0	1779	4.4
SSV-84	57	104	232.8	41.7	1707	4.2
CSV-24SS	64	117	228.3	41.0	1681	4.2
CVSH24MF	67	102	260.6	40.3	1479	3.7
CSV-20 ©	56	112	257.9	37.7	2237	5.5
CD at 5%	-	-	-	-	255	-

At Chianki, in a horsegram varietal trial, 'Madhu' gave maximum seed yield of 917 kg/ha followed by GHG-19, GHG-13 and AK-51 varieties with seed yields of 820, 780 and 763 kg/ha, respectively compared to other varieties (Table 3.49).

Table 3.49: Evaluation of horsegram varieties - Chianki

Variety	Days to 50% flowering	Days to maturity	Plant height (cm)	No. of pods/plant	No. of seeds/pod	100 seed weight (g)	Seed yield (kg/ha)
Madhu	50	108	33.7	28.4	4.3	3.9	917
GHG-19	41	90	31.4	22.6	4.1	3.6	820
GHG-13	47	93	31.8	21.9	3.9	3.5	780
AK-51	48	101	34.5	13.5	3.7	3.4	763
AK-21	45	95	28.5	17.5	4.3	3.4	747
AK-41	45	102	27.4	14.7	4.3	3.4	737
Birsa Kulthi-1(c)	46	106	32.6	19.8	3.9	3.4	720
VLG-20	47	102	31.4	17.7	4.1	3.5	677
VLG-22	45	98	28.3	17.8	4.4	3.3	640
VLG-21	44	100	29.7	15.1	4.1	3.5	603
GHG-20	45	98	34.4	10.8	4.1	3.3	553
CD at 5%	-	-	-	-	-	-	157

In a linseed varietal trial at Chianki, out of 20 varieties, BAU-2K-16 variety performed better with higher seed yield of 1023 kg/ha and RWUE of 12.78 kg/ha-mm followed by PKDL-91 variety with seed yield of 939 kg/ha and RWUE of 11.74 kg/ha-mm compared to other varieties (Table 3.50).

Table 3.50: Evaluation of linseed varieties - Chianki

Variety	Days to 50% flowering	Days to maturity	Plant height (cm)	No. of capsules/ plant	1000 seed wt. (g)	No. of seeds/ capsule	Seed yield (kg/ha)	RWUE (kg/ha-mm)
BAU- 2K-16	77	120	51.33	72.27	6.07	8.87	1023	12.78
Shekhar	76	118	51.73	56.80	5.33	8.27	894	11.17
RLC- 94	78	112	45.73	43.20	5.00	7.07	923	11.53
Subhra	82	107	49.53	56.07	5.67	9.13	931	11.64
T-397 (NC)	79	117	46.60	58.27	6.00	8.20	857	10.71
PCL- 42-1	80	122	45.67	50.67	6.00	9.60	910	11.37
NDL- 2006-10	83	120	50.93	60.87	4.67	9.00	832	10.40
NL-259	79	118	49.40	66.93	5.00	10.07	872	10.90
PKDL- 91	78	117	50.67	69.80	6.33	10.80	939	11.74
RL- 27005	77	117	51.93	40.40	6.33	8.53	840	10.50
PCL- 40	77	118	53.40	65.17	5.67	9.33	851	10.64
SLS- 74	83	118	47.07	44.00	6.00	9.07	811	10.13
SLS- 75	83	116	51.07	43.53	6.33	8.13	871	10.88
LMS 2007-4	85	111	48.80	52.07	6.00	8.33	900	11.25
BAU-9906	83	119	61.60	47.77	6.33	8.00	722	9.03
BAU-06-03	84	117	53.53	51.07	5.00	8.27	786	9.83
BAU-11-08	81	119	50.80	75.67	5.67	8.47	863	10.79
BAU- 2K-2012	82	112	59.67	58.00	7.33	8.90	799	9.99
BAU-10-08	80	118	60.87	44.67	5.33	9.20	779	9.74
LG- 54	81	-	-	-	6.00	7.80	801	10.01
CD at 5%	-	-	-	-	-	-	138	-

Out of 16 entries of drought tolerant lines of safflower evaluated at Chianki, AKS-204 recorded maximum seed yield of 1456 kg/ha with RWUE of 18.20 kg/ha-mm, while local check (A-1) gave seed yield of 1139 kg/ha and RWUE of 14.23 kg/ha-mm (Table 3.51).

Table 3.51: Evaluation of drought tolerant lines of safflower under dryland condition - Chianki

Entry	Days to 50% flowering	Days to maturity	Plant height (cm)	No. of effective capitula/ plant	No. of seeds/ capitulum	100 seed weight (g)	Seed yield (kg/ha)	RWUE (kg/ha-mm)
JSI-116	78	120	90.07	12.80	20.27	7.17	1020	12.75
PBNS-72	78	120	94.60	16.47	20.96	6.67	948	11.85
AKS-204	79	124	106.80	11.17	19.00	6.67	1456	18.20
AKS/GMU-2724	79	119	99.80	17.73	20.27	6.83	1345	16.81
AKS-307	76	123	90.00	12.07	20.87	7.50	818	10.23
AKS-310	77	121	101.93	13.47	14.93	6.00	934	11.67
NARI-57	79	128	101.27	14.07	17.13	6.17	1095	13.68
AKS/S-41	83	125	104.07	13.80	17.30	6.33	980	12.25
AKS-311	81	119	92.27	8.80	16.00	5.50	1305	16.31
AVT-10-1	82	122	84.47	13.00	18.80	7.63	1312	16.40
AVT-10-2	80	118	93.40	8.57	17.80	7.67	941	11.77
AVT-10-3	82	117	102.20	8.60	15.33	7.50	1162	14.53
AVT-10-4	83	123	89.20	9.73	20.60	7.67	1088	13.60
AVT-10-5	81	138	85.80	10.60	19.67	8.00	1070	13.38
AVT-10-6	83	117	101.40	12.40	19.80	7.00	1147	14.34
Local check (A-1)	82	123	90.13	11.07	21.00	6.83	1139	14.23
CD at 5%	-	-	-	-	-	-	68	-

At Faizabad, in an evaluation of lentil varieties, out of 12 varieties, NDL-1 produced significantly higher seed yield (1367 kg/ha) and stalk yield (2016 kg/ha) as compared to other varieties. However, higher RWUE of 22.12 kg/ha-mm was recorded with HUL-57 variety (Table 3.52).

Table 3.52: Performance of lentil varieties under rainfed condition of eastern U.P. – Faizabad

Variety	Seed yield (kg/ha)		Stalk yield (kg/ha)		RWUE (kg/ha-mm)
	2014	Mean (2 yrs)	2014	Mean (2 yrs)	
NDL-1	1367	1511	2016	2164	12.69
DPL-15	1100	1244	1594	1761	10.21
DPL-62	1147	1274	1673	1812	10.65
IPL-81	922	1056	1300	1451	15.50
IPL-406	900	1011	1312	1438	15.13
PL-4	1000	1134	1425	1570	9.29
PL -5	989	1117	1406	1537	9.18
PL- 63	844	989	1200	1363	7.84
PL- 234	1251	1381	1810	1944	11.62
PL- 406	844	972	1234	1383	14.18
K- 75	1022	1156	1475	1618	17.18
HUL- 57	1316	1453	1922	2077	22.12
CD at 5%	139	-	217	-	-

At Phulbani, in a participatory evaluation of 18 rice varieties, CRR 616-B-66-2 gave maximum grain yield of 1845 kg/ha with RWUE of 1.49 kg/ha-mm closely followed by Vandana (1825 kg/ha). Two genotypes, CRR-427-21 and CRR-455-109, were badly affected due to early season drought and exhibited almost zero population in field. Days taken to flowering and maturity also increased in this year as compared to previous years. However, maximum drought tolerance (score on the basis of leaf rolling, unrolling & tip drying) was noticed in 9 varieties such as- Lalitgiri, CRR 427-21, CRR 455-109, Virendra, CRR 616-B-66-2, ZHU 11-26, Vandana, ODR-3-14 and DDR-121 while Jyotirmayee was found to be most susceptible to drought (Table 3.53 a & b).

Table 3.53a: Participatory evaluation of rice varieties for yield and resistance to biotic and abiotic stresses – Phulbani

Variety	Days to 50% flowering	Days to maturity	Plant height (cm)	Effective grains /panicle	Grain yield (kg/ha)		Straw yield (kg/ha)	RWUE (kg/ha-mm)
					2014	Mean (3 yrs)		
Jyotirmayee	86	115	80.3	27.8	377	834	2440	0.28
Yogesh	76	113	69.7	38.6	1468	1130	2421	1.10
Badami	76	115	100.1	49.7	377	600	2440	0.28
Lalitgiri	79	115	79.7	44.5	1040	843	2401	0.78
Nilagiri	84	114	66.9	50.5	567	831	2734	0.42
Ashoka-228	78	119	88.0	48.7	520	748	2417	0.39
Ghanteswari	76	107	68.9	54.9	833	829	2421	0.67
N-22	72	103	96.4	53.1	1151	1413	2718	0.93
Pathara	86	116	72.5	50.2	1091	921	2560	0.82
CR Dhan-40	85	115	94.9	54.7	1032	914	2381	0.77
Virendra	80	116	78.0	58.6	635	1125	2282	0.47
CRR 616-B-66-2	79	108	101.6	59.1	1845	1137	2421	1.49
ZHU 11-26	66	105	76.1	50.8	1766	1650	2437	1.43
Vandana	77	109	85.2	42.1	1825	1958	2520	1.48
Sahabhagi	86	115	89.9	47.3	774	891	2294	0.58
ODR-3-14	75	104	76.5	42.7	1171	1119	2556	0.95
DDR-121	77	106	87.0	45.9	1218	1175	2369	0.99
Siddhant	88	117	68.7	48.6	456	584	2440	0.34
CD at 5%	2	2	4.5	4.9	248	-	NS	-

*Two genotypes, CRR-427-21 and CRR-455-109, were badly affected due to early season drought and exhibited almost zero population in field for which their biometric observations were not taken.

Table 3.53b: Response of upland rice varieties to drought and biotic stresses during kharif 2014 - Phulbani

Variety	Drought tolerance (1-5 Scale)	BLB (0-9 scale)	Helminthosporium leaf spot (0-9 scale)	Blast (0-9 scale)	% loss in crop stand due to termites
Jyotirmayee	5	0	3	-	20
Yogesh	2	3	3	-	5
Badami	3	1	6	2	10
Lalitgiri	1	2	3	-	2
Nilagiri	2	4	2	-	5

Variety	Drought tolerance (1-5 Scale)	BLB (0-9 scale)	Helminthosporium leaf spot (0-9 scale)	Blast (0-9 scale)	% loss in crop stand due to termites
Ashoka-228	3	1	1	-	15
Ghanteswari	3	3	3	-	10
N-22	2	5	7	-	5
Pathara	2	1	2	-	15
CRR 427-21	1	4	1	-	-
CR Dhan-40	2	1	2	-	10
CRR 455-109	1	1	2	-	5
Virendra	1	3	3	-	15
CRR 616-B-66-2	1	3	3	-	-
ZHU 11-26	1	1	1	2	5
Vandana	1	0	2	-	8
Sahabhagi	3	1	2	-	10
ODR-3-14	1	3	4	-	10
DDR-121	1	3	6	-	-
Siddhant	4	3	2	-	10

*Two genotypes, CRR-427-21 and CRR-455-109, were badly affected due to early season drought and exhibited almost zero population in field for which their biometric observations were not taken.

Drought tolerance (1-5 Scale, based on intensity of leaf rolling & drying) (observed at 10th day of dry spell, i.e. 08.09.2013): 1.No sign of stress; 2.Rolling of leaves during mid day, leaves unrolled in the evening; 3.Rolling of leaves followed by tip drying, unrolling in morning; 4.Rolling of leaves followed by tip drying, partially unrolled in early morning; 5.Tightly rolled leaves, tip drying and no unrolling.

Rice crop at cv. CRR 616-B-66-2

At Phulbani, in a study on crop improvement in rice through hybridization between selected parents followed by pedigree selection, ODR 55 (1) produced highest grain yield of 3300 kg/ha closely followed by ODR 12 (C) (3267 kg/ha). The maturity duration varied from 96 to 108 days. The plant height ranged from 59.25 cm in ODR 55(1) to 110.60 cm in ODR 58 (Table 3.54).

Table 3.54: Crop improvement in rice through hybridization between selected parents followed by pedigree selection - Phulbani

Genotype	Days to 50% flowering	Plant height (cm)	Tillers/ plant	Panicle length (cm)	Grain yield (kg/ha)	Straw yield (kg/ha)
ODR-1-3	74	95.4	16.2	26.0	2107	2487
ODR-2	70	70.9	14.9	23.1	1480	2347
ODR 24 (1)	76	85.8	10.5	25.1	2393	2947
ODR 1-2	74	80.5	11.6	23.0	1847	2560
ODR 12-1 (1)	70	83.7	11.8	17.4	2220	2807
ODR 12-1	81	78.5	18.2	18.5	1953	2260

Genotype	Days to 50% flowering	Plant height (cm)	Tillers/ plant	Panicle length (cm)	Grain yield (kg/ha)	Straw yield (kg/ha)
ODR 1	72	84.6	16.2	26.1	2187	2373
ODR 38	74	92.9	17.0	22.6	1633	2347
ODR 41	76	80.0	20.2	20.9	2573	2453
ODR 17	72	76.2	14.8	20.9	1340	2947
ODR 58	76	110.6	12.7	25.3	1747	2620
ODR 5	74	68.6	7.8	24.6	2280	2333
DDR 121	74	79.9	5.6	22.4	2007	2007
ODR 55 (1)	72	59.3	9.5	20.7	3300	2413
ODR 10	78	86.0	8.6	27.3	1853	2833
ODR 12C	79	81.4	11.9	22.2	3267	1953
ODR 12	74	88.3	12.2	19.3	2420	2500
ODR 1 (1)	75	81.8	11.5	20.3	2533	2460
ODR 24	77	88.9	23.8	22.4	2720	2913
ODR 59	73	92.5	7.6	20.8	1760	1553
ODR 3-14	72	80.8	7.3	20.1	2100	2840
ODR 12-3	73	80.3	11.2	22.7	2980	2947
ODR 30	77	109.1	3.4	21.7	2140	2500
CD at 5%	1.19	3.51	1.13	11	390	256

In an evaluation trial on turmeric at Phulbani, among four varieties, highest rhizome yield (7899 kg/ha) was recorded by Lakdong variety with the nutrient treatment comprising lime (10% LR) + 50% organic + 50% inorganic, followed by Rajendra Sonia with rhizome yield of 7826 kg/ha. Similarly, Lakdong variety gave higher mean rhizome yield (10452 kg/ha) over five years followed by Rajendra Sonia (10408 kg/ha) with the same nutrient management practice (Table 3.55).

Table 3.55: Rhizome yield (kg/ha) of turmeric varieties under different nutrient management practices - Phulbani

Treatment	Lakdong		Rajendra Sonia		Roma		Phulbani local (Check)	
	2014	Mean (5 years)	2014	Mean (5 years)	(2014)	Mean (5 years)	(2014)	Mean (5 years)
Control	5072	5800	6957	6017	4855	6095	3986	5180
100% N (organic)	7826	11105	7101	7817	5797	8471	6304	7785
100% N (inorganic)	7174	8651	7826	8673	5507	7752	4855	6536
50% organic + 50% inorganic	6304	9687	7681	8237	5870	8634	5725	6800
Lime (10% LR) + 50% organic + 50% inorganic	7899	10452	7826	10408	6014	8297	5942	7423

In a groundnut evaluation trial at Phulbani, out of 11 varieties tested, TAG-24 recorded higher pod yield of 1646 kg/ha with RWUE of 2.39 kg/ha-mm. The lowest pod yield (606 kg/ha) and RWUE (1.06 kg/ha-mm) were recorded by AK-159 variety (Table 3.56).

Table 3.56: Participatory evaluation of groundnut varieties for yield and resistance to biotic and abiotic stresses - Phulbani

Variety	Days to 50% flowering	Plant height (cm)	Branches/ Plant	Effective pods/Plant	Pod yield (kg/ha)		RWUE (kg/ha-mm)
					2014	Mean (2 yrs)	
Smruti	27.67	42.20	6.73	12.47	1434	1863	2.19
Tmv-2	27.33	48.63	6.20	10.73	1162	1456	1.71
Kadiri-6	28.00	53.67	6.93	20.30	1263	1307	1.50
ICGV-00308	25.33	43.73	5.67	11.87	758	1147	1.37
Devi	27.67	32.63	5.47	11.07	1111	1401	1.64
AK 12-24	27.33	52.00	7.13	22.73	1101	1244	1.44
TG-38 B	27.33	40.63	7.60	21.53	1152	1398	1.63
TAG-24	26.00	39.37	6.30	21.70	1646	2043	2.39
AK-159	25.67	42.83	6.73	21.43	606	893	1.06
ICGV-02266	27.67	54.83	8.20	12.47	1384	1384	1.36
ICGV-07220	26.00	34.93	11.50	13.63	1242	1242	1.22
CD at 5%	1.36	2.80	0.45	1.40	182	-	-

At Varanasi, in a study on genetic improvement of lentil for terminal heat tolerance under two sowing dates, sowing in the first fortnight of November (12.11.2014) and untreated control treatment gave maximum seed yield of 1044 kg/ha, over check variety HUL-57, while 20 kR of gamma-rays + EMS (0.3%) gave seed yield of 870 kg/ha (Table 3.57).

Table 3.57: Effect of different mutagenic treatments on seed yield and economics in lentil (M4 generation) - Varanasi

Treatment	Seed yield (kg/ha) in 2014	Seed yield (g/plant) in 2013	Stalk yield (kg/ha)	DSI	DTE	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
Untreated control	866	2.43	1506					
Gamma-rays 10 kR	1044	2.69	1600	0.18	87.04	22078	2.64	7.97
Gamma-rays 20 kR	870	2.50	1483	0.39	72.50	16333	2.21	6.61
Gamma-rays 30 kR	823	2.04	1392	0.45	68.58	14795	2.10	6.28
EMS (0.3%)	868	2.36	1358	0.39	72.25	16118	2.20	6.62
10 kR of Gamma-rays + EMS (0.3%)	741	2.73	1303	0.45	61.73	12069	1.89	5.65
20 kR of Gamma-rays + EMS (0.3%)	837	2.33	1293	0.43	69.75	15033	2.12	6.39
30 kR of Gamma-rays + EMS (0.3%)	745	1.98	1194	0.54	62.07	11978	1.89	5.68
CD at 5%	54.68	0.403	87.83		4.56	1775.08	0.13	0.42

DSI: Drought susceptibility index; DTE: Drought tolerance efficiency; Cost of cultivation: Rs.13500/ha

Among ten rice varieties (Shusk samrat, HUR-3022, NDR-97, Sahbhagi, Vandana, Rajendra Bhagwati, Virendra, Anjali, *rabi* and APO) tested at Varanasi, NDR-97 produced maximum grain yield (2560 kg/ha), with net returns of Rs.32713/ha, B:C ratio of 2.91 and RWUE of 3.6 kg/ha-mm followed by HUR-3022 (2243 kg/ha) as compared to other varieties (Table 3.58).

Table 3.58: Evaluation of rice varieties for terminal heat tolerance - Varanasi

Variety	Yield (kg/ha)			DSI	DTE	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Grain yield in 2014	Mean grain yield (2 yrs)	Stalk yield					
Shusk samrat	1813	1920	4506	0.433	69.757	21306	2.20	2.6
HUR3022	2243	2300	4490	0.3	76.94	27508	2.59	3.2
NDR-97	2560	2460	4796	0.163	86.01	32713	2.91	3.6
Sahbhagi	1723	1802	4300	0.43	70.017	19588	2.1	2.4
Vandana	1335	400	3270	0.603	62.397	11897	1.62	1.9
Rajendra Bhagwati	1252	981	3163	0.557	64.26	10490	1.53	1.8
Virendra	1606	1829	4161	0.553	64.437	17620	1.97	2.2
Anjali	1440	1510	3450	0.357	73.73	13780	1.73	2.1
Rabi	1711	1829	4176	0.503	66.61	19172	2.07	2.4
APO	1695	1839	4396	0.443	69.18	19370	2.08	2.4
Mean	1738.1	1987	4071	0.4342	70.3338	19344	2.08	2.4
CD at 5%	43.40	-	93.207	0.026	1.737	680	0.04	0.06

DSI: Drought susceptibility index; DTE: Drought tolerance efficiency; Cost of cultivation: Rs.16000/ha

Rice cv. 'NDR-97'

3.1.6 Integrated weed management

At Faizabad, in an integrated weed management trial for upland rice, pretilachlor @ 750 g/ha applied as pre-emergence (PE) fb Bispyribac sodium @ 25 g/ha at 25 DAS gave maximum grain yield of 2152 kg/ha and straw yield of 2808 kg/ha with RWUE of 6.96 kg/ha-mm (Table 3.59). All the treatments recorded significant reduction in density and biomass of weeds compared with weedy check. Significantly lower density (5.51/m^2) and biomass of weeds (4.56 g/m2) were recorded with application of Pretilachlor @ 750 g/ha (PE 0-3 DAS) followed by Bispyribac sodium @ 25 g/ha at 25 DAS as compared with other treatments. The weed control efficiency (WCE) of different weed control measures ranged from 75.4 to 93.8%. The highest WCE (93.8%) was achieved with pretilachlor @ 750 g/ha (PE 0-3 DAS) followed by Bispyribac sodium @ 25 g/ha at 25 DAS. However, the lowest WCE (75.4%) was recorded for the treatment involving mechanical weeding alone.

Table 3.59: Efficiency of various herbicide combinations for integrated weed management in upland rainfed rice - Faizabad

Treatment	Seed yield (kg/ha)		Straw yield (kg/ha)		RWUE (kg/ha-mm)	Weed density (no./m²) (60 DAS)	Weed dry matter (g/m²)	WCE (%)	WI (%)
	2014	Mean (2 yrs)	2014	Mean (2 yrs)					
Bispyribac sodium @ 25 g/ha at 25 DAS	1763	2062	2300	2588	5.72	10.70 (113.5)	8.12 (65.0)	79.7	21.8
Bispyribac sodium @ 20 g/ha + Almix @ 4 g/ha at 20 DAS	1871	2174	2427	2712	6.03	8.17 (65.8)	7.20 (50.8)	84.2	17.0
Pendimethalin (PE 0-3 DAS) @ 1000 g/ ha fb by Bispyribac sodium @ 25 g/ha at 25 DAS	1974	2324	2503	2959	6.45	6.40 (40.0)	5.44 (28.6)	91.1	12.5
Pyrazosulfuron (PE 0-3 DAS) @ 20 g/ha fb Bispyribac sodium @ 25 g/ha at 25 DAS	1883	2173	2451	2716	6.03	6.68 (43.6)	5.97 (34.6)	89.2	16.5
Pretilachlor @ 750 g/ha (PE 0-3 DAS) fb Bispyribac sodium @ 25 g/ha at 25 DAS	2152	2509	2808	3205	6.96	5.51 (29.4)	4.56 (19.8)	93.8	4.6
Oxadiarzyl (PE 0 -2 DAS) @ 100 g/ha fb Bispyribac sodium @ 25 g/ha at 25 DAS	1846	2145	2395	2690	5.95	8.17 (65.8)	6.24 (38.0)	88.2	18.1
Pendimethalin (PE 0-3 DAS) @ 1000 g/ha fb mechanical weeding (Cono weeder) at 30 DAS	1591	1865	2005	2347	5.18	9.77 (94.4)	7.21 (51.0)	84.1	29.4
3 Mechanical weedings by Cono weeder at 20, 40 & 60 DAS	1652	1926	2188	2462	5.34	12.04 (144.0)	8.94 (79.0)	75.4	26.7
Weed free check	2255	2597	2942	3334	7.20	1.0 (0.0)	1.0 (0.0)	100.0	-
Weedy check	947	1080	1277	1422	2.99	22.50 (505.4)	17.94 (320.8)	-	58.0
CD at 5%	1.75	1.37	3.80	2.48	-	-	-	-	-

*Figures in parentheses are original values; PE: Pre-emergence; WCE: Weed control efficiency; WI: Weed index; fb: followed by

At Jagdalpur, in an integrated weed management trial for lowland rice, application of post-emergence herbicide (bispyribac sodium) + 1 hand weeding recorded significantly higher number of effective tillers (5.30) and grain yield (4967 kg/ha). However, in midland rice, application of pre-emergence herbicide (pyrazosulfuron ethyl) + 1 hand weeding recorded significantly higher number of effective tillers (7.67) and grain yield (6389 kg/ha) compared to other treatments (Table 3.60).

Table 3.60: Effect of weed management in lowland rice - Jagdalpur

Treatment	Lowland rice			Midland rice		
	No. of tillers/plant	Test wt. (g)	Yield (kg/ha)	No. of tillers/plant	Test wt. (g)	Yield (kg/ha)
Control (T_1)	2.00	2.13	1344	3.40	2.27	2398
2 hand weedings (T_2)	2.87	2.22	2149	6.00	2.17	4228
2 mechanical weedings (T_3)	2.52	2.22	1841	5.33	2.23	3915
1 hand weeding + 1 mechanical weeding (T_4)	3.43	2.22	2523	6.00	2.47	4829
Pyrazosulfuron ethyl (pre-emergence) (T_5)	3.93	2.07	2693	6.56	2.33	5037
Bispyribac sodium (post-emergence) (T_6)	3.93	2.23	2978	7.20	2.27	5268
T_5 + 1 hand weeding	4.58	2.24	3617	7.67	2.50	6389
T_5 + 1 mechanical weeding	4.10	2.23	3220	7.00	2.50	5833
T_6 + 1 hand weeding	5.30	2.26	4967	7.31	2.50	6200
T_6 + 1 mechanical weeding	4.63	2.24	3894	7.37	2.50	6139
CD at 5%	1.23	0.10	961	1.18	NS	839

3.1.7 Alternate land use system

At Faizabad, in an evaluation of various alternate land use systems, pigeonpea equivalent yield was almost similar in maize-mustard cropping sequence and in sole pigeonpea, while ber + pigeonpea system recorded lowest pigeonpea equivalent yield (972 kg/ha) (Table 3.61).

Table 3.61: Evaluation of most remunerative land use system for rainfed areas of eastern U.P. - Faizabad

Treatment	Grain yield (kg/ha)			Pigeonpea equivalent yield (kg/ha)
	Maize	Pigeonpea	Mustard	
Ber + maize-mustard	1690	-	613	1071
Ber + pigeonpea	-	972	-	972
Aonla + maize-mustard	1620	-	648	1075
Aonla + pigeonpea	-	1042	-	1042
Guava + kajurina + maize-mustard	1609	-	660	1080
Guava + kajurina + pigeonpea	-	1076	-	1076
Kajurina + maize-mustard	1713	-	579	1051
Kajurina + pigeonpea	-	1007	-	1007
Maize-mustard	1713	-	637	1098
Pigeonpea	-	1088	-	1088

At Varanasi, in custard apple based agri-horti system, among nine treatment combinations i.e. three planting methods (flat bed, ridge furrow & raised bed) and three fertility levels (50, 75 and 100% RDF)., 100% fertility level and ridge furrow planting method were found more effective with custard apple equivalent yield (CAEY) of 1595-1599 kg/ha and B:C ratio of 1.93-2.19 as compared to other methods of planting and fertility levels (Table 3.62).

Table 3.62: Performance of custard apple + pearlmillet under agri-horti system - Varanasi

Treatment	Yield (kg/ha)			CAEY (kg/ha)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Main crop (Custard apple)	Intercrop (Pearlmillet)	Stover/ stalk yield					
Method of planting								
Flat bed	870	830	2460	1368	13600	13760	2.01	1.93
Raised bed	1040	870	2600	1562	14600	16640	2.14	2.20
Ridge furrow	1050	915	2650	1599	14600	17380	2.19	2.25
CD at 5%	-	26.23	127.11	-	-	-	-	-
Fertilizer level								
50% RDF	840	750	2400	1290	14500	11300	1.78	1.82
75% RDF	920	900	2600	1460	15500	13700	1.88	2.06
100 % RDF	1025	950	2730	1595	16500	15400	1.93	2.25
CD at 5%	-	108.36	216.02	-	-	-	-	-

CAEY: Custard apple equivalent yield

3.1.8 Integrated farming systems

In a trial for optimizing best intercrops between inter-rows of fruit crops on farmers' fields at Jagdalpur, pigeonpea gave highest net returns of Rs. 28440/ha and B:C ratio of 2.36 with seed yield of 450 kg/ha and kutki was the next best crop with net returns of Rs.24819/ha (Table 3.63).

Table 3.63: IFS for homestead garden (optimization of best intercrop between rows of fruit plants at farmer's field) – Jagdalpur

Crop	Yield (kg/ha)	RWUE (kg/ha-mm)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio
Maize	3190	0.38	16780	21500	1.28
Pigeonpea	450	0.25	12060	28440	2.36
Sesame	567	1.66	7895	14785	1.87
Upland rice	2145	3.14	11900	7405	0.62
Cowpea-niger	1567	0.50	14356	24819	1.73
Kutki	589	1.26	6578	14037	2.13

At Jagdalpur, in a study on dryland horticulture under *tikra* and *marhan* situation with mango, amla, guava, sapota and cashew, the biometric observations revealed that the fruit plants performed better under *marhan* situation (Table 3.64 a & b).

Table 3.64a: Biometric observation on different fruit plantation in *Tikra* situation – Jagdalpur

Crop	Plant height (cm)	Girth (cm)	Branches	Canopy	
				East-West	North-South
Aonla	326	17.47	8.33	26.61	22.04
Mango	194	18.89	7.92	44.56	39.20
Guava	372	18.48	9.85	43.98	52.91
Chiku	135	11.58	7.41	30.78	37.07
Cashew	280	21.43	9.95	29.76	32.19

Table 3.64b: Biometric observation on different fruit plantation in *Marhan* situation - Jagdalpur

Crop	Plant height (cm)	Girth (cm)	Branches	Canopy	
				East-West	North-South
Aonla	520	26	5.21	38.09	47.02
Mango	331	26	10.40	44.56	62.15
Guava	422	10	8.82	20.82	30.77
Chiku	211	13	7.04	30.78	39.71
Cashew	267	26	11.05	87.95	70.48
Litchi	160.87	8.63	4.84	15.44	18.38

In a study on integrated farming system for bunded midland (*Mal*) and lowland (*Gabhar*) situations at Jagdalpur, fish rearing in farm ponds in midlands gave additional income of Rs. 12673 with pond area of 2250 m^3 while in lowlands Rs. 9534 was obtained with pond area of 1650 m^3 (Table 3.65).

Table 3.65: Fish cultivation under midland & lowland situations – Jagdalpur

Village	Situation	Pond area (m^3)	Fish production (kg/pond)	GMR (Rs/ha)
Tahakapal	Midland	2250	133.40	12673
Gumiapal	Lowland	1650	125.34	9534

At Varanasi, integrated animal based systems (two buffalo + two buffalo calf) gave highest NMR (Rs.65850/ha) and B:C ratio (1.65) with rice equivalent yield of 7300 kg/ha while agri-horti-system recorded net returns of Rs.59000/ha and B:C ratio of 4.7 with REY of 3560 kg/ha (Table 3.66).

Table 3.66: Evaluation of agri-horti based integrated farming system - Varanasi

Farming system	Productivity (kg/ha)			System productivity (REY) (kg/ha)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	Employment generation (man-days/ha/yr)
	Crop	Livestock	Any other enter-pries					
Integrated animal based systems	Rice (2650)	Two buffalo (1800 litre) + two buffalo calf	Fish yield (200 kg)	7300	40000	65850	1.65	182
Agri-horti system	Aonla (800)	-	Greengram (380)	3560	16000	59000	4.7	163

REY: Rice equivalent yield

3.2 Maize Based Production System

3.2.1 Rainwater management

At Arjia, in an experiment on catchment-command and rainfall-runoff relationship, a rainfall of 345.5 mm with runoff of 33.8% was maximum in the month of August followed by 9.9% runoff with 231.7 mm rainfall in July. During June to December, a total of 710.6 mm rainfall with 55.1% runoff was recorded (Table 3.67).

Table 3.67: Runoff from the small agricultural watershed during the year 2014 - Arjia

Month	Rainfall (mm)		Runoff (m^3)	% runoff of monthly rainfall	% runoff producing rainfall
	Monthly	Runoff producing rainfall			
June	5.4	-	0	0	0
July	231.7	71.0	146.38	4.9	9.9
August	345.5	240.5	424.96	16.9	33.8
September	128.0	81.5	186.54	5.7	11.4
October	0.0	0	0	0	0
November	0.0	0	0	0	0
December	0.0	0	0	0	0
Total	710.6	393.0	757.88	27.5	55.1

Among different *rabi* vegetables, *Kachri* (cucumber) recorded significantly higher maize equivalent yield (6873 kg/ha) compared to other crop with highest net returns (Rs. 86841/ha) and B:C ratio (5.34) under recycling of harvested rainwater with highest water productivity (3.56 kg/cum). Application of irrigation water through drip recorded highest WUE (3.12) and B:C ratio (3.88) as compared to surface irrigation (Table 3.68).

Table 3.68: Productivity and economics of *kharif* crops as influenced by recycling of harvested rainwater through different methods -Arjia

Treatment	Maize eq. yield (kg/ha)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	Water productivity (kg/m^3)
Crop					
Sponge gourd	5054	20810	55004	2.65	2.18
Bottle gourd	5867	20211	67789	3.36	2.27
Ridge gourd	5511	21211	61456	2.94	2.07
Kachri	6873	16259	86841	5.34	3.56
Cowpea	5544	19441	63726	3.28	2.77
CD at 5%	1340	-	-	-	-
Irrigation					
Surface irrigation	5388	20029	60785	3.15	2.02
Drip irrigation	6152	19144	73141	3.88	3.12
CD at 5%	470	-	-	-	-
Maize (5 ha cm)	2800	16750	36340	2.17	3.59
Maize (10 ha cm)	3750	20750	48905	2.36	2.27

Among different *rabi* vegetables, coriander recorded significantly higher pea pod equivalent yield (4387 kg/ha) compared to other crops with highest net returns (Rs.49087/ha) and B:C ratio (2.37) under recycling of harvested rainwater and water saving by 30.6% over brinjal. Application of irrigation water through drip was recorded highest RWUE (2.02 kg/ha-mm) and B:C ratio (2.18) as compared to surface irrigation. Further, drip irrigation saved the water by 132% with increased pea pod equivalent yield by 22.6% (Table 3.69).

Table 3.69: Productivity and economics of *rabi* crops as influenced by recycling of harvested rainwater through different methods (2014-15) -Arjia

Crop	Pea pod equivalent yield (kg/ha)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	WUE (kg/m^3)
Coriander green	4387	21100	49087	2.37	4387
Pea	2817	19911	25155	1.29	2817
Brinjal	3333	21892	31441	1.47	3333
CD at 5%	569	-	-	-	569
Surface irrigation	3156	22470	28019	1.24	22470
Drip irrigation	3869	19466	42436	2.18	19466
CD at 5%	456	-	-	-	-

During *kharif*, 2014, different vegetables and maize with different irrigation depth were evaluated. Results revealed that *Kachari* recorded the highest MGEY of 8102 kg/ha with water productivity of 6.09 kg/cum followed by ridge gourd. The highest mean B:C ratio (5.52) was attained in *kachari* followed by ridgegourd. Drip irrigation saved the water by 58% over surface irrigation and increased MGEY maize grain equivalent yield by 15.6 (Table 3.70).

Table 3.70: Crop productivity and water productivity of *kharif* crops as influenced by recycling of harvested rainwater - Arjia

Treatment	Maize grain equivalent yield (kg/ha)						Water productivity (kg/cum)						B:C ratio					
	2009	2010	2011	2012	2014	Mean	2009	2010	2011	2012	2014	Mean	2009	2010	2011	2012	2014	Mean
Spongegourd	0.00	6361	7767	5454	5054	4927	0.00	3.34	3.20	2.63	2.18	2.27	0.00	2.95	4.42	3.71	2.65	2.75
Bottlegourd	5321	5667	8125	6440	5867	6284	3.99	2.93	3.32	3.11	2.27	3.12	2.11	2.70	4.75	4.48	3.36	3.48
Ridgegourd	7916	8428	7097	6540	5511	7098	6.01	5.60	2.92	3.16	2.07	3.95	2.88	3.69	3.82	4.59	2.94	3.58
Kachari	8270	9231	9017	7120	6873	8102	7.84	7.84	6.46	4.74	3.56	6.09	4.09	5.49	6.53	6.17	5.34	5.52
Veg cowpea	3932	7655	6267	6650	5544	6010	3.66	6.20	4.33	4.42	2.77	4.28	1.62	3.80	3.81	4.8	3.28	3.46
CD at 5%	595	943	810	311.7	1340	-	-	-	-	-	-	-	-	-	-	-	-	-8
Surface irrigation	4604	6934	7021	6126	3156	5568	2.70	3.46	2.45	4.36	2.02	3.00	1.97	3.51	4.33	4.36	3.15	3.46
Drip irrigation	5571	8003	8288	6755	3869	6497	5.90	6.91	5.64	4.70	3.12	5.25	2.31	3.95	5.01	4.70	3.88	3.97
CD at 5%	376	597	512	115.85	456	-	-	-	-	-	-	-	-	-	-	-	-	-
Maize (irrigated) 5 cm	4789*	4547	4333	4082	2800	3941	0.00	5.72	5.56	5.83	3.59	4.14	0.22	3.99	3.77	4.57	2.17	2.94
Maize (irrigated) 10 cm	5266	-	-	-	3750	4508	3.40	-	-	-	2.27	2.84	3.20	-	-	-	2.36	2.78
Maize unirrigated	3433*	2850	2534	2241	1870	2374	-	-	-	-	0.0	0.00	0.55	4.29	3.28	3.69	1.75	2.71

*Indicate the maize stover yield due to severe drought during the year 2009

At Arjia, in an experiment on micro-agricultural watershed and rainfall runoff relationship, a rainfall of 285 mm with runoff of 512.06 m^3 was maximum in the month of August with runoff producing rainfall (184.08 mm). During June to December, a total of 729.6 mm rainfall with runoff 1004.71 m^3 was recorded (Table 3.71).

Table 3.71: Mean runoff from a micro-agricultural watershed (1994 –2014) - Arjia

Month	Runoff (m^3)													
	1994	1996	1997	2004	2006	2007	2008	2009	2010	2011	2012	2013	2014	Mean
June	386.0	0.0	0.0	0.0	197.8	0.0	155.8	0.0	149.7	111.5	0.0	0.0	0.0	77.0
July	1201.1	390.5	501.2	311.0	438.6	232.2	72.0	150.6	32.1	227.6	173.0	191.3	146.4	312.9
Aug	150.1	687.4	71.4	1158.0	969.9	20.4	126.6	0.0	662.8	565.6	797.4	1022.3	425.0	512.1
Sep	64.0	158.5	54.5	0.0	88.2	0.0	234.6	0.0	0.0	174.3	75.5	0.0	186.5	79.7
Oct	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nov	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	300.1	0.0	0.0	0.0	0.0	23.1
Dec	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	1801.2	1236.4	627.2	1469.0	1694.3	252.6	589.0	150.6	1144.6	1079.0	1046.0	1213.6	757.9	1004.7

Month	Runoff producing rainfall (mm)													
	1994	1996	1997	2004	2006	2007	2008	2009	2010	2011	2012	2013	2014	Mean
June	179.8	0.0	0.0	0.0	89.0	0.0	76.0	0.0	73.0	68.0	0.0	-	-	44.2
July	401.6	162.4	163.0	140.0	210.0	168.8	65.0	146.0	49.0	147.0	57.0	66.7	71.0	142.1
Aug	61.0	267.4	46.8	469.4	348.0	28.4	95.0	0.0	202.0	218.4	151.5	264.7	240.5	184.1
Sep	26.0	103.0	38.0	0.0	43.0	0.0	118.4	0.0	0.0	65.0	30.0	0.0	81.5	38.8
Oct	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nov	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	126.0	0.0	0.0	0.0	0.0	9.7
Dec	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	668.4	532.8	247.8	609.4	690.0	197.2	354.4	146.0	450.0	498.4	238.5	331.4	393.0	412.1

In an assessment of crop residue management for sustainable production of maize at Arjia, application of FYM @ 5 t/ha + vertical mulch with sesame straw @ 5 t/ha at 10 m interval resulted in a minimum runoff of soil loss of 1.33 t/ha with a runoff producing rainfall of 10.3% loss which further resulted in a maximum yield of maize (2428 kg/ha) while farmers` practice (no residue management) recorded lowest yield of 1429 kg/ha with maximum runoff and high soil loss (8.5 t/ha). Results revealed that incorporation of crop residue in soil recorded higher maize grain yield (10 to 70%) over farmers' practice. Incorporation of FYM @ 5 t/ha + vertical mulch of sesame straw @ 5 t/ha at 10 m interval increased maize grain yield by 70% over farmers' practice (1429 kg/ha). Whereas, higher runoff soil loss was recorded in cultivated fallow followed by farmers practice. Application of FYM @ 5 and 10 t/ha increased maize grain yield by 22 & 50%, respectively over farmers' practice (Table 3.72).

Table 3.72: Yield, economics, runoff and soil loss in maize as affected by crop residue management practices - Arjia

Treatment	Yield (kg/ha)		Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	Runoff producing rainfall (%)	Soil loss (t/ha)	RWUE (kg/ha-mm)
	Grain	Stover						
FYM @ 10 t/ha	2143	5543	20755	21714	2.0	18.6	2.114	3.7
FYM @ 5 t/ha	1771	5657	17955	19572	2.1	23.1	2.326	3.1
Mustard straw @ 5 t/ha	1714	5457	20455	15822	1.8	22.4	2.291	3.0
Sesame straw @ 5 t/ha	1571	4714	17955	14651	1.8	19.1	2.438	2.7
Vertical mulch of mustard straw at 10 m interval @ 5 t/ha	1943	5314	20455	18700	1.9	20.2	2.224	3.4
Vertical mulch of sesame at 10 m interval @ 5 t/ha	2114	5028	17955	22955	2.3	16.8	1.84	3.7

Treatment	Yield (kg/ha)		Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	Runoff producing rainfall (%)	Soil loss (t/ha)	RWUE (kg/ha-mm)
	Grain	Stover						
FYM @ 5 t/ha + vertical mulch of mustard straw at 10 m interval @ 5 t/ha	1828	6114	22955	16400	1.7	11.7	1.756	3.2
FYM @ 5 t/ha + vertical mulch of sesame straw @ 5 t/ha at 10 m interval	2428	6428	20455	28001	2.4	10.3	1.322	4.2
Farmers' practice	1429	5428	14245	17968	2.3	9.5	8.547	2.5
Cultivated fallow	0	0	1600	-	-	53.4	15.625	-

In an assessment of crop residue management for sustainable production of maize at Arjia, application of FYM @ 5 t/ha + vertical mulch with sesame straw @ 5 t/ha at 10 m interval resulted in a higher energy use efficiency of 15.91 with higher energy productivity (329.73 g/MJ) compared to other treatments and resulted in maximum yield of maize (2428 kg/ha) while farmers` practice (no residue management) recorded lowest yield of 1429 kg/ha. Application of FYM @ 5 t/ha + vertical mulch with sesame straw @ 5 t/ha at 10 m interval resulted in a higher soil moisture content at different depths compared to other treatments at harvest of the crop (Table 3.73).

Table 3.73: Energy use efficiency, energy productivity and soil moisture as influenced by different crop residue management practices in maize - Arjia

Treatment	Energy input (MJ/ha)	Energy output (MJ/ha)	Energy use efficiency	Energy productivity (g/MJ)	Soil moisture (%)		
					0-15 cm	15-30 cm	30-45 cm
FTM @ 10 t/ha	7406	124065	16.14	300.42	8.94	9.67	11.14
FYM @ 5 t/ha	7404	102533	13.80	238.69	8.04	9.75	10.65
Mustard straw @ 5 t/ha	7400	99172	13.83	237.10	8.52	9.35	10.26
Sesame straw @ 5 t/ha	7400	90908	14.46	270.37	8.88	9.62	10.98
Vertical mulch of mustard straw at 10 m interval @ 5 t/ha	7417	112653	15.52	260.62	8.34	9.14	10.08
Vertical mulch of sesame at 10 m interval @ 5 t/ha	7417	122583	17.16	280.99	9.04	9.87	10.75
FYM @ 5 t/ha + vertical mulch of mustard straw at 10 m interval @ 5 t/ha	7422	106098	13.36	282.07	9.26	10.03	11.11
FYM @ 5 t/ha + vertical mulch of sesame straw @ 5 t/ha at 10 m interval	7422	140885	15.91	329.73	9.41	10.31	11.43
Farmers' practice	73168	817141	9.17	165.01	6.71	7.54	8.76
Cultivated fallow	2377	-	-	-	7.34	8.23	10.14

In an experiment on rainwater harvesting in *nadi* and efficient utilization with different irrigation methods at Arjia, maximum maize equivalent yield (2817 kg/ha) was obtained with blackgram (TAU 2) with surface irrigation with net returns of Rs. 28743/ha, B:C ratio (2.89), water use 647 cum/ha and RWUE of 4.35 (kg/cum) than all other crops and varieties/hybrids evaluated. The lowest MEY was obtained with clusterbean (RGC 986) with control (no irrigation) (1064 kg/ha). The soil moisture status was high at all depths with surface irrigation compared to furrow irrigation and least with no irrigation (Table 3.74).

Table 3.74: Effect of supplemental irrigation on yield and water use efficiency in different crops during *kharif* - Arjia

Treatment	MEY (kg/ha)		Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	Water use (m^3/ha)	RWUE (kg/ha-mm)
	Grain	Stover					
T_1	1748	3715	14855	17970	2.21	0	-
T_2	2072	4641	15830	23615	2.49	397	5.21
T_3	2292	4768	16355	26455	2.62	638	3.59
T_4	1771	3761	14855	18398	2.24	0	-
T_5	2055	4194	15830	22383	2.41	394	5.21
T_6	2211	4618	16355	24982	2.53	665	3.32
T_7	2087	2156	13975	20095	2.44	0	-
T_8	2460	2134	14950	24293	2.62	450	5.47
T_9	2643	2093	15475	26231	2.70	667	3.96
T_{10}	2420	1898	13975	24183	2.73	0	-
T_{11}	2778	2134	14950	28743	2.92	444	6.26
T_{12}	2817	2338	15475	29226	2.89	647	4.35
T_{13}	1085	1368	13705	4558	1.33	0	-
T_{14}	1356	1955	14680	8698	1.59	418	3.24
T_{15}	1457	2013	15205	9729	1.64	681	2.14
T_{16}	1064	1732	13705	5091	1.37	0	0.00
T_{17}	1424	2033	14680	9823	1.67	439	3.25
T_{18}	1505	2162	15205	10727	1.71	690	2.18
T_{19}	2244	1898	18650	17037	1.91	0	-
T_{20}	2572	2134	19625	21180	2.08	432	5.95
T_{21}	2748	2636	20150	24256	2.20	691	3.97
T_{22}	2294	3091	18650	20426	2.10	0	-
T_{23}	2622	2165	19625	21957	2.12	421	6.22
T_{24}	2773	2542	20150	24397	2.21	669	4.14
CD at 5%	716	675	-	-	-	52.1	-

T_1: Maize (PEHM 2) with control (no irrigation); T_2: Maize (PEHM 2) with furrow irrigation; T_3: Maize (PEHM 2) with surface irrigation; T_4: Maize (PM 1) with control (no irrigation); T_5 : Maize (PM 1) with furrow irrigation; T_6: Maize (PM 1) with surface irrigation; T_7: Blackgram (T_9) with control (no irrigation); T_8: Blackgram (T_9) with furrow irrigation; T_9: Blackgram (T_9) with surface irrigation; T_{10}: Blackgram (TAU-2) with control (no irrigation); T_{11}: Blackgram (TAU-2) with surface irrigation; T_{12}: Blackgram (TAU-2) with surface irrigation; T_{13}: Clusterbean (RGC-936) with control (no irrigation); T_{14}: Clusterbean (RGC-936) with furrow irrigation; T_{15}: Clusterbean (RGC-936) with surface irrigation; T_{16}: Clusterbean (RGC-986) with control (no irrigation); T_{17}: Clusterbean (RGC-986) with furrow irrigation; T_{18}: Clusterbean (RGC-986) with surface irrigation; T_{19}: Groundnut (TAG-24) with control (no irrigation); T_{20}: Groundnut (TAG-24) with furrow irrigation; T_{21}: Groundnut (TAG-24) with surface irrigation; T_{22}: Groundnut (TAG-37A) with control (no irrigation); T_{23}: Groundnut (TAG-37A) with furrow irrigation; T_{24}: Groundnut (TAG-37A) with surface irrigation.

At Arjia, a field experiment was conducted (2014-15) to explore the possibility to raise the *rabi* crops with rainwater harvesting through *nadi* system. Results revealed that mustard recorded significantly higher mustard seed equivalent yield (1413 kg/ha) with highest net returns (Rs.43322/ha) and B:C ratio (2.54) compared to taramira. Application of one supplemental irrigation at 45 DAS recorded highest WUE (1.12) and B:C ratio (2.13) as compared to two supplemental irrigations at 45 & 60 DAS. Mustard seed equivalent yield increased by 23 and 40% over no irrigation, respectively (Table 3.75).

Table 3.75: Mustard equivalent yield and economics of different crops influenced by supplemental irrigation in *nadi* system - Arjia

Treatment	Mustard equivalent yield (kg/ha)		Straw yield (kg/ha)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	WUE (kg/ha-mm)
	Seed	Mean (3 yrs)					
Crop							
Taramira	845	977	2217	16500	20308	1.23	0.523
Mustard	1413	1539	3231	17050	43322	2.54	0.596
Chickpea	1205	1303	2958	17477	34512	1.97	0.625
CD at 5%	43	-	167	-	-	-	-
Supplemental irrigation							
No irrigation	954	976	2338	13453	27694	2.06	-
One irrigation at 45 DAS	1176	1304	2807	16120	34412	2.13	1.119
Two irrigation at 45 & 60 DAS	1333	1569	3262	21453	36036	1.68	0.624
CD at 5%	92	-	205	-	-	-	-

At Arjia, the maize yield differed significantly due to different tillage treatments and highest yield was recorded by minimum tillage (5165 kg/ha), with net returns of Rs.18743/ha, B:C ratio of 2.50 and RWUE of 3.66 kg/ha-mm. Among mulch treatments, significantly higher grain yield was recorded with soil mulch (5228 kg/ha) with net returns of Rs.27315/ha, B:C ratio (2.47) and RWUE of 3.60 kg/ha-mm. The soil moisture regimes at harvest did not differ much due to tillage practices but slight variation was noted in mulching treatments and polythene mulch retained more soil moisture as compared to other treatments (Table 3.76).

Table 3.76: Effect of tillage and mulching practices on maize yield and economics - Arjia

Treatment	Grain yield (kg/ha)		Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	2014	Mean (4 yrs)				
Tillage						
Conventional	4606	2473	18743	23320	2.26	3.36
Minimum	5165	2741	18743	27369	2.50	3.66
Raised bed	5130	2517	19613	20794	2.08	3.06
CD at 5%	226	217	-	-	-	-
Mulching operation						
M_0 - No mulch	4858	2429	15170	22264	2.47	2.81
M_1 - Farm waste mulch	4669	2205	19595	23027	2.18	3.41
M_2 - Polythene mulch	5112	2739	22695	22706	2.00	3.60
M_3 - Soil Mulch	5228	2936	18670	27315	2.47	3.63
CD at 5%	536	-	-	-	-	-

At Ballowal Saunkhri, in an assessment of the effect of vegetative barriers on water use efficiency in *kharif* crops *viz.*, maize, sesame and blackgram, *Kanna* as vegetative barrier was effective due to which maize recorded higher grain yield (3509 kg/ha) and RWUE of 8.7 kg/ha-mm with maximum net returns of Rs. 27128/ha and B:C ratio of 1.82 compared to other vegetative barriers. Similar trend was also observed in sesame and blackgram. Similarly, *Kanna* as vegetative barrier was effective due to which maize recorded higher mean grain yield 3583 kg/ha over 3 years compared to other vegetative barriers (Table 3.77).

Table 3.77: Effect of vegetative barriers on yield and economics of *kharif* crops - Ballowal Saunkhri

Treatment	Grain/ seed yield (kg/ha)		Stalk yield (kg/ha)	RWUE (kg/ha-mm)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio
	2014	Mean (3 yrs)					
Maize							
Control	2944	2605	5650	7.3	31188	18622	1.60
NH bajra	3417	3427	6425	8.5	32936	26744	1.81
Vetiver	3185	3139	5937	7.9	32756	21956	1.67
Babbar	3296	3299	5969	8.2	32842	24567	1.75
Kanna	3509	3583	6501	8.7	33008	27128	1.82
Subabul	3093	2892	5832	7.7	32684	20543	1.63
CD at 5%	264	-	NS	-	-	-	-
Sesame							
Control	377	237	2571	0.98	16134	21566	2.34
NH bajra	493	331	3100	1.28	17474	33826	2.94
Vetiver	467	296	3034	1.21	17474	30226	2.73
Babbar	487	324	3106	1.26	17474	33226	2.90
Kanna	527	341	3444	1.37	17474	36226	3.07
Subabul	427	312	2697	1.11	17474	26226	2.50
CD at 5%	56	-	457	-	-	-	-
Blackgram							
Control	656	2605	2326	1.7	21481	12253	1.57
NH bajra	789	3427	2879	2.1	23135	19249	1.83
Vetiver	709	3139	2378	1.9	22947	14437	1.63
Babbar	735	3299	2445	1.9	23008	16676	1.72
Kanna	846	3583	2896	2.2	23270	20964	1.90
Subabul	688	2892	2347	1.8	22897	13437	1.59
CD at 5%	63	-	350	-	-	-	-

Among *rabi* crops, *kanna* as vegetative barrier gave maximum wheat yield of 3987 kg/ha during 2014-15 with net returns of Rs. 54620/ha, B:C ratio of 3.05 and RWUE of 10.13 kg/ha-mm. In raya, *kanna* treatment gave recorded maximum yield of 861 kg/ha, net returns of Rs.15386/ha, B:C ratio (1.89) and RWUE (1.84 kg/ha-mm). Similarly, *kanna* as vegetative barrier gave maximum wheat mean yield of 2428 kg/ha over 3 years (Table 3.78).

Table 3.78: Effect of vegetative barriers on yield and economics of *rabi* crops - Ballowal Saunkhri

Treatment	Grain/seed yield (kg/ha)		Straw yield (kg/ha)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	2014-15	Mean (3 yrs)					
Wheat							
Control	3439	2456	5513	26113	43048	2.65	10.19
N. Bajra	3793	2378	6315	26493	50608	2.91	9.31
Vetiver	3649	2282	6134	26338	48041	2.82	12.03
Babbar	3835	2428	6278	26538	51042	2.92	11.97
Kanna	3987	2360	6717	26701	54620	3.05	10.13
Subabul	3603	2260	5954	26289	46794	2.78	11.28
CD at 5%	NS	-	NS	-	-	-	-

Treatment	Grain/seed yield (kg/ha)		Straw yield (kg/ha)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	2014-15	Mean (3 yrs)					
Raya							
Control	708	1295	1324	16504	10400	1.63	2.91
N. bajra	764	1171	1435	17332	11700	1.68	2.08
Vetiver	861	1149	1583	17332	15386	1.89	2.22
Babbar	847	1183	1463	17332	14854	1.86	2.05
Kanna	861	1269	1315	17332	15386	1.89	1.84
Subabul	792	1066	1306	17332	12764	1.74	2.41
CD at 5%	NS	-	NS	-	-	-	-

At Ballowal Saunkhri, in a study on monitoring of discharge from Makkowal type water harvesting system (MTWHS), the maximum discharge (10.1 lps) was observed in the month of August 2014, while minimum (1.4 lps) was observed in the month of April,2015. The water table depth varied from shallow (78.5 cm) during May 2014 to deep (150.0 cm) during Jan 2015 (Table 3.79).

Table 3.79: Average monthly discharge and water table depth of the makkowal type water harvesting system - Ballowal Saunkhri

Month	Average discharge (lps)	
	2014-15	Mean over 3 years
May	5.9	6.9
June	6.1	7.5
July	8.9	14.1
August	10.1	13.7
September	8.1	20.1
October	7.7	14.9
November	7.4	14.5
December	7.2	15.3
January	5.8	14.2
February	4.8	11.7
March	3.7	12.9
April	1.4	11.5
Mean	6.4	14.3
CV (%)	36.9	17.9
Rainfall (mm)	896.9	1035.2

At Ballowal Saunkhri, mulching with different plant residues significantly enhanced maize yield over control. Highest maize yield (3514 kg/ha) was recorded with soil mulch (hoeing), with net returns of Rs.27115/ha and RWUE (8.0 kg/ha-mm) but B:C ratio was highest with *kanna* mulch (1.91) followed by *Nara* mulch. Similarly, averaged over 3 years, highest maize yield (2194 kg/ha) was recorded with hoeing and *kanna* mulch (Table 3.80).

Table 3.80: Influence of *in-situ* moisture conservation on yield and economics of rainfed maize in maize-wheat sequence - Ballowal Saunkhri

Treatment	Grain yield (kg/ha)		Stalk yield (kg/ha)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	2014	Mean (3 years)					
Control	2801	1610	5521	26343	21193	1.80	6.4
Kanna	3482	2124	6658	30893	27995	1.91	7.9
Hoeing	3514	2194	6663	32258	27115	1.84	8.0
Raya stalks	3270	1996	6330	29388	25992	1.88	7.4
Subabul	3129	1900	6175	30619	22491	1.73	7.1
Nara	3432	2284	6577	30854	27203	1.88	7.8
CD at 5%	451	-	764	-	-	-	-

Similarly, during *rabi* season, highest wheat yield (2555 kg/ha), with net reruns (Rs.25930/ha), B:C ratio (2.05) was recorded when mulching in the previous season was done with *kanna* followed by hoeing. Whereas, RWUE was highest with hoeing (7.87 kg/ha-mm) (Table 3.81).

Table 3.81: Influence of *in-situ* moisture conservation on yield and economics of rainfed wheat in maize- wheat sequence – Ballowal Saunkhri

Treatment	Grain yield (kg/ha)		Straw yield (kg/ha)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	2014-15	Mean of 3 years					
Control	2188	1234	3278	24335	18864	1.78	7.54
Kanna	2555	1627	3889	24729	25930	2.05	7.67
Hoeing	2529	1548	3777	24702	25188	2.02	7.87
Raya stalks	2352	1419	3593	24511	22168	1.90	7.19
Subabul	2404	1428	3762	24567	23458	1.95	6.58
Nara	2519	1451	3746	24691	24946	2.01	7.45
CD at 5%	NS	-	NS	-	-	-	-

Mulching with *Kanna* in maize

3.2.2 Cropping systems

At Arjia, during 2014 under stable production system in varying monsoon conditions, cereal dominant system (CDS) gave the highest maize equivalent grain yield (3300 kg/ha) with net returns of Rs.41123/ha, B:C ratio of 3.33 and RWUE of 4.9 kg/ha-mm followed by maize + blackgram (2:2) which gave 49.7 and 48.5% higher yield compared to sole maize (2204 kg/ha), respectively with, highest net returns (Rs.42645/ha) and B:C ratio (4.9). At Arjia on the basis of mean of 6 years, cereal dominant system (CDS) gave the highest maize equivalent grain yield (4054 kg/ha) followed by seed mixture line and maize + blackgram (2:2) which were gave 54, 42 and 32% higher yield compared to sole maize (2619 kg/ha), respectively (Table 3.82).

Table 3.82: Yield and economics of different production systems - Arjia

Treatment	Maize equivalent yield (kg/ha)		Stover yield (kg/ha)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Grain	Mean (6 yrs)					
Maize	3300	4054	5575	17617	41123	3.33	4.9
Blackgram	2720	3214	3782	15783	30799	2.95	4.0
Sesame	2646	3335	3318	15757	28745	2.82	3.9
Crop seed mixture in lines	2996	3720	4724	16765	35809	3.14	4.5
Maize + blackgram (2:2)	3273	3455	5991	16655	42645	3.56	4.9
Sole sorghum (dual purpose)	1389	1676	12984	15055	33603	3.23	2.1
Sole sesame	3021	3173	577	13705	29885	3.18	4.5

Treatment	Maize equivalent yield (kg/ha)		Stover yield (kg/ha)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Grain	Mean (6 yrs)					
Farmers' practice (broadcast)	2798	3133	3967	17525	30568	2.74	4.2
Sole maize	2204	2619	4381	14855	25860	2.74	3.3
Sole blackgram	2638	3285	3087	13975	29905	3.14	3.9
CD at 5%	626	-	1298	-	-	-	-

N: In calculation only blackgram yield was used (because due late onset of monsoon and terminal drought maize and sesame crop could not set grain)

At Ballowal Saunkhri, among different *kharif* crops evaluated for contingency crop planning, highest maize equivalent yield (MEY) was obtained in maize followed by sesame under normal sowing (last week of June). Delayed sowing (by 15 days) of crops decreased the MEY in maize, while it increased in sesame, blackgram & greengram. However, if the sowing was further delayed by 15 days the MEY decreased in all crops (Table 3.84).

Table 3.84: Contingency crop planning with altrante crops during *kharif* - Ballowal Saunkhri

Crop	Variety	Maize equivalent yield (kg/ha)			% increase/ decrease in yield of 2nd sowing over 1st sowing	% increase/ decrease in yield of 3rd sowing over 1st sowing
		1st sowing (06.07.14)	2nd sowing (22.07.14)	3rd sowing (01.08.14)		
Maize	Prakash	3640	3006	484	-17.4	-86.7
Greengram	PAU 911	2291	2675	1613	16.8	-29.6
Blackgram	Mash 338	1769	2846	1735	60.9	-1.9
Guar	Guara 80	1332	630	638	- 52.7	-52.1
Sesame	RT 346	2991	4017	2422	34.3	-19.0
Pearlmillet (G)	PHB 2168	220	421	137	91.4	-37.7
Pearlmillet (F)	FBC 16	2579	2021	1635	-21.6	-36.6
CD at 5%	-	329	600	198		

At Ballowal Saunkhri, among *rabi* crops evaluated for contingency crop planning, higher wheat equivalent yield (WEY) was obtained when the sowing was done in the last week of October compared to delayed sowing after the rains. Under delayed sowing (22 December), lentil and chickpea recorded higher yields compared to normal sowing (Table 3.85).

Table 3.85: Contingency crop planning with *rabi* crops - Ballowal Saunkhri

Crop	Variety	Wheat equivalent yield (kg/ha)			% increase/decrease in yield of 2nd sowing over 1st sowing	% increase/decrease in yield of 3rd sowing over 1st sowing
		1st sowing (27.10.14)	2nd sowing (22.12.14)	3rd sowing (06.01.14)		
Wheat	PBW 660	3299	3595	3214	8.97	-2.58
Triticale	TL 1210	3724	3299	2977	-11.41	-20.06
Barley	PL 419	4223	4200	3192	-0.54	-24.41
Lentil	LL 699	865	1022	815	18.15	-5.78
Raya	PBR 97	2501	2203	373	-11.92	-85.09
Chickpea	PBG 7	3554	3669	1565	3.24	-55.97
Taramira	TMLC 2	692	432	401	-37.57	-42.05
CD at 5%	-	1002	597	418	-	-
Rainfall (mm)	-	324.4	272.2	259.8	-	-

At Rakh Dhiansar, in a study on different intercropping systems, the highest maize equivalent yield (MEY) was obtained with paired rows of maize with 2 rows of cowpea with the MEY and LER of 2340 kg/ha and 1.26, respectively with the highest B:C ratio of 1.53. It was followed by treatment two rows of maize + 3 rows of cowpea with maize equivalent yield of 2150 kg/ha with B:C ratio of 1.34 compared to all other systems. The lowest MEY value of 1070 kg/ha was registered in sole til (T_9) treatment with RWUE of 1.79 kg/ha-mm. Average yield of two years under different intercropping systems revealed that the highest MEY was obtained with paired rows of maize with 2 rows of cowpea (2616 kg/ha) compared to all other systems (Table 3.86).

Table 3.86: Yield and economics of maize based intercropping systems - Rakh Dhiansar

Treatment	Yield (kg/ha)				MEY (kg/ha)		LER	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Main crop	Intercrop			2014	Mean (2 yrs)					
	Maize	Cowpea	Sesame	Groundnut							
2 rows of maize + 2 rows of cowpea	1220	195	-	-	2340	2616	1.26	21681	11544	1.53	2.04 (3.91)
2 rows of maize + 3 rows of cowpea	1090	180	-	-	2150	2334	1.13	22735	7793	1.34	1.82 (3.60)
2 rows of maize + 2 rows of sesame	1170	-	55	-	1914	2370	1.05	21135	6047	1.29	1.96 (3.20)
2 rows of maize + 3 rows of sesame	1030	-	30	-	1731	2250	0.93	21915	2659	1.12	1.72 (2.90)
2 rows of maize + 2 rows of ground-nut*	1382	-	-	*	1861	2566	-	27210	(-)788	0.97	2.31 (3.11)
2 rows of maize + 3 rows of groundnut	1420	-	-	*	1900	2436	-	31150	(-)4170	0.86	2.38 (3.18)
Sole maize	1530	-	-	-	-	2075	-	19575	9266	1.47	2.56
Sole cowpea	424	-	-	-	1492	1732	-	14258	6992	1.49	0.71 (2.50)
Sole sesame	190	-	-	-	1070	1440	-	12450	2750	1.22	0.31 (1.79)
Sole groundnut	*	-	-	*	-	2441	-	-	-	-	-

*Groundnut crop failed

At Rakh Dhiansar, in a study on different intercropping systems during *rabi* 2014-15, highest value of SEY was obtained in sole wheat with the corresponding yield, B:C ratio and RWUE of 1540 kg/ha, 3.26 and 5.07, respectively and lowest in T_2 with paired rows of gobhi sarson with 2 rows of chickpea (526 kg/ha). However, among the different intercropping systems, highest gobhi sarson equivalent yield (GSEY) was obtained with paired rows of gobhi sarson with 2 rows of peas with the corresponding (1198 kg/ha) having LER value of 1.11 compared to all other intercropping systems. Average yield of two years under different intercropping systems revealed that the highest SEY was obtained paired rows of mustard + 2 rows of peas (1412 kg/ha) (Table 3.87).

Table 3.87: Yield and economics of different intercropping systems - Rakh Dhiansar

Treatment	Yield (kg/ha)				GSEY		LER	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Main crop	Intercrop			2014	Mean (2 yrs)					
	Mustard	Chickpea	Peas	Wheat							
2 rows of mustard + 2 rows of chickpea	590	-	-	-	1114	590	-	17470	3180	1.18	2.01(2.01)
2 rows of mustard + 3 rows of chickpea	526	-	-	-	1013	526	-	18990	(-)580	0.97	1.88(1.88)

Treatment	Yield (kg/ha)				GSEY		LER	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Main crop	Intercrop			2014	Mean (2 yrs)					
	Mustard	Chickpea	Peas	Wheat							
2 rows of mustard + 2 rows of peas	625	-	1006	-	1412	1198	1.11	18310	23605	2.29	2.23(4.27)
2 rows of mustard + 3 rows of peas	563	-	870	-	1275	1060	0.99	20120	16985	1.84	2.0(3.280
2 rows of mustard + 2 rows of wheat	536	-	-	683	1306	1087	0.93	16225	21829	2.35	1.91(3.87)
2 rows of mustard + 3 rows of wheat	422	-	-	815	1292	1074	0.87	17250	20343	2.18	1.5(3.83)
Sole mustard	895	-	-	-	1163	895	-	13172	18153	2.37	3.19
Sole chickpea	-	-	-	-	653	-	-	-	-	-	-
Sole peas	-	-	-	-	1037	1388	-	20500	28100	2.37	8.67(4.95)
Sole wheat	-	-	2430	2054	1550	1540	-	16500	37415	3.26	6.78(5.07)

At Arjia, in a field experiment on weed management in clusterbean, post-emergence spray of imazethapyr @ 100 g/ha at 2-4 leaf stage + one hand weeding at 30 days after sowing gave significantly higher seed yield (538 kg/ha) but at par with two hand weedings at 15 & 30 DAS and imazethapyr @ 100 g/ha but highest net returns (Rs.14610/ha) was recorded under application of imazethapyr @ 100 g/ha at 2-4 leaf stage + one hand weeding at 30 DAS. Further, application of imazethapyr @ 100 g/ha at 2-4 leaf stage gave highest B:C ratio (2.34) (Table 3.88).

Table 3.88: Yield and economics of clusterbean under different weed management practices - Arjia

Treatment	Yield (kg/ha)		Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Seed	Stover				
T_1: Imazethapyr @ 100 g/ha	484	1164	10370	13898	2.34	0.72
T_2: Quizalofop ethyl @ 100 g/ha	374	1014	10420	8763	1.84	0.56
T_3: T_1 + hand weeding at 30 DAS	538	1295	12370	14610	2.18	0.80
T_4: T_2 + hand weeding at 30 DAS	432	1158	12420	9693	1.78	0.64
T_5: Two hand weedings at 15 & 30 DAS	543	1368	14330	13134	1.92	0.81
T_6: Weedy check	128	531	8320	-1074	0.87	0.19
CD at 5%	70	218				

3.2.3 Nutrient management

At Arjia, maize crop could not set grain due to late onset of monsoon and terminal drought but blackgram crop produced higher maize grain equivalent yield (2848 kg/ha) with net returns of Rs.17441/ha, B:C ratio (1.88) and RWUE of 3.17 kg/ha-mm under (maize + blackgram-maize) with 50% RDF + FYM @ 5 t/ha + biofertilizers as compared to other treatments (Table 3.89).

Table 3.89: Effect of inegrated nutrient management on yield and economics of maize based intercropping systems - Arjia

Treatment	Maize equivalent Yield (kg/ha)		Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Grain	Stover				
Maize – maize	1945	3047	17967	16112	1.91	2.89
Maize- blackgram	1871	3005	17967	14982	1.86	2.78
Maize + blackgram (2:2)- maize	1866	2922	17967	14729	1.84	2.77
Maize + blackgram - maize + blackgram	2714	3720	19767	26602	2.39	4.03
CD at 5%	153	673	-	-	-	-
100 % RDF	2042	3152	15305	20376	2.31	3.03
75% RDF + FYM @ 5 t/ha + biofertilizers	2824	4240	20310	16502	1.81	3.15
50% RDF + FYM @5 t/ha + biofertilizers	2848	4250	19635	17441	1.88	3.17
CD at 5%	673	605	-	-	-	-

At Arjia, to mitigate the dry spell stress and improve the production of maize under dryland conditions, different nutrient/chemicals were used as foliar spray. During 2014, spray of zinc sulphate @ 0.5% + NPK (soluble) @ 2% at before tasseling and grain filling stage, gave significantly higher maize grain yield (2510 kg/ha) but at par with NPK soluble (19:19:19) @ 2.0% (2441 kg/ha) which was 25.4 and 21.9% higher over control (2001 kg/ha), respectively. Similar trend was recorded for net returns and B:C ratio. Combined results of two years reveled that, spray of zinc sulphate @ 0.5% + NPK (soluble) @ 2% during the two dry spells before tasseling and at grain filling stage gave higher maize grain yield (3137 kg/ha) followed by NPK (soluble) @ 2% (2998 kg/ha) and zinc sulphate @ 0.5% (2933 kg/ha) which were 27, 21 and 1% higher over control (2473 kg/ha), respectively (Table 3.90).

Table 3.90: Effect of foliar spray of nutrients/chemicals for mitigating dry spell in maize - Arjia

Treatment	Yield (kg/ha)		Stover yield (kg/ha)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Grain	Mean (2 yrs)					
T_1- Control	2001		3852	14855	21826	2.47	2.97
T_2- Water spray	2013	2473	4048	15115	22170	2.47	2.99
T_3- NPK @ 2%	2441	2511	5032	16063	29426	2.83	3.63
T_4- $ZnSO_4$ @ 0.5%	2336	2998	4395	15267	27333	2.79	3.47
T_5- $T_3 + T_4$	2510	2933	5263	16474	30507	2.85	3.73
T_6 - Selenium @ 20 g/ha	2394	3137	4708	15695	28417	2.81	3.56
T_7-Urea @ 2%	2302	2743	4384	15474	26614	2.72	3.42
T_8-KNO_3 @ 2%	110	-	309	-	-	-	-
CD at 5%	2001	2808	3852	14855	21826	2.47	2.97

At Arjia, in a field experiment on evaluation of K and Mg levels, application of K upto 40 kg K_2O/ha and application of Mg u pto 30 kg $MgSO_4.7H_2O$/ha significantly increased maize grain (2358 & 2400 kg/ha) and stover yields (7190 & 7320 kg/ha), with higher net returns (Rs.33277/ha & Rs.34471/ha) and B:C ratio (3.09 & 3.21), respectively. Application of K upto 40 kg K_2O/ha and application of Mg upto level of 30 kg $MgSO_4.7H_2O$/ha. Significantly increased uptake of nutrients in maize grain and stover (Table 3.91).

Table 3.91: Effect of potassium and magnesium on yield, economics and nutrient uptake by maize - Arjia

Treatment	Yield (kg/ha)		Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	N (kg/ha)	P (kg/ha)	K (kg/ha)	Mg (kg/ha)
	Grain	Stover							
K_0	2003	6111	14855	26937	2.81	28.94	5.92	16.67	29.85
K_{20}	2256	6801	15386	31657	3.06	36.21	7.37	20.34	35.65
K_{40}	2358	7190	15917	33277	3.09	41.25	8	25.39	38.57
K_{60}	2415	7209	16448	33924	3.06	42.72	8.34	27.96	38.68
CD at 5%	294	934	-	-	-	2.45	0.52	1.55	2.27
Mg_0	1905	5812	14855	24897	2.68	4.99	1.06	3.17	4.65
Mg_{15}	2135	6485	15230	29309	2.92	30.18	5.58	18.72	27.66
Mg_{30}	2400	7320	15605	34471	3.21	35.59	7.31	21.3	32.74
Mg_{45}	2592	7898	15980	38080	3.38	40.16	8.47	24.47	39.14
CD at 5%	294	934	-	-	-	-	-	-	-

At Arjia, in a field experiment on long-term application of various INM treatments on yield of blackgram under maize-blackgram rotation, treatment having 25 kg N through FYM and 25 kg N through chemical fertilizer + 30 kg P_2O_5 gave higher seed yield of blackgram (1120 kg/ha), with net returns (Rs.49852/ha) and B:C ratio (5.25) over control (834 kg/ha) and increase was 34.29% over control. The mean blackgram seed yield ranged between 834 to 1120 kg/ha and stover yield ranged from 1554 to 2569 kg/ha. The soil moisture content was higher in organic manure treatments like addition of FYM, compost and crop residues etc (Table 3.92).

Table 3.92: Effect of integrated nutrient management on productivity and economics of blackgram - Arjia

Treatment	Yield (kg/ha)		Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	Soil moisture at harvest (%) (10/10/2014)
	Seed	Straw				
Control	834	1554	11730	33052	3.82	6.05
100% RD of NP	1013	2343	11730	44022	4.75	6.32
25 kg N through FYM and 25 kg N through IF + 30 kg P_2O_5	1120	2569	11730	49852	5.25	6.15
25 kg N through compost and 25 kg N through IF + 30 kg P_2O_5	1031	2325	11730	44830	4.82	6.21
25 kg N through crop residues and 25 kg N through IF + 30 kg P_2O_5	1023	2483	11730	44948	4.83	6.19
15 kg N through FYM + 10 kg N through crop residues and 25 kg N through IF + 30 kg P_2O_5	1024	2308	11730	44457	4.79	6.20
15 kg N through FYM + 10 kg N through compost and 25 kg N through IF + 30 kg P_2O_5	1026	2454	11730	44991	4.84	6.11
15 kg N through FYM + 10 kg N through greenleaf and 25 kg N through IF + 30 kg P_2O_5	1077	2372	11730	47191	5.02	6.18
100% recommended N through IF without P	929	1924	11730	38727	4.30	6.10
CD at 5%	93	337				

FYM: Farmyard manure; IF: Inorganic fertilizer

At Arjia, the available nitrogen content of the soil was affected by application of organic manure and chemical fertilizers. It varied from 206 kg/ha (control) to 250.1 kg/ha in the treatment receiving 15 kg N through FYM + 10 Kg N through greenleaf and 50% N through chemical fertilizer. The variation in available phosphorous and available potassium was found to be significant with the application of organic manure, chemical fertilizers and their combinations. The bulk density was reduced in plots where organic matter was added (Table 3.93).

Table 3.93: Effect of integrated nutrient management on soil chemical and physical properties - Arjia

Treatment	Organic carbon (%)	Available N (kg/ha)	Available P (kg/ha)	Available K (kg/ha)	Bulk density (Mg/m^3)
Control	0.35	206.8	28.0	336.9	1.52
100% RD of NP	0.37	241.4	36.5	361.5	1.54
25 kg N through FYM and 25 kg N through IF + 30 kg P_2O_5	0.41	245.8	39.9	373.7	1.48
25 kg N through compost and 25 kg N through IF + 30 kg P_2O_5	0.40	234.7	35.1	374.4	1.46
25 kg N through crop residues and 25 kg N through IF + 30 kg P_2O_5	0.38	223.2	39.4	365.6	1.48
15 kg N through FYM + 10 kg N through crop residues and 25 kg N through IF + 30 kg P_2O_5	0.39	231.9	37.4	375.2	1.49
15 kg N through FYM + 10 kg N through compost and 25 kg N through IF + 30 kg P_2O_5	0.42	247.6	37.8	376.1	1.47
15 kg N through FYM + 10 kg N through greenleaf and 25 kg N through IF + 30 kg P_2O_5	0.42	250.1	37.9	381.6	1.49
100% recommended N through IF without P	0.36	238.9	32.8	359.4	1.50
CD at 5%	0.019	3.99	2.00	16.81	-

The results over the 8 years of experimentation showed that the treatment 25 kg N through FYM and 25 kg N through inorganic fertilizer + 30 kg P_2O_5 gave highest maize grain equivalent yield (3136 kg/ha) as compared to control (2106 kg/ha) which was closely followed by 100% recommended dose of NP through chemical fertilizer (T_2), and 15 kg N (FYM) and 10 kg N (green leaf) +25 kg N (IF)+ 30 kg P_2O_5 (T_8) (Table 3.94).

Table 3.94: Effect of integrated nutrient management on yield of maize-blackgram system -Arjia

Treatment	Maize grain equivalent yield (kg/ha)							
	2007 (M)	2008 (BG)	2009 (M)	2010 (BG)	2011 (M)	2012 (BG)	2014 (BG)	Mean
T_1	995	1268	729	3922	2839	2126	2860	2106
T_2	1554	1814	892	5784	3815	3122	3472	2922
T_3	1304	1979	961	6023	4395	3454	3839	3136
T_4	1365	1929	880	5310	3977	2816	3533	2830
T_5	1246	1817	905	5140	3867	3027	3507	2787
T_6	1270	1923	928	5329	3906	2952	3510	2831
T_7	1341	1966	940	5209	4069	2832	3517	2839
T_8	1455	1783	1089	5159	4408	3018	3692	2943
T_9	1208	1672	859	4864	3652	2708	3185	2593

FYM: Farm yard manure; IF: Inorganic fertilizer; T_1 :Control; T_2: 100% RD of NP; T_3: 25 kg N through FYM and 25 kg N through IF + 30 kg P_2O_5; T_4: 25 kg N through compost and 25 kg N through IF + 30 kg P_2O_5; T_5: 25 kg N through crop residues and 25 kg N through IF + 30 kg P_2O_5; T6: 15 kg N through FYM + 10 kg N through crop residues and 25 kg N through IF + 30 kg P_2O_5; T_7: 15 kg N through FYM + 10 kg N through compost and 25 kg N through IF + 30 kg P_2O_5; T_8: 15 kg N through FYM + 10 kg N through green leaf and 25 kg N through IF + 30 kg P_2O_5; T_9: 100% recommended N through IF without P; *During 2013, maize crop failed due to severe drought; M: Maize; BG: Blackgram,

At Ballowal Saunkhri, in a permanent manurial trial in maize-wheat system, highest yield of maize (4593 kg/ha) was recorded with 100% NPK + FYM 10 t/ha which was significantly higher than control and 100% N treatment but at par with all other treatments. It also gave highest net returns (Rs.45011/ha), B:C ratio (2.4) and RWUE (10.4 kg/ha/mm) (Table 3.95).

Table 3.95: Effect of nutrient management on yield and economics of maize - wheat Ballowal Saunkhri

Treatment	Maize grain yield (kg/ha)	Straw yield (kg/ha)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
Control	3180	6669	25662	28707	2.12	7.2
N (100% RDF)	3715	7588	29464	33849	2.15	8.5
NP (100% RDF)	3819	7182	27420	37453	2.37	8.7
NPK (100% RDF) (DAP)	4118	7926	30336	39360	2.30	9.4
NPK (100% RDF +S (SSP)	4189	7734	30661	39908	2.30	9.5
NPK (100% RDF) + $ZnSO_4$	4228	7992	31199	40213	2.29	9.6
NPK (50% RDF) + FYM 10 t/ha	4052	7635	30036	38379	2.28	9.2
NPK (100% RDF) + FYM 10 t/ha	4593	8274	32158	45011	2.40	10.4
NPK (125% RDF)	4375	8409	31386	42648	2.36	10.0
CD at 5%	808	1097	-	-	-	-

100% NPK + FYM @ 10 t/ha in maize

During *rabi*, highest yield of wheat (3986 kg/ha) was recorded with 125% NPK which was significantly higher than control. It also gave highest net returns (Rs.53317/ha) compared to other treatments (Table 3.96).

Table 3.96: Effect of nutrient management on yield and economics of rainfed wheat - Ballowal Saunkhri

Treatment	Grain yield (kg/ha)	Straw yield (kg/ha)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
Control	2713	4251	20682	33535	2.62	6.47
N (100% RDF)	3304	5014	22586	42871	2.90	7.57
NP (100% RDF)	3634	5547	25343	46764	2.85	8.16
NPK (100% RDF) (DAP)	3794	5932	26118	49657	2.90	9.14
NPK (100% RDF) + S (SSP)	3669	5747	26253	47062	2.79	8.02
NPK (100% RDF) + $ZnSO_4$	3780	6191	26372	50107	2.90	8.41
NPK (50% RDF) + FYM 10 t/ha	3459	5399	24031	45021	2.87	14.22
NPK (100% RDF) + FYM 10 t/ha	3901	6407	26502	52487	2.98	15.59
NPK (125% RDF)	3986	6607	27604	53317	2.93	14.54
CD at 5%	676	1046	-	-	-	-

At Rakh Dhiansar, in a field experiment on nutrient management in maize maximum grain yield of maize (1525 kg/ha) was obtained with application of 50% recommended NPK + 50% N through FYM. However, highest net returns of Rs.4751/ha were realized with the application of 100% recommended NPK + $ZnSO_4$ @ 20 kg/ha. Similar trend was observed in B:C ratio. Application of 50% recommended NPK + 50% N nutrient management FYM recorded maximum RWUE of 2.31 while control evinced the minimum RWUE of 1.20 kg/ha-mm. The combined data for the last 12 years (2003-2014) revealed that recommended dose of NPK (60:40:20) coupled with 20 kg $ZnSO_4$/ha recorded the highest mean grain yield of 2162 kg/ha followed by application of 100% recommended dose of NPK and application of 50% recommended NPK + 50% N through FYM with grain yield of 1997 and 1954 kg/ha, respectively (Table 3.97).

Table 3.97: Effect of nutrient management in maize on yield and economics - Rakh Dhiansar

Treatment	Yield (kg/ha)			Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Grain (2014)	Mean grain yield (2003-2014)	Stover				
Control	793	1076	2057	16300	-1712	0.89	1.20
100% rec. NPK	1312	1997	2928	19445	3822	1.20	1.97
50% rec. NPK	972	1491	2438	17873	-126	0.99	1.47
50% rec. N (crop residue)	977	1450	2377	19600	-1872	0.90	1.48
50% rec. N (FYM)	985	1478	2235	22300	-4665	0.79	1.49
50% rec. NPK + 50% N (crop residue)	1433	1833	3077	22273	3125	1.14	2.17
50% rec. NPK + 50% N (FYM)	1525	1954	3233	23873	3089	1.13	2.31
FYM @ 10 t/ha	1292	1626	2788	24300	-1388	0.94	1.96
100% rec. NPK + $ZnSO_4$ @ 20 kg/ha	1374	2162	2981	19645	4751	1.24	2.08
Farmers` practice (FYM @ 4 t/ha + 40 kg urea/ha)	1208	1646	2722	20766	837	1.04	1.83
CD at 5%	217	-	-	-	-	-	-

The soil pH of different treatments ranged from 6.28 to 6.37. The maximum organic carbon content was obtained with application of FYM @ 10 t/ha followed by 50% recommended NPK + 50% N through FYM, and 50% recommended NPK + 50% N through crop residue. Intégration of 50% recommended NPK + 50% N through FYM recorded maximum available nitrogen of 211 kg/ha followed by application of 50 % recommended NPK + 50% N through crop residue (207.4 kg/ha) (Table 3.98).

Table 3.98: Effect of treatments on soil chemical properties - Rakh Dhiansar

Treatment	pH	OC (%)	Available nutrients (kg/ha)	
			N	P
Control	6.36	0.30	142.5	12.6
100% rec. NPK	6.28	0.37	167.6	15.6
50% rec. NPK	6.30	0.33	157.2	13.9
50% rec. N (crop residue)	6.32	0.36	159.2	14.5
50% rec. N (FYM)	6.34	0.38	171.8	15.6
50% rec. NPK + 50% N (crop residue)	6.35	0.45	207.4	17.4
50% rec. NPK + 50% N (FYM)	6.37	0.48	211.6	18.0
FYM @ 10 t/ha	6.31	0.53	192.8	18.3
100% rec. NPK + $ZnSO_4$ @ 20 kg/ha	6.29	0.38	173.9	15.8
Farmers practice (FYM @ 4 t/ha + 40 kg urea/ha)	6.30	0.41	184.4	16.1

At Rakh Dhiansar, application of treatments in *kharif* maize, resulted in significant residual effect on succeeding crop yield. Significantly higher sarson yield of 1005 kg/ha was obtained with FYM @ 10 t/ha applied during *kharif*, with higher, net returns (Rs. 20000/ha), B:C ratio (2.52) and RWUE (2.71). The combined analysis of 12 years data revealed that the highest sarson yield of 1175 kg/ha was recorded with application of FYM @ 10 t/ha to maize (Table 3.99).

Table 3.99: Residual effect of nutrient management on gobhi sarson yield and economics - Rakh Dhiansar

Treatment	Yield (kg/ha)		Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	2014-15	Mean seed yield (2003-14)				
Control	351	546	13150	-1560	0.88	0.95
100% recommended NPK	622	839	13150	7365	1.56	1.68
50% recommended NPK	476	748	13150	2555	1.19	1.29
50% recommended N (Crop residue)	543	728	13150	4780	1.36	1.47
50% recommended N (FYM)	568	896	13150	5590	1.43	1.53
50% recommended NPK + 50% N (crop residue)	788	978	13150	12865	1.98	2.13
50% recommended NPK + 50% N (FYM)	913	1106	13150	16985	2.29	2.47
FYM @ 10 t/ha	1005	1175	13150	20000	2.52	2.71
100% recommended NPK + $ZnSO_4$ @ 20 kg/ha	693	895	13150	9725	1.74	1.87
Farmer's method (FYM @ 4 t/ha + 40 kg urea/ha)	833	982	13150	14330	2.09	2.25
CD at 5%	109	-	-	-	-	-

At Rakh Dhiansar, in an experiment on INM in pearlmillet, significantly higher grain yield of 2586 kg/ha was obtained with application of 100% NPK through fertilizer which was at par with application of 75% N through inorganic + 25% N through vermicompost (2437 kg/ha). The maximum B:C ratio, net returns and RWUE of 2.92, Rs.29492/ha and 3.92, respectively were obtained with 100% NPK. The combined data for the last two years revealed that the recommended dose of NPK recorded highest mean grain yield of pearlmillet (2932 kg/ha) followed by 75% N inorganic + 25% N through vermicompost with grain yield of 2631 kg/ha (Table 3.100).

Table 3.100: Effect of nutrient management on pearlmillet yield and economics - Rakh Dhiansar

Treatment	Yield (kg/ha)			Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Grain (2014)	Mean grain yield (2013-14)	Stover				
Control	1346	1534	3802	13000	11820	1.91	2.04
100% NPK	2586	2932	5433	15372	29492	2.92	3.92
75% N inorganic + 25% N (FYM)	2317	2460	5220	16509	24223	2.47	3.51
50% N inorganic + 50% N (FYM)	2023	2196	5089	17648	18706	2.06	3.07
100% N FYM	1917	2153	4972	18000	16675	1.93	2.91
75% N inorganic + 25% N (VC)	2437	2631	5266	17509	25002	2.43	3.70
50 % N inorganic + 50% N (VC)	2311	2387	5189	19648	20953	2.07	3.51
100% N (VC)	2150	2325	4998	22000	16032	1.73	3.26
CD at 5%	257	-	361	-	-	-	-

VC:Vermicompost

The soil analysis showed that pH of different treatments ranged from 6.49 to 6.54. Organic carbon varied from 0.29 to 0.42% and highest organic carbon was obtained with application of 100% N through VC followed by 100% N through FYM. The higher value of nitrogen and phosphorus (194.9 and 16.41 kg/ha), respectively was recorded with application of 75% N inorganic + 25% N through VC (Table 3.101).

Table 3.101: Effect of treatments on soil chemical properties - Rakh Dhiansar

Treatment	pH	OC (%)	Available nutrients (kg/ha)	
			N	P
Control	6.53	0.29	157.2	12.89
100% NPK	6.49	0.32	173.9	14.93
75% N inorganic + 25% N (FYM)	6.52	0.35	184.4	15.85
50% N inorganic + 50% N (FYM)	6.51	0.35	176.0	15.02
100% N FYM	6.50	0.41	178.1	15.30
75% N inorganic + 25% N (VC)	6.53	0.38	194.9	16.41
50 % N inorganic + 50% N (VC)	6.54	0.36	186.5	16.13
100% N (VC)	6.52	0.42	182.3	15.39

At Rakh Dhiansar, significantly higher seed yield (867 kg/ha) of gobhi sarson was obtained with the application of 100% N through vermicompost which was statistically at par with application of 100% N through FYM. Similarly, maximum B:C ratio, net returns and RWUE (2.46, Rs 16986/ha and 2.34, respectively) was obtained with application of 100% N through VC. The combined data for the last two years revealed that the 100% N through vermicompost recorded highest mean seed yield of gobhi sarson (1142 kg/ha) followed by 100% N through FYM (Table 3.102).

Table 3.102: Effect of treatments on gobhi sarson yield and economics-Rakh Dhiansar

Treatment	Yield (kg/ha)			Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Seed (2014-15)	Mean seed yield (2013-15)	Stover				
Control	491	681	2176	11625	4578	1.39	1.33
100% NPK	672	867	2754	11625	10551	1.91	1.81
75% N inorganic +25%N FYM	681	914	2763	11625	10848	1.93	1.84
50% N inorganic + 50% N FYM	726	987	2802	11625	12333	2.06	1.96
100% N FYM	839	1110	2902	11625	16062	2.38	2.27
75% N inorganic +25% N VC	694	944	2769	11625	11277	1.97	1.87
50 % N inorganic + 50%N VC	741	1025	2824	11625	12828	2.10	2.00
100% N VC	867	1142	2920	11625	16986	2.46	2.34
CD at 5%	167						

3.2.4 Energy management

In a tillage and nutrient management study for maize-wheat cropping sequence at Ballowal Saunkhri, conventional tillage + interculture was better than other treatments in terms of yield. In case of nitrogen application, 100% recommended N through inorganic source gave highest yield. However, it was statistically at par with application of 50% N through organic source + 50% N through inorganic source. Conventional tillage (CT) + interculture with 100% recommended N through inorganic source gave highest maize yield (3732 kg/ha), with higher net returns (Rs.30630/ha), B:C ratio (1.96) and RWUE (8.7 kg/ha-mm) followed by conventional tillage + interculture with 50% N through organic + 50% through inorganic source and both the treatments were statistically at par. Similar trend was observed in case of wheat crop during *rabi* 2014-15 (Table 3.103).

The input energy requirement of maize and wheat increased with increase in inorganic source of nitrogen. Application of 100% N through organic source, and 50 % N through organic source + 50% N through inorganic source saved 24.9 and 7.9% input energy over 100% N through inorganic source in case of maize, while 21.1% and 7.9% in case of wheat, respectively. The output energy in both crops was highest with 100% N through inorganic source followed by 50 % N through organic source + 50%N through inorganic source. The energy use efficiency of maize and wheat was maximum under 100% CT, followed by 50% (CT) + interculture and 50 % (CT) + interculture + herbicide treatments. However, energy-use efficiency decreased with increase in the inorganic nitrogen and it was lowest when 100% N was applied through inorganic source.

Table 3.103: Influence of tillage and sources of nitrogen on yield and economics of maize in maize-wheat cropping sequence - Ballowal Saunkhri

Treatment	Grain yield (kg/ha)	Stalk yield (kg/ha)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)	Input energy (MJ/ha)	Output energy (MJ/ha)	Energy use efficiency
T_1F_1	3212	5107	37782	15505	1.41	7.5	9362	122088	13.0
T_1F_2	3303	5548	33936	21157	1.62	7.7	8434	108468	12.9
T_1F_3	3732	6598	31948	30630	1.96	8.7	8699	112590	12.9
T_2F_1	2749	4252	34247	11240	1.33	6.4	7777	104326	13.4
T_2F_2	3119	4923	32486	19222	1.59	7.3	9004	114233	12.7
T_2F_3	3428	5926	30404	26942	1.89	8.0	9715	124601	12.8
T_3F_1	3126	4992	33680	18202	1.54	7.3	-	-	-
T_3F_2	3270	5548	31743	22855	1.72	7.6	-	-	-
T_3F_3	3357	5011	29489	25877	1.88	7.9	-	-	-

T_1: Conventional tillage (CT) + interculture; T_2: 50% CT + interculture; T_3: 50% CT + interculture + chemical weed control; F_1: 100% N through organic source; F_2: 50% N through organic source + 50 % N through inorganic source; F_3: 100% N through inorganic source

Similarly, during *rabi* 2014-15, conventional tillage + interculture was better than other treatments in terms of yield. In case of nitrogen application, 100% recommended N through inorganic source gave highest yield. However, it was statistically at par with application of 50% N through organic source + 50% N through inorganic source. Conventional tillage (CT) + interculture with 100% recommended N through inorganic source gave highest wheat yield (3506 kg/ha) with net returns (Rs.27816/ha), B:C ratio (1.91) and RWUE (8.2 kg/ha-mm). (Table 3.104)

Table 3.104: Influence of tillage and sources of nitrogen on the yield and economics of rainfed wheat in maize-wheat cropping sequence - Ballowal Saunkhri

Treatment	Grain yield (kg/ha)		Stalk yield (kg/ha)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	2014-15	Mean (3 yrs)					
Tillage practice							
T_1	3415	2582	5751	34556	22430	1.66	7.99
T_2	3099	2124	5033	32379	19135	1.60	7.25
T_3	3251	2416	5184	31637	22311	1.71	7.60
CD at 5%	NS	-	NS	-	-	-	-
Source of nitrogen							
F_1	3029	2115	4784	35237	14982	1.43	7.08
F_2	3231	2438	5339	32722	21078	1.65	7.56
F_3	3506	2568	5845	30614	27816	1.91	8.20
CD at 5%	304	-	542	-	-	-	-

T_1: Conventional tillage (CT) + interculture; T_2: 50% CT + interculture; T_3: 50% CT + interculture + chemical weed control; F_1: 100% N through organic source; F_2: 50% N through organic source + 50 % N through inorganic source; F_3: 100% N through inorganic source

At Ballowal Saunkhri, in a study on laser land levelling in maize, significantly higher maize yield was recorded with laser levelling (flat) (3563 kg/ha), with net returns (Rs.31415/ha), B:C ratio (2.06) and RWUE (8.87 kg/ha-mm) followed by laser levelling (mild slope) (3358 kg/ha) and conventional levelling as flat configuration gave more time to the rainwater to percolate in the soil (Table 3.105).

Table 3.105: Influence of conventional and laser land levelling on yield and economics of rainfed maize - Ballowal Saunkhri

Treatment	Grain yield (kg/ha)		Stalk yield (kg/ha)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	2014	Mean (3 yrs)					
Conventional levelling	3083	2821	6695	29271	23669	1.81	7.68
Laser leveling (mild slope)	3358	3162	6818	29485	27703	1.94	8.36
Laser levelled (Flat)	3563	3349	7614	29644	31415	2.06	8.87
CD at 5%	274	-	529	-	-	-	-

During *rabi* season, the differences in yield among the three land configurations were non-significant as sufficient rainfall was received during the crop growth period. Marginally, higher wheat yield was recorded with laser levelling (flat) (3852 kg/ha), with net returns (Rs.48726/ha), B:C ratio (2.83) and RWUE (8.85 kg/ha-mm) followed by laser levelling (mild slope) (3588 kg/ha) (Table 3.106).

Table 3.106: Influence of conventional and laser land levelling on yield and economics of rainfed wheat - Ballowal Saunkhri

Treatment	Grain yield (kg/ha)		Straw yield (kg/ha)	Cost of Cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	2014-15	Mean (3 yrs)					
Conventional levelling	3495	1618	4786	26173	41256	2.58	8.10
Laser leveling (mild slope)	3588	1854	5152	26273	43785	2.67	7.81
Laser levelled (Flat)	3852	2084	5551	26556	48726	2.83	8.85
CD at 5%	NS	-	NS	-	-	-	-

At Ballowal Saunkhri, among the two tillage practices i.e. conventional and rotavator, no significant difference was observed in terms of yield. Highest grain yield of maize (4345 kg/ha) was recorded with conventional tillage + 80 kg N/ha (T_1F_3) during 2014-15 (Table....). Among nitrogen sources, lowest input energy for maize (5481 MJ/kg) and wheat (5592 kg/ha) cultivation was consumed under control (no nitrogen application). But maximum output energy in maize and wheat was produced when recommended dose of nitrogen (80 kg/ha) was applied to maize and wheat and it was 29.9 and 45.4% higher than control. However, maximum energy use efficiency of 19.4 in maize was under control treatment, while it was highest when only 50% recommended nitrogen (40 kg/ha) was applied in case of wheat (Table 3.107).

Table 3.107: Influence of tillage and sources of nitrogen on the yield and economics of rainfed maize in maize - wheat cropping sequence - Ballowal Saunkhri

Treatment	Grain yield (kg/ha)		Stalk yield (kg/ha)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)	Input energy (MJ/ha)	Output energy (MJ/ha)	Energy use efficiency
	2014-15	Mean (3 yrs)								
T_1F_1	2082	2067	3371	29358	5243	1.18	4.9	9466	118766	12.5
T_1F_2	3674	2833	6456	31088	30478	1.98	8.6	8871	101374	11.4

Treatment	Grain yield (kg/ha)		Stalk yield (kg/ha)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)	Input energy (MJ/ha)	Output energy (MJ/ha)	Energy use efficiency
	2014-15	Mean (3 yrs)								
T_1F_3	4345	3541	7557	32101	40631	2.27	10.2	5481	65490	11.9
T_1F_4	2897	2697	5187	32316	16326	1.51	6.8	7933	124642	15.7
T_1F_5	4174	3009	6760	35627	33743	1.95	9.8	10357	147027	14.2
T_1F_6	2713	2705	4297	34853	10139	1.29	6.3	10262	99674	9.7
T_2F_1	1669	1646	2695	25302	2428	1.10	3.9	9315	135392	14.5
T_2F_2	3227	2328	5370	27005	26770	1.99	7.5	11663	88207	7.6
T_2F_3	3941	2627	6223	28052	37286	2.33	9.2	-	-	-
T_2F_4	2556	2126	4347	28315	14372	1.51	6.0	-	-	-
T_2F_5	3546	2645	5825	31403	27612	1.88	8.3	-	-	-
T_2F_6	2338	2425	3876	30826	8120	1.26	5.5	-	-	-
CD at 5%	NS	-	NS	-	-	-	-	-	-	

T_1: Conventional tillage (CT); T_2: Rotavator (RTV); F_1: Control; F_2: 40 kg N/ha (inorganic-urea); F_3: 80 kg N/ha; F_4: 20 kg N/ha (compost) + 20 kg N/ha (inorganic-urea); F_5: 40 kg N/ha (compost) + 40 kg N/ha (inorganic-urea); F_6: 20 kg N/ha (compost) + 20 kg N/ha (green leaf)

During *rabi* 2014-15, the highest grain yield of wheat (3463 kg/ha) was recorded with conventional tillage + 80 kg/ha N through urea (T_1F_3) with net returns (Rs.35084/ha), B:C ratio (2.0) and RWUE (11.50 kg/ha-mm) followed by CT + 40 kg/ha N through compost + 40 kg/ha N through urea. However, the highest straw yield in wheat was observed in tillage with rotavator + 80 kg/ha N through urea followed by tillage with rotavator + 40 kg/ha N through urea (Table 3.108).

Table 3.108: Influence of tillage and sources of nitrogen on the yield and economics of rainfed wheat in maize- wheat cropping sequence - Ballowal Saunkhri

Treatment	Grain yield (kg/ha)	Straw yield (kg/ha)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
T_1F_1	1691	2245	29513	2864	1.10	6.42
T_1F_2	2602	4533	33642	19952	1.59	8.84
T_1F_3	3463	5693	35055	35084	2.00	11.50
T_1F_4	2507	3969	35374	14869	1.42	8.41
T_1F_5	3263	5602	38502	28418	1.74	8.74
T_1F_6	2304	3626	36931	9168	1.25	6.38
T_2F_1	2044	3587	25410	16782	1.66	7.59
T_2F_2	3089	5150	29683	33132	2.12	8.06
T_2F_3	3293	5724	30390	37392	2.23	8.80
T_2F_4	2528	3883	30915	19332	1.63	9.43
T_2F_5	3033	5372	33773	29007	1.86	12.07
T_2F_6	2278	3263	32449	12003	1.37	8.22
CD at 5%	385	791	-	-	-	-

Conventional tillage + 80 kg N/ha

Conentional tillage + 40 kg N/ha

At Rakh Dhiansar, in a field study on tillage and nutrient management in maize, the highest grain yield of maize (1737 kg/ha) was obtained with 50% CT + herbicide + interculture (T_3) and recommended dose of fertilizer (F3) and the lowest grain yield of (1153 kg/ha) was obtained with conventional tillage + interculture (T_1) with 50% N (organic) + 50% N (inorganic). Highest B:C ratio, RWUE (1.65 and 2.59, respectively), net returns (Rs.11694/ha) were also recorded with T_3F_3. The fourteen years data revealed that maximum average maize yield was obtained in treatment T_3 (1873 kg/ha) compared to other treatments. Among fertilizer application, the highest grain yield (1889 kg/ha) was recorded in F_3 (100% N through inorganic fertilizer) followed by F_2 and F_1 with grain yield of 1816 and 1656 kg/ha, respectively (Table 3.109).

Table 3.109: Effect of tillage and N source on maize yield and economics - Rakh Dhiansar

Treatment		Yield (kg/ha)		Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)	Mean grain yield (2001-14)
Main treatment	Sub treatment	Grain	Stalk					
T_1	F_1	1220	308	18670	3635	1.19	1.82	1367
	F_2	1153	283	21562	-588	0.97	1.72	
	F_3	1273	308	17350	5738	1.33	1.90	
	Mean	1216	300	19194	2928	1.15	1.81	
T_2	F_1	1403	325	19642	5586	1.28	2.09	1343
	F_2	1313	289	19534	3849	1.20	1.96	
	F_3	1467	318	17251	8780	1.51	2.18	
	Mean	1394	311	18809	6072	1.32	2.08	

Treatment		Yield (kg/ha)		Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)	Mean grain yield (2001-14)
Main treatment	Sub treatment	Grain	Stalk					
T_3	F_1	1477	326	19985	6321	1.32	2.20	1492
	F_2	1563	313	19763	7595	1.38	2.33	
	F_3	1737	309	18122	11694	1.65	2.59	
	Mean	1592	316	19290	8537	1.44	2.37	
CD at 5%	-	99	-	-	-	-	-	

T_1: Conventional tillage + interculture; T_2: 50% CT + interculture; T_3: 50% CT + herbicide + interculture; F_1: 100% N through organic manure; F_2: 50% N through inorganic + 50% N through organic manure; F_3: 100% N through inorganic fertilizers

At Rakh Dhiansar, durig *rabi* 2014-15, T_3 (50% CT + herbicide + interculture) recorded the highest wheat grain yield of 1907 kg/ha, with net returns of Rs.27382, B:C ratio (2.35) and RWUE (4.75 kg/ha-mm) followed by T_1 (CT + interculture) (1616 kg/ha). Among the sub plot treatments, 100% N through inorganic fertilizer (F_3) recorded higher grain yield. Overall data revealed that the highest yield was recorded with 50% CT + herbicide + interculture and 100% N through inorganic fertilizer. Long-term data of fourteen years revealed that T_3 recorded the highest grain yield of 2273 kg/ha. Among the sub plot treatments, 100% N through inorganic fertilizer (F_3) recorded higher grain yield of 2283 kg/ha (Table 3.110).

Table 3.110: Effect of tillage and N source on wheat yield and economics - Rakh Dhiansar

Treatment		Yield (kg/ha)		Cost of cultivation (Rs/ha)	Net returns (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)	Grain yield (kg/ha) (2001-14)
Main treatment	Sub treatment	Grain	Stover					
T_1	F_1	1513	3293	21882	16528	1.76	3.77	1652
	F_2	1607	4017	21897	21483	1.98	4.01	
	F_3	1727	4317	19473	27147	2.39	4.30	
	Mean	1616	3876	21086	21717	2.03	4.03	
T_2	F_1	1673	3160	20151	19912	1.99	4.17	174
	F_2	1720	3700	19869	23571	2.19	4.29	
	F_3	1870	4110	17457	30208	2.73	4.66	
	Mean	1754	3657	19159	24563	2.28	4.37	
T_3	F_1	1770	3570	20600	22915	2.11	4.41	1885
	F_2	1893	4067	20412	27375	2.34	4.72	
	F_3	2057	4360	19767	31855	2.61	5.13	
	Mean	1907	3999	20259	27382	2.35	4.75	
CD at 5%	-	170	-	-	-	-	-	-

T_1: Conventional tillage + interculture; T_2: 50% CT + interculture; T_3: 50% CT + herbicide + interculture; F_1: 100% N through organic manure; F_2: 50% N through inorganic + 50% N through organic manure; F_3: 100% N through inorganic fertilizers.

3.2.5 Evaluation of improved varieties

At Arjia, in a trial to assess performance of nine horsegram cultivars, cultivar VLG-39 exhibited highest seed yield and B:C ratio (709 kg/ha, 2.55) closely followed by VLG-15 (579 kg/ha, 2.21). The cultivar BGHG-1 gave highest stover yield (3424 kg/ha) followed by CRHG-19 (3194 kg/ha). Similarly, VLG-39 recorded higher net returns (Rs.21367/ha), B:C ratio (2.55) and RWUE (1.20 kg/ha-mm) compared to other treatments. The maturity of the cultivars ranged from 97 days (VLG-15) to 113 days (CRHG-23) (Table 3.111).

Table 3.111: Yield and economics of horsegram cultivars - Arjia

Cultivar	Days to maturity	Seed yield (kg/ha)	Stover yield (kg/ha)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
CRHG-23	113	227	3027.78	13775	4080	1.30	0.38
CRHG-19 ©	105	181	3194.44	13775	2829	1.21	0.30
CRHG-22	107	329	2893.52	13775	7541	1.55	0.55
BGHG-1	102	337	3423.61	13775	9457	1.69	0.57
VLG-39	98	709	2685.19	13775	21367	2.55	1.20
BHG-13-2	111	188	2851.85	13775	2083	1.15	0.32
VLG-15 ©	97	578	2782.41	13775	16702	2.21	0.98
VLG-38	99	457	2557.87	13775	11390	1.83	0.77
BHG-13-1	110	275	2148.15	13775	3244	1.24	0.46
C D at 5%	4.80	57	347.42	-	-	-	-

Cost of cultivation :Rs.13775/ha

At Arjia, in a study on four superior lines of sesame, selected from the advanced breeding lines of crossing programme of the station, cultivar Pratap Til-10 gave highest seed yield (387 kg/ha), with net returns Rs.27523/ha, B:C ratio (2.98) and RWUE (0.65 kg/ha-mm) followed by Pratap Til-2 (258 kg/ha) and exhibited 62.6 and 8.4% yield superiority over the best check RT 346 (238 kg/ha), respectively. The maturity of cultivars ranged from 75 days (RT-127) to 84 days (Pratap Til-3) (Table 3.112).

Table 3.112: Yield and economics of sesame cultivars - Arjia

Cultivar	Days to maturity	Seed yield (kg/ha)	Straw yield (kg/ha)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
Pratap Til - 1	83	122	605	13872	-745	0.95	0.21
Pratap Til - 2	81	258	872	13872	13607	1.98	0.43
Pratap Til - 3	84	146	669	13872	1802	1.13	0.25
Pratap Til - 10	76	387	1523	13872	27523	2.98	0.65
RT-46 ©	79	195	869	13872	7043	1.51	0.33
RT-127 ©	75	171	792	13872	4517	1.33	0.29
RT-346 ©	82	238	1131	13872	11713	1.84	0.40
RT-351 ©	76	214	979	13872	9067	1.65	0.36
CD at 5%	1.30	26	108				

Cost of cultivation : Rs.13782/ha

At Arjia, in a study on eight blackgram cultivars to identify high yielding and early maturing cultivars suitable for dryland conditions, cultivar KU 96-3 gave highest seed yield (1458 kg/ha), with net returns (Rs.66420/ha), B:C ratio (5.50) and RWUE (2.46 kg/ha-mm) followed by Vallabh U-1 (1443 kg/ha) under *in-situ* moisture conservation practice. Likewise, the cultivar KPU 405 gave the highest straw yield (3972 kg/ha) under *in-situ*

moisture conservation practice. Similar trends of seed yield was also observed for cultivars KU 96-3 (1378 kg/ha) with net returns of Rs.62808/ha, B:C ratio of 5.49 and RWUE of 2.32 kg/ha-mm. and Vallabh U-1 (1293 kg/ha) under without moisture conservation practice (Table 3.113).

Table 3.113: Yield and economics of blackgram cultivars with *in-situ* moisture conservation practices - Arjia

Cultivar	Days to maturity	Seed yield (kg/ha)	Stalk yield (kg/ha)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
Pant U - 31	71	1314	3018.23	14775	57514	4.89	2.21
Pant U - 40	77	1202.	3426.85	14775	53344	4.61	2.02
Vallabh U - 1	74	1443	3835.59	14775	66174	5.48	2.43
KU 96-3	73	1458	3670.49	14775	66420	5.50	2.46
Pratap U -1	77	1135	3401.80	14775	50100	4.39	1.91
KPU - 405	76	1005	3971.64	14775	45588	4.09	1.69
T - 9 ©	77	1052	3531.25	14775	46495	4.15	1.77
NUL - 7 ©	74	1179	3472.91	14775	52401	4.55	1.99
CD at 5%	1.93	126	354.46	-	-	-	-

Cost of cultivation :Rs.14775/ha

At Arjia, four groundnut cultivars were screened to identify high yielding and early maturing cultivars suitable for zone IVa of Rajasthan. The cultivar TG 37 A gave highest groundnut pod yield (1646 kg/ha) with net returns (Rs.45716/ha) and B:C ratio (3.76) followed by Pratap Raj Mungfali (UG-5) (1451 kg/ha) which were 35 and 19% higher over Pratap Mungfali-2 (1222 kg/ha) (Table 3.114).

Table 3.114: Yield and economics of groundnut cultivars - Arjia

Cultivar	Yield (kg/ha)		Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio
	Pod	Haulm			
GPBD - 4	1329	2950	16550	33651	3.03
Pratap Mungfali 2	1222	2740	16550	29696	2.79
TG 37 A	1646	3687	16550	45716	3.76
Pratap Raj Mungfali (UG-5)	1451	3224	16550	38276	3.31
CD at 5%	211				

At Arjia, four greengram cultivars were screened to identify high yielding and early maturing cultivars suitable for zone Iva of Rajasthan. The cultivar RMG 492 gave significantly higher seed yield (640 kg/ha), with net returns (Rs.32514/ha), B:C ratio (3.29) and RWUE (0.95 kg/ha-mm) followed by SML 668 (604 kg/ha), which gave 27 and 19% higher seed yield over RMG 268 (506 kg/ha) (Table 3.115).

Table 3.115: Yield and of greengram cultivars - Arjia

Cultivar	Yield (kg/ha)		Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Sedd	Stalk				
RMG 492	640	1179	14225	32514	3.29	0.95
SML 668	604	1037	14225	29592	3.08	0.90
RMG 268	506	883	14225	22498	2.58	0.75
RMG 344	572	990	14225	27304	2.92	0.85
CD at 5%	54	187	-	-	-	-

At Ballowal Saunkhri, among the five cultivars of cowpea tested for dual purpose, highest seed (1313 kg/ha) as well as fodder yield (301 q/ha) was recorded by UPC 9202 followed by CL 367 for seed and IT 38956-1 for fodder. The highest net returns of Rs.41062/ha with a B:C ratio of 2.87 was obtained with UPC-9202 (Table 3.116).

Table 3.116: Yield and economics of different cultivars of cowpea - Ballowal Saunkhri

Cultivar	Seed yield (kg/ha)		Fodder yield (q/ha)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	2014	Mean (3 yrs)					
CL 367	1090	633	234	21978	29817	2.36	2.52
IT 38956-1	918	-	267	21978	24070	2.10	2.12
UPC 607	1040	627	216	21978	27191	2.24	2.41
UPC 9202	1313	646	301	21978	41062	2.87	3.04
CD at 5%	184	NS	328	-	-	-	-

Cost of cultivation :Rs.21978/ha

At Ballowal Saunkhri, among the four castor cultivars evaluated, DCH 177 gave highest seed yield (1568 kg/ha) followed by DCH 519 (1397 kg/ha) with net returns of Rs. 38459/ha, B:C of ratio 2.70 and RWUE of 2.95 kg/ha-mm (Table 3.117).

Table 3.117: Yield and economics of different cultivars of castor - Ballowal Saunkhri

Cultivar	Seed yield (kg/ha)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
GCH 07	1257	21826	27225	2.25	2.37
DCH 177	1567	22681	38459	2.70	2.95
DCH 519	1396	22209	32258	2.45	2.63
Local	589	19980	2987	1.15	1.11
CD at 5%	130	-	-	-	-

At Ballowal Saunkhri, among ten maize hybrids evaluated under rainfed conditions, highest grain yield was recorded in case of PMH 1 (check) (5389 kg/ha) and no genotype under evaluation was superior to the check genotypes (Table 3.118).

Table 3.118: Yield and economics of different cultivars of maize - Ballowal Saunkhri

Cultivar	Grain yield (kg/ha)	Stalk yield (kg/ha)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
JH 31555	4858	5876	30372	43516	2.43	11.24
JH 31601	4967	5956	30451	45043	2.48	11.49
PMH 1	5389	6566	30757	51255	2.67	12.47
JH 31658	3911	4794	29684	29864	2.01	9.05
PMH 4	4961	6269	30447	45276	2.49	11.48
JH 31610	4394	5290	30035	36771	2.22	10.17
PMH 2	4844	5922	30362	43376	2.43	11.21
JH 31613	4258	5093	29936	34769	2.16	9.85
Prakash	4808	5917	30336	42893	2.41	11.13
JH 31602	4314	5322	29977	35741	2.19	9.98
CD at 5%	621.04	465.79	-	-	-	-

At Ballowal Saunkhri, among five varieties of barley for dual purpose, highest single cut green fodder (after 55 days), grain yield, straw yield and B:C ratio (2.27) was recorded with variety HBL 276 followed by HBS 380 (Table 3.119).

Table 3.119: Yield and economics of different cultivars of barley - Ballowal Saunkhri

Cultivar	Green fodder yield (kg/ha)		Grain yield (kg/ha)	Straw yield (kg/ha)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	2014-15	Mean (3 yrs)						
HBS - 380	6356	3708	2519	3775	27066	23974	1.89	6.54
HBL - 276	8511	3927	3080	4607	27648	35250	2.27	7.33
HBL - 113	7267	3687	2235	3507	26772	20126	1.75	5.86
HBL - 316	8194	3215	2130	3494	26663	19375	1.73	6.03
PL - 807	8011	3099	1932	3381	26457	16101	1.61	5.00
CD at 5%	364.5	-	972.7	3.63.8	-	-	-	-

At Ballowal Saunkhri, among four taramira varieties evaluated, TMLC 2 gave highest seed yield of 885 kg/ha with net returns of Rs. 24887/ha, B:C ratio of 3.37 and rainwater use efficiency of 2.95 kg/ha-mm. T 27 was the next best variety with a seed yield of 848 kg/ha and net returns of Rs.23439/ha (Table 3.120).

Table 3.120: Yield and economics of different cultivars of taramira - Ballowal Saunkhri

Variety	Seed yield (kg/ha)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
RTM 2002	706	10513	17739	2.69	2.35
RTM 314	565	10513	12087	2.15	1.88
T 27	848	10513	23439	3.23	2.83
TMLC 2	885	10513	24887	3.37	2.95
CD at 5%	129	-	-	-	-

3.2.6 Alternate land use

At Arjia, in existing neem tree rows on marginal land under different methods of grass sowing, mud ball/pallet seed sowing gave significantly higher dry grass yield (3426 kg/ha), with net returns (Rs.6468/ha), B:C ratio (2.70) and RWUE (4.85 kg/ha-mm), while, lowest grass yield (3107 kg/ha) was recorded in direct seeded sowing. Further, 20 kg N + 30 kg P_2O_5/ha recorded, significantly higher dry grass yield (3741 kg/ha) but was at par with 10 kg N + 15 kg P_2O_5 /ha. It was 50 & 47% higher yield, respectively, over control (2489 kg/ha). The mean data of 3 years revealed that, on marginal land in existing *neem* tree rows, grass sowing with mud ball/pallet seed sowing significantly highest grass yield (2079 kg/ha), while, lowest grass yield (1802 kg/ha) was recorded in direct seed sowing. Further, 20 kg N + 30 kg P_2O_5 increase significantly grass yield (2168 kg/ha) but at par with 10 kg N + 15 kg P_2O_5. It improve grass yield 36.6 and 30.4% over control (1587 kg/ha) (Table 3.121).

Table 3.121: Effect of establishment method and nutrient levels on *Cenchrus* spp. grass yield and economics - Arjia

Treatment	Grass yield (kg/ha)		Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	2014	Mean (3 yrs)				
Establishment methods						
E_1- Direct seed sowing	3107	1802	3772	5550	2.47	4.40
E_2- Mud ball/ Pellet sowing	3426	2079	3810	6468	2.70	4.85

Treatment	Grass yield (kg/ha)		Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	2014	Mean (3 yrs)				
E_3- $CuSO_4$ 50 ppm socked seed (50 ppm) for 16 hours	3356	1945	3778	6289	2.66	4.75
CD at 5%	419	-	-	-	-	-
Nutrient levels						
N_0 - No fertilizer	2489	1587	3128	4338	2.39	3.52
N_1 - 10 kg N + 15 kg P_2O_5	3659	2070	3787	7191	2.90	5.18
N_2 - 20 kg N + 30 kg P_2O_5	3741	2168	4445	6777	2.52	5.30
CD at 5%	419	-	-	-	-	-

Rainfall during crop growing period 581.3 mm

At Ballowal Saunkhri, in a study on guava and amla based agri-horti systems, the plant height and collar girth was 191 and 6.1 cm in case of amla, and 220 & 6.9 cm in case of guava, respectively. The yield of blackgram was 254 & 316 kg/ha, respectively in association with guava and amla plantation under agro-horticulture. Sesame failed under guava plantation due to excessive shading effect. Guava and amla yielded 19103 and 16842 kg/ha fruit, respectively in case of sole crops. The net returns from amla as well as guava based system were higher than sole cultivation of crops and fruit plants (Table 3.122).

Table 3.122: Crop yield and economics of guava and amla based agri-horti systems - Ballowal Saunkhri

Treatment	Yield (kg/ha)			MCEY (kg/ha)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio
	Main crop (fruit)	Intercrop (annual crop)	Stover/ stalk yield				
Sole blackgram		712	2962	1602	21604	11370	1.53
Sole sesame		476	2832	5950	16294	31306	2.92
Sole gauva	19103	-	-	19103	53277	328783	7.17
Sole amla	16842	-	-	16842	48658	86078	2.77
Blackgram + guava	18682	254	1062	19254	52530	333474	7.35
Blackgram + amla	17124	316	1129	18902	46474	103332	3.22
Sesame +amla	16361	164	1015	18411	46175	101113	3.19

Agri-horti system of guava + blackgram and amla + blackgram

At Rakh Dhiansar, in a study on different agri-horti-pastoral systems, mixed fodder grown in the alleys of *Leucaena* trees under silvi-agri-pastoral system during *kharif* was most remunerative system as compared to all other systems which recorded the highest net returns of Rs.21580/ha with a B:C ratio of 2.58. The average data of nine years revealed that maize and blackgram recorded yield 2443 and 310 kg/ha under cereal-cereal (maize-wheat)

and pulse-cereal system (blackgram-wheat). However, in case of fodder treatments under various systems, pure mixed fodder, fodder in the alleys of *Leucaena* and aonla trees recorded the yield of 31418, 27828 and 25951 kg/ha under agri-pastoral, silvi-agri-pastoral and agri-horti-pastoral systems, respectively (Table 3.123).

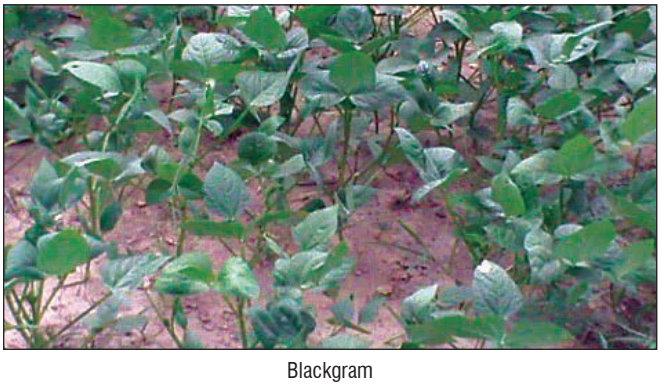
Table 3.123: Yield and economics of *leucaena* and aonla based agri-horti-pastoral systems during 2014 - Rakh Dhiansar

Treatment	Yield (kg/ha)			Mean of nine years (2006-14) (kg/ha)		MEY (kg/ha)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Main crop	Intercrop		Intercrop						
	Fruit plants	Annual crop (Grain/seed)	Stover/ stalk yield	Annual crop-Grain/ seed	Stover/ stalk yield					
Maize	-	1680	3612	2443	3563	-	18435	10839	1.58	2.53
Blackgram	-	296	976	310	1467	907	15250	(-)2374	0.84	0.49
Fodder	-	27000	-	-	31418	1901	11850	15150	2.28	97.82
Leucaena leucocephala + mixed fodder	7888 (4284)	24960	-	-	27828	2481	13650	21580	2.58	90.43
Aonla + mixed fodder	-	23280	-	-	25951	1639	11850	11430	1.96	84.34
Okra	-	-	-	1886	-	-	-	-	-	-

Fodder

Maize

Aonla + mixed Fodder



Blackgram

Agri-horti-pastoral

At Rakh Dhiansar, during *rabi* 2014-15, gobhi sarson grown in the alleys of aonla under agri-horti-pastoral (T_5) system was the most remunerative system as compared to all other systems which recorded the highest net returns of Rs. 49220/ha with B:C ratio of 3.0. It was followed by T_2, T_3, T_1 with B:C ratio values of 2.74, 2.58 and 2.19, respectively. Growing of wheat in the alleys of *Leucaena* trees (T_4) proved to be more beneficial as the system also provides dry fuel wood and green leaves (*in-situ* green manuring). Whereas, wheat crop grown after blackgram (T_2) yielded more as compared to that grown after maize with yield of 1852 and 1520 kg/ha, respectively (Table 3.124).

Table 3.124: Yield and economics of different crops under agri-horti-pastoral systems - Rakh Dhiansar

Treatment	Yield (kg/ha)			MCEY	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Main crop	Intercrop						
	Fruits/ plant	Annual crop	Stover/ stalk yield					
Wheat (T_1)	-	1520	2827	-	16500	19675	2.19	4.1
Wheat (T_2)	-	1852	3685	-	16500	28779	2.74	5.0
Toria + gobi sarson (T_3)	-	890 (180)	3364 (738)	2583	14535	22915	2.58	2.92
Leucaena leucocephala + wheat (T_4)	2630 (1255)	1340	2532	2213	17700	14390	1.81	3.61
Aonla + gobi sarson (T_5)	4512	820	2993	5198	24600	49220	3.0	2.32
Green peas (T_6)	-	920	--	1269	20500	-2100	0.90	2.35

Crops under agri-horti-silvi pastoral systems during *rabi* 2014-15

3.2.7 Integrated Farming System

At three agroforestry models under three farming situations i) Agriculture + trees on boundary, ii) Agriculture + trees in block plantation and iii) Silvi-pasture. Among maize, sesame and blackgram sown during *kharif* in model (i) and (ii), sesame gave highest net returns of Rs.10253/ha and Rs.6123/ha along with B:C ratio of 2.91 and 2.14, respectively and B:C ratio was highest with sesame in both cases. Among the two models, the net returns (Rs.79276/ha), B:C ratio (3.38) employment generation (128 man-days/ha/yr) were highest with situation-II (agriculture + trees in block plantation) compared to situation-I (agriculture + trees on boundary) (Table 3.125).

Table 3.125: Performance of various crops during *kharif* under farming system-I - Ballowal Saunkhri

Crop	Yield (kg)		Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	Employment generation (man-days/ha/yr)
	Grain/ Fruit	Straw/ stalk				
Situation-I (Agriculture + trees on boundary) - 1 ha						
Maize	894	1776	9097	6089	1.67	30
Sesame	156	1602	5377	10253	2.91	25
Blackgram	204	708	6774	2420	1.36	25
Fuel wood (q)	10	-	6000	34000	6.67	20
Napier bajra cuttings (No.)	8000	-	1350	6650	5.93	4
Guava (6)	211	-	1250	2970	3.38	6
Pomegranate (6)	92	-	1750	5610	4.21	6
System productivity	-	-	31598	67992	3.15	116
Situation-II (Agriculture + trees in block plantation) - 1 ha						

Crop	Yield (kg)		Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	Employment generation (man-days/ha/yr)
	Grain/ Fruit	Straw/ stalk				
Maize	653	1178	9035	1930	1.21	30
Sesame	115	1121	5377	6123	2.14	25
Blackgram	145	563	6732	-212	0.97	25
Fuel wood	15	-	9000	51000	6.67	30
Guava (14)	634	-	1675	11005	7.57	10
Pomegranate (8)	122	-	1550	9430	7.08	8
System productivity	-	-	33369	79276	3.38	128

In *rabi*, under model (i) & (ii) wheat gave highest net returns (Rs.10677/ha & Rs.6945/ha) and B:C ratio (2.32 and 1.87) compared to other crops. Raya was the next best crop under situation-I with net returns of Rs.5536/ha and Rs.4951/ha under situation-II (agriculture + trees in block plantation) (Table 3.126)

Table 3.126: Performance of various crops during *rabi* under farming situation-I - Ballowal Saunkhri

Crop	Yield (kg)		Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio
	Grain/seed	Straw/stalk			
Situation-I (Agriculture + trees on boundary) - 1 ha					
Wheat	896	1642	8062	10677	2.32
Raya	289	779	5446	5536	2.02
Taramira	109	293	3443	917	1.27
Kinnow (24)	338		2150	4610	3.14
Rainfall (mm)	Wheat: 328.4, Raya: 300.3 & Taramira: 294.9				
Situation-II (Agriculture + trees in block plantation) - 1 ha					
Wheat	718	1295	7999	6945	1.87
Raya	138	415	4951	293	1.06
Taramira	60	215	3443	-1043	0.70
Kinnow (43)	654		4050	9030	3.23

View of agri-horticulture and silvi-pasture blocks of farming system

At Ballowal Saunkhri, in a study on crop-based integrated farming system, among *kharif* crops, maize fetched highest net returns (Rs.30351/ha) followed by sesame (Rs.30006/ha), while B:C ratio (2.84) was highest with sesame. Among *rabi* crops, linseed gave highest net returns (Rs.68363/ha) with B:C ratio of 2.57 followed by wheat with net returns of Rs.47981/ha (Table 3.127).

Table 3.127: Performance of different *kharif* and *rabi* crops in crop based farming system - Ballowal Saunkhri

Crops	Yield (kg/ha)		Cost of Cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio
	Grain/seed	Straw/stalk			
Kharif					
Maize	3545	6806	29630	30351	2.02
Blackgram	737	2545	21658	12441	1.57
Greengram	1107	5336	20755	29060	2.40
Sesame	463	2992	16294	30006	2.84
Lemon grass cuttings (No.)	2000	-	-	-	-
System productivity	-	-	22084	25465	2.21
Rabi					
Wheat	3718	6152	27462	47981	2.75
Raya	792	2404	16504	13592	1.82
Lentil	292	2681	20217	-5617	0.72
Taramira	380	1846	10433	4767	1.46
Linseed	1278	3236	21097	68363	4.24
Napier bajra cuttings (No.)	10000	-	2660	7340	-
Kinnow (20)	300	-	2450	3550	-
System productivity	-	-	24253	36707	-

3.3 Nutritious Cereals Based Production System

3.3.1 Sorghum Based Production System

3.3.1.1 Rainwater management

At Vijayapura, in a study to assess the effect of set furrow cultivation with crop residues on pigeonpea and groundnut, set furrow with residue incorporation (RI) + glyricidia recorded pooled mean of pigeonpea equivalent yield (PEY) of 1633 kg/ha with mean maximum NMR (Rs. 59900/ha) and RWUE of 4.04 kg/ha-mm followed by set furrow with silt + residue incorporation + *glyricidia* (Table). The soil moisture at different stages in furrows with residue incorporation (RI) + glyricidia and set furrow with silt + residue incorporation + *glyricidia* were on par and superior with maximum soil moisture at 15-30 cm soil depths compared to all other treatments (Table 3.128).

Table 3.128a: Effect of set furrow cultivation on moisture conservation, crop yield and economics– Vijayapura

Treatment	Pigeonpea seed yield (kg/ha)	Groundnut pod yield (kg/ha)	PEY (kg/ha)	Mean PEY (kg/ha) (2009-14)	NMR (Rs/ha)	Mean NMR (Rs/ha) (2009-14)	RWUE (kg/ha-mm)
Set furrow with RI + *Glyricidia*	977	887	1864	1633	71931	59900	4.04
Set furrow with silt + RI + *Glyricidia*	937	841	1778	1556	67477	55907	3.87
Set furrow without any GLM and crop residue	861	800	1660	1423	63843	50657	3.52
Control	802	676	1479	1137	54389	34671	3.18
CD at 5%	36	119	128	110	6479	8561	-

GLM- Greenleaf manure; PEY: pigeonpea equivalent yield; RI: Residue incorporation

Table 3.128b: Soil moisture (%) at different stages of crop growth in set furrow cultivation - Vijayapura

Treatment	Depth (cm)	At sowing			At 50% flowering			At harvest		
		Left	Right	Middle	Left	Right	Middle	Left	Right	Middle
Set furrow with RI + *Glyricidia*	0-15	14.27	14.26	16.21	16.08	14.24	8.61	17.76	11.67	7.23
	15-30	17.51	18.78	14.93	17.80	16.14	18.76	9.74	14.17	14.00
	30-60	14.15	16.78	17.75	19.53	17.12	20.79	17.62	19.54	9.52
Set furrow with silt + RI + *Glyricidia*	0-15	17.39	14.04	14.39	16.08	11.16	8.78	14.75	8.93	7.23
	15-30	15.36	15.84	19.20	17.80	18.61	20.03	15.15	11.58	14.00
	30-60	18.03	18.45	18.00	19.53	24.12	20.39	11.53	13.33	9.52
Set furrow without any GLM and crop residue	0-15	12.27	16.45	24.40	15.84	16.72	11.55	5.19	7.83	8.72
	15-30	14.75	17.45	22.23	24.84	17.94	20.37	6.70	15.30	13.16
	30-60	15.59	14.47	19.95	16.05	17.90	15.97	10.81	8.59	11.06
Control	0-15	14.99	16.91	18.29	15.73	12.56	19.51	4.11	3.92	4.77
	15-30	13.21	14.76	16.28	18.93	16.04	17.91	10.77	6.00	11.40
	30-60	15.09	12.69	21.73	17.72	18.14	15.12	12.18	10.56	34.40

In a micro-watershed at Vijayapura, chickpea + sorghum (4:2) recorded highest sorghum equivalent yield of 940 kg/ha with RWUE of 12.93 kg/ha-mm. The highest B: C ratio (2.43) was also realized with chickpea + sorghum (4:2) intercropping system (Table 3.129).

Table 3.129: Increasing water productivity in microwatershed – Vijayapura

Crop	Yield (kg/ha)	RWUE (kg/ha-mm)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio
Kharif					
Cucumber	231	2.34	9000	228	1.03
Pigeonpea	431	2.82	13370	12476	1.93
Rabi					
Chickpea + sorghum (4:2) (Equivalent yield of sorghum)	940	12.93	8900	12720	2.43
Sapota + chickpea	393	2.57	6685	7070	2.05

In an experiment on catchment-storage-command relationship during July month, on 7.7.2014 one high rainfall event of 71.40 mm occurred in one spell with rainfall intensity of 15.58 mm /hr and the farm pond received 384 m^3 of water. During August, 235.3 mm rainfall was received and 1543 m^3 of water was harvested. During June to October, a total of 18 runoff events were recorded and 2375 m^3 of water was harvested (Table 3.130).

Table 3.130: Rainfall, intensity and volume of water harvested in farm pond - Vijayapura

Date	Rainfall (mm)	Rainfall intensity* (mm/hr)			Volume of water harvested (m^3)	Cumulative volume harvested (m^3)
		1	2	3		
04.06.2014	0.0	-	-	-	156**	156
05.06.2014	36.60	2.40	4.09	10.50	55	211
07.07.2014	71.40	15.58	-	-	384	595
08.07.2014	19.4	10.00	11.00	4.27	62.3	657
23.07.2014	13.0	14.00	6.67	3.00	7	664
24.07.2014	22.4	20.00	4.00	11.40	12	676
19.08.2014	40.2	16.00	9.20	30.67	27.8	704
22.08.2014	31.0	28.00	13.33	7.00	39	743
23.08.2014	11.5	15.00	36.00	-	12	755
27.08.2014	14.0	2.80	-	-	29	784
28.08.2014	65.2	19.20	5.43	3.25	465.5	1249
29.08.2014	32.0	2.00	4.09	6.50	408.5	1658
30.08.2014	41.4	22.00	14.86	1.96	561	2219
07.09.2014	19.5	40.50	36.00		20	2239
17.09.2014	22.6	19.00	11.00	5.07	72	2311
18.09.2014	9.8	21.20	2.25	-	19	2330
09.10.2014	13.0	26.00	-	-	9	2339
26.10.2014	31.6	6.33	25.20	-	27	2366
27.10.2014	9.3	2.60	3.50	0.57	9	2375

**Different rainfall intensity events in the same day; **Dead storage before the onset of monsoon*

The harvested rainwater was utilized for giving one supplemental irrigation of 5 cm depth at the flowering stage of both chickpea and sorghum crops to mitigate long dry spell. The supplemental irrigation was given on 5th and 6th December 2014 through the sprinkler system from the harvested rainwater in farm pond. In the irrigated plot, an additional yield of 43.9 and 33.3% was recorded in sorghum + chickpea and chickpea crops, respectively (Table 3.131).

Table 3.131: Impact of supplemental irrigation on yield of sorghum and chickpea (kg/ha) - Vijayapura

Crop	Irrigation with 5 cm depth of water	Control	% Yield increase over control
Sorghum* (equivalent yield)	1354	940	43.9
Chickpea (in sapota)	524	393	33.3

*Sorghum+ chickpea (2:4)

In an experiment for determination of crop factor values, the mean cucumber yield was in the range of 416 to 583 kg/ha. The average cucumber yield recorded was 521 kg/ha, with the B:C ratio of 1.2 and RWUE of 5.2 kg/ha-mm. Whereas, sorghum grain yield was in the range of 2217 to 2467 kg/ha. The average sorghum grain yield was 2296 kg/ha with the B:C ratio of 4.3 and RWUE of 26.2 kg/ha-mm (Table 3.132).

Table 3.132: Determination of crop factor values for the prevailing cropping systems - Vijayapura

Crop	Yield (kg/ha)					Cost of cultivation (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	R_1	R_2	R_3	R_4	Mean			
Cucumber	500.00	416.67	583.33	583.33	520.83	9000	1.2	5.2
Sorghum	2083	2217	2417	2467	2296	8000	4.3	2.6

The crop factor is the ratio of soil loss from land cropped under specified conditions to corresponding soil loss from continuous fallow on identical soil slope and rainfall conditions. The crop factor assessed for the cucumber was 0.38 while for sorghum, the crop factor value was 0.50 (Table 3.133).

Table 3.133: Runoff, soil loss and crop factor values for cucumber and sorghum - Vijayapura

Treatment	Rainfall (mm)	Runoff (m^3/ha)	Soil loss (kg/ha)	Crop factor
Greengram				
With crop	197.0	297 (15.1%)*	583.84	0.38
Without crop	197.0	524.31 (26.6%)	1744.90	
***Rabi* sorghum**				
With crop	53.9	66.83 (12.4%)	22.45	0.50
Without crop	53.9	91.73 (17%)	45.16	

* Figures in the parentheses indicate the percentage of rainfall

The impact of soil conservation structures on groundwater recharge was assessed in Doddahalla watershed. The individual recharge of the well was in the range of 31 to 77 mm. The mean recharge was 66.00 and 57.09 mm, respectively in the treated and control watersheds. There was no difference in the groundwater recharge in treated and control plots; it was attributed to the low annual rainfall than the normal rainfall. Because of low rainfall, no harvesting structure received any runoff. The ground water recharge was about 10.8% of the annual rainfall (Table 3.134a & b).

Table 3.134a: Impact of SWC structures on groundwater regime of the Doddahalla watershed - Vijayapura

Name of the village	Well No.	Recharge (mm)	Name of the village	Well No.	Recharge (mm)
Jigajevanagi	1	62	D. Nimbaragi	9	-
	2	61		10	-
	3	39	Satalgaon PB	11	53
D. Nimbaragi	4	73		12	73
	5	70		13	71
	6	64		14	67
	7	71		15	70
	8	70		16	73

Table 3.134b: Groundwater recharge in control watershed

Name of the village	Well No.	Recharge (mm)	Name of the village	Well No.	Recharge (mm)
Katral	1	76	Baradol	8	35
	2	32		9	--
	3	31		10	29
	4	71		11	75
	5	73		12	39
	6	76		13	72
	7	77			

At Solapur, total rainfall received during the year 2014 was 609.1 mm in 40 rainy days which was deficit by 15.6% as against normal of 721.4 mm. There was no runoff producing storm. Hence, the value of exponent m in the modified Universal Soil Loss Equation (MUSLE) could not be computed due to unavailability of runoff data. From the analysis of rainfall, it was observed that for Chas, the maximum probability of 20% was in the range of 501-600 mm rainfall followed by 17.5% for 401-500 mm rainfall (Table 3.135).

Table 3.135 : Probability of occurrence of rainfall at Chas, Solapur district - Solapur

Rainfall (mm)	Number of events	% probability
0-100	2	5.0
101-200	1	2.5
201-300	4	10.0
301-400	3	7.5
401-500	7	17.5
501-600	8	20.0
601-700	5	12.5
701-800	5	12.5
801-900	3	7.5
901-1000	0	0.0
1001-1100	1	2.5
1101-1200	0	0.0
1201-1300	0	0.0
	1	2.5

In an assessment of the effect of soil and water conservation on grain and stover yields of *rabi* sorghum at Solapur, tied ridges method was superior with grain yield of 307 kg/plot and stover yield of 6304 kg/plot. The ridges and furrow practice was the second best with grain yield of 183 kg/plot and stover yield of 2849 kg/plot compared to compartment bund and cultivated fallow (Table 3.136).

Table 3.136: Effect of different *in-situ* moisture conservation measures on *rabi* sorghum - Solapur

Treatment	Grain yield (kg/plot)	Stover yield (kg/plot)
Ridges and furrow system	183	2849
Compartment bund ing	151	1850
Tied ridges	307	6304
Cultivated fallow	80	2419

3.3.1.2 Cropping systems

In an assessment of different crops for contingency planning during *Punarvasu* (July 06-22) in shallow black soils at Vijayapura, growing of pigeonpea + groundnut (2:4) gave significantly higher pearlmillet equivalent yield of 6400 kg/ha with NMR of Rs.77395/ha and RWUE of 15.4 kg/ha-mm as compared to other crops and cropping systems. During *Pushya nakshatra,* growing of pearlmillet + pigeonpea (2:1) gave significantly higher pearlmillet equivalent yield of 5904 kg/ha with NMR of Rs.71966/ha and RWUE of 16.8 kg/ha-mm as compared to other crops and cropping systems (Table 3.137).

Table 3.137: Effect of sowing dates on performance of different crops in shallow black soils - Vijayapura

Crop	Crop yield (kg/ha)	*Punarvasu* (July 06 – 22)					Crop yield (kg/ha)	*Pushya* (July 22- Aug 03)				
		PEY (kg/ha)		NMR (Rs/ha)		RWUE (kg/ha-mm)		PEY (kg/ha)		NMR (Rs/ha)		RWUE (kg/ha-mm)
		2014-15	Mean (3 yrs)	2014-15	Mean (3 yrs)			2014-15	Mean (2 yrs)	2014-15	Mean (2 yrs)	
Pearlmillet	1412	1412	1690	14393	18837	3.9	1644	1644	1588	18096	17207	4.5
Pigeonpea	1481	4815	5520	54537	65820	13.3	1632	5304	5461	62361	64869	14.6
Groundnut	972	3160	3283	33556	35522	8.7	-	-	-	-	-	-
Sesamum	618	2704	2642	35764	34781	7.5	-	-	-	-	-	-
Niger	579	1411	1364	15169	14417	3.9	574	1399	1364	14989	14417	3.9
Foxtailmillet	1343	2937	2949	39591	39780	8.1	1042	2279	1796	29058	21335	6.3
Horsegram	856	2141	1956	26759	23796	5.9	556	1389	1333	14722	13827	3.8
Mothbean	694	3255	3215	44583	43947	9.0	486	2279	3075	28958	41690	6.3
Castor	1435	2691	2196	34156	26239	7.4	1366	2561	2583	32072	32419	7.1
Pearlmillet + Pigeonpea (2:1)	1273 + 1134	4959	5433	56852	64428	13.7	1994 + 1273	6082	5904	74815	71966	16.8
Pearlmillet + castor (2:1)	1366 + 949	3145	2997	31329	28965	8.7	1759 + 1088	3799	3567	41792	38075	10.5
Groundnut + pigeonpea (4:2)	671 + 1042	5567	6400	64074	77395	15.4	-	-	-	-	-	-
Pearlmillet + groundnut (2:4)	1157 + 718	3490	3801	38833	43811	9.6	-	-	-	-	-	-
Pearlmillet 135 cm	1644	1644	2013	18096	24010	4.5	1852	1852	1924	21430	22578	5.1
Sunflower – 60 cm	-	-		-	-	-	1528	4106	4397	53444	58089	13.2
Sunflower 135 cm	-	-		-	-	-	1852	4790	4946	64394	66882	11.3
CD at 5%		437	267	9093	11180	1.6	-	672	429	10397	7118	1.9

Sowing of onion under onion- *rabi* sorghum sequence during punarvasu nakshatra (06-22 July) produced significantly highest sorghum equivalent yield of 5353 kg/ha with net returns (Rs. 92869/ha) and RWUE of 20.3 kg/ha-mm during 2014-15. However, mean yield over last 3 years revealed that pearlmillet + pigeonpea recorded significantly higher *rabi* sorghum equivalent yield (3550 kg/ha) with net returns (Rs.43381/ha) as compared to growing other crops and cropping systems. Sowing in pushya nakshatra, intercropping of pigeonpea + groundnut recorded significantly higher *rabi* sorghum equivalent yield (3283 kg/ha) with net returns (Rs.30272/ha) and RWUE of 5.5 kg/ha-mm as compared to growing other crops and cropping systems during 2014-15. While comparing 2 years mean, foxtail millet recorded significantly highest net returns of Rs.37931/ha (Table 3.138).

Table 3.138: Effect of sowing dates on performance of different crops in medium black soils - Vijayapura

Crop	*Punarvasu* (July 06-22)						*Pushya* (July 22- Aug 03)					
	Crop yield (kg/ha)	*Rabi* sorghum equivalent yield (kg/ha)		NMR (Rs/ha)		RWUE (kg/ha-mm)	Crop yield (kg/ha)	*Rabi* sorghum equivalent yield (kg/ha)		NMR (Rs/ha)		RWUE (kg/ha-mm)
		2014-15	Mean (3 yrs)	2014-15	Mean (3 yrs)			2014-15	Mean (2 yrs)	2014-15	Mean (2 yrs)	
Pigeonpea	1097	2593	3254	25156	39104	9.9	1106	2615	2801	25637	29292	4.7
Groundnut-*rabi* sorghum	1139 + 1060	3752	3068	43941	28356	14.3	-	-	-	-	-	-
Onion- *rabi* sorghum	4722 + 1227	5353	2844	92869	39121	20.3	-	-	-	-	-	-
Pearlmillet	1370	997	1155	6226	9187	3.8	1380	1003	1283	6374	10812	1.2
Pearlmillet -135 cm	1611	1172	1285	10078	11423	4.5	1593	1158	1161	9782	9529	1.8
Chilli	625	2841	-	32900	-	10.8	-	-	-	-	-	-
Foxtailmillet	889	1414	2075	18106	28230	5.4	602	957	2898	8060	37931	1.5
Sesame	521	1657	1046	25758	14035	6.3	-	-	-	-	-	-
Castor	1648	2247	1441	23244	14140	8.5	1435	1957	1738	16856	16313	3.1
Pearlmillet + pigeonpea (2:1)	1083 + 750	2561	3550	24933	43381	9.7	1500 + 495	2262	2698	18459	22716	3.4
Groundnut + pigeonpea (4:2)	805 + 681	3513	2660	35327	43899	13.4	759 + 630	3283	3255	30272	25120	5.5
Pearlmillet + castor (2:1)	1078 + 556	1542	2400	7726	7851	5.9	1611 + 431	1759	1825	15194	14182	2.8
Pearlmillet + groundnut (2:4)	986 + 861	2753	1946	19286	14831	10.5	630 + 759	2465	2119	13022	7423	2.4
Cotton	-	-	-		-	0.3	889	1212	2168	10767	25289	2.0
CD at 5%	-	247	275	5440	5841	-	-	215	289	4753	5304	0.9

In an assessment of different crops for contingency in medium deep black soils at Vijayapura, in magha nakshatra (17-31 August), growing sunflower at 135 and 60 cm recorded significantly higher *rabi* sorghum equivalent yield (2972 kg/ha) and net returns (Rs.38750/ha) than growing cotton. During *Hubba Nakshatra* (31st August to 14th September) sunflower with row spacing of 135 cm was recorded significantly higher *rabi* sorghum equivalent yield of 2772 kg/ha and net returns of Rs. 38750/ha (mean of 4 years) and RWUE of 19.4 kg/ha-mm (Table 3.139).

Table 3.139: *Rabi* sorghum equivalent yield (kg/ha) as influenced by contingency cropping plan in medium deep black soil - Vijayapura

Crop	*Magha* (August 17 – August 31)						*Hubba* (Aug 31- Sept 14)					
	Crop yield (kg/ha)	*Rabi* sorghum equivalent yield (kg/ha)		NMR (Rs/ha)		RWUE (kg/ha-mm)	Crop yield (kg/ha)	*Rabi* sorghum equivalent yield (kg/ha)		NMR (Rs/ha)		RWUE (kg/ha-mm)
		2014-15	Mean (3 yrs)	2014-15	Mean (3 yrs)			2014-15	Mean (4 yrs)	2014-15	Mean (4 yrs)	
Sunflower	1759	3439	1961	53751	29869	5.1	1496	2924	2389	42429	31892	18.2
Sunflower (135 cm)	1783	3485	2044	54766	30489	5.2	1587	3102	2772	46354	38750	19.4
Cotton	641	874	668	3326	6664	1.3	-	-	-	-	-	-
Sorghum	-	-	-	-	-	-	1188	1188	868	5389	4387	7.6
CD at 5%	-	65	121	1420	2709	0.11	-	82	149	1799	3319	2.1

Among different crops sown during Uttara nakshatra (14-27 September), sunflower with row spacing of 135 and 60 cm were on par and gave significantly higher *rabi* sorghum equivalent yield of 2987 and 2879 kg/ha with net returns of Rs. 46589 and 35547/ha, respectively and RWUE of 25.0 kg/ha-mm over rest of crops (Table 3.140).

Table 3.141: Effect of sowing dates on performance of different crops in medium deep black soils - Vijayapura

Crop	*Uttara* (Sept 14 – Sept 27)					
	Crop yield (kg/ha)	*Rabi* sorghum equivalent yield (kg/ha)		NMR (Rs/ha)		RWUE (kg/ha-mm)
		2014-15	Mean (2 yrs)	2014-15	Mean (2 yrs)	
Sunflower	1306	2552	2879	34239	35547	24.0
Sunflower 135 cm	1483	2898	2987	58279	46589	25.0
Sorghum	1222	1222	1449	5289	10929	11.0
Chickpea	1188	2375	1906	33950	24331	22.0
Safflower	1038	1180	1514	1055	9388	11.0
Sorghum + chickpea (2:1)	965+747	2458	2280	28383	22199	23.0
Safflower + chickpea (2:4)	652+743	2227	2197	41347	28508	21.0
CD at 5%	-	135	165	2962	2933	1.2

In an assessment of effect of hydrogel on *rabi* sorghum at Vijayapura, there was no significant difference in the grain and stover yield of *rabi* sorghum due to application of hydrogel. The growth and yield components of *rabi* sorghum also did not show any significant difference due to the application of hydrogel (Table 3.142).

Table 3.142: Effect of hydrogel on *rabi* sorghum - Vijayapura

Treatment	Grain yield (kg/ha)		Stover yield (kg/ha)		RWUE (kg/ha-mm)
	2014	Mean (2 yrs)	2014	Mean (2 yrs)	
Broadcasting of hydrogel @ 2.5 kg/ha mixed with soil (10 kg) - 15 DAS	1867	1371	4174	2967	20.3
Broadcasting of hydrogel @ 5.0 kg/ha mixed with soil (10 kg) - 15 DAS	1929	1383	4823	3187	20.9
Mix hydrogel @ 2.5 kg/ha with seeds	1836	1339	4321	2944	19.9
Mix hydrogel @ 5.0 kg/ha with seeds	1651	1336	4552	3032	20.3
Mix hydrogel @ 2.5 kg/ha with fertilizer at sowing time	1713	1319	4128	2932	19.9
Mix hydrogel @ 5.0 kg/ha with fertilizer at sowing time	1960	1386	4630	3036	21.3
Control (no hydrogel)	1767	1340	4784	3090	20.6
CD at 5%	NS	NS	NS	NS	NS

At Vijayapura, growing of Bt. cotton at 120 cm x 45 cm gave significantly higher seed cotton yield of 1544 kg/ha as compared to rest of the crop geometry. Application of 60:30:30 kg NPK/ha produced significantly higher seed cotton yield of 1382 kg/ha as compared to application of 30:15:15 kg NPK/ha (1161 kg/ha). Interaction effect was also significant. Crop geometry of 120 cm x 45 cm with application of 60:30:60 kg NPK/ha produced significantly higher seed cotton yield of 1708 kg ha-1 as compared to rest of the treatments (Table 3.143).

Table 3.143: Growth and yield of Bt cotton as influenced by crop geometry and nutrient management - Vijayapura

Treatment	Plant height (cm)	Branches/ plant	Bolls/ plant	Boll weight/ plant (g)	Seed cotton weight/ plant (g)	Seed cotton yield (kg/ha)	RWUE (kg/ha-mm)
Crop geometry (G)							
90 cm x 45 cm	94.3	10.5	12.7	20.28	48.33	1007	2.2
90 cm x 60 cm	97.1	10.4	14.1	21.10	48.83	1171	2.5
120 cm x 45 cm	101.5	10.9	14.5	21.88	57.17	1544	3.3
120 cm x 60 cm	105.6	11.1	15.8	23.87	59.25	1337	2.9
CD at 5%	2.3	0.23	0.4	0.379	1.16	32	0.07
Nutrient management (N, P_2O_5 and K_2O kg/ha) (N)							
30:15:15	96.2	9.9	12.8	19.17	48.83	1161	2.5
45:22.5:22.5	98.1	10.8	14.6	21.63	52.92	1215	2.6
60:30:30	102.0	10.9	14.8	23.13	54.67	1382	2.9
75:37.5:37.5	102.1	11.3	14.9	23.20	57.17	1300	2.9
CD at 5%	2.8	0.31	0.3	0.45	0.98	33	0.07
Interaction (N×G)	-	-	-	-	-	66	-

Similarly, at Vijayapura, growing of onion at 45 cm x 10 cm gave significantly higher bulb yield of 8750 kg / ha as compared to rest of the crop geometry. Application of 62.5:25:62.5 kg NPK/ha produced significantly higher bulb yield of 9185 kg/ha as compared to application of 125:50:125 kg NPK/ha (7358 kg/ha). Interaction effect was also significant. Crop geometry of 45 cm x 10 cm with application of 62.5:25:62.5 kg NPK/ha produced significantly higher bulb yield of 9815 kg/ha as compared to rest of the treatments (Table 3.144).

Table 3.144: Growth and yield of onion as influenced by crop geometry and nutrient management - Vijayapura

Treatment	Plant height (cm)	Bulb weight/ plant (g)	Bulb yield (kg/ha)	RWUE (kg/ha-mm)
Crop geometry (G)				
30 cm with criss cross sowing	31.8	34.500	7426	16.23
30 cm x 10 cm	33.0	36.500	8111	17.8
45 cm x 10 cm	36.8	37.333	8750	19.1
CD at 5%	0.7	0.6	513	1.2
Nutrient management (N, P_2O_5 & K_2O kg/ha) (N)				
125:50:125	33.3	33.4	7358	16.0
93.75:37.5:93.75	33.4	35.0	7383	16.1
62.5:25:62.5	33.9	38.8	9185	20.2
30:10:30	34.8	37.2	8457	18.4
CD at 5%	1.2	0.5	385	1.0
Interaction (N×G)	-	-	667	-

3.3.1.3 Nutrient management

In a permanent manurial trial in *rabi* sorghum + chickpea (2:4) rotated with *rabi* sorghum + safflower at Vijayapura, 100% RDF gave maximum equivalent yield of sorghum (2598 and 2162 kg/ha) during 2012 and 2014 and 1362 kg/ha of safflower during 2013, respectively. Application of crop residue @ 5 t/ha with decomposing culture + RDF was the next best treatment. The control treatment gave lowest sorghum yield of 1502 and 1478 kg/ha and safflower yield of 690 kg/ha (Table 3.145).

Table 3.145: Permanent manurial trial in *rabi* sorghum + chickpea (2:4) rotated with safflower + chickpea (2:4) – Vijayapura

Treatment	Sorghum		Chickpea		Equivalent yield (kg/ha)		
	Grain yield (kg/ha)	Stover yield (kg/ha)	Seed yield (kg/ha)	Stalk yield (kg/ha)	Sorghum (2014-15)	Sorghum (2012-13)	Safflower (2013-14)
Control	670	1122	512.5	800.6	1478	1502	690
100% RDF	737	1609	557.4	905.4	2162	2598	1362
RDN alone	445	823	340.4	643.5	1043	1942	864
RD P_2O_5 alone	584	1040	460.2	714.6	1508	1900	777
RDN and P_2O_5	527	1126	475.1	733.3	1418	2037	1033
FYM to meet 100%N	393	995	497.6	793.1	1657	1860	948
FYM to meet 50% N + 50% RDF	715	1489	538.7	856.7	1727	2280	1301
Green manuring to meet 100% N	625	1040	419.0	662.2	1188	1906	949
Green manuring to meet 50% N + 50% RDF	700	1332	527.5	800.6	1704	2245	1275
Crop residue with decomposing culture to meet 50% N + 50% RDF	554	1238	482.6	781.9	1505	2245	1250
Crop residue (5 t/ha) with decomposing culture + RDF	423	1066	426.5	763.2	1298	2349	1273
CD at 5%	NS	NS	NS	NS	NS	106.6	110

In a study on foliar spray of nutrients for *rabi* sorghum at Vijayapura, RDF + KNO_3 (1% spray) sprays at 45 & 75 DAS was superior with maximum grain yield of 1821 kg/ha, while the control gave lowest yield of 611 kg/ha. However, spraying of thiourea @ 250 g/ha at 45 DAS resulted in production of higher stover yield (3511 kg/ha) (Table 3.146).

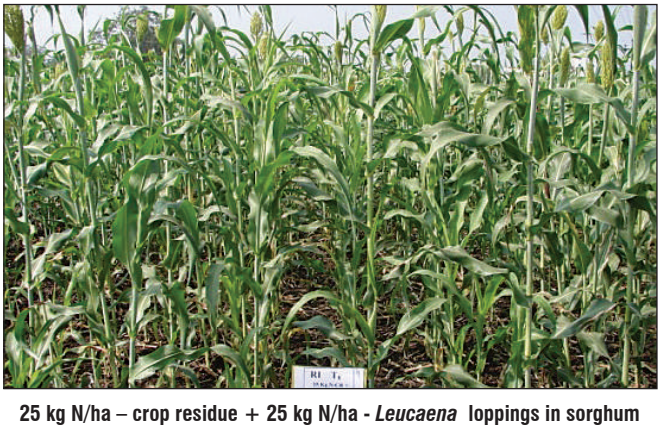
Table 3.146: Effect of foliar spray of nutrients on *rabi* sorghum yield - Vijayapura

Treatment	Grain yield (kg/ha)	Stover yield (kg/ha)
RDF + no spray	611	1392
RDF + water spray at 45 & 75 DAS	995	2083
RDF + KNO_3 (1% spray) sprays at 45 & 75 DAS	1821	2971
RDF + KCl (1% spray) sprays at 45 & 75 DAS	1551	3449
RDF + Thiourea @ 250 g/ha at 45 DAS	1543	3511
CD at 5%	NS	NS

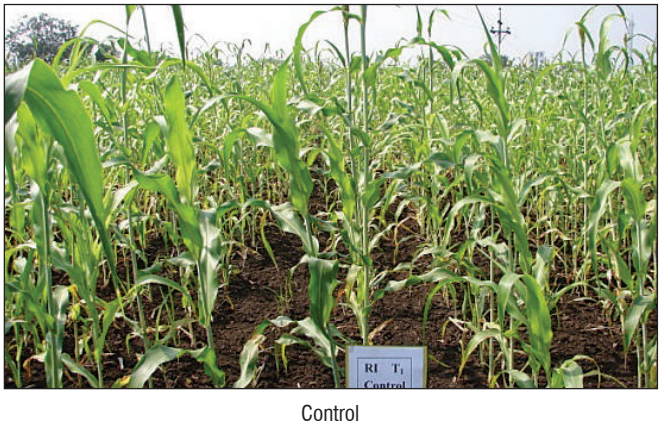
In a permanent maneurial trial (PMT) in *rabi* sorghum at Solapur, application of 25 kg N/ha through crop residue (CR) + 25 kg N/ha through *Leucaena* loppings was superior with maximum sorghum grain yield (2093 kg/ha), stover yield (3900 kg/ha), NMR (Rs. 45559/ha), B:C ratio (2.37) and MUE (14.91 kg/ha-mm) and it was on par with 25 kg N/ha (FYM) + 25 kg N/ha (urea) in case of grain yield (1996 kg/ha). The control treatment gave lowest grain yield of 1207 kg/ha with net returns of Rs. 28424/ha and B: C ratio of 8.6 (Table 3.147).

Table 3.147: Influence of nutrient management practices on yield and economics of *rabi* sorghum (PMT) - Solapur

Treatment	Yield (kg/ha)		Mean yield (kg/ha) (4 yrs)		Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Grain	Stover	Grain	Stover				
Control	1207	2467	1042	2313	28172	28424	2.00	8.60
25 kg N/ha (urea)	1708	3449	1501	3343	29544	37399	2.26	12.17
50 kg N/ha (urea)	1822	3814	1646	3743	29853	42952	2.44	12.98
25 kg N/ha (crop residue-CR)	1629	3449	1391	3133	31467	33981	2.08	11.61
25 kg N/ha (FYM)	1692	3696	1468	3415	33141	35949	2.08	12.05
25 kg N/ha CR + 25 kg N/ha (urea)	1862	3531	1625	3460	31776	38914	2.22	13.27
25 kg N/ha (FYM) + 25 kg N/ha (urea)	1996	3778	1802	3826	33450	41244	2.23	14.22
25 kg N/ha CR + 25 kg N/ha (*Leucaena* loppings)	2093	3900	1851	3912	33203	45559	2.37	14.91
25 kg N/ha (*Leucaena* loppings)	1636	3696	1415	3325	30971	37061	2.20	11.66
25 kg N/ha (*Leucaena* loppings) + 25 kg N/ha (urea)	1733	3860	1565	3632	31280	40244	2.28	12.35
CD at 5%	40.2	21.6	-	-		2657.71	-	-



25 kg N/ha – crop residue + 25 kg N/ha - *Leucaena* loppings in sorghum



Control

The nutrients uptake by *rabi* sorghum was significantly influenced by different treatments. The highest uptake of total K (67.31 kg/ha), S (13.4 kg/ha), Fe (146.8 g/ha), Zn (136.9 g/ha), Cu (20.3 g/ha) and Mn (48.3 g/ha) were recorded with 25 kg N/ha CR + 25 kg N/ha (*Leucaena* loppings) treatment. The highest N and P uptake was recorded with 25 kg N/ha (FYM) + 25 kg N/ha (urea) (Table 3.148).

Table 3.148: Nutrient uptake by sorghum as affected by different treatments - Solapur

Treatment	Nutrient uptake (kg/ha)				Micronutrients (g/ha)			
	N	P	K	S	Fe	Zn	Cu	Mn
Control	38.56	7.72	54.67	5.3	92.1	92.4	13.4	29.9
25 kg N/ha (urea)	46.62	11.48	58.80	9.2	114.9	108.1	16.0	36.9
50 kg N/ha (urea)	50.61	13.03	65.69	10.7	125.6	118.7	17.6	41.0
25 kg N/ha (crop residue-CR)	45.07	9.45	55.76	8.2	11.2	106.1	15.6	35.3
25 kg N/ha (FYM)	47.71	10.50	62.54	8.6	121.7	115.9	17.1	40.7
25 kg N/ha CR + 25 kg N/ha (urea)	48.82	11.98	62.83	8.7	127.1	118.7	17.5	41.9
25 kg N/ha (FYM) + 25 kg N/ha (urea)	85.92	13.64	67.19	12.6	138.6	129.5	19.4	45.8
25 kg N/ha CR +25 kg N/ha (*Leucaena* loppings)	57.64	13.38	67.31	13.4	146.8	136.9	20.3	48.3
25 kg N/ha (*Leucaena* loppings)	50.02	9.60	62.71	9.4	120.6	115.9	17.3	40.5
25 kg N/ha (*Leucaena* loppings) + 25 kg N/ha (urea)	49.99	12.04	64.18	11.1	129.5	124.3	18.6	43.2
CD at 5%	3.00	1.00	3.12	0.18	6.47	9.82	0.79	2.11

In a permanent manurial trial on *rabi* sorghum at Solapur, the soil available nutrient contents were increased at harvesting as compared to sowing but it was reduced in control. Among the various treatments, application of 25 kg N/ha (CR) + 25 kg N/ha (*Leucaena* loppings) recorded significantly higher values for various soil available nutrients. The next best treatment was application of 25 kg N/ha (FYM) + 25 kg N/ha (urea) (Table 3.149).

Table 3.149: Effect of integrated nutrient management on soil properties - Solapur

Treatment	Organic carbon (%)		Available N (kg/ha)		Available P (kg/ha)		Available K (kg/ha)	
	At sowing	At harvest	At sowing	At harvest	At sowing	At harvest	At sowing	At harvest
Control	0.49	0.49	109	103	9.70	9.03	700	687
25 kg N/ha (urea)	0.68	0.68	157	160	10.16	10.79	779	717
50 kg N/ha (urea)	0.66	0.70	135	146	11.49	12.54	724	716
25 kg N/ha (crop residue-CR)	0.64	0.66	167	175	13.18	14.51	818	832
25 kg N/ha (FYM)	0.69	0.71	141	150	19.40	21.43	836	831
25 kg N/ha CR + 25 kg N/ha (urea)	0.71	0.71	164	180	19.40	19.76	824	835
25 kg N/ha (FYM) + 25 kg N/ha (urea)	0.74	0.76	175	175	21.10	22.02	856	864
25 kg N/ha CR +25 kg N/ha (*Leucaena* loppings)	0.76	0.71	180	181	22.85	23.41	826	842
25 kg N/ha (*Leucaena* loppings)	0.70	0.71	165	170	20.43	19.31	782	790
25 kg N/ha (*Leucaena* loppings) + 25 kg N/ha (urea)	0.70	0.71	176	180	21.38	20.69	785	812
CD at 5%	0.009	0.015	5.48	2.93	1.17	1.12	18.95	10.16

In a balanced nutrition study on *rabi* sorghum at Solapur, foliar spray of 1% KNO_3 at 35 and 55 DAS recorded maximum grain (1824 kg/ha) and stover yield (4630 kg/ha) and was at par with rest of treatments except RDF and control. Higher RWUE of 13 kg/ha-mm was obtained with foliar spray of 1% KNO_3 at 35 and 55 DAS, while it was lowest in absolute control. Foliar sprays of 1% KNO_3 at 35 and 55 DAS registered significantly higher NMR (Rs. 47499/ha) and B:C ratio (2.42) (Table 3.150).

Table 3.150: Effect of balanced nutrition on *rabi* sorghum yield and economics - Solapur

Treatment	Yield (kg/ha)		Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Grain	Stover				
Control	1333	2593	28172	23087	1.82	9.50
RDF (50:25:25 N:P_2O_5:K_2O kg/ha)	1445	3148	30553	28377	1.93	10.29
Water spray at 35 and 55 DAS	1631	3333	32053	32263	2.00	11.62
Foliar sprays of 1% water soluble NPK fertilizer (19:19:19) at 35 and 55 DAS	1648	4074	33453	38606	2.15	11.74
Foliar spray of 0.5% $ZnSO_4$ at 35 and 55 DAS	1633	4167	32253	40447	2.25	11.63
Foliar spray of 1% DAP at 35 and 55 DAS	1639	3741	32303	36245	2.12	11.68
Foliar spray of 1% KNO_3 at 35 and 55 DAS	1824	4630	33453	47499	2.42	13.00
Foliar spray of selenium @ 20 g/ha at 35 and 55 DAS	1611	3426	33465	31409	1.94	11.48
CD at 5%	218	629	-	7522	-	-

Foliar sprays 1% KNO_3 at 35 and 55 DAS in sorghum

Absolute control

Under balanced nutrition study in *rabi* sorghum at Solpur, soil available nutrients at harvest of *rabi* sorghum were significantly influenced by different treatments. However, there was no significant difference in respect of available Fe content of soil. Significantly higher values of organic carbon (0.38%), available K (723 kg/ha) and S (22.2 kg/ha), Fe (3.48 mg/kg) was registered with foliar sprays of 1% DAP Zn (0.98 mg/kg) and Cu (0.88 mg/kg) with 1% water soluble NPK fertilizer (19:19:19) at 35 and 55 DAS. Significantly higher available soil nutrients *viz.*, N (162 kg/ha) and P (15.11 kg/ha) was recorded by foliar spray of 1% KNO_3 and 0.5% $ZnSO_4$, respectively (Table 3.151).

Table 3.151: Effect of balanced nutrition on soil fertility - Solapur

Treatment	OC (%)	Soil available nutrients (kg/ha)				DTPA extractable micronutrients (mg/kg)			
		N	P	K	S	Fe	Zn	Cu	Mn
Control	0.37	139	8.55	679	16.6	3.21	0.97	0.81	26.49
RDF (50:25:25 N:P_2O_5:K_2O kg/ha)	0.37	152	12.48	680	18.8	3.28	0.91	0.74	25.81
Water sprays at 35 and 55 DAS	0.35	156	12.34	681	19.6	3.17	0.93	0.75	25.81
Foliar spray of 1% water soluble NPK fertilizer (19:19:19) at 35 and 55 DAS	0.38	158	11.99	598	21.9	3.16	0.98	0.88	27.50
Foliar spray of 0.5% $ZnSO_4$ at 35 and 55 DAS	0.36	152	15.11	693	21.1	3.32	0.91	0.79	29.55
Foliar spray 1% DAP at 35 and 55 DAS	0.38	157	14.75	723	22.2	3.48	0.94	0.75	27.50
Foliar spray 1% KNO_3 at 35 and 55 DAS	0.34	162	11.62	649	19.9	3.23	0.91	0.78	25.99
Foliar spray of Selenium @ 20 g/ha at 35 and 55 DAS	0.38	155	9.83	670	21.9	3.22	0.93	0.83	23.99
CD at 5%	0.015	5.40	0.57	2.25	0.62	NS	0.022	0.018	1.28

The effect of foliar application of nutrients on nutrients uptake by *rabi* sorghum was significantly influenced by different treatments over absolute control (Table 152). The maximum nutrient uptake *viz.,* N (54.65 kg/ha), P (13.67 kg/ ha), K (74.22 kg/ha), S (11.38 kg/ ha), Fe (139.1 g /ha), Zn (135.9 g/ha), Cu (20.4 g/ha) and Mn (48.0 g/ha) was recorded with the application of foliar sprays of 1% KNO_3 at 35 and 55 DAS and it was on par with foliar sprays of 1% water soluble NPK (50.38 and 69.57 kg /ha) and foliar sprays of 0.5 % $ZnSO_4$ (50.23 and 68.92 kg/ha) in case of N and K, respectively. The uptake of S (11.38 kg/ha) by foliar sprays 1% KNO_3 at 35 and 55 DAS was significantly superior over rest of the treatments.

Table 3.152: Uptake of nutrients by sorghum as influenced by different treatments - Solapur

Treatment	Nutrient uptake (kg/ha)				Micronutrients (g/ha)			
	N	P	K	S	Fe	Zn	Cu	Mn
Control	34.4	6.9	44.4	4.9	87.2	81.8	11.8	27.1
RDF (50:25:25 N:P_2O_5:K_2O kg/ha)	41.0	8.3	53.7	7.1	100.2	96.8	14.4	34.5
Water spray at 35 and 55 DAS	44.2	9.5	56.7	9.2	111.7	105.7	15.7	38.1
Foliar spray of 1% water soluble NPK fertilizer (19:19:19) at 35 and 55 DAS	50.3	12.1	69.6	11.0	124.2	120.7	18.1	42.8
Foliar spray of 0.2% $ZnSO_4$ at 35 and 55 DAS	50.2	11.0	68.9	7.8	121.9	120.6	17.9	42.6
Foliar spray of 1% DAP at 35 and 55 DAS	48.3	12.1	64.5	11.3	120.7	116.3	17.5	40.5
Foliar spray of 1% KNO_3 at 35 and 55 DAS	54.6	13.7	74.2	11.4	139.1	135.9	20.4	48.0
Foliar sprays of Selenium @ 20 g/ha at 35 and 55 DAS	44.4	10.5	53.6	9.7	114.2	107.2	16.2	38.5
CD at 5%	5.3	1.1	9.5	0.3	12.9	13.1	1.9	4.6

3.3.1.4 Energy management

At Vijayapura, pooled analysis of *rabi* sorghum over 7 years indicated that the conventional tillage (1 ploughing + 2 harrowings + 2 hoeings + 1 hand weeding) was superior with mean maximum grain and stover yield of 1558 and 3530 kg/ha, respectively. Among different nutrient management treatments, farmer's practice of nutrient application plus sunhemp green manuring was comparable with that of 100% RDF through inorganic fertilizers with respect to grain yield (1561 kg/ha) only and recorded mean maximum grain and stover yield of 1567 and 3315 kg/ha, respectively (Table 3.153).

Table 3.153: Effest of tillage and nutrient management on *rabi* sorghum – Vijayapura

Treatment	Yield (kg/ha)		Pooled yield (kg/ha)	
	Grain	Stover	Grain (7 yrs)	Stover (7 yrs)
Tillage				
Conventional tillage (1 ploughing + 2 harrowings + 2 hoeings + 1 hand weeding)	1344	2969	1558	3530
Low till (LT_1 2 harrowings + 1 hoeing + 1 hand weeding)	1131	2470	1385	3244
Low till (LT_2 1 harrowing + 1 hoeing + herbicide)	1098	2273	1369	3120
CD at 5%	234.9	956.2	132.9	252.3
Nutrient management				
Sunnhemp incorporation @ 5 t/ha	1178	2370	1234	2370
Sunnhemp incorporation @ 2.5 t/ha + 50% RDF through fertilizer	1320	2349	1528	2349
100% RDF through inorganic fertilizer	1023	2202	1561	2202
Farmer's practice	1165	2617	1298	2617
Farmer's practice + sunnhemp green manuring	1270	3315	1567	3315
CD at 5%	258.7	765.3	157.7	765.3

At Vijayapura, different seed drills were evaluated for sowing of greengram. Greengram sowing with bullock drawn CRIDA seed drill recorded 10.9% higher seed yield than the Bhopal seed drill. In case of tractor drawn seed drills, 10.1% higher yield (887 kg/ha) was recorded with the CRIDA automatic tractor drawn seed drill over the control. However, there was no difference amongst the seed drills in respect of field efficiency and soil moisture. Field efficiency was in the range of 4.1-3.9 hr/ha in bullock drawn seed drills, while it was 1.2-1.25 hr/ha for the tractor drawn seed drill. Higher RWUE was recorded with CRIDA seed drill both bullock drawn (9.8 kg/ha-mm) and tractor drawn 10.3 (kg/ha-mm) (Table 3.154).

Table 3.154: Evaluation of different seed drills for greengram sowing – Vijayapura

Seed drill	Yield (kg/ha)	Field efficiency (hr/ha)	Average soil moisture (%)	Average spacing of seed placement (cm)	Avg. depth of seed placement (cm)	% increase in yield over control	RWUE (kg/ha-mm)
Bullock drawn							
CRIDA seed drill	843	4.1	18.5	15.16	5.89	10.9	9.8
Bhopal seed drill	774	4.0	19.1	10.40	5.09	3.8	9.0
Ordinary seed drill (control)	751	3.9	18.2	13.63	5.06	-	8.8
Tractor drawn seed drill							
CRIDA seed drill	887	1.2	19.2	9.45	4.78	10.1	10.3
Ordinary seed drill (control)	797	1.25	18.5	17.23	6.19	-	9.3
CD at 5%	0.358	-	-	-	-	-	-

At Solapur, medium tillage was significantly superior over low tillage for *rabi* sorghum with maximum grain yield of 2091 kg/ha and stover yield of 3713 kg/ha with net returns of Rs.51116/ha, B:C ratio of 2.98 and RWUE of 14.91 kg/ha-mm. Among different fertilizer treatments, 50% N (organic) + 50% N (inorganic) gave maximum grain (2216 kg/ha) and stover yield (4084 kg/ha) with net returns of Rs.56303/ha, B:C ratio of 3.15 and RWUE of 15.79 kg/ha-mm. Further, the mean yield over four years showed similar trend (Table 3.155).

Table 3.155: Yield and economics of *rabi* sorghum as influenced by tillage and nutrient management – Solapur

Treatment	Yield (kg/ha)		Mean grain yield (4 yrs)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Grain	Stover				
Tillage (T)						
Low tillage	1861	3574	1547	47862	3.07	13.26
Medium tillage	2091	3713	1778	51116	2.98	14.90
Conventional tillage	1956	3620	1713	42377	2.37	13.94
CD at 5%	165	NS	256	5025	-	-
Nutrient management (N)						
100% organic-N	1708	3295	1475	37595	2.38	12.17
50% organic-N + 50% fertilizer-N	2216	4084	1840	56303	3.15	15.79
100% fertilizer-N	1984	3527	1723	47457	2.89	14.14
CD at 5%	77	421	-	4433	-	-

The effect of tillage on nutrient uptake by *rabi* sorghum was found significant with respect to N, P, S and Fe. Among nutrient sources, application of 50% N through organic and 50% N through chemical fertilizers recorded significantly higher uptake of N (61.31 kg/ha), P (13.90 kg/ha), K (67.00 kg/ha), Fe (154g/ha), Zn (143 g/ha), Cu (22.4 g/ha) and Mn (50.4g/ha) and it was significantly superior over 100% N through organic and inorganic except P and S uptake by *rabi* sorghum whereas interaction effects for nutrient uptake by *rabi* sorghum were found non-significant (Table 3.156).

Table 3.156: Nutrient uptake by sorghum as influenced by tillage and nutrient management – Solapur

Treatment	Nutrient uptake (kg/ha)				Micronutrients uptake (g/ha)			
	N	P	K	S	Fe	Zn	Cu	Mn
Tillage (T)								
Low tillage	51.33	11.34	57.31	10.8	126	119	18.6	40.8
Medium tillage	56.49	12.71	61.10	12.0	139	128	18.8	44.9
Conventional tillage	55.34	12.24	59.88	12.0	133	123	18.3	42.5
CD at 5%	3.92	1.29	NS	0.34	9.02	NS	NS	NS
Nutrient management (N)								
100% organic-N	47.01	9.40	52.04	10.8	111	105	15.5	34.5
50% organic-N + 50% fertilizer-N	61.31	13.90	67.00	11.9	154	143	22.4	50.4
100% fertilizer-N	54.84	12.99	59.24	12.0	133	122	17.8	43.3
CD at 5%	3.26	1.16	5.74	0.26	5.42	11.08	2.62	2.97

Regarding soil available nutrients, the medium tillage and conventional tillage were statistically on par with respect to organic carbon (0.43%), available N (159 and 162 kg/ha) and available P (11.65 and 12.22 kg/ha). However, conventional tillage recorded significantly higher available K (728 and 716 kg/ha) and low tillage recorded higher P (13.90 and 14.31 kg/ha) at sowing and harvesting over rest of treatments. The low tillage recorded the lowest soil organic carbon and available N and K (Table 3.157). Application of 50% N through organic + 50% N through chemical fertilizer recorded higher soil available N, P and K both at sowing and harvesting. Application of 100% through organic recorded higher soil organic carbon content compared to other treatments. The interaction effects were found significant in respect of organic carbon, soil available nutrients like N and K content at sowing and harvesting and P at sowing.

Table 3.158: Effect of different treatments on soil organic carbon and available nutrients – Solapur

Treatment	Soil organic carbon (%)		Available N (kg/ha)		Available P (kg/ha)		Available K (kg/ha)	
	At sowing	At harvest	At sowing	At harvest	At sowing	At harvest	At sowing	At harvest
Tillage (T)								
Low tillage	0.38	0.41	159	159	13.90	14.31	680	678
Medium tillage	0.42	0.43	161	159	13.49	11.65	711	696
Conventional tillage	0.39	0.43	160	162	13.05	12.22	728	716
CD at 5%	0.012	0.016	NS	NS	0.33	2.05	5.44	4.58
Nutrient management (N)								
100% organic-N	0.45	0.45	153	153	13.50	10.85	694	691
50% organic-N + 50% fertilizer-N	0.42	0.43	169	168	14.24	15.68	727	732
100% fertilizer-N	0.33	0.39	159	159	12.70	11.65	700	668
CD at 5%	0.012	0.012	2.36	2.15	0.15	1.09	3.73	3.97
Interaction (T x N)								
CD at 5%	0.019	0.021	3.51	3.77	0.34	NS	6.78	6.67

In an experiment on tillage and residue retention for resource conservation in blackgram at Solapur, the green biomass yield at flowering as green manure (12517 kg/ha) and grain and stalk yield of blackgram was 1088 and 2796 kg/ha, respectively. The highest green and dry biomass yield of blackgram was recorded in the order of conventional tillage (CT) > reduced tillage (RT) > zero tillage (ZT) with mean green (13847 kg/ha) and dry (3460 kg/ha) foliage yield, respectively (Table 3.159).

Table 3.159: Effect of tillage and residue retention on *kharif* blackgram yield in blackgram - *rabi* sorghum sequence – Solapur

Residue management	Tillage systems							
	Conventional (CT)		Reduced (RT)		Zero (ZT)		Mean	
S_1 Fallow	Green	Dry	Green	Dry	Green	Dry	Green	Dry
S_2 Green manuring	138.47	34.60	125.71	31.42	111.34	27.83	125.17	31.28
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
S_3 Blackgram (Seed)	11.83	27.61	11.33	30.66	9.48	25.61	10.88	27.96

Nutrient composition of black gram as a green manure : N-2.33%; P-0.27%; K-2.14%; OC-41.8%; C:N- 18.49

The effect of tillage on yield of *rabi* sorghum was found significant. The conventional tillage (CT) recorded significantly higher grain (1873 kg/ha) and stover yield (2646 kg/ha). RWUE for *rabi* sorghum grain was in the order of CT > RT > ZT. Keeping *kharif* fallow (S_1), *rabi* sorghum recorded significantly higher grain (2324 kg/ha) and stover (3240 kg/ha) yield than rest of residue management treatments (S_2 and S_3). The treatment of *kharif* fallow with conventional tillage recorded significantly higher stover yield (3451 kg/ha) which was on par with *kharif* fallow with reduced tillage (3393 kg/ha). Conventional tillage (CT) recorded highest net returns (Rs. 34204/ha) followed by reduced tillage (Rs.32096/ha). The highest B:C ratio (1.81) was recorded by conventional tillage closely followed by reduced tillage (1.80). The blackgram for grain (S_3) recorded significantly highest net returns (Rs.36858/ha) with B:C ratio (1.90) which was on par with *kharif* fallow treatment (Rs.35750/ha) treatment. Thus growing of black gram for grain (S_3) or keeping *kharif* fallow (S_1) were found equally beneficial in terms of net returns and B:C ratio (Table 3.160).

Table 3.160: Effect of tillage and residue retention on *rabi* sorghum yield in blackgram - *rabi* sorghum sequence – Solapur

Treatment	Yield (kg/ha)		Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Grain	Stover				
Tillage (T)						
Conventional tillage(CT)	1873	2646	41954	34204	1.81	13.34
Reduced tillage (RT)	1759	2511	39954	32096	1.80	12.53
Zero tillage (ZT)	1573	2339	39890	23920	1.60	11.21
CD at 5%	143	157	-	5905	-	-
Residue management (S)						
S_1-*Kharif* fallow	2324	3240	40798	35750	1.88	16.56
S_2- Blackgram- green manuring	1758	2358	40244	17611	1.43	12.53
S_3- Blackgram- grain	923	1898	40757	36858	1.90	6.57
CD at 5%	095	202	-	3482	-	-
Interaction (T x S)						
CD at 5%	NS	349	-	NS	-	-

The effect of tillage on nutrient uptake by *rabi* sorghum was found to be significant in respect of N, P, K, Fe, Zn, Cu and Mn (Table). Among tillage treatments, conventional tillage (CT) recorded higher uptake of N (44.55 kg/ha), P (9.73 kg/ha), K (48.13 kg/ha), S (14.92 kg/ha), Fe (108.9 g/ha), Zn (97.7 g/ha), Cu (15.2 g/ha) and Mn (33.9 g/ha). In case of residue management, green manuring (S_2) recorded significantly higher uptake of N (56.20 kg/ha), P (11.33 kg/ha), K (60.02 kg/ha) while *kharif* fallow recorded significantly higher uptake of Fe, Zn, Cu and Mn (Table 3.161).

Table 3.161: Nutrient uptake by *rabi* sorghum in blackgram-*rabi* sorghum sequence under tillage and residue management – Solapur

Treatment	Nutrient uptake (kg/ha)				Micronutrients (g/ha)			
	N	P	K	S	Fe	Zn	Cu	Mn
Tillage (T)								
Conventional tillage (CT)	44.55	9.73	48.13	14.92	108.9	97.7	15.2	33.9
Reduced tillage (RT)	40.84	9.06	45.80	14.68	101.7	92.1	14.1	32.0
Zero tillage (ZT)	37.87	7.97	41.39	14.33	90.4	83.3	12.3	28.6
CD at 5%	3.99	0.91	3.04	NS	4.75	6.88	1.23	1.90
Residue management (S)								
S_1- *Kharif* fallow	56.20	11.33	60.02	14.45	135.1	121.9	17.0	40.7
S_2- Blackgram- green manuring	39.86	8.98	42.92	14.58	101.1	90.1	14.8	32.4
S_3- Blackgram- grain	27.20	6.46	32.39	14.91	64.9	61.1	9.8	21.5
CD at 5%	2.54	0.73	3.24	NS	7.00	6.51	0.75	1.18
Interaction (T x S)								
CD at 5%	NS	NS	5.17	NS	NS	NS	1.44	2.25

The tillage systems did not show significant differences in respect of soil organic carbon at sowing and harvest of *rabi* sorghum. Conventional tillage recorded significantly higher available N at sowing (178 kg/ha) and harvest (162 kg/ha) and available K at harvest (767 kg/ha). Green manuring (S_2) recorded significantly higher soil organic carbon and available nutrients at harvesting. Both S_2 and S_3 were statistically significant over S_1 in respects of soil organic carbon and soil available nutrient content at sowing and harvesting. However, at *rabi* sowing reduced tillage with blackgram green manuring recorded significantly higher available P (29.94 kg/ha) and it was superior over rest of the treatment combinations (Table 3.162).

Table 3.162: Effect of treatments on soil organic carbon and available nutrients at sowing and harvest of *rabi* sorghum - Solapur

Treatment	Organic carbon (%)	Available N (kg/ha)	Available P kg/ha)	Available K (kg/ha)	SO_4-S K (kg/ha)	DTPA extractable micronutrients (mg/kg)	
						Fe	Zn
Tillage (T)							
Conventional tillage	0.34	162	13.8	767	17.2	3.6	0.93
Reduced tillage	0.35	162	13.3	718	17.9	3.7	0.89
Zero tillage	0.36	157	13.8	705	17.6	3.4	0.88
CD at 5%	NS	2.11	NS	20.9	1.2	0.05	0.017
Kharif fallow	0.30	167	10.0	686	18.0	3.7	0.91
Blackgram- green manuring	0.39	158	18.3	780	18.7	3.6	0.91
Blackgram- seed	0.36	156	12.6	723	17.8	3.5	0.89
CD at 5%	0.016	1.41	0.4	15.9	0.5	0.09	0.008
Interaction (T x S)							
CD at 5%	0.036	2.58	0.9	27.8	1.2	0.1	0.018

3.3.1.5 Evaluation of improved varieties

In an evaluation of mothbean genotypes at Vijayapura, genotype MBS-27 recorded significantly highest seed yield (745 kg/ha) compared to local (705 kg/ha) and other genotypes KBMB-1 (661 kg/ha). Seed yield was significantly influenced by spacing. The spacing of 45 cm x 10 cm recorded significantly higher seed yield (719 kg/ha) than 30 cm x 10 cm. The organic treatments significantly influenced the seed yield. Application of vermicompost @ 1 t/ha recorded significantly higher seed yield (722 kg/ha) than FYM @ 2.5 t/ha. The interaction effect due to genotypes, spacing and organics did not show significant difference for seed yield (Table 3.163).

Table 3.163: Seed yield, haulm yield and harvest index of bean moth genotypes as influenced by spacing and organics - Vijayapura

Treatment	Plant height (cm)	50% flowering	Days to maturity	Test weight (g)	Seed yield (kg/ha)	Haulm yield (kg/ha)	HI (%)	RWUE (kg/ha-mm)
Genotype (G)								
MBS-27	50.65	96.6	136.5	1.48	1.63	4442	14.39	1.63
KBMB-1	50.32	96.4	134.9	1.63	1.44	4841	12.09	1.44
Local	51.20	96.2	133.0	1.48	1.54	5509	11.38	1.54
CD at 5%	NS	NS	2.02	NS	30	202	0.76	0.064
Spacing (S)								
30 cm x 10 cm	51.42	96.8	134.2	1.57	1.50	4960	12.32	1.5
45 cm x 10 cm	50.02	96.5	135.4	1.49	1.57	4901	12.92	1.57
CD at 5%	NS	NS	NS	NS	24	NS	NS	0.052
Organics (O)								
FYM @ 2.5 t/ha	51.13	96.7	135.0	1.52	1.50	4893	12.44	1.5
Vermicompost @ 1 t/ha	50.31	96.1	134.6	1.53	1.58	4968	12.80	1.58
CD at 5%	NS	NS	NS	NS	24	NS	NS	0.052
Interaction								
G x S	7.39	NS	NS	NS	NS	286	NS	NS
G x O	NS	NS	NS	NS	NS	300	NS	NS
G x S x O	10.45	NS	NS	NS	NS	424	NS	NS

A multi-location varietal trial of horsegram was conducted at Vijayapura with 18 entries. The entries DS 22 (534 kg/ha), AK 42 (530 kg/ha) and GPM 23 (517 kg/ha) were superior over GPM 6 (499 kg/ha). However, pooled data across two locations indicated that AK-42 followed by GPM-06 and IC-100935 were superior with respect to seed yield (Table 3.164).

Table 3.164: Performance of horsegram genotypes at diffrent locations - Vijayapura

Entry	Seed yield (kg/ha)		
	ARS Bailhongal	RARS Vijayapuraa	Pooled
CRHG-09	679	439	559
DS-22	650	534	592
DEH-1	713	434	573
BGM-1183	496	500	498
IC-100938	640	480	560
GPM-30	483	410	446
GPM-23	652	517	584
IC-100935	711	483	597
Bailhongal L	513	393	453
BJPL-1	585	504	544
GPM-06	710	499	604
Vijayapura L	466	516	490
KBHG-1	644	374	509
PHG-09	630	415	522
AK-21	592	441	516
AK-42	753	530	641

In another trial at Vijayapura, 12 horsegram entries were evaluated in three replications. The entries AK 42 (813 kg/ha), KBHG 1 (764 kg/ha) and CRHG 04 (762 kg/ha) gave higher yield than check GPM 6 (740 kg/ha). The entry Vijayapura local gave higher number of pods/ plant (36) (Table 3.165).

Table 3.165: Performance of horsegram genotypes - Vijayapura

Entry	50 % flowering	Plant height (cm)	No. of pods/ plant	No. of seeds/ pod	100 seed wt. (g)	Seed yield (kg/ha)	Stover yield (kg/ha)
CRHG-04	65	26.5	21.1	3.7	3.4	762	219
CRHG-06	67	22.6	19.9	4.0	3.3	566	188
CRHG-08	68	28.2	21.1	4.2	3.5	455	213
CRHG-19	68	27.0	26.3	4.0	3.3	348	241
CRIDA-18R	66	29.6	24.7	4.1	3.5	545	373
GPM-06	79	39.8	26.4	4.1	3.5	740	395
BJPL-1	77	33.4	30.6	4.1	3.4	702	343
KBHG-1	75	36.2	25.0	3.9	3.3	764	336
Vijayapura Local	76	38.1	36.2	4.0	3.3	710	259
PHG-09	78	38.8	32.6	4.2	3.3	575	302
AK-21	72	34.3	20.4	4.1	3.4	565	327
AK-42	75	30.6	24.8	4.1	3.6	813	373
CD at 5%	0.6	9.8	6.73	0.51	0.36	190.2	102.9

Another trial consisted of 12 horsegram entries evaluated in three replications at Vijayapura. The entries AK 44 (667 kg/ha), AK 21 (653 kg/ha), BL 44 (609 kg/ha) gave higher yield than check GPM 6 (532 kg/ha) (Table 3.166). However, entry PHG-09 recorded marginally higher stover yield (419 kg/ha) compared to AK -44, BL-78 and BJPL-1.

Table: Performance of horsegram genotypes - Vijayapura

Entry	50 % flowering	Plant height (cm)	No. of pods/ plant	No. of seeds/ pod	100 seed wt. (g)	Seed yield (kg/ha)	Stover yield (kg/ha)
AK-44	67	31.0	16.3	3.8	3.7	667	411
GPM-06	75	30.1	19.7	3.8	3.6	532	343
BL-15	72	32.6	19.4	3.6	3.6	574	273
BL-44	69	30.1	21.6	3.9	3.6	609	324
BL-78	76	30.1	20.2	4.0	3.2	365	417
PHG-09	72	31.5	25.1	4.1	3.6	579	419
GPM-51	76	32.9	19.5	4.1	3.2	326	309
BJPL-1	77	32.8	19.2	4.2	3.2	501	411
AK-42	75	35.9	19.1	3.6	3.6	506	373
CRHG-04	65	27.8	21.7	3.7	3.2	452	253
CRIDA-18R	66	28.3	17.3	3.8	3.4	409	265
AK-21	73	36.7	22.1	4.1	3.6	653	284
CD at 5%	0.6	6.0	6.6	0.7	0.53	166.3	101.2

In a trial on evaluation of mothbean entries at Vijayapura, all the genotypes recorded higher seed yield compared to local variety. The entries BL-12-26 (709 kg/ha) and NL-12-32 (695 kg/ha) gave significantly higher seed yield than local check (518 kg/ha). The entry KBMB 1 gave higher number of pods/plant (143) compared to other entries (Table 3.167).

Table 3.167: Performance of mothbean genotypes - Vijayapura

Entry	Plant height (cm)	No .of branches /plant	No. of pods/ plant	Seed yield (kg/ha)
BL-12-26	44.0	3.7	91.3	709
BL-12-52	41.6	3.1	124.9	553
BL-12-25	50.0	3.4	120.1	664
BL-12-23	47.0	3.0	120.1	462
BL-12-37	48.9	3.4	121.5	528
BL-12-49	54.7	3.8	126.2	405
BL-12-18	63.2	3.1	127.5	468
BL-12-47	45.4	4.0	136.4	538
BL-12-32	55.9	3.4	121.1	695
KBMB-1	52.2	3.0	142.9	600
Local	42.8	3.0	76.9	518
CD at 5%	NS	6	24.9	175

In another trial on evaluation of mothbean entries at Vijayapura, all the genotypes recorded higher seed yield compared to local variety. The entries RMB 408 (882 kg/ha) and Kavalagi local (806 kg/ha) gave significantly higher seed yield than local check (518 kg/ha). The next best entry was 13 RMB-141 with seed yield of 688 kg/ha. The entry RMM 102 gave higher number of pods/plant (161) compared to all other entries (Table 3.168).

Table 3.168: Performance of mothbean genotypes - Vijayapura

Entry	Plant height (cm)	No .of branches/ plant	No. of pods/ plant	Seed yield (kg/ha)
RMB-408	51.4	3.4	135.5	882
BGMB-8	50.0	3.0	149.0	667
GPM-14	50.4	3.6	103.7	501
RMM-102	55.9	3.4	161.8	635
CGM-18	60.8	3.2	148.7	556
RMB-00	49.2	2.9	105.1	544
13RMB-141	44.3	3.1	89.1	688
BGMBG-16	61.6	2.9	115.5	512
KBMB-1	59.7	3.3	155.3	523
KAVALAGI L	52.2	3.0	128.8	806
CD at 5%	9.3	0.6	43.8	178.6

In the initial Hybrid trial on Sunflower (*kharif*) genotypes conducted at RARS, Vijayapura, none of the test entries were superior to the local check DSFH 3 (2375 kg/ha) (Table). The oil content was lowest (35.6%) in entry SVSH 498 compared to other entries whereas, NDSH-1012 recorded significantly higher oil content (43.1%) than other entries (Table 3.169).

Table 3.169: Performance of sunflower genotypes in Initial Hybrid Trial (IHT-*Kharif*) - Vijayapura

Genotype	Plant height (cm)	Days to 50% flowering	Days to maturity	Head diameter (cm)	100 seed wt. (g)	Volume weight (g/100 ml)	Oil content (%)	Seed yield (kg/ha)
KBSH-73	140.7	58.3	90.3	14.9	3.5	35.75	40.80	1494
S-2150	135.3	58.3	90.3	13.9	4.0	43.25	39.53	2046
DRSH-1 ©	172.9	62.8	94.8	16.5	4.6	42.25	41.86	2359
NSFH-1016	166.2	66.0	99.0	17.5	4.5	39.38	40.74	1828
KSFH-418	148.0	59.8	92.8	14.7	4.1	39.88	41.37	2326
CSFH-12205	152.7	60.0	93.0	17.7	4.5	40.50	41.45	1899
NSSH-1438	143.5	57.5	89.5	15.4	3.8	38.50	38.64	1575
PKVSH-956	140.8	65.8	97.8	13.9	3.6	34.13	37.41	1304
KBSH-44	170.2	65.0	98.0	15.2	4.5	39.88	37.40	1844
LSFH-4951	174.2	62.8	94.8	15.9	4.1	42.00	41.54	1994
LG-52-01	135.9	61.5	93.5	14.6	4.6	37.25	39.13	2238
SVSH498	146.9	62.0	94.0	17.7	5.0	37.88	35.61	1971

Genotype	Plant height (cm)	Days to 50% flowering	Days to maturity	Head diameter (cm)	100 seed wt. (g)	Volume weight (g/100 ml)	Oil content (%)	Seed yield (kg/ha)
KSFH-473	145.1	63.0	95.0	17.9	4.0	39.13	40.72	1589
KBSH-74	146.3	53.5	84.5	15.4	4.1	39.75	41.32	2120
SVSH-475	150.0	57.0	88.8	15.2	4.5	40.25	39.81	1900
PKVSH-957	134.9	58.0	90.0	13.9	3.6	39.13	39.53	1699
NDSH-1012	160.9	59.0	91.0	14.8	4.4	41.50	43.11	1533
RC	145.2	63.3	96.3	17.3	3.9	36.75	41.16	2028
RSFH-10-427	138.7	61.3	94.3	15.5	3.9	39.88	40.85	1816
DSFH-03	154.3	53.8	83.8	13.7	5.0	39.50	40.92	2375
CD at 5%	12.0	1.8	1.8	3.1	0.6	5.13	1.60	377

In the UAS, Dharwad multi-location trial (MLT), the entries SFMLTD-14-03 (1369 kg/ha), SFMLTD-14-08 (1348 kg/ha) and SFMLTD-14-01 (1336 kg/ha) were found to be superior to the best check KBSH 53 (1316 kg/ha) (Table 3.170).

Table 3.170: Performance of sunflower hybrids under university MLT during *kharif* 2014 - Vijayapura

Hybrid	Days to 50% flowering	Plant height (cm)	Volume weight (g/100 ml)	Head diameter (cm)	Seed yield (kg/ha)	100 seed wt. (g)
SFMLTD-14-01	55	149	45.2	12.7	1336	4.6
SFMLTD-14-02	56	152	43.2	13.4	1264	5.2
SFMLTD-14-03	62	159	42.2	14.7	1369	5.2
SFMLTD-14-04	60	158	41.2	14.7	1039	6.2
SFMLTD-14-05	55	150	41.2	12.3	942	5.2
SFMLTD-14-06	56	154	43.7	12.7	916	5.1
SFMLTD-14-07	58	153	40.2	14.0	972	5.2
SFMLTD-14-08	62	170	40.5	15.6	1348	5.7
KBSH-44 (c)	62	163	44.7	15.0	1309	5.2
KBSH-53 (c)	65	154	42.2	13.7	1316	5.7
SB.207 (c)	64	144	45.8	12.8	1253	5.2
CD at 5%	1.6	16.1	3.5	2.6	257	0.7

In an evaluation of 20 genotypes of *rabi* sorghum for grain and stover yield at Solapur, RSV 1674 was superior with significantly higher grain yield of 2575 kg/ha followed by RSV1979 with grain yield of 2396 kg/ha. In case of stover yield, CSV-22 was superior with significantly higher yield (7619 kg/ha) followed by RSV 1979 with yield of 7513 kg/ha (Table 3.171). The genotype RSV 1674 followed by RSV1979 gave highest net returns of Rs.48559 and 47124/ha, B:C ratio (3:86 and 3.77) with highest RWUE of 18.35 and 17.08, kh/ha-mm, respectively.

Table 3.171: Performance of *rabi* sorghum genotypes - Solapur

Genotype	Grain yield (kg/ha)	Stover yield (kg/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
RSV 1503	1845	6058	32705	2.92	13.15
RSV 1512	1813	4239	29786	2.75	12.92
RSV 1525	1676	7110	30080	2.77	11.95
RSV 1572	1749	3294	27180	2.60	12.47
RSV 1617	1839	5483	31877	2.88	13.11
RSV 1620	2156	6944	40921	3.41	15.37
RSV 1657	1832	5913	32232	2.90	13.06
RSV 1674	2575	5278	48559	3.86	18.35
RSV 1676	2073	6541	38528	3.27	14.78
RSV 1711	2020	6812	37634	3.21	14.40
RSV 1736	1618	4610	25746	2.51	11.53
RSV 1746	1779	4821	29702	2.75	12.68
RSV 1751	1561	7196	27538	2.62	11.13
RSV 1767	1862	4206	30873	2.82	13.27
RSV 1786	2138	4769	37897	3.23	15.24
RSV 1979	2396	7513	47124	3.77	17.08
MSV 101	2303	7083	44469	3.62	16.41
CSV 22 (c)	2156	7619	41731	3.45	15.37
Phule Vasudha (c)	1985	6276	36186	3.13	14.15
M 35-1 (c)	1832	4511	30549	2.80	13.06
CD at 5%	620.71	1180.25	-	-	-

Cost of cultivation Rs. 17,000/ha

Among 15 genotypes of pigeonpea evaluated at Solapur, the genotype BDN 2014-2 recorded significantly higher seed yield (883 kg/ha) over the best check, BSMR 736 (723 kg/ha). The genotype BDN 2014-2 also recorded highest cost B:C ratio (2:62) and RWUE (2.61 kg/ha-mm) among the entries tested (Table 3.172).

Table 3.172: Performance of pigeonpea genotypes - Solapur

Genotype	Seed yield (kg/ha)	Stalk yield (kg/ha)	NMR (Rs/ha)	B:C ratio	RWUE (Kg/ha-mm)
PT 04-386	634	1852	14064	1.94	1.87
PT 04-378	741	1548	17736	2.18	2.19
BDN-2010-1	607	1356	11992	1.80	1.79
BDN- 2014-2	883	2000	24320	2.62	2.61
BDN-2014-3	508	1633	8586	1.57	1.50
BWR-133	469	1674	7108	1.47	1.39
AKTM-11-2	589	1653	11866	1.79	1.74
AKTM-10-13	615	1311	12222	1.81	1.82
AKTM-11-19	539	1881	10322	1.69	1.59

Genotype	Seed yield (kg/ha)	Stalk yield (kg/ha)	NMR (Rs/ha)	B:C ratio	RWUE (Kg/ha-mm)
Vipula (Ch)	570	1508	10816	1.72	1.68
BSMR-736 (Ch)	723	1719	17358	2.16	2.14
BSMR-853(Ch)	709	1449	16258	2.08	2.10
BDN-708 (Ch)	675	1492	14984	2.00	1.99
PKVTARA(Ch)	519	1517	8794	1.59	1.53
ICPL-87119	569	1229	10218	1.68	1.68
CD at 5%	115.11	-	-	-	-

Cost of cultivation Rs. 15,000/ha

Among 16 genotypes of chickpea evaluated at Solapur, the genotype BDNG 2013-2 (1198 kg/ha) recorded significantly higher seed yield over the best check JAKI 9218 (981 kg/ha). Whereas the genotype Phule G-0611-14 (1166 kg/ha) and Phule G -03202-10 (1134 kg/ha) recorded significantly higher seed yield over the second check variety Digvijay (894 kg/ha). The genotype BDNG 2013-2 also recorded highest B:C ratio (3:00) and RWUE (8.54 kg/ha-mm) as compared to other entries (Table 3.173).

Table 3.173: Performance of chickpea genotypes – Solapur

Genotype	Yield (kg/ha)		NMR (Rs/ha)	B:C ratio	RWUE (Kg/ha-mm)
	Seed	Stalk			
Phule G-0302-10	1134	2835	30278	2.84	8.08
Phule G-08108	867	2254	19480	2.18	6.18
Phule G-0611-14	1166	3008	31830	2.93	8.31
BDNG-2013-1	878	2256	19870	2.20	6.26
BDNG-2013-2	1198	3042	33035	3.00	8.54
BDNG-2003-1	1049	2937	27558	2.67	7.48
BCP-26	855	2052	18555	2.12	6.09
AKG-1108	820	2100	17450	2.06	5.84
AKG-1106	998	2495	24668	2.50	7.11
AKG-1103	688	1740	11930	1.72	4.90
Vijay (Ch)	775	2093	15858	1.96	5.52
Vishal (Ch)	976	2479	23858	2.45	6.96
Digvijay (Ch)	894	2397	20783	2.26	6.37
BDNG-797 (Ch)	907	2277	20938	2.27	6.46
JAKI-9218 (Ch)	981	2472	24015	2.46	6.99
SAKI-9516 (Ch)	880	2235	-10913	0.34	6.27
CD at 5%	193	-	-	-	-

Cost of cultivation Rs. 16,500/ha

On the basis of mean performance of 15 trials (Table 3.174), the horsegram genotype *Phule Sakas* (SHG 0628-4) recorded 1025 kg/ha seed yield compared to check Man (719 kg/ha) and Sina (780 kg/ha) which was 42.55% and 31.41% increase over both the checks, respectively. Out of twenty two adaptive trials conducted on farmers fields in Solapur, Ahmednagar, Satara, Sangli, Nandurbar and Dhule Districts, the genotype SHG 0628-4 recorded 24.16% increase in grain yield over the check variety Man and is recommended for release for cultivation on shallow to medium soils of Scarcity zone of Western Maharashtra State.

Table 3.174: Overall performance of SHG 0628-4 in comparison with different checks during 2010-2013 - Solapur

Name of trial	No. of trials	Mean grain yield (kg/ha)		
		SHG 0628-4	Man ©	Sina ©
Station trial 2010	1	1013	627	738
MLT 2011	6	970	680	746
MLT 2012	2	1207	747	867
MLT 2013	6	1036	764	792
Mean	15	1025	719	780

Phule Sakas (SHG 0628-4)

3.3.1.6 Alternate land use

At Vijayapura, the fruit yield of tamarind was significantly higher in the geometry of 10 m x 6 m (1295 kg/ha) than 10 m x 3 m (1095 kg/ha) and 10 m x 9 m (471 kg/ha). Among different grasses, there was no significant difference in the fruit yield of tamarind. However, there was no significant difference in the production of green fodder due to the geometry of tamarind. Among the geometry, the gross income was significantly higher in tamarind geometry of 10 m x 6 m (Rs.132481/ha) as compared to 10 m x 3 m (Rs.112475/ha) and 10 m x 9 m (Rs.50082/ha). Among the different grasses, the gross income was significantly higher with guinea grass (Rs. 99861/ha) than signal grass (Rs.96831/ha) (Table 3.175).

Table 3.175: Evaluation of tamarind based silvi-horti system in eroded soils - Vijayapura

Treatment	Fruit yield (2014-15)	Mean fruit yield (kg/ha) (2013-15)	Mean grass yield (kg/ha) (2013-15)	Gross income (Rs/ha) 2014-15	System RWUE (kg/ha-mm) 2014-15	System gross income (Rs/ha) (2010-14)
Geometry of tamarind						
T_1 (10 m x 3 m)	1095	65.0	2415	112475	11.3	28135
T_2 (10 m x 6 m)	1295	54.9	2413	132481	13.2	31250
T_3 (10 m x 9 m)	471	31.5	2413	50082	5.00	12891
CD at 5%	28.9	-	NS	2974	0.29	-

Treatment	Fruit yield (2014-15)	Mean fruit yield (kg/ha) (2013-15)	Mean grass yield (kg/ha) (2013-15)	Gross income (Rs/ha) 2014-15	System RWUE (kg/ha-mm) 2014-15	System gross income (Rs/ha) (2010-14)
Grass						
G_1 Guinea grass	963	52.9	3010	99861	10.0	24721
G_2 Signal grass	944	48.2	1817	96831	9.70	23463
CD at 5%	NS	-	49	2028	0.19	-

Among aonla, henna and custard apple based agri-horti systems intercropped with chickpea and safflower at Vijayapura, the chickpea equivalent yield was highest with aonla + henna + custard apple (719 kg/ha) than other horticulture components. Among the arable crops, the chickpea equivalent yield was highest with chickpea + safflower intercropping systems (866 kg/ha). While in the interaction of horticulture and arable crops, the chickpea equivalent yield was highest with intercropping of safflower + chickpea (2:4) system in the aonla + henna + custard apple (1093 kg/ha) as compared to other treatments (Table 3.176a & b).

Table3.176 a: Performance of aonla based agri-silvi-horti system in medium black soils – Vijayapura

Horticulture component	Arable crop	Crop yield (kg/ha)	Henna leaf yield (kg/ha)	Custard apple fruit yield (kg/ha)	Chickpea equivalent yield (kg/ha)	Mean chickpea equivalent yield (kg/ha) 2007-14	RWUE (kg/ha-mm)
Aonla alone	No intercrop	0	-	-	0	0	0.000
	Chickpea	501	-	-	310	506	0.630
	Chickpea + safflower	471+444	-	-	433	676	0.706
Aonla + henna	No intercrop	0	6173	-	701	363	0.952
	Chickpea	517	5583	-	942	785	1.487
	Chickpea + safflower	438 + 418	6199	-	1153	962	1.564
Aonla + custard apple (CA)	No intercrop	0	-	295	134	108	0.182
	Chickpea	486	-	277	459	566	0.728
	Chickpea + safflower	454 + 417	-	274	565	732	0.662
Aonla + CA + henna	No intercrop	0	6558	177	826	-	1.120
	Chickpea	482	6353	167	1144	896	1.448
	Chickpea + safflower	391 + 424	6199	144	1236	1093	1.410

Table 3.176 b: Interaction effect of aonla based agri-silvi-horti system in medium black soils – Vijayapura

Intercrop	Aonla only	Aonla + henna	Aonla + custard apple	Aonla + henna + custard apple	Mean
No intercrop	0	363	108	169	160
Chickpea	506	785	566	896	688
Chickpea + safflower	676	962	732	1093	866
Mean	394	703	469	719	

Among sapota based agri-horti systems evaluated in shallow to medium deep black soils at Vijayapura, sapota, guava, custard apple and drumstick seedlings have been planted. Among the main plots, significantly higher gross returns of Rs.38507/ha were obtained with plantation of sapota + guava as compared to other horticulture components. Among the sub-plots, inter planting of guava recorded significantly higher gross returns of Rs.40439/ha. There was no chickpea yield during the year due to the closure of canopy by the horticulture component (Table 3.177).

Table 3.177: Performance of sapota based agri-horti system in shallow to medium deep black soils – Vijayapura

Treatment	Drumstick yield (No./ha)	Guava fruit yield (kg/ha)	Gross income (Rs/ha)	RWUE (kg/ha-mm)	Pooled chickpea yield in sapota (2007-14) (kg/ha)	Pooled gross returns (Rs/ha) (207-13)
Intra-row planting						
Sapota alone	1279	276	6154	0.557	417	15730
Sapota + guava	1335	1149	23651	2.140	438	38507
Sapota + custard apple	1315	235	5357	0.485	451	17233
Sapota + drumstick	936	203	5921	0.536	351	19400
CD at 5%	-	-	2105	0.19	32	2900
Inter-row planting						
No intercrop	868	322	6867	0.621	441	15867
Guava	793	992	20245	1.832	435	40439
Custard apple	877	295	6339	0.574	411	14192
Drumstick	1283	253	7633	0.691	371	14372
CD at 5%	-	-	2560	0.23	45	2706

In an experiment on simarouba based agri-horti system at Vijayapura, among the main-plots, significantly higher gross returns of Rs.36223/ha was obtained with plantation of simarouba + guava as compared to other horticulture components. Among the sub-plots, guava plantation recorded significantly higher gross returns of Rs.43946/ha. There was no chickpea yield due to the closure of canopy by the horticulture component (Table 3.178).

Table 3.178: Performance of simarouba based agri-horti system in shallow to medium deep black soils - Vijayapura

Treatment	Guava fruit yield (kg/ha)	Simarouba beans yield (kg/ha)	Gross returns (Rs/ha)	Pooled seed yield of chickpea (2007-13) (kg/ha)	Pooled gross returns (2007-13) (Rs/ha)	RWUE (kg/ha-mm)
Intra-row planting						
Simaruba alone	425	273	12591	482	19857	0.557
Simaruba + guava	823	247	20162	482	36223	2.140
Simaruba + custard apple	388	232	11240	487	18136	0.485
Simaruba + drumstick	360	231	10671	413	15682	0.536
CD at 5%	-	46	4774	44	3506	0.19
Inter-row planting						
No intercrop	323	266	10447	515	18046	0.621
Guava	1301	251	29783	478	43946	1.832
Custard apple	123	241	6061	463	14589	0.574
Drumstick	250	225	8374	408	13315	0.691
CD at 5%	-	25	3267	45	4008	0.23

At Solapur, neem + *Acacia nilotica* + *Cenchrus ciliaris* + stylo system was recorded highest neem height (335 cm), wood yield (85.54 cubic ft/ha), *Acacia nilotica* wood yield (184.64 cubic ft/ha), Stylo grass yield (6.37 t/ha) with highest net returns (Rs.173996/ha) and B:C ratio (9.65). The next best treatment was neem + bakan (Limbara) + *Cenchrus ciliaris* + Stylo treatment recorded highest neem wood yield (54.10 cubic ft/ha), intercrop tree species wood yield (138.40 cubic ft/ha), Stylo grass yield (5.38 t/ha) with highest net returns (Rs.118904/ha) and B:C ratio (6.91) (Table 3.179).

Table 3.179: Performance of need based silvi-pastoral system on shallow soils – Solapur

Treatment	Neem height (cm)	Neem collar girth (cm)	Neem spread (cm)	Intercrop spread (cm)	Estimated yield (cubic ft)			NMR (Rs/ha)	B:C ratio
					Base neem tree	Intercrop trees sp	Grass yield (t/ha)		
Neem + Anjan + *Cenchrus ciliaris* + Stylo	327	202	27.1	200	55.6	71.1	6.30	59440	3.95
Neem + Acacia nilotica + *Cenchrus ciliaris* + Stylo	335	249	33.2	174	85.5	184.6	6.37	173996	9.65
Neem + Jatropha + *Cenchrus ciliaris* + Stylo	214	157	22.8	163	25.8	149.8	5.53	31924	2.58
Neem + Pongamia + *Cenchrus ciliaris* + Stylo	242	170	25.2	160	35.6	72.1	4.96	44768	3.22
Neem + Glyricidia + *Cenchrus ciliaris* + Stylo	312	306	34.8	196	87.5	144.7	5.31	88548	5.40
Neem + Simaruba glauca + *Cenchrus ciliaris* + Stylo	283	259	27.5	168	49.5	194.8	6.33	78064	4.88
Neem + Bakan (Limbara) + *Cenchrus ciliaris* + Stylo	296	245	28.1	166	54.1	138.4	5.38	118904	6.91
Neem + Australian babul + *Cenchrus ciliaris* + Stylo	249	166	23.0	156	30.5	52.7	5.99	32392	2.61
CD at 5%	68	56.4	5.5	26	-	-	-	-	-

3.3.1.7 Integrated farming system

At Solapur, an integrated farming system was evaluated with 6 different components crops, horticulture, livestock and farm pond in 1 ha area at Solapur *viz.,* crop production (0.50 ha), horticulture (0.40 ha), livestock (0.05 ha), dairy (1 milking buffalo), poultry (150 birds/batch), goat rearing (10 + 1) farm shed, buffalo shed poultry house and farm pond on an area of 0.05 ha (Table 3.180).

Table 3.180. Details of integrated farming system - Solapur

Components	Area	Season		
		Kharif	*Rabi*	Summer
Agri-horti system - anona + (pearlmillet + pigeonpea)	0.40	0.40	0.40	0.40
Cowpea-*rabi* sorghum	0.30	0.30	0.30	-
Fodder crops (maize/ sorghum fodder)	0.10	0.10	0.10	-
Chickpea	0.10	-	0.10	-
Livestock: buffalo 1+ goats (10 +1) + poultry - 150	0.05	0.05	0.05	0.05
Farm pond (Size 15 m x 15 m x 03 m)	0.05	0.05	0.05	0.05
Total	1.00	0.90	1.00	0.50

The crop production component recorded grain and fodder yield 394 and 3472 kg, respectively. The cost of production, net returns and B:C ratio were found to be Rs.12363, Rs.8079/ha and 1.77, respectively (Table 3.181).

Table 3.181: Yield and economics of crop production component in IFS (2009-10 to 2013-14) - Solapur

Crop	Yield (kg)		Economics		
	Grain yield	Fodder yield	Cost of cultivation (Rs.)	NMR (Rs.)	B:C ratio
Cowpea	142	1290	2636	1534	1.58
Rabi sorghum	146	6.45	4126	2154	1.53
Chickpea	106	1.20	2729	601	1.27
Maize (fodder)	-	34.80	1655	2855	2.72
Sorghum (fodder)	-	19.00	1217	938	1.77
Total	394	3472	12363	8079	1.77

Economics of all components of integrated farming system in an area of 1.00 ha revealed that the cost of production, gross returns, net returns and B:C ratio was found to be Rs.76056/ha, Rs.152720/ha, Rs.76664 /ha and 2.00, respectively. Among the IFS component the maximum net returns was recorded with dairy farming followed by goat rearing. The highest total employment generation was from required for goat rearing (122) followed by dairy farming (91) (Table 3.182).

Table 3.182: Overall economics of the IFS (1.00 ha) model (2009-10 to 2013-14) - Solapur

Component	Area (ha)	Allocation %	Cost of cultivation (Rs.)	NMR (Rs.)	B:C ratio	Employment generation (Man-days / year)
Crop production	0.50	10.53	12363	8079	1.77	82
Horticulture	0.40	10.05	9333	7705	1.82	60
Animal component	0.05	-	-	-	-	-
1. Dairy farming		34.99	22598	26830	2.18	91
2. Poultry farming		10.76	8799	8256	1.93	45
3. Goat rearing		33.64	22963	25791	2.12	122
Farm pond	0.05	-	-	-	-	-
Total	1.00	99.97	76056	76664	2.00	400

3.3.2 Pearlmillet Based Production System

3.3.2.1 Rainwater management

At Agra, in a study on catchment-storage-command relationship, the run-off water was harvested in farm pond only in three events. The amount of run-off water of 803.43, 43.26 and 61.51 m^3 was received on 18th July, 6th August and 6th September, in three rainfall events during *kharif* season. The maximum loss of water (110.05 & 109.76 m^3) from the pond was measured in 30th (23rd - 29th July) and 31st week (30th July- 5th August), respectively. These losses of water were mainly due to high infiltration, seepage and evaporation from the tank, because at initial stage the surface was not saturated. The maximum seepage rate of 44.42 mm/day was measured in 30th week (23 - 29 July) and maximum evaporation rate of 6.30 mm/day closely followed by 5.30 mm/day was measured in 38th week (17 - 23 Sep.) and in 39th week No. 9 (24 - 30 Sept.). While minimum evaporation losses of 1.6 mm/day were noted in 36th week (3 to 9 Sep.) (Table 3.183).

Table 3.183: Seepage and evaporation losses from the farm pond - Agra

SMW	Duration	Water depth (m)	Water loss (m^3)	Evaporation (mm/day)	Surface available for evaporation (m^2)	Evaporation loss/ week (m^3)	Seepage loss per week (m^3)	Weekly seepage rate (mm/day)
29	16 - 22 July	1.84	76.66	2.90	470.02	10.51	73.16	32.19
30	23 - 29 July	1.60	110.05	3.10	449.44	6.82	103.23	44.42
31	30 July - 5 Aug	1.35	109.76	4.43	428.49	9.30	100.46	44.20
32	6 -12 Aug	1.33	56.08	2.30	426.10	4.80	51.28	22.56
33	13-19 Aug	1.23	38.01	4.49	418.61	9.20	28.81	12.67
34	20 – 26 Aug	1.14	37.32	5.90	411.27	11.88	25.46	11.20
35	27 Aug - 2 Sep	1.05	36.69	2.90	404.01	5.74	30.95	13.61
36	3 - 9 Sep	1.17	24.78	1.60	413.71	3.24	21.54	9.47
37	10 - 16 Sep	1.10	38.76	4.10	408.08	8.19	30.57	13.42
38	17 - 23 Sep	1.00	40.40	6.30	400.00	12.34	28.06	12.34
39	24 - 30 Sep	0.90	39.60	5.30	392.04	10.18	29.42	12.94
40	1 - 7 Oct	0.51	31.75	4.60	361.76	8.15	23.60	10.38
41	8 - 14 Oct	0.45	21.57	4.10	537.21	7.17	14.40	6.34
42	15 - 21Oct	0.40	17.77	3.40	353.44	5.88	11.89	5.23
43	22 - 28 Oct	0.35	17.58	3.90	349.69	6.68	10.90	4.79
44	29 Oct - 4 Nov	0.30	17.39	3.00	345.96	5.08	12.31	5.41
45	5 Nov - 11 Nov	0.25	17.20	2.60	342.25	4.36	12.84	5.64
46	12 Nov - 18 Nov	0.22	13.64	2.30	340.03	3.83	9.81	4.31
47	19 Nov - 25 Nov	0.19	13.51	1.60	337.82	2.64	10.87	4.78
48	26 Nov - 2 Dec	0.16	10.06	1.70	335.62	2.79	7.81	3.43
49	3 Dec - 9 Dec	0.14	10.00	1.50	334.15	2.45	0.00	0.00
50	10 Dec - 16 Dec	0.02	6.49	1.40	325.44	0.00	0.00	0.00
51	17 Dec - 23 Dec	0.00	0.00	0.00	0.00	0.00	0.00	0.00
52	24 Dec - 31 Dec	0.00	0.00	0.00	0.00	0.00	0.00	0.00

SMW : Standard Meteorological Week

Rainwater harvested in farm pond

The maximum harvested water in the tank was available in 29th week (726.34 m³) in *kharif* season by which, 1.21, 0.90 and 0.72 ha of land can be irrigated, if 6.0, 8.0 and 10.0 cm depth of irrigation are applied. The harvested water was applied in barley experiment as pre-sowing irrigation, 30 DAS and 45 DAS irrigation, respectively with sprinkler system as well as flood system as per treatment (Table 3.184).

Table 3.184: Water availability from runoff storage after recession of rainfall during monsoon - Agra

SMW	Duration	Rainfall (mm)	Water availability at the end of week (m^3)	Area covered with stored water at different depth of irrigation (ha)		
				6 cm	8 cm	10 cm
29	16 - 22 July	110.5	726.34	1.21	0.90	0.72
30	23 - 29 July	-	616.02	1.03	0.77	0.62
31	30 July - 5 Aug	33.4	506.29	0.84	0.63	0.52
32	6 - 12 Aug	81.2	493.47	0.82	0.61	0.49
33	13 - 19 Aug	-	455.46	0.75	0.56	0.45
34	20 - 26 Aug	-	418.12	0.69	0.52	0.41
35	27 Aug - 2 Sep	26.6	381.43	0.63	0.47	0.38
36	3 - 9 Sep	75.0	430.49	0.71	0.53	0.43
37	10 - 16 Sep	10.0	401.73	0.66	0.50	0.40
38	17 - 23 Sep	-	361.33	0.60	0.45	0.36
39	24 - 30 Sep	-	321.73	0.53	0.40	0.32
40	1 - 7 Oct	-	174.78	0.29	0.21	0.17
41	8 - 14 Oct	-	153.21	0.25	0.19	0.15
42	15 - 21 Oct	-	135.44	0.22	0.16	0.13
43	22 - 28 Oct	-	117.86	0.19	0.14	0.11
44	29 - 4 Nov	-	100.47	0.16	0.12	0.10
45	5 - 11 Nov	-	83.27	0.13	0.10	0.08
46	12 - 18 Nov	-	69.63	0.11	0.08	0.06
47	19 - 25 Nov	-	62.86	0.10	0.07	0.05
48	26 Nov - 2 Dec	-	53.76	0.07	0.05	0.04
49	3 - 9 Dec	-	13.01	0.02	0.016	0.013
50	10 - 16 Dec	-	6.49	0.01	0.008	0.006

SMW : Standard Meteorological Week

At SK Nagar, in a study on evaluation of hydrogel in castor, significantly higher seed and stalk yield of castor (1377 and 991 kg/ha) was recorded with the application of hydrogel @ 7.5 kg/ha which was 87.1 and 72.2% higher than control (736 kg/ha) with higher net returns (Rs.33451/ha), B:C ratio (3.19) and RWUE (2.21 kg/ha-mm). However, it was at par with the application of hydrogel @ 5 kg/ha (1211and 875 kg/ha) (Table 3.185).

Table 3.185: Effect of hydrogel on yield and economics of castor - SK Nagar

Treatment	Yield (kg/ha)		Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Seed	Stalk				
No hydrogel	736	579	8500	17563	3.07	1.18
hydrogel@ 2.5 kg/ha	781	573	10750	16880	2.57	1.25
hydrogel @ 5 kg/ ha	1211	875	13000	29820	3.29	1.94
hydrogel @ 7.5 kg/ha	1377	991	15250	33451	3.19	2.21
hydrogel @ 10 kg/ha	829	600	17500	11815	1.68	1.33
CD at 5%	191	154.3	-	-	-	-

At SK Nagar, in a study on different land configuration treatments in cotton among the land configuration treatments significantly higher seed cotton yield (547 kg/ha) was recorded with open furrow at 3.6 m interval and was at par (509 kg/ha) with farmer's method (flat bed) of sowing. Maximum net returns (Rs.19183/ha), B: C ratio (3.35) and RWUE (1.36 kg/ha-mm) were also recorded with open furrow at 3.6 m interval. Further, application of castor shell mulch @ 10 t/ha after last interculturing (60-75 DAS) recorded significantly higher seed cotton yield (563 kg/ha) than other treatments but was at par (548 kg/ha) with mustard straw mulch @ 10 t/ha after last interculturing (60 -75 DAS). The increase in seed cotton yield with application of castor shell and mustard straw mulch was to the tune of 15.9 and 13.6%, respectively than no mulch. The maximum net returns of Rs.17572/ha were recorded with the application of castor shell mulch but higher B: C ratio (2.66) was recorded with mustard straw mulch (Table 3.186).

Table 3.186: Effect of land configuration and mulches on cotton yield and economics - SK Nagar

Treatment	Seed cotton yield (kg/ha)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
Land treatment					
Ridge and furrow method of sowing	415	8455	12285	2.45	1.03
Open the furrow at 3.6 m interval	547	8180	19183	3.35	1.36
Farmer's method (flat bed sowing)	509	8070	17364	3.15	1.27
CD at 5%	86.0	-	-	-	-
Mulch					
No mulch (3-4 interculturing)	473	10170	13497	2.33	1.18
Castor shell mulch @ 10 t/ha after last interculturing	563	10570	17572	2.66	1.40
Mustard straw mulch @ 10 t/ha after last interculturing	548	10070	17313	2.72	1.37
Sunhemp *in situ* as a mulch	377	11970	6887	1.58	0.94
CD at 5%	48.7	-	-	-	-

3.3.2.2 Cropping systems

At Agra, in a study on different crops under delayed onset of monsoon, among *kharif* crops, PEY varied from 1337 to 2379 kg/ha with mean of 1919 kg/ha and 1943 to 3297 kg/ha with mean of to 2653 kg/ha in flat bed sowing and ridge and furrow system under delayed sowing conditions. Highest PEY in flat system as well as in ridge and furrow system was obtained with sesame (2379 and 3297 kg/ha) followed by pearlmillet + clusterbean grown in strip (4:4) under both sowing methods (2117 and 2889 kg/ha). It was observed that planting of *kharif* crops on ridges under delayed onset of monsoon or delayed sowing proved to be more productive and gave 38.2% more mean PEY over flat system of sowing. Higher net returns of Rs.23239/ha was registered with sesame followed by pearlmillet grown with association of clusterbean in strip cropping (4:4 row ratio), (Rs.23069/ha) under ridge and furrow system (Table 3.187a & b).

Table 3.187a. Yield and economics of various crops grown under delayed monsoon conditions - Agra

Crop	Yield (kg/ha)		PEY (kg/ha)	RWUE (kg/ha-mm)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio
	Grain/seed	Stover/stalk					
Pearlmillet	2375	4721	2375	10.26	17817	16577	1.98
Blackgram	357	989	1987	1.54	14092	8756	1.58
Greengram	401	1119	2374	1.73	14752	12550	1.85
Sesame	340	853	2838	1.47	14681	17959	2.22
Clusterbean	460	1411	1640	1.98	14162	4698	1.33
PM + cluster bean (4:4)	1492 + 283	3201 + 823	2503	6.45 + 1.22	8908 + 708	17599	2.15

PM: Pearlmillet; PEY: Pearlmillet equivalent yield

Table 3.187b. Yield and economics of various crops grown under delayed monsoon conditions - Agra

Treatment	Yield kg/ha			Pearlmillet equivalent yield (Kg/ha)		RWUE (kg/ha-mm)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio
	Grain/seed		Straw/stalk	Mean of 3 years	2014				
	Mean of 3 years	2014	2014						
Flat bed sowing									
Pearlmillet (PM)	2005	1960	3724	1960	2005	8.47	17817	10309	1.58
Blackgram	342	304	851	1692	1734	1.31	14092	5364	1.30
Greengram	364	343	950	2028	1998	1.48	14752	8572	1.58
Sesame	299	285	660	2379	2973	1.23	14681	12679	1.86
Clusterbean	454	375	1132	1337	3260	1.62	14162	1213	1.08
PM + clusterbean	1103 + 260	1255 + 242	2510 + 750	2117	2894	5.42 + 1.04	8908 + 7081	12130	1.78
Ridge & furrow system									
Pearlmillet	2521	2790	5719	2790	2521	12.06	17817	22846	2.38
Blackgram	433	410	1127	2282	2655	1.77	14092	12148	1.86
Greengram	465	460	1288	2720	2583	1.98	14752	16528	2.12
Sesame	360	395	1047	3297	3535	1.71	14681	23239	2.58
Clusterbean	584	545	1690	1943	4152	2.35	14162	8183	1.58
PM + clusterbean	1392 + 321	1730 + 325	3892 + 897	2889	3620	7.48+ 1.40	8908 + 7081	23069	2.52

At Agra, in an experiment on evaluation of mustard varieties under different sowing dates, among the sowing dates, sowing in 2nd week of October produced significantly higher yield by 44.7 and 80.7% as compared to the yield recorded with sowing in 4th week of October and 1St week of November, respectively. Mustard sown in 3rd week of October also produced significantly higher yield by 24.3 and 55.2%, respectively over than yield recorded with sowing in 4th week of October and sowing in 1st week of November. The highest net returns (Rs.26671/ha) and B:C ratio (2.46) was also recorded with sowing in 2nd week of October. Among mustard varieties, no significant difference were observed in seed yield (814 - 882 kg/ha). Bio-902 variety recorded higher net returns (Rs.18112/ha) and B:C ratio (2.0) compared to other varieties (Table 3.188).

Table 3.188: Yield and economics of mustard as affected by sowing time and varietyies - Agra

Treatment	Yield (kg/ha)			Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Mean of 2 years	Seed (2014-15)	Stalk				
Sowing time							
2nd week of October	1595	1090	5189	18173	26671	2.46	4.56
3rd week of October	1444	936	4491	18973	19588	2.03	4.12
4th week of October	1234	753	3646	18973	12098	1.64	3.44
1St week of November	1133	603	2866	18973	5828	1.31	2.92
CD at 5%	155.47	96.04	527.69	-	-	-	-
Variety							
NRCBH-101	1363	872	4183	18173	17750	1.98	3.88
Laxmi	1327	816	3906	18173	15430	1.85	3.70
Rohini	1324	814	3908	18173	15365	1.85	3.85
Bio-902	1400	882	4198	18173	18112	2.00	4.11
Urvashi	1343	844	4042	18173	16586	1.91	3.89
CD at 5%	NS	NS	NS	-	-	-	-

At Agra, seed yield of pearlmillet was significantly influenced by foliar application of nutrients. Foliar application of nutrients was done at vegetative growth stage during 1st dry spell on 22nd Aug at leaf curling stage. The maximum seed yield of 3167 kg/ha was registered with foliar spray of 2% urea + 2% KNO_3 which was significantly superior over all other treatments except foliar spray of 2% KNO_3 and foliar spray of 2% KCl being at par to each other. Highest rainwater use efficiency of 14.00 kg/ha-mm was recorded with foliar spray of 2% urea + 2% KNO_3 with net returns of Rs.26832/ha and B:C ratio of 2.34 (Table 3.189).

Table 3.189: Yield and economics of pearlmillet as influenced by foliar nutrition - Agra

Treatment	Yield (kg/ha)		Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Grain	Stover				
Absolute control	1845	4567	15184	12884	1.85	8.17
RDF (60:40:40 NPK kg/ha)	2489	5575	18950	18036	1.95	11.0
Water spray	2500	5604	19100	19091	2.00	11.05
Foliar spray of 1% water soluble fertilizer (19:19:19 NPK)	2667	6054	19340	21843	2.13	11.79
Foliar spray of 2% urea	2695	5814	19180	24745	2.29	11.91
Foliar spray of 2% KNO_3	3067	7115	19820	23114	2.17	13.56
Foliar spray of 2% KCl	2889	6586	19304	20358	2.05	12.77
Foliar spray of 2% urea + 2% KNO_3	3167	7774	19990	26832	2.34	14.00
CD at 5%	396.6	1065.9	-	-	-	-

Pearlmillet wihout foliar spray

Pearlmillet after foliar spray (2% urea + 2% KNO_3)

At Agra, combined application of 100% N & P + K with 2% NPK spray was found to be effective in increasing the seed yield of mustard (1245 kg/ha) as compared to other treatments. The highest net returns (Rs.31498/ha), B:C ratio (2.57) and RWUE (5.47 kg/ha-mm) were also recorded with 100% N & P + 75 kg K and foliar spray of 2% NPK compared to other treatments (Table 3.190).

Table 3.190: Effect of various fertility treatments on grain yield and economics of mustard - Agra

Treatment	Yield (kg/ha)		Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Seed	Stalk				
T_1: Control	648	3279	15540	11410	1.73	3.09
T_2: 100% RDF (60:40:40 kg/ha NPK)	1015	4824	19406	22340	2.15	4.66
T_3: 100% N & P + 75 kg K on basal dose	1130	5447	20297	26299	2.29	5.11
T_4 : 100% N & P + 50 kg K on basal dose	1146	5569	19589	27728	2.41	5.09
T_5: T_3 + 2% KCl spray before flowering	1172	5719	20651	27775	2.34	5.19
T_6: T_4 + 2% KCl spray before flowering	1189	5826	19943	29222	2.46	5.26
T_7: T_3 + 2% NPK spray (19:19:19) at siliqua formation	1210	5953	20727	29342	2.41	5.33
T_8: T_4 + 2.0% NPK spray (19:19:19) at siliqua formation	1245	6125	20019	31498	2.57	5.47
CD at 5%	212	1239	-	-	-	-

3.3.2.3 Nutrient management

At Agra, in a study on INM in pearlmillet, the highest grain yield of 3103 kg/ha was registered with 50% RDN through FYM + 50% N through inorganic fertilizer. Similarly, higher net returns of Rs.27337/ha, B:C ratio of 2.48 and RWUE of 13.41 kg/ha-mm. Application of recommended fertilizers + $ZnSO_4$ at 25 kg/ha was the next best treatment (Table 3.191).

Table 3.191: Yield and economics of pearlmillet as influenced by intigrated nutrient management - Agra

Treatment	Yield (kg/ha)			Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Grain		Stover				
	2014	Mean (6 yrs)					
Control	890	1350	2100	15184	(-) 1799	0.88	3.85
RDF(60 kg N + 40 kg P_2O_5/ha)	2825	2392	5904	17817	23256	2.32	12.21
50% RDF	1884	2135	4220	16501	11495	1.69	8.14

Treatment	Yield (kg/ha)			Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Grain		Stover				
	2014	Mean (6 yrs)					
50% RDN through farm reside	1932	2132	4444	16984	11900	1.70	8.35
50% RDN meet through FYM	2005	2207	4692	17084	13011	1.76	8.66
50% RDN through fertilizer + 50% RDN through farm residue	3015	2893	6452	18301	26049	2.42	13.03
50% RDN through fertilizer + 50% RDN through FYM	3103	3116	6702	18401	27337	2.48	13.41
RDF + zinc as soil application (25 kg $ZnSO_4$/ha)	3065	3009	6498	19442	25552	2.31	13.24
Farmers' method (15 kg N/ha)	1408	1681	3407	15351	5,951	1.39	6.08
CD at 5%	390	407	1037	-	-	-	-

At Agra, in a study on nutrient management in mustard, addition of K, Zn, B and S in conjunction with RDF resulted in significantly higher grain yield as compared to yield recorded with recommended package of practice. The plot receiving 75 kg N + 50 kg P_2O_5 + 50 kg K_2O along with zinc @ 25 kg, Boron @ 5 kg and sulphur @ 25 kg/ha produced significantly highest yield (1225 kg/ha) which was 92.9, 25.6 and 13.2% more than the yield recorded in control (635 kg/ha). Application of 25% more RDF along with sulphur application gave highest net returns (Rs. 29646/ha), B:C ratio (2.46) and RWUE (5.26 kg/ha-mm). Pooled analysis of data showed that 25% higher RDF with boron @ 5 kg/ha recorded highest mean yield (2810 kg/ha) (Table 3.192).

Table 3.192: Effect of nutrient management on yield and economics of mustard - Agra

Treatment	Yield kg/ha			Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Seed		Stalk				
	2014-15	Mean (3 yrs)					
T_1: Control (no fertilizer)	635	887	3226	15,540	10,889	1.70	3.02
T_2: RDF (60 kg N + 40 kg P_2O_5/ha)	975	1655	4600	18,173	21,877	2.20	4.46
T_3: 25% more than RDF (75 kg N + 50 kg P_2O_5 + 50 kg K_2O/ha) (Soil test based)	1150	1855	5543	20,248	27,166	2.34	5.13
T_4: T_3 + Zn	1175	1893	5687	21,873	26,607	2.22	5.14
T_5: T_3 + B	1160	2810	5591	21,948	25,878	2.18	5.09
T_6: T_3 + S	1208	1959	5907	20,286	29,646	2.46	5.26
T_7: T_3 + Zn + B + S	1225	1990	6015	23,611	27,061	2.15	5.25
T_8: T_2 + K	1082	1809	5204	19,406	25,188	2.30	4.74
CD at 5%	245	300	1197	-	-	-	-

At SK Nagar, in a permanent manurial trial on pearlmillet/clusterbean/castor rotation, application of 50% RDN through chemical fertilizers + 50% RDN through castor cake + seed inoculation with *Azotobactor* (Azo 8) + PSB registered significantly higher castor seed and stalk yield (1008 and 1266 kg/ha), respectively, with net returns of Rs.23239/ha, B:C ratio of 2.53 and RWUE 0.93 kg/ha-mm under 50% RDN through chemical fertilizers (TD) + 50% RDN through castor cake + *Azotobactor* (*Azo* 8) + PSB compared to other treatments. However, it was found on par with 50% RDN through chemical fertilizers (TD) + 50% RDN through vermicompost + seed inoculation with *Azotobactor* (*Azo* 8) + PSB (Table 3.193).

Table 3.193: Permanent manurial trial effect on yield and economics of castor - SK Nagar

Treatment	Yield (kg/ha)		Mean seed yield (kg/ha)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Seed	Stalk					
100% RDN through chemical fertilizer (50% RDN as basal + 50% RDN at 30-40 DAS TD)	642	822	619	11360	13139	2.16	0.59
50% RDN through chemical fertilizers (TD) + 50% RDN through FYM	713	859	704	19951	7226	1.36	0.66
50% RDN through chemical fertilizers (TD) + 50% RDN through castor cake	912	1157	855	15042	19718	2.31	0.84
50% RDN through chemical fertilizers (TD) + 50% RDN through vermicompost	806	999	699	20951	9763	1.47	0.74
50% RDN through chemical fertilizers (TD) + 25% RDN through FYM + *Azotobactor* (Azo 8) + PSB	736	872	711	15601	12418	1.80	0.68
50% RDN through chemical fertilizers (TD) + 50% RDN through castor cake + *Azotobactor* (Azo 8) + PSB	1008	1266	941	15192	23239	2.53	0.93
50% RDN through chemical fertilizers (TD) + 50% RDN through vermicompost + *Azotobactor* (Azo 8) + PSB	855	1031	718	21101	11490	1.54	0.79
CD at 5%	163	233	-	-	-	-	-

TD: Top dressing

In a long term manurial trial on pearlmillet/clusterbean/caster rotation at SK Nagar, higher values of available N (159 kg/ha), P_2O_5 (34.46 kg/ha) and K_2O (189 kg/ha) in soil at harvest were recorded with 50% RDN through chemical fertilizers (TD) + 50% RDN through vermicompost + seed inoculation with *Azotobactor* (Azo 8) + PSB, but these values were at par with rest of all treatments except 100% RDN through chemical fertilizers (50% RDN as basal + 50% RDN at 30-40 DAS (TD). Organic carbon (%) was significantly increased due to application of 50% RDN through chemical fertilizers (TD) + 50% RDN through FYM compared to rest of the treatments except 50% RDN through chemical fertilizers (TD) + 50% RDN through vermicompost (Table 3.194).

Table 3.194: Permanent manurial trial effect on soil properties - SK Nagar

Treatment	Organic carbon (%)	Available soil nutrients (kg/ha)		
		N	P_2O_5	K_2O
100% RDN through chemical fertilizer (50% RDN as basal + 50% RDN at 30-40 DAS TD)	0.254	134	26.71	157
50% RDN through chemical fertilizers (TD) + 50% RDN through FYM	0.327	145	30.54	180
50% RDN through chemical fertilizers (TD) + 50% RDN through castor cake	0.296	150	28.27	177
50% RDN through chemical fertilizers (TD) + 50% RDN through vermicompost	0.317	153	30.25	184
50% RDN through chemical fertilizers (TD) + 25% RDN through FYM + *Azotobactor* (Azo 8) + PSB	0.297	156	30.79	184
50% RDN through chemical fertilizers (TD) + 50% RDN through castor cake + *Azotobactor* (Azo 8) + PSB	0.287	155	30.93	186
50% RDN through chemical fertilizers (TD) + 50% RDN through vermicompost + *Azotobactor* (Azo 8) + PSB	0.307	159	34.46	189
CD at 5%	0.021	13.4	4.22	18.9

At SK Nagar, in a study on the effect of foliar application of nutrients on maize, significantly higher grain and stalk yield (1394 and 3815 kg/ha) were recorded due to $ZnSO_4$ spray @ 0.5% + $FeSO_4$ spray @ 0.5%, with higher net returns (Rs.18626/ha) B: C ratio (3.44) and RWUE (2.07 kg/ha-mm) compared to other treatments, except $ZnSO_4$ spray @ 0.5% and $ZnSO_4$ spray @ 1.0%. There was no significant effect of different treatments on soil moisture after harvest of the crop (Table 3.195).

Title 3.195: Effect of foliar nutrition on yield of maize - SK Nagar

Treatment	Yield (kg/ha)			Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)	Soil moisture (%)
	Grain	Stalk	Mean (yrs)					
Water spray	948	2099	836	7310	9314	2.27	1.40	4.32
$ZnSO_4$ spray @ 0.5%	1268	3506	1072	7435	16546	3.23	1.88	4.54
$ZnSO_4$ spray @ 1.0%	1370	3702	1122	7560	18135	3.40	2.03	4.48
$FeSO_4$ spray @ 0.5% + citric acid @ 0.05%	1167	3163	1028	7560	14352	2.90	1.73	4.44
$FeSO_4$ spray @ 1.0% + citric acid @ 0.05%	1181	2939	1056	7910	13610	2.72	1.75	4.48
$ZnSO_4$ spray @ 0.5% + $FeSO_4$ spray @ 0.5%	1394	3815	1187	7640	18626	3.44	2.07	4.42
Urea spray @ 1.5%	1161	2917	1026	7635	13590	2.78	1.72	4.40
Ammonium sulphate spray @ 1.0%	157	2578	1043	7550	12779	2.69	1.71	4.38
CD at 5%	200	616	-	-	-	-	-	NS

The foliar application of different nutrients had no significant effect on the available N, P_2O_5 and K_2O status of soil. However, Fe and Zn content in soil were affected significantly due to foliar spray of plant nutrients. $FeSO_4$ spray @ 0.5% + citric acid @ 0.05% and $ZnSO_4$ spray @ 1.0% recorded highest Fe (5.53 ppm) and Zn (0.48 ppm) contents in soil at harvest (Table 3.196).

Table 3.196: Effect of foliar nutrient content in soil after maize harvest - SK Nagar

Treatment	Available nutrients (kg/ha)			Available nutrients (ppm)	
	N	P_2O_5	K_2O	Fe	Zn
Water spray	163	26.90	193	4.75	0.35
$ZnSO_4$ spray @ 0.5%	167	30.19	204	4.88	0.45
$ZnSO_4$ spray @ 1.0%	167	29.85	202	4.92	0.48
$FeSO_4$ spray @ 0.5%	175	31.60	209	5.33	0.43
$FeSO_4$ spray @ 0.5% + citric acid @ 0.05%	178	32.55	213	5.53	0.47
$ZnSO_4$ spray @ 0.5% + $FeSO_4$ spray @ 0.5%	176	31.93	206	5.14	0.43
Urea spray @ 1.5%	177	33.21	216	4.90	0.43
Ammonium sulphate spray @ 1.0%	174	33.82	212	4.93	0.42
CD at 5%	NS	NS	NS	0.35	0.04

In a study on effect of foliar and soil application of micro-nutrients on sorghum at SK Nagar, In pooled results, the application of 7.5 kg $ZnSO_4$/ha as soil application along with three sprays of $ZnSO_4$ @ 0.5% recorded the highest grain and straw yield of sorghum (754 and 6846 kg/ha), with net returns (Rs.31753/ha), B:C ratio (4.86) and RWUE (1.01 kg/ha-mm) which was significantly superior compared to other treatments. Same trend was observed during 2010, 2013 and 2014 (Table 3.197).

Table 3.197: Effect of foliar and soil application of micronutrients on yield of sorghum - SK Nagar

Treatment	Yield (kg/ha)				Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	2014-15		Mean(2010-14)					
	Grain	Straw	Grain	Straw				
Three water sprays	471	4602	571	4709	7850	17696	3.25	0.64
Three foliar sprays of $FeSO_4$ @ 0.5% + citric acid @ 0.05%	527	4826	707	5637	8210	22842	3.78	0.80
Three foliar sprays of $ZnSO_4$ @ 0.5%	555	5028	721	5829	7970	23936	4.00	0.81
Three foliar sprays of $FeSO_4$ @ 0.5% + $ZnSO_4$@ 0.5% + citric acid @ 0.05%	563	5118	746	5816	8330	24039	3.89	0.84
12.5 kg $FeSO_4$/ha as soil application	569	5189	735	5875	8088	24236	4.00	0.83
7.5 kg $ZnSO_4$/ha as soil application	623	5836	774	6224	7800	26353	4.38	0.87
12.5 kg $FeSO_4$/ha as soil application + three sprays of $FeSO_4$ @ 0.5%	558	5095	780	6237	8598	25714	3.99	0.88
7.5 kg $ZnSO_4$/ha as soil application + three sprays of $ZnSO_4$ @ 0.5%	754	6846	900	7324	8220	31753	4.86	1.01
CD at 5%	120.6	1129.8	86.2	569	-	-	-	-

At SK Nagar, in a study on nutrient management in greengram, application of 100% RDN through vermicompost registered significantly higher seed (1151 kg/ha) and stalk yield (1413 kg/ha) with higher net returns (Rs. 40882/ha) and RWUE (1.85 kg/ha-mm) compared to other treatments except 100% RDF through FYM. Significantly lowest yield was recorded under control (no fertilizer) but higher B:C ratio was observed in control due to less cost of cultivation (Table 3.198).

Table 3.198: Effect of nutrient management on yield and economics of greengram - SK Nagar

Treatment	Yield (kg/ha)			Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Seed	Stalk	Mean				
Control (no fertilizer)	688	954	404	7010	25371	3.62	1.10
RDN through chemical fertilizer	821	1142	527	9195	30268	3.29	1.35
RDN through FYM	1072	1381	596	13010	37289	2.87	1.72
RDN through vermicompost	1151	1413	627	13010	40882	3.14	1.85
CD at 5%	126	227	-	-	-	-	-

At SK Nagar, in a study on nutrient management in sesame, application of 100% RDN through vermicompost registered significantly higher seed yield (419 kg/ha) and RWUE (0.67 kg/ha-mm) compared to other treatments except 100% RDN through FYM. The net returns were higher (Rs. 3525/ha) with RDN through chemical fertilizer. Compared to other treatments whereas B:C ratio was highest (4.87) with control (Table 3.199).

Table 3.199: Effect of nutrient management on yield and economics of sesame - SK Nagar

Treatment	Yield (kg/ha)			Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Seed	Stalk	Mean (yrs)				
Control (no fertilizer)	296	411	187	6335	30861	4.87	0.48
RDN through chemical fertilizer	349	461	238	8637	35251	4.08	0.56
RDN through FYM	374	478	253	21335	25617	1.20	0.60
RDN through vermicompost	419	578	264	21335	31361	1.47	0.67
CD at 5%	53.28	80.94	-	-	-	-	-

At SK Nagar, significantly higher build up of available N (189 kg/ha) was recorded under 100% RDN through vermicompost whereas higher P_2O_5 (47.1 kg/ha) and K_2O (210 kg/ha) in soil were recorded with 100% RDN through FYM in greengram crop. In case of sesame, significantly higher build up of available N (170 kg/ha), and P_2O_5 (49.3 kg/ha) in soil were recorded under 100% RDN through FYM compared to other treatments except 100% RDN through vermicompost. Available K_2O was found non significant due to different treatments (Table 3.200).

Table 3.200: Effect of nutrient management on soil fertility status (kg/ha) after harvest of greengram and sesame - SK Nagar

Treatment	Greengram			Sesame		
	N	P_2O_5	K_2O	N	P_2O_5	K_2O
Control (no fertilizer)	155	38.2	169	148	45.1	165
RDN through chemical fertilizer	158	43.0	174	151	45.0	171
RDN through FYM	181	47.1	210	170	49.3	182
RDN through vermicompost	189	45.0	202	165	47.6	178
CD at 5%	13.0	3.79	14.6	12.9	2.40	NS
Initial	163	46.2	172	153	39.2	168

At SK Nagar, in a study on nutrient management in castor, the seed and stalk yield of castor were significantly affected due to different manurial treatments. Application of 50% RDN-urea along with 50% RDN-FYM recorded significantly higher seed yield (1229 kg/ha) and stalk yield (873 kg/ha) with higher net returns (Rs.10761/ha), B:C ratio (3.42) and RWUE (0.32 kg/ha-mm). Significantly higher moisture content (2.15%) and water holding capacity (25.08%) were recorded under 50% RDN-urea along with 50% RDN-FYM over rest of the treatments. Significantly higher values of available N (155 kg/ha), P_2O_5 (57.1 kg/ha) and K_2O (227 kg/ha) in soil were recorded due to application of 50% RDN-FYM along with 50% RDN–urea over rest of the treatments except 100% RDN through urea in case of available N in soil. The maximum net returns (Rs. 35326/ha) and B:C (5.34) were recorded with 50% RDN-urea along with 50% RDN-FYM (Table 3.201 a & b).

Table 3.201a. Effect of nutrient management on yield and economics of castor - SK Nagar

Treatment	Yield(kg/ha)			Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Seed	Stalk	Mean (yrs)				
Control (T_1)	674	478	557	4000	1850	1.46	0.12
100% RDN – fertilizer (T_2)	1029	731	827	4222	7470	2.77	0.24
50% RDN – fertilizers (T_3)	907	644	748	4111	5786	2.41	0.21
50% RDN–FYM (T_4)	960	682	815	4333	8637	2.99	0.27
$T_3 + T_4$	1229	873	1016	4444	10761	3.42	0.32
Farmers method	811	576	670	4000	6196	2.55	0.21
CD at 5%	181.3	128.7					

Table 3.201b. Effect of nutrient management on physico-chemical properties of soil after castor - SK Nagar

Treatment	Moisture (%)	Bulk density (Mg/m^3)	Max. water holding Cap. (%)	Available nutrients (kg/ha)		
				N	P_2O_5	K_2O
Control (T_1)	-	-	20.50	108	37.4	168
100% RDN – fertilizer (T_2)	-	-	22.40	150	44.5	189
50% RDN – fertilizers (T_3)	1.61	1.71	22.44	132	42.5	187
50% RDN–FYM (T_4)	1.96	1.66	24.73	140	48.9	201
$T_3 + T_4$	2.15	1.64	25.08	155	57.1	227
Farmers' method	1.89	1.67	22.68	119	44.0	195
CD at 5%	0.11	NS	1.97	13.57	6.25	21.57

3.3.2.4 Energy management

At Agra, in a study on the effect of tillage and sowing implements on pearlmillet MB plough was found superior with highest grain yield of 2829 kg/ha. The mean increase yield of pearlmillet due to MB plough was 47.11, 29.71 and 3.06% as compared to other implements, with net returns of Rs.22391/ha, B:C ratio of 2.20 and RWUE of 12.51 kg/ha-mm. Disc plough was also affective and gave next to best B:C ratio of 2.13. Among different sowing implements, raised bed planter and ridger seeder gave similar but significantly higher yield (2783-2862 kg/ha) compared to other implements (Table 3.202).

Table 3.202: Yield and economics of pearlmillet as affected by tillage and sowing implements - Agra

Treatment	Grain yield (kg/ha)		Stover yield (kg/ha)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	2014	Mean (3 yrs)					
Tillage implement							
Cultivator	1923	2085	3413	17711	9523	1.53	8.50
Harrow	2181	2210	4041	17816	13327	1.74	9.64
Disc plough	2745	2503	5270	18446	21026	2.13	12.13
MB plough	2829	2638	5676	18656	22391	2.20	12.51
CD at 5%	291	-	765	-	-	-	-
Sowing implement							
Broadcasting	1773	1797	3181	17134	9523	1.46	7.83
Seed drill	2260	2303	4096	17816	13327	1.80	9.99
Ridger seeder	2783	2656	5398	18026	21026	2.22	12.30
Raised bed planter	2862	2680	5725	18236	22391	2.27	12.65
CD at 5%	148	-	437	-	-	-	-

Ridger seeder

Raised bed planter

Seed drill

Sowing of pearlmillet with different implements

Ridger seeder

Raised bed planter

Broadcasting

Performance of pearlmillet under different sowing methods

In the study on the effect of sowing implements on pearlmillet at Agra, the energy use pattern showed that tillage by mould broad plough consumed more energy (10946 MJ/ha) and cultivator consumed lesser energy (10165 MJ/ha). The highest energy use efficiency and energy productivity of 13.13 and 0.258 kg/MJ was obtained with MB plough followed by disc plough (12.66 and 0.256 kg/MJ). The energy use by sowing implements varied from 10140 to 10741 MJ/ha and the highest was with sowing by raised bed planter (10741MJ/ha) and lowest value of (10140 MJ/ha) was with broadcasting method (Table 3.203).

Table 3.203: Energy use efficiency and energy productivity as influenced by tillage implements and sowing methods - Agra

Treatment	Input energy (MJ/ha)	Output energy (MJ/ha)	Energy use efficiency	Energy productivity (kg/MJ)
Tillage implement				
Cultivator	10165.50	89715.17	8.82	0.189
Harrow	10220.86	104817.64	10.25	0.213
Disc plough	10681.86	135221.84	12.66	0.256
MB plough	10946.51	143769.02	13.13	0.258
Sowing implement				
Broadcasting	10140.58	83335.82	8.21	0.174
Seed drill	10412.56	106967.29	10.27	0.217
Ridger seeder	10719.44	138086.09	12.88	0.259
Raised bed planter	10741.97	145134.47	13.51	0.266

At SK Nagar, in a study on different tillage practices in clusterbean, the highest seed yield of clusterbean (468 kg/ha) with net returns (Rs.15534/ha), B:C ratio (4.09) and RWUE (0.75 kg/ha-mm) was recorded under treatment roto till drill. It was at par with strip till drill (420.6 kg/ha) and raised bed planter (406.9 kg /ha) but significantly superior to zero till drill (381.3 kg /ha) and control. The stalk yield of the clusterbean was also highest under treatment roto till drill (406 kg/ha) compared to other treatments (Table 3.204).

Table 3.204: Effect of treatments on yield and economics of clusterbean - SK Nagar

Treatment	Seed yield (kg/ha) (2014)	Mean seed yield (5 yrs)	Stalk yield kg/ha	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
Zero till drill	381	319	388.8	3500	12333	3.52	0.61
Strip till drill	420	386	393.8	3800	13616	3.58	0.68
Roto till drill	468	456	406.3	3800	15534	4.09	0.75
Raised bed planter	406	292	387.5	4500	12356	2.75	0.65
Control (Farmers' practice)	334	268	387.5	4100	9831.3	2.40	0.54
CD at 5%	72	-	NS	-	-	-	-

3.3.2.5 Evaluation of improved varieties

In an evaluation of pearlmillet hybrids at Agra, out of 13 entries of sesame and 01 local check, only 10 were successfully harvested. Entries IAVT-14-5, IAVT-14-8, IAVT-14-12, and IAVT-14-13 failed to produce seed. Local check produced significantly higher seed yield (328 kg/ha), with net returns of Rs.16807/ha, B:C ratio of 2.14 and RWUE of 1.45 kg/ha-mm as compared to all other except IAVT-14-2 and IAVT-14-3 (Table 3.205).

Table 3.205: Evaluation of sesame genotypes for productivity and profitability - Agra

Genotype	Seed yield (kg/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
IAVT-14-1	265	10759	1.73	1.17
IAVT-14-2	316	15655	2.07	1.40
IAVT-14-3	303	14407	1.98	1.34
IAVT-14-4	273	11527	1.79	1.21
IAVT-14-6	239	8263	1.56	1.06
IAVT-14-7	269	11143	1.76	1.19
IAVT-14-9	266	10855	1.74	1.18
IAVT-14-10	229	7303	1.50	1.01
IAVT-14-11	272	11431	1.78	1.20
Local check	328	16807	2.14	1.45
CD at 5%	30			

Cost of cultivation: Rs.14681/ha

In a trial on evaluation of pearlmillet hybrids at SK Nagar, GHB-905 performed better and gave higher grain yield of 1199 kg/ha, stover yield of 5578 kg/ha, net returns of Rs. 20833/ha, B:C ratio of 3.78 and RWUE of 1.11 kg/ha-mm compared to other hybrids followed by GHB 744 with grain and straw yield of 1194 and 5486 kg/ha, respectively (Table 3.206)

Table 3.206: Performance of different hybrids of pearlmillet - SK Nagar

Hybrid	Yield (kg/ha)		NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Grain	Stover			
JPP 1	626	2847	7130	1.95	0.58
JPP 2	930	3171	11588	2.55	0.86
JPP 3	839	3634	11653	2.55	0.77
JPP 4	927	3125	11437	2.52	0.86
JPP 5	873	4028	13046	2.74	0.81
JPP 6	918	4166	13931	2.86	0.85
GHB 538	1193	3287	15034	3.00	1.10
GHB 744	1194	5486	20543	3.74	1.10
GHB 905	1199	5578	20833	3.78	1.11

Cost of cultivation: Rs.7500/ha

3.3.2.6 Integrated farming system

At SK Nagar, in a on-farm participatory integrated farming system, all the intercropping systems gave higher net returns over traditional sole crop system. Among the different intercropping systems, castor + greengram recorded the highest net return of (Rs. 46990/ha) followed by castor + cowpea (Rs.38627/ha) which were 123 and 81% higher, respectively over farmer's traditional practice of maize. The results also showed that the farmer got additional net income of Rs. 75805/ha from livestock component in integrated farming system (Tables 3.207 a & b).

Table 3.207a. Yield of different crops and their economics - SK Nagar

Cropping system	Yield of main crop (kg/ha)		Yield of intercrop (kg/ha)		Mean grain/ seed yield (kg/ha) (5 yrs)		Cost of cultivation (Rs/ha)	NMR (Rs/ha)	% over increase farmer's practice
	Grain/ seed	Straw/ stalk	Grain	Straw /stalk	Main crop	Intercrop			
Pearlmillet + karingdo	1055	3750	188	680	791	127	10245	21645	7.8
Castor + cowpea	1150	1380	275	485	695	248	14380	38687	81.0
Maize + cowpea	1225	4500	230	430	813	247	10350	25580	15.3
Castor + greengram	1225	1865	325	710	692	245	15570	46990	122.7
Sorghum + karingdo	-	9850	140	480	-	119	9100	26990	22.4
Farmers' practice (maize)	1290	4450	-	-	990	1024	8980	19947	-

Table 3.207b: Income from livestock and poultry unit - SK Nagar

Livestock	Production				Income (Rs/ha)				Gross income (Rs/ha)	Cost of production (Rs/ha)
	Milk (litres)	Meat (kg)	Eggs (No.)	FYM (kg)	Milk	Meat	Eggs	FYM		
Cow (1)	1150	-	-	1000	29900	-	-	2100	32000	17602
Buffalo (1)	2350	-	-	2000	103400	-	-	3300	106700	58338
Goat (11)	2150	75	-	1000	49450	27000	-	1800	78250	39127
Cock (1)	-	-	-	-	-	-	-	-	-	211.23
Hen (10)	-	-	950	-	-	-	2850	-	2850	1056.1
Bullock (2)	-	-	-	-	-	-	-	-	-	27660
Total gross income					219800					
Net returns from livestock system					75805					

3.3.3 Fingermillet Based Production System

3.3.3.1 Rainwater management

In a field experiment on evaluation of different polymers in fingermillet at Bengaluru, grain and straw yield of fingermillet with different levels of polymers were statistically at par among different levels and control. Higher levels (50 & 75 kg/ha) of the polymers recorded negative net returns, due to higher cost of polymers (Table 3.208).

Table 3.208: Effect of polymers on yield, economics and rainwater use efficiency in fingermillet – Bengaluru

Treatment	Grain yield (kg/ha)	Straw yield (kg/ha)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)	Soil moisture content (%)
Control	2992	5619	23816	55209	3.32	4.66	11.86
Polymer aquasorb @ 25 kg/ha	3002	5650	68816	10390	1.15	4.67	12.16
Polymer aquasorb @ 50 kg/ha	3011	5666	113816	-34282	0.70	4.69	13.03
Polymer aquasorb @ 75 kg/ha	3119	5846	158816	-76464	0.52	4.85	12.91
Polymer aquapod @ 25 kg/ha	3008	5682	33216	46251	2.39	4.68	12.86
Polymer aquapod @ 50 kg/ha	3100	5871	42616	39281	1.92	4.83	13.03
Polymer aquapod @ 75 kg/ha	3220	6045	52016	33010	1.63	5.01	11.99
CD at 5%	NS	NS					NS

Similarly, in another field experiment, the grain and straw yield of fingermillet under long term use of polymers was on par during the first year of study. The net returns were higher with control (Rs.57955/ha) compared to treatments involving polymers due to high cost of polymers and no significant increase in grain yield (Table 3.209).

Table 3.209: Long-term effect of polymers on yield, economics and rainwater use efficiency of fingermillet – Bengaluru

Treatment	Grain yield (kg/ha)	Straw yield (kg/ha)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)	Soil moisture (%) at tillering stage
Polymer aquasorb once in 2 years	3134	5919	80066	2735	1.03	4.88	13.19
Polymer aquasorb once in 3 years	3182	6020	61316	22744	1.37	4.95	12.29
Polymer aquasorb once in 4 years	3134	5893	51941	30841	1.59	4.88	10.65
Polymer aquasorb once in 5 years	3166	5950	46316	37297	1.81	4.93	11.31
Polymer aquapod once in 2 years	3232	6086	35566	49806	2.40	5.03	13.33
Polymer aquapod once in 3 years	3270	6128	31649	54702	2.73	5.09	12.43
Polymer aquapod once in 4 years	3229	6061	29691	55584	2.87	5.03	11.16
Polymer aquapod once in 5 years	3258	6111	28516	57507	3.02	5.07	12.61
Control	3097	5808	23816	57955	3.43	4.82	13.39
CD at 5%	NS	NS	-				-

In an experiment on recharging of borewells using runoff water, discharge rate of a bore-well from August 2014 to February 2015 data were recorded every 15 days intervals from the borewells located in National Seed Project, GKVK. After implementing recharge treatment, the discharge rate of bore well 1, 2 and 3 with filter bed was on an average of 3.9, 3.0 and 0.9 litre/sec, respectively throughout the year. During rainy season, the average discharge rate of bore well 1, 2 and 3 was 4.2, 3.0 and 0.8 litre/sec, respectively. During summer season the average discharge rate of bore well 1, 2 and 3 was 3.2, 3.0 and 1.2 litre/sec, respectively (Table 3.210 & Fig. 3.2).

Table 3.210: Recharging of bore wells by runoff water - Bengaluru

Particular	Borewell 1	Borewell 2	Borewell 3
Location		National Seed Project, GKVK	
Depth (ft)	850	750	600
Discharge at the time of installation (lt/sec)	0	1.6	0.4
HP of pump	5	5	5
Type of pump		Multi stage submersible	
Filter dimensions		Length: 3.00 m Width : 3.00 m Depth : 3.00 m	
Catchment (ha)	1.2	1.6	2.4

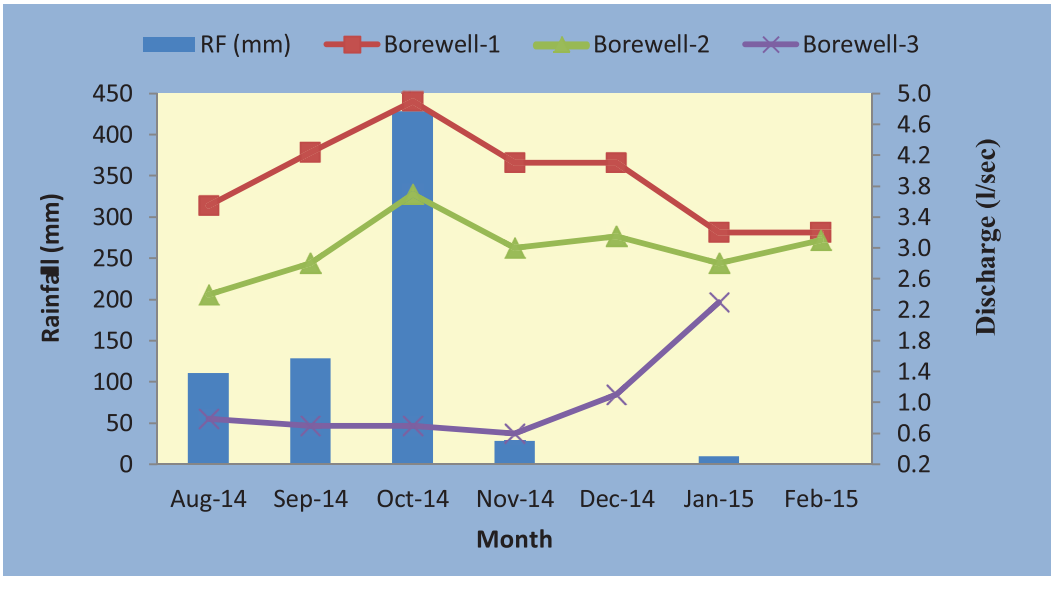


Fig. 3.2: Water discharge rate from recharged bore well-1, 2 and 3 - Bengaluru

At Bangalore, in a study on rainwater management in the existing three amla plots (3200 m^2), higher yield and net returns were recorded in trench–cum-crescent bund (16949 kg/ha) (T_1) followed by continuous trenches (15482 kg/ha) (T_2) and no trenches (13522 kg/ha) (T_3). In the year 2014, rainfall of 992.3 mm was received and 1, 2 and 5 runoff events were noticed in T_1, T_2 and T_3, respectively. Less runoff (mm), soil loss and nutrient losses were noticed under T_1 followed by T_2 and T_3. T_1 recorded higher average moisture content followed by T_2 and T_3 (Table 3.211 a &b).

Table 3.211a: Yield and economics of amla plants under different moisture conservation techniques - Bengaluru

Treatment	Yield (kg/ha)	Cost cultivation (Rs/ha)	NMR (Rs/ha)
Trench–cum-crescent bund	16949	7200	162290
Continuous trenches	15482	6000	148820
No trenches	13522	4000	131220

Table 3.211b: Runoff, soil loss and nutrient loss in relation to rainfall intensity in different conservation techniques - Bengaluru

Date	Rainfall (mm)	Runoff (m^3)	Soil loss (kg)	Total N loss (g/lt) x runoff (lt)	Total P loss (g/lt) x runoff (lt)	Total K loss (g/lt) x runoff (lt)
T_1: Trench–cum-crescent bund						
22.08.2014	33.4	0.09	0.86	0.2	2	4
T_2: Continuous trenches using deep trencher						
06.06.2014	43.8	0.29	3.4	1.0	10	13
22.08.2014	33.4	3.74	45.8	15.7	113	161
T_3: No trenches (control)						
06.06.2014	43.8	16.00	207.9	62.4	667	727
22.08.2014	33.4	4.60	59.7	17.5	181	208
23.09.2014	43.2	21.05	273.6	80.0	781	1027
23.10.2014	21.6	0.37	4.7	1.3	15	17
28.10.2014	55.2	14.11	183.4	49.4	614	673

Trench-cum-crescent bund in aonla plantation

At Bangalore, in a study on catchment-storage-command relationship for enhancing water productivity in micro–watershed, among the live barriers *Nase* plots recorded higher mean grain and straw yield of fingermillet (1231 and 2553 kg/ha, respectively) followed by *Khus* live barrier plots (1074 and 2206 kg/ha, respectively) as compared to control (903 and 1950 kg/ha, respectively). Trends were similar with respect of B: C ratio (1.13) and RWUE (1.52 kg/ha-mm) (Table 3.212).

Table 3.212: Fingermillet yield and economics as influenced by live barriers - Bengaluru

Treatment	Yield (kg/ha)			NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Grain	Mean grain yield (4 yrs)	Straw			
Khus grass upper	1025	1685	2156	1809	1.08	1.45
Lower	1123	1899	2256	4259	1.18	1.59
Mean	1074	1797	2206	3034	1.13	1.52
Nase grass upper	1096	1933	2256	3584	1.15	1.55
Lower	1365	2189	2850	10309	1.43	1.93
Mean	1231	2059	2553	6947	1.29	1.74
Control	903	1382	1950	-1241	0.95	1.27

In a study on evaluation of different lining materials, the total water loss per day was maximum with soil + cement (8:1) lining while the loss per unit volume was higher with stone powder + cement (8:1) lining (54.3 lt /m^3) followed by stone slab (45.5 lt /m^3). The loss per unit volume is minimum in bric lining (20.1 lt / m^3) (Table 3.213).

Table 3.213: Water loss from farm ponds with different lining materials - Bengaluru

Lining material	Average loss per day (lt)			Average water loss per cu. m (lt)		
	Total	Seepage	Evaporation	Total	Seepage	Evaporation
Stone powder + cement (8:1)	595.6	456.5	139.1	54.5	43.3	11.2
Soil + cement (8:1)	949.9	828.6	121.4	32.1	20.4	11.7
Brick lining	845.8	677.0	168.8	20.1	13.7	6.4
Brick (1 m^2) & soil + cement (8:1)	659.4	534.4	124.9	36.9	20.7	13.1
Stone slabs	520.3	430.7	89.6	40.5	30.8	9.6

The soil loss from farm ponds with different lining materials is shown in Table 3.214. The total soil loss per ha/year was maximum with soil + cement 8:1 lining while the loss (1716.1 kg/ha) followed by brick (1 m^2) & soil + cement (8:1) (1360.3 kg/ha) (Table 3.214).

Table 3.214: Soil loss from catchment area - Bengaluru

Lining material	Catchment area (ha)	Water harvested (m^3)	Overflow of water (m^3)	Total water harvested (m^3)	Soil loss (kg)	Soil loss (kg/m^2)
Soil + cement (8:1)	0.561	481.3	160.0	641.3	1716.1	0.30
Brick lining	0.612	340.5	198.0	538.5	Yet to analyse	
Brick (1 m^2) & soil + cement (8:1)	0.561	325.1	120.0	445.1	1360.3	0.24

Reduced runoff farming with an intervention of efficient use of natural resources and fulfilling the farm needs, different sub project crops were imposed in the catchment. In catchment area among different crops fodder maize followed by chickpea recorded higher finger millet equivalent yeild (FEY) (4540 kg/ha), net returns Rs.89684/ha) and B:C ratio (4.70) followed fingermillet + pigeonpea (8:2) (Table 3.215).

Table 3.215: Performance of cropping system grown in catchment area - Bengaluru

Treatment	Yield (kg/ha)		FEY (kg/ha)	NMR (Rs/ha)	B:C ratio	Soil moisture (%)	RWUE (kg/ha-mm)
	Main crop	Intercrop					
Pomello + fingermillet	1102	1020	2122	29243	2.33	13.37	3.00
Pigeonpea + cowpea (1:1) (*Khus* upper)	400	293	1275	8053	1.34	13.57	1.55
Pigeonpea + field bean (1:1) (*Khus* lower)	396	306	1294	8522	1.36	13.80	1.57
Fodder maize – chickpea (*Nase* upper)	Fodder maize - 57500 Chickpea - 350	-	4010	76434	4.20	Fodder maize - 13.30 Chickpea - 13.50	5.38
Fodder maize - chickpea (*Nase* lower)	Fodder maize - 65000 Chickpea - 400	-	4540	89684	4.70	Fodder maize - 13.93 Chickpea - 14.0	6.09
Fingermillet + pigeonpea (8:2)	2850	320	3490	63434	3.66	13.47	4.88
Aerobic rice	1325	-	1060	2684	1.11	17.03	1.39

At Bengaluru, in a study on efficient utilization of farm pond water for intensive and profitable crop production, the forage yield of giant bajra was significantly higher (32250 kg/ha) with main crop equivalent yield (37788 kg/ha), net returns (Rs. 41973/ha) and B:C ratio (1.95) followed by SA maize (22562 kg/ha). Significantly higher chickpea seed yield was recorded in early sown giant bajra (945 kg/ha) followed by South Africa maize

(849 kg/ha). Between the varieties of chickpea, JG-11 recorded significantly higher seed yield (866 kg/ha) as compared to Annigeri-1 (808 kg/ha). Chickpea receiving 100% RDF recorded significantly higher seed yield (884 kg/ha) compared to 75% of recommended dose of fertilizer (790 kg/ha). Higher system B:C ratio was obtained with giant bajra (1.95) followed by SA maize (1.22) under fodder and chickpea double cropping system. JG-11 recorded higher B:C ratio (1.34) as compared to Annigeri-1 (1.25) (Table 3.216).

Table 3.216: Double cropping of forage crops followed by chickpea with protective irrigation during dry spells utilizing farm pond water - Bengaluru

Treatment	Yield (kg/ha)		MCEY	System cost of cultivation (Rs/ha)	System net returns (Rs/ha)	System B:C ratio	RWUE (kg/ha-mm)	
	Crop 1	Crop 2					Crop 1	Crop 2
Forage crop (M)								
South African maize (SA Tall)	22562	849	33965	46435	10092	1.22	108	3.40
Sweet sorghum (SSV-74)	2058	718	28704	41929	-10138	0.76	10	2.87
Giant bajra	32250	945	37788	44190	41973	1.95	154	3.78
CD at 5%		86.73	3469					
Chickpea variety (V)								
Annigeri-1		808	32319	23845	6050	1.25	-	3.23
JG-11		866	34652	23845	8208	1.34	-	3.47
CD at 5%		52.38	2095.3					
Fertilizer (F)								
100% RDF		884	-	25863	6857	1.27	-	3.54
75% RDF		790	-	24994	4234	1.17	-	3.16
CD at 5%		85.73	3429.4					

MCEY: Main crop equivalent yield

3.3.3.2 Cropping systems

At Bengaluru, in a study on the performance of intercrops in nipped castor, castor equivalent yield (CEY) varied significantly due to intercropping. Castor + fingermillet recorded significantly higher CEY (2135 kg/ha) with higher net returns of Rs. 60377/ha, B:C ratio of 3.41 and RWUE of 2.73 kg/ha-mm as compared to all other treatments. This was followed by sole fingermillet (1872 kg/ha). Significantly lower CEY was recorded with sole chilli (635 kg/ha). Castor + fingermillet recorded higher land equivalent ratio (LER) (1.43) followed by castor + clusterbean (1.41), castor + cowpea (1.38) and castor + chilli (1.35) (Table 3.217a & b).

Table 3.217a: Productive performance of intercrops in nipped castor - Bengaluru

Treatment	Mean yield (kg/ha)		CEY (kg/ha)	LER	MAI	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Castor	Intercrop							
Castor + fingermillet (1:2)	915	1952	2135	1.43	18263	25008	60377	3.41	2.73
Castor + chilli (1:1)	1090	535	1357	1.35	5994	30757	23540	1.77	1.73
Castor + cowpea (1:1)	971	530	1634	1.38	10836	25028	40334	2.61	2.17
Castor + cluster bean (1:2)	1129	782	1520	1.41	8755	26258	34530	2.32	2.18
Castor + field bean (1:1)	1071	355	1515	1.22	5929	27158	33442	2.23	2.01
Castor + grain amaranth (1:1)	1031	195	1324	1.22	4958	25758	27199	2.06	2.44

Treatment	Mean yield (kg/ha)		CEY (kg/ha)	LER	MAI	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Castor	Intercrop							
Castor	1179	-	1179	-	-	24757	22415	1.91	1.49
Fingermillet	-	2996	1872	-	-	23879	51018	3.14	2.39
Chilli	-	1270	635	-	-	31966	-6569	0.79	0.81
Cowpea	-	952	1190	-	-	22676	24943	2.10	1.58
Clusterbean	-	1728	864	-	-	25952	8616	1.33	1.24
Field bean	-	1182	1477	-	-	26852	32231	2.20	1.96
Grain amaranth	-	626	938	-	-	29755	7776	1.26	1.73
CD at 5%	158.43	-	258.46	0.15	-	30757	23540	1.77	1.73

Castor + fingermillet (1:2)

Castor + grain amaranth (1:1)

Table 3.217b: Pooled mean (2009-14) of castorbean equivalent yield (CEY) in nipped castor - Bengaluru

Treatment	CEY (kg/ha)	LER	RWUE (kg/ha-mm)
Castor + fingermillet (1:2)	1520	1.27	5.45
Castor + chilli (1:1)	840	0.97	1.94
Castor + cowpea (1:1)	963	1.08	1.69
Castor + cluster bean (1:2)	998	1.03	1.87
Castor + fieldbean(1:1)	1045	1.08	2.30
Castor + grain amaranth (1:1)	685	0.98	1.49
Castor	1087	-	2.95
Grain amaranth	-	-	1.63

3.3.3.3 Nutrient management

At Bengaluru, INM in fingermillet–groundnut cropping system indicated that application of 10 t/ha FYM + rec. NPK + bio-fertilizers recorded higher groundnut pod yield (1024 kg/ha) with net returns (Rs.23674/ha), B:C ratio (1.82) and RWUE (1.42 kg/ha-mm) followed by *ex-situ* green manure (7.5 t/ha) + 75% N & P + 100% K + bio- fertilizers (995 kg/ha) as compared to recommended NPK (701 kg/ha). The haulm yield was higher (2267 kg/ha) with application of 10 t/ha FYM + rec. NPK + bio-fertilizers followed by application rec. NPK + bio-fertilizers (2217 kg/ha). The lowest pod and haulm yield was recorded in control (632 and 1533 kg/ha, respectively) (Table 3.218).

Table 3.218: Yield maximization through integrated nutrient management in fingermillet – groundnut cropping system - Bengaluru

Treatment	Pod yield (kg/ha)	Haulm yield (kg/ha)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
Control	632	1533	20870	17813	1.85	0.88
NPK (50:40:25 kg NPK/ha)	701	1722	24229	18720	1.77	0.97
10 t/ha FYM + rec. NPK	922	2011	34229	22081	1.65	1.28
Rec. NPK + biofertilizers	948	2217	24309	38249	2.39	1.32
10 t/ha FYM + rec. NPK + biofertilizers	1024	2267	34309	23674	1.82	1.42
10 t/ha FYM + 75% N & P + 100% K + biofertilizers	886	1944	33637	20468	1.61	1.23
Ex-situ green manure (7.5 t/ha) + 75% N & P + 100% K + biofertilizers	995	2111	25887	34860	2.35	1.38
In-situ green manure + 75% N & P + 100% K + biofertilizers	817	2000	25887	24133	1.93	1.14
10 t/ha FYM + 100% N & P + 150% K + biofertilizers	930	2022	34645	22158	1.64	1.29
CD at 5%	154.26	295.97	-	-	-	

Further, the results revealed that the pH and EC of soil increased in all the treatments. The available nitrogen, phosphorus and potassium content of soil increased with the application of 10 t/ha FYM + 100% N & P + 150% K + bio-fertilizers (16.3, 108.4 and 126.1 N, P_2O_5 & K_2O kg/ha) compared to application of NPK alone and control. Higher exchangeable calcium and magnesium was observed with application of FYM combined with inorganic fertilizers and bio fertilizers compared to green manuring and inorganic fertilizers. Significantly higher available sulphur (19.3 ppm) was recorded with application of 10 t/ha FYM + 100% N & P + 150% K + biofertilizers (Table 3.219).

Table 3.219: Soil chemical properties after the harvest of groundnut as influenced by integrated nutrient management - Bengaluru

Treatment	pH (1:2.5)	OC (%)	Available nutrients (kg/ha)			Exchangeable cations (meq/100 g)		Available S (ppm)
			N	P_2O_5	K_2O	Ca	Mg	
Initial	5.30	0.41	143.4	103.2	101.5	1.53	0.83	14.2
Control	5.41	0.33	136.5	86.1	80.7	1.27	0.70	12.6
NPK (50 :40 :25 kg NPK/ha)	5.43	0.38	159.6	98.8	92.6	1.33	0.93	13.3
10 t/ha FYM + rec.NPK	5.59	0.49	203.7	108.4	104.2	1.38	1.06	18.2
Rec. NPK + biofertilizers	5.71	0.51	212.1	104.0	103.7	1.50	0.94	20.0
10 t/ha FYM + rec. NPK + biofertilizers	5.47	0.49	202.0	107.8	102.7	1.52	0.97	18.9
10 t/ha FYM + 75% N & P + 100% K + biofertilizers	5.82	0.51	214.2	112.4	102.6	1.52	0.99	17.8
Ex-situ green manure (7.5 t/ha) + 75% N & P + 100% K + biofertilizers	5.34	0.50	207.9	104.0	117.0	1.45	0.93	18.7
In-situ green manure + 75% N & P+ 100% K + biofertilizers	5.38	0.48	201.6	107.8	107.4	1.45	0.95	18.3
10 t/ha FYM + 100% N & P + 150% K + biofertilizers	5.45	0.52	216.3	108.4	126.1	1.62	0.97	19.3
CD at 5%	NS	0.09	37.94	12.66	23.95	0.18	0.08	4.48

In a field experiment involving different levels of K and Mg in fingermillet, among different levels of potassium, application of K @ 56.25 kg/ha recorded significantly higher grain and higher straw yield (2393 and 3806 kg/ha) followed by K @ 46.87 kg/ha (2386 and 3852 kg/ha) as compared to control and higher net returns and B:C ratio was recorded due to application of K @ 46.87 kg/ha compared to other treatments. Among different levels of magnesium, application of magnesium @ 15 kg/ha recorded higher grain, straw yield and B:C ratio (2385 kg/ha, 3772 kg/ha and 3.71, respectively) (Table 3.220).

Table 3.220: Yield and economics of fingermillet as influenced by levels of potassium and magnesium - Bengaluru

Treatment	Grain yield (kg/ha)	Straw yield (kg/ha)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
K_1: No K	2158	3292	23463	32957	2.40	3.36
K_2: K @ 37.50 kg/ha	2255	3622	24463	34638	2.42	3.51
K_3: K @ 46.87 kg/ha	2386	3852	24712	37844	2.53	3.71
K_4: K @ 56.25 kg/ha	2393	3806	24963	37734	2.51	3.73
CD at 5%	NS	406.08	-	-	-	-
M_1: No Mg	2214	3557.	23753	34271	2.44	3.45
M_2: Magnesium @ 15.0 kg/ha	2385	3772	24400	38079	2.56	3.71
M_3: Magnesium @ 30.0 kg/ha	2295	3600	25046	35029	2.40	3.57
CD at 5%	NS	NS	-	-	-	-
K_1M_1	2061	3052	22816	30998	2.36	3.21
K_1M_2	2263	3601	23463	35813	2.53	3.52
K_1M_3	2150	3224	24109	32059	2.33	3.35
K_2M_1	2119	3532	23816	31808	2.34	3.30
K_2M_2	2353	3738	24463	37166	2.52	3.66
K_2M_3	2294	3598	25109	34939	2.39	3.57
K_3M_1	2359	3772	24066	37738	2.57	3.67
K_3M_2	2476	3944	24712	40146	2.62	3.85
K_3M_3	2325	3841	25359	35647	2.41	3.62
K_4M_1	2318	3875	24316	36540	2.50	3.61
K_4M_2	2452	3807	24963	39193	2.57	3.82
K_4M_3	2411	3738	25609	37469	2.46	3.75
CD at 5%	NS	NS	-	-	-	-

Different levels potassium and magnesium had no significant effect on soil pH, EC, OC, available N, P_2O_5 and S. However application of K @ 56.25 kg/ha recorded significantly higher available K_2O, exchangeable Ca and Mg (117.46 kg/ha, 5.00 and 3.62 meq/100 g) compared to other treatments. Among different levels of magnesium, application of magnesium @ 15.0 kg/ha recorded significantly higher exchangable Ca and Mg (5.65 and 4.33 meq/100 g). Interaction effect of application of different levels of potassium and magnesium on soil properties was non-significant (Table 3.221).

Table 3.221: Soil chemical properties after the harvest of fingermillet as influenced by levels of potassium and magnesium - Bengaluru

Treatment	pH	OC (%)	Available nutrients (kg/ha)			Exch. cations (meq/100g)		Av. S (ppm)
			N	P_2O_5	K_2O	Ca	Mg	
K_1: No K	5.34	0.43	174.15	100.68	67.94	4.46	2.78	14.72
K_2: K @ 37.50 kg/ha	5.34	0.45	177.71	103.13	94.29	5.14	3.77	15.42
K_3: K @ 46.87 kg/ha	5.38	0.46	177.92	104.65	103.92	4.98	3.16	15.31
K_4: K @ 56.25 kg/ha	5.38	0.44	180.01	104.27	117.46	5.00	3.62	15.86
CD at 5%	NS	NS	NS	NS	7.70	0.36	0.26	NS
M_1: No Mg	5.35	0.44	173.26	101.28	93.46	3.64	1.94	15.21
M_2: Magnesium @ 15.0 kg/ha	5.34	0.45	181.10	103.85	98.61	5.40	3.73	15.35
M_3: Magnesium @ 30.0 kg/ha	5.38	0.44	177.97	104.42	95.65	5.65	4.33	15.42
CD at 5%	NS	NS	NS	NS	NS	0.31	0.23	NS

K @ 46.87 kg/ha +Mg @ 15.0 kg/ha in fingermillet

In a permanent manurial trial, in the 37th year under mono-cropping of fingermillet, FYM @ 10 t/ha + rec. NPK recorded significantly highest grain yield (2376 kg/ha) with a yield increase of 73% over application of rec. NPK alone (1367 kg/ha) with a B: C ratio of 2.38. Also, straw yield was significantly highest (4753 kg/ha) with application of FYM @ 10 t/ha + rec. NPK compared to other treatments. Moderately low yields were recorded with maize residue (MR) application. Application of MR @ 5 t/ha + rec. NPK recorded significantly higher grain yield (2214 kg /ha) compared Rec. NPK alone (1351 kg/ha) (Table 3.222).

Table 3.222: Influence of long term use of FYM/ maize residue (MR) and fertilizers on productivity and economics of fingermillet under mono-cropping (37th year) - Bengaluru

Treatment	Grain yield (kg/ha)	Straw yield (kg/ha)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
FYM series						
T_1 : Control	202	586	12820	-7331	0.43	0.29
T_2 : FYM (10 t/ha)	1774	3516	22820	24167	2.06	2.57
T_3 : FYM (10 t/ha) + 50% rec. N, P_2O_5 & K_2O	2132	4508	24648	32033	2.30	3.09

Treatment	Grain yield (kg/ha)	Straw yield (kg/ha)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
T_4 : FYM (10 t/ha) + 100% rec. N, P_2O_5 & K_2O	2376	4753	26475	36490	2.38	3.45
T_5 : Rec. N, P_2O_5 & K_2O	1367	3483	16475	20312	2.23	1.98
CD at 5%	282.42	559.01	-	-	-	-
MR series						
T_1 : Control	190	594	12820	-7625	0.41	0.28
T_2 : MR (5 t/ha)	618	1195	14320	2026	1.14	0.90
T_3 : MR (5 t/ha) + 50% rec. N, P_2O_5 & K_2O	1807	4134	16148	32128	2.99	2.62
T_4 : MR (5 t/ha) + 100% rec. N,P_2O_5 & K_2O	2214	4460	17975	40720	3.27	3.21
T_5 : Rec. N, P_2O_5 & K_2O	1351	3418	16475	19863	2.21	1.96
CD at 5%	232.79	615.70	-	-	-	-

Fingermillet-FYM @ 10 t/ha + Rec. NPK

Fingermillet - control

In the 12th year cycle of rotation with groundnut under FYM series, the groundnut pod and haulm yield was found to be significantly highest (1499 and 3125 kg/ha, respectively) with FYM @ 10 t/ha + 100% rec. NPK, compared to rec. N, P_2O_5 & K_2O (879 and 1416 kg/ha, respectively) with a higher B:C ratio of 2.70. Under maize residue (MR) series, similar trend of result was obtained with lower values. The net returns were highest (Rs.57474/ha) with FYM at 10 t/ha + 100% NPK comared to other treatments (Table 3.223).

Table 3.223: Influence of long term application of FYM/ maize residue (MR) and fertilizers on productivity and economics of groundnut under fingermillet-groundnut rotation (12th year) - Bengaluru

Treatment	Grain yield (kg/ha)	Haulm yield (kg/ha)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg ha- mm)
Fingermillet-groundnut rotation (FYM series)						
T_1	625	960	20870	17110	1.82	0.91
T_2	1248	3044	30870	45532	2.47	1.81
T_3	1440	3060	32549	55381	2.70	2.09
T_4	1499	3125	34029	57474	2.69	2.18
T_5	879	1416	24029	29419	2.22	1.28
CD at 5%	248.49	437.43	-	-	-	-

Treatment	Grain yield (kg/ha)	Haulm yield (kg/ha)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg ha- mm)
Fingermillet-groundnut rotation (MR series)						
T_1	720	846	20870	22753	2.09	1.04
T_2	933	1107	22370	34164	2.53	1.35
T_3	952	1270	24049	33706	2.40	1.38
T_4	981	1286	25729	33774	2.31	1.42
T_5	830	1253	24029	26398	2.10	1.20
CD at 5%	160.42	207.12	-	-	-	-

Under fingermillet monocropping (FYM series), the soil pH and EC decreased significantly in control compared to NPK/ INM treatments. Higher organic carbon content, available P and K was observed in NPK and INM treatments. Almost similar results were recorded with maize residue application (Table 3.224).

Table 3.224: Soil properties as influenced by long term application of FYM, MR and NPK fertilizers under fingermillet monocropping - Bengaluru

Treatment	pH (1:2.5)	OC (%)	Available nutrients (kg/ha)			Exchangable cations (meq/100 g)		Av. S (ppm)
			N	P_2O_5	K_2O	Ca	Mg	
Fingermillet-groundnut rotation (FYM series)								
T_1	5.25	0.26	103.5	36.9	47.0	0.87	0.97	10.13
T_2	5.85	0.46	159.9	77.9	92.4	2.61	1.46	14.93
T_3	5.90	0.49	178.8	93.4	105.6	3.52	2.47	15.89
T_4	5.93	0.50	207.0	108.3	109.2	3.96	2.51	19.54
T_5	5.35	0.39	136.4	91.2	85.0	1.72	1.00	13.40
CD at 5%	1.12	0.15	34.06	14.02	19.05	0.49	0.34	3.45
Fingermillet-groundnut rotation (MR series)								
T_1	5.26	0.30	112.9	35.7	48.7	0.77	1.01	8.33
T_2	5.57	0.44	149.6	74.0	85.2	1.97	1.46	12.10
T_3	5.67	0.45	171.2	93.0	97.3	1.96	1.57	13.98
T_4	5.73	0.49	189.1	97.6	101.0	2.92	1.92	15.43
T_5	5.39	0.38	140.2	93.0	83.2	1.63	1.04	13.11
CD at 5%	0.53	0.08	21.59	17.41	20.68	0.39	0.27	3.22

Under rotation system (FYM series), the soil pH and EC increased with FYM/INM treatment compared to control. Significantly lower organic carbon (0.30%) was observed in control and NPK alone (0.38%) compared to INM treatment (0.56%). The available PK also followed the similar trend as that of organic carbon. Similar trends of results were observed in maize residue series with lesser values (Table 3.225).

Table 3.225: Soil properties as influenced by long term application of FYM, MR and NPK fertilizers under fingermillet-groundnut rotation-Bengaluru

Treatment	pH (1:2.5)	EC (dSm^{-1})	OC (%)	Available nutrients (kg/ha)			Exch. cations (meq/100g)		Available S (ppm)
				N	P_2O_5	K_2O	Ca	Mg	
Fingermillet-groundnut rotation (FYM series)									
T_1	5.29	0.02	0.30	103.5	43.1	48.8	1.05	0.92	9.00
T_2	5.86	0.03	0.53	169.3	79.0	98.0	2.83	1.32	15.10
T_3	5.83	0.04	0.52	197.6	92.7	117.6	3.83	2.42	16.11
T_4	5.93	0.04	0.56	225.8	110.4	124.8	4.22	2.42	18.09
T_5	5.41	0.03	0.38	150.5	88.2	86.8	2.63	2.22	13.81
CD at 5%	0.64	0.01	0.11	32.19	19.41	17.83	0.69	0.38	2.66
Fingermillet-groundnut rotation (MR series)									
T_1	5.26	0.02	0.33	94.1	41.9	42.4	1.13	0.8	8.19
T_2	5.54	0.02	0.42	169.3	60.9	82.7	2.52	1.3	12.90
T_3	5.67	0.03	0.50	178.8	84.3	101.5	3.63	2.1	13.19
T_4	5.60	0.03	0.52	207.0	101.0	111.4	4.13	2.4	13.84
T_5	5.30	0.03	0.37	141.1	83.1	85.8	2.47	1.9	13.18
CD at 5%	0.90	0.003	0.07	39.61	17.27	17.05	0.60	0.21	2.96

3.3.3.4 Evaluation of improved varieties

Out of 14 promising fingermillet genotypes evaluated, KMR-301 gave the highest yield (4194 kg/ha) but it was on par with all other varieties except KMR-126 (3171 kg/ha) and AVT-3 (2589 kg/ha). Mean performance over 5 years (2010-14) indicated that under long duration group MR-1 was the highest yielder (4563 kg/ha). While, under medium duration group, GPU-75 (4380 kg/ha), GPU-28 (4292 kg/ha) showed consistent performance (Table 3.226).

Table 3.226: Evaluation of promising fingermillet varieties - Bengaluru

Variety	Yield (kg/ha)			Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Grain yield (2014)	Mean grain yield (2010-14)	Stover				
MR-1	3827	4563	7928	23816	45070	2.89	5.88
MR-6	3777	3997	7022	23816	44170	2.85	5.81
AVT-3	2589	-	5293	23816	22786	1.96	3.99
AVT-8	3507	-	4309	23816	39310	2.65	5.40
GPU-28	3943	4292	5706	23816	47158	2.98	6.06
GPU-66	3908	4032	5019	23816	46528	2.95	6.01
GPU-67	3997	4034	5556	23816	48130	3.02	6.14
GPU-84	4140	4168	5621	23816	50704	3.13	6.36
KMR-301	4194	4194	6960	23816	51676	3.17	6.45
KMR-316	4163	4163	5502	23816	51118	3.15	6.41
GPU-48	4163	3789	5309	23816	51118	3.15	6.41
KMR-204	3989	-	4707	23816	47986	3.01	6.13
KMR-128	3893	-	7596	23816	46258	2.94	5.98
KMR-126	3171	-	6709	23816	33262	2.40	4.87

Long duration fingermillet variety MR-1

Among the 12 promising groundnut genotypes evaluated, genotype GKVK-5 gave highest yield (3505 kg/ha) followed by GKVK-13 (3202 kg/ha) as against the check TMV-2 (1610 kg/ha) and KCG-2 (1616 kg/ha). Mean performance of groundnut genotypes during 2010 to 2015 resulted in identifying the promising genotypes *viz*., KCG-6 (3501 kg/ha) and GKVK-5 (3512 kg/ha). KCG-6 variety was released by SVRC during 2014 for zone 4 and 5, while GKVK-5 is the process of release (Table 3.227).

Table 3.227: Evaluation of groundnut genotypes for high pod yield - Bengaluru

Genotype	Pod yield (kg/ha)		NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	2014	Mean (2010-14)			
GKVK-13	3202	2517	128087	5.00	4.46
KCG-6	3169	3501	126437	4.95	4.42
GKVK-5	3505	3512	143237	5.47	4.88
KCG-9	2238	-	79887	3.50	3.12
GKVK-3	2727	-	104337	4.26	3.8
ICGV-0350	3098	3030	122887	4.84	4.32
ICGV-0351	2026	2796	69287	3.16	2.82
NARAYANI	1471	-	41537	2.30	2.19
TMV-2 (SEL)	1701	-	53037	2.66	2.37
ICGV-91114	2061	1677	71037	3.22	2.87
TMV-2 (c)	1610	1777	48487	2.51	2.34
KCG-2 (c)	1616	1955	48787	2.52	2.41
CD at 5%	0.49				

3.4 Oilseed Based Production System

3.4.1 Groundnut Based Production System

3.4.1.1 Rainwater management

In a catchment-command relationship study at Anantapur, supplemental irrigation of 10 mm was given to pigeonpea (5 varieties) and groundnut during flowering and pod formation stage. All pigeonpea varieties gave very low seed yield due to prolonged dry spells. The net returns were highest with groundnut (Rs.60270/ha) compared to pigeonpea (Table 3.228).

Table 3.228: Effect of supplemental irrigation on pigeonpea varities and groundnut - Anantapur

Pigeonpea variety	Seed/ pod yield (kg/ha)	Stalk yield (kg/ha)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
TRG 38	198	450	5200	13860	2.66	0.88
LRG 30	223	476	5200	15610	3.00	1.00
LRG 41	69	380	5200	4830	0.92	0.31
TRG 53	125	396	5200	8750	1.68	0.56
WRG 33	129	385	5200	9030	1.74	0.58
Groundnut with supplemental irrigation	861	1210	22000	60270	2.73	3.86

In an experiment on minimizing the evaporation losses from the farm pond using different materials, bamboo mat material was found effective in preventing evaporation losses. Among different chemicals, steryl alcohol was found effective in minimizing evaporation losses followed by silicon oil and cetyl alcohol. The chemicals were found effective for period of one week, later on their efficiency decreased.

At Rajkot, in an assessment of rainfall erosivity index and soil erodibility factor, maximum groundnut pod equivalent yield (869 kg/ha) was obtained with sole cotton with higher net returns (Rs.36498/ha) and B:C ratio (1.63) followed by groundnut + castor intercropping system (3:1) (411 kg/ha) as compared to sole groundnut GG-20 (127 kg/ha). Maximum soil loss (592.24 kg/ha) and maximum runoff (28.96%) was recorded under sole cotton. Maximum RWUE was also higher with sole cotton (1.80 kg/ha-mm), followed by groundnut + castor (3:1) intercropping system (0.85 kg/ha-mm) (Table 3.229).

Table 3.229: Evaluation of rainfall erosivity index and soil erodibility factor in medium black soil under sole and intercropping systems - Rajkot

Treatment	Groundnut equivalent yield (kg/ha)		Stover/ stalk yield (kg/ha)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	2014	Mean (3 yrs*)					
Sole groundnut (GG-20)	127	794	2753	23645	5080	0.21	0.26
Sole cotton (Bij Dhan-2)	869	2503	1693	22413	36498	1.63	1.80
Groundnut (GG-5) + castor (3:1)	411	1004	1447(GN) 967(CA)	21420	16440	0.77	0.85

*Year 2012 - not including

In another study to assess the response of groundnut to supplemental irrigation from harvested rainwater at Rajkot, higher pod (898 kg/ha) and haulm yield (4439 kg/ha) with higher net returns (Rs.35920/ha) and B:C ratio (1.51) was obtained with irrigation applied at 40% soil moisture deficit (Table 3.230). Similarly, maximum rainwater use efficiency (1.86 kg/ha-mm), crop water use efficiency (20.32 kg/ha-mm) and field water use efficiency (15.87 kg/ha-mm) were recorded with irrigation applied at 40% soil moisture deficit. Whereas, irrigation applied at 50% soil moisture deficit was the next best treatment.

Table 3.230: Response of groundnut to supplemental irrigation - Rajkot

Treatment	Pod yield (kg/ha)		Haulm yield (kg/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)	Crop WUE (kg/ha-mm)	RWUE (kg/ha-mm)
	2014	Mean (4 yrs)						
No irrigation (control)	330	556	3115	13200	0.56	0.68	7.47	7.40
Irrigation at 40% soil moisture deficit	898	1077	4439	35920	1.51	1.86	20.32	15.87
Irrigation at 50% soil moisture deficit	727	941	4008	29080	1.23	1.50	16.45	14.37
Irrigation at 60% soil moisture deficit	615	774	3743	24600	1.04	1.27	13.91	12.15
Irrigation at 70% soil moisture deficit	560	722	3546	22400	0.94	1.16	12.67	11.07
Irrigation at 80% soil moisture deficit	519	682	3233	20760	0.87	1.07	11.74	10.26

In the above experiment, stage-wise ETo, ETc and effective rainfall during experimental period were recorded. The observed evapotranspiration (ETo), crop evapotranspiration (ETc) and effective rainfall (ER) were 442.1, 370.4 and 446.2 mm, respectively of the crop growth period (Table 3.231).

Table 3.231: Stage-wise ETo, ETc and effective rainfall – Rajkot

Parameter	Stage I	Stage II	Stage III	Stage IV	Total (mm)
	Sowing to flower initiation (25 days)	Flowering to full pegging (30 days)	Full pegging to pod development (35 days)	Pod development to pod maturity (25 days)	
ETo	95.5	113.9	134.7	98.0	442.1
ETc	38.2	87.4	154.9	89.9	370.4
ER	229.5	179.4	37.3	0.0	446.2

ETo: Potential evapotranspiration; ETc: Crop evapotranspiration; ER: Effective rainfall

In an assessment of tillage and nutrient management practices in cotton at Rajkot, there were no significant differences among tillage treatments. However, among management practices, higher seed cotton yield was obtained with application of FYM @ 10 t/ha with kaoline spray @ 4% (1298 kg/ha). Similarly, higher net return (Rs.50736/ha) and rainwater use efficiency (2.50 kg/ha-mm) was also recorded with the same treatment followed by application of FYM @ 10 t/ha with gaur gum spray @ 0.3% (1207 kg/ha) as compared to control (Table 3.232).

Table 3.232: Response of cotton to tillage and crop management practices - Rajkot

Treatment	Yield (kg/ha)			Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Seed cotton		Stalk (2014)				
	2014	Mean (3 yrs)					
Tillage							
Ploughing every year upto 30 cm in set row	1208	1755	2185	23113	50736	2.20	2.50
Ploughing alternate year upto 30 cm in set row	1104	1726	2019	23113	46368	2.01	2.29
CD at 5%	NS	-	NS	-	-	-	-
Management practices							
FYM @ 10 t/ha + kaolin @ 4% spray	1298	1903	2391	29365	54516	1.86	2.69
FYM @ 10 t/ha + guar gum @ 0.3% spray	1207	1802	2313	29403	50694	1.72	2.50
Gypsum @ 1 t/ha + kaolin @ 4% spray	1172	1806	2093	26140	49224	1.88	2.43
Gypsum @ 1 t/ha + guar gum @ 0.3% spray	1100	1718	1978	26178	46200	1.76	2.28
Control	1078	1569	1903	22663	45276	2.00	2.23
CD at 5%	121	-	219	-	-	-	-

In an assessment of tillage and nutrient management practices in groundnut at Rajkot, there were no significant differences among tillage treatments. However, among management practices, higher pod and haulm yield (382 and 4046 kg/ha, respectively) was recorded with application of FYM @ 10 t/ha with kaoline spray @ 4%. Similarly, the maximum net returns (Rs.15280/ha), B:C ratio (0.50) and rainwater use efficiency (0.79 kg/ha-mm) were recorded with the same treatment followed by application of FYM @ 10 t/ha with gaur gum spray @ 0.3% over control (Table 3.233).

Table 3.233: Response of groundnut to tillage and crop management practices - Rajkot

Treatment	Yield (kg/ha)			Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Seed cotton		Stalk yield (2014)				
	2014	Mean (3 yrs)					
Tillage							
Ploughing every year upto 30 cm in set row	245	787	3521	24345	9800	0.40	0.51
Ploughing alternate year upto 30 cm in set row	356	648	3793	24345	14240	0.58	0.74
CD at 5%	NS	-	NS	-	-	-	-
Management practices							
FYM @ 10 t/ha + kaolin @ 4% spray	382	870	4046	30597	15280	0.50	0.79
FYM @ 10 t/ha + guar gum @ 0.3% spray	356	795	3838	30635	14240	0.46	0.74
Gypsum @ 1 t/ha + kaolin @ 4% spray	298	784	3672	27372	11920	0.44	0.62
Gypsum @ 1 t/ha + guar gum @ 0.3% spray	286	745	3547	27410	11440	0.42	0.59
Control	231	715	3358	23895	9240	0.39	0.48
CD at 5%	51	-	289	-	-	-	-

3.4.1.2 Cropping systems

In a study to assess the effect of different alternate crops at Anantapur, eleven crops comprising of groundnut, castor, sunflower, sorghum, pearlmillet, foxtailmillet, pigeonpea, greengram, clusterbean, fieldbean and cowpea were tested on 5 dates of sowing for 6 years during 2009 to 2014. Significantly higher yields of clusterbean (361 kg/ha), cowpea (804 kg/ha), sunflower (371 kg/ha), castor (1251 kg/ha), sorghum (911 kg/ha) and setaria (711 kg/ha) were recorded when these crops were sown with onset of monsoon in 1st fortnight of June (D_1). However, the maximum yield of groundnut (1199 kg/ha), pigeonpea (1262 kg/ha), field bean (903 kg/ha), greengram (412 kg/ha) and pearlmillet (1683 kg/ha) were recorded when these crops were sown with onset of monsoon in 2nd fortnight of June (D_2), respectively. While, decrease in yields were oberved with the successive 15 day interval dates of sowing (D_3, D_4 and D_5) for all crops. Similarly, higher RWUE was observed in groundnut, pigeonpea, field bean, castor, sorghum and pearlmillet (2.92, 3.05, 2.105, 3.77, 2.73 and 3.98 kg/ha-mm, respectively) when they were sown with onset of monsoon in 1st fortnight of June (D_1), while higher RWUE in clusterbean, cowpea, greengram and setaria (3.55, 2.82, 2.63 and 3.01 kg/ha-mm, respectively) were recorded with D_2 (sowing at 2nd fortnight of June). Whereas, the higher net returns were recorded in cowpea, pigeonpea, castor and sorghum (Rs. 26618, 31699, 32497 and 11487/ha, respectively) with sowing in 1st fortnight of June (D_1). The maximum net returns of Rs.44938, 28004 and 5290/ha were recorded with groundnut, field bean and pearlmillet, respectively with sowing at 2nd fortnight of June (D_2). Similar trends were observed for B:C ratio (Table 3.234).

Table 3.234: Performance of alternate crops for groundnut as influenced by time of sowing (2009-10 to 2014-15) – Anantapur

Crop	D_1 (June 1st fortnight)				D_2 (June 2nd fortnight)				D_3 (July 1st fortnight)				D_4 (July 2nd fortnight)				D_5 (August 1st fortnight)			
	Yield (kg/ha)	RWUE (kg/ha-mm)	NMR (Rs/ha)	B:C ratio	Yield (kg/ha)	RWUE (kg/ha-mm)	NMR (Rs/ha)	B:C ratio	Yield (kg/ha)	RWUE (kg/ha-mm)	NMR (Rs/ha)	B:C ratio	Yield (kg/ha)	RWUE (kg/ha-mm)	NMR (Rs/ha)	B:C ratio	Yield (kg/ha)	RWUE (kg/ha-mm)	NMR (Rs/ha)	B:C ratio
Groundnut	948	2.92	30345	2.31	1199	2.68	44938	2.92	1074	1.85	13569	1.58	799	2.60	22166	1.95	363	0.87	-2724	0.88
Clusterbean	361	2.53	15172	2.14	353	1.01	18472	2.39	357	3.04	23329	2.83	276	1.33	11532	1.87	104	0.25	-3938	0.70
Cowpea	804	3.12	26618	3.18	698	1.76	22862	2.90	751	3.55	24079	2.97	593	2.40	17587	2.46	592	1.15	17537	2.46
Pigeonpea	1174	3.05	31699	3.44	1262	2.29	30750	3.29	1218	2.82	18741	2.48	486	1.40	3570	1.27	198	0.38	-6514	0.52
Field bean	799	2.15	18519	2.11	903	1.52	28004	2.63	851	1.75	6610	1.36	424	1.07	4071	1.24	638	1.23	14754	1.86
Greengram	319	1.34	6980	1.81	412	0.88	9458	2.35	365	2.63	14481	2.80	399	1.43	8951	2.27	271	0.53	3805	1.54
Sunflower	371	1.14	1120	1.11	286	0.81	-1420	0.86	246	1.35	-2640	0.74	453	1.48	3600	1.36	303	0.73	-920	0.91
Castor	1251	3.77	32497	3.57	1012	2.01	24198	3.16	1132	3.64	25151	2.85	853	2.62	18631	2.66	576	1.11	8932	1.80
Sorghum	911	2.73	11487	2.09	652	1.63	2608	1.25	782	2.52	9499	1.92	1123	3.75	12029	2.15	223	0.43	-5982	0.43
Setaria	711	2.94	6795	1.79	608	1.43	179	1.01	660	3.01	7277	1.72	342	0.97	-5148	0.57	338	0.76	-5221	0.56
Pearlmillet	1173	3.98	3435	1.26	1683	4.06	5290	1.27	1428	3.49	1078	1.23	841	2.69	-7328	0.63	799	1.55	-7958	0.60

The mean maximum groundnut equivalent yield (612 kg/ha) was recorded with groundnut with sustainable yield index (SYI) of 1.00 followed by castor (552 kg/ha) and SYI of 0.87, and clusterbean (530 kg/ha) and SYI of 0.82 (Table 3.235).

Table 3.235: Groundnut equivalent yield (GEY) of different alternate crops for groundnut as influenced by time of sowing (mean of 6 years) - Anantapur

Crop	GEY (Kg/ha)							
	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	Mean	SYI
Groundnut	443	1157	750	530	366	423	612	1.00
Castor	357	832	289	301	573	962	552	0.87
Clusterbean	564	679	690	522	200	525	530	0.82
Pigeonpea	377	793	375	410	310	760	504	0.76
Cowpea	345	1077	571	172	299	437	484	0.72
Field bean	479	1248	285	370	151	355	481	0.71
Greengram	261	276	376	130	200	646	315	0.35
Pearlmillet	272	432	133	251	211	312	268	0.25
Sorghum	289	164	495	267	113	211	257	0.22
Setaria	222	325	154	188	78	297	211	0.12
Sunflower	186	180	192	186	-	-	186	0.07

Among different intercropping systems evaluated at Anantapur, sole clusterbean recorded significaly higher groundnut equivalent yield (817 kg/ha) compared to groundnut + castor (15:1) intercropping system (650 kg/ha), sole groundnut (573 kg/ha) and clusterbean + redgram intercropping system (553 kg/ha). Similarly, higher net returns (Rs. 23960/ha) and B:C ratio (3.0) were recorded by sole clusterbean as compared to all other intercropping systems. Maximum land equivalent ratio (1.16) was recorded with groundnut + castor (15:1) intercropping system compared to other intercropping systems. The higher RWUE (5.35 kg/ha-mm) was recorded with the sole clusterbean followed by clusterbean + redgram (15:1) intercropping system (3.34) (Table 3.236).

Table 3.236: Performance of different intercropping systems – Anantapur

Treatment	Yield (kg/ha)		GEY (kg/ha)	LER	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Main crop	Inter crop						
Groundnut (sole)	573	-	573	1.0	13328	13152	1.6	2.55
Clusterbean (sole)	878	-	817	1.0	12046	23960	3.0	5.35
Castor (sole)	581	-	527	1.0	23396	6619	1.4	2.58
Pigeonpea (sole)	326	-	326	1.0	17146	6277	1.5	1.40
Clusterbean + pigeonpea (15:1)	549	42	553	0.75	13448	12590	2.0	CB-3.34 RG-0.18
Clusterbean + castor (15:1)	324	85	379	0.52	13408	4853	1.4	CB-1.98 Cas-0.38
Groundnut + pigeonpea (15:1)	332	55	387	0.75	23516	5952	1.3	GN-1.48 RG-0.24
Groundnut + castor (15:1)	474	193	650	1.16	23476	16094	1.8	GN-2.11 Cas-0.86
CD at 5%	-	-	173	-	-	-	-	-

Groundnut + pigeonpea (15:1)

Groundnut + castor (15:1)

Clusterbean + pigeonpea (15:1)

Clusterbean+ castor (15:1)

Performance of intercropping systems

Among different intercropping systems studied at Rajkot, higher groundnut pod yield was recorded with groundnut + sesame (2:1) intercropping system (2047 kg/ha). Whereas, highest groundnut pod equivalent yield (8105 kg/ha), net monetary returns (Rs.258852/ha) and B:C ratio (17.59) was recorded with sole sesame. However, the highest LER (2.11) and MAI (Rs.64649/ha) was recorded with groundnut + sesamum (2:1) intercropping system, while higher rainwater use efficiency (6.81 kg/ha-mm) was recorded with sole blackgram compared to other cropping systems (Table 3.237).

Table 3.237: Performance of groundnut based intercropping systems - Rajkot

Treatment	Yield (kg/ha)		GEY (kg/ha)	LER	MAI	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Main crop	Intercrop							
Groundnut (sole) (GG-5)	1100	-	1100	-	-	30073	17777	0.59	2.28
Cotton (sole) (Bt. Bijdhan-2)	2702	-	3403	-	-	28063	86924	3.10	5.59
Castor (sole) (GCH-7)	2091	-	2478	-	-	18745	65028	3.47	4.33
Sesame (sole) (G.Til-2)	3218	-	8105	-	-	14717	258852	17.59	6.66
Blackgram (sole) (Urad G. -1)	3292	-	5852	-	-	12024	185531	15.43	6.81
Groundnut + cotton (3:1)	655	1556	2615	1.20	13415	29955	70550	2.36	4.58
Groundnut + castor (3:1)	544	1559	2392	1.26	16707	27800	63935	2.30	4.35
Groundnut + sesame (2:1)	2047	657	3701	2.11	64649	24848	107366	4.32	5.60
Groundnut + blackgram (2:1)	1877	623	2985	1.94	47852	23940	83060	3.47	5.17
CD at 5%	1110	-		-	-	-	-	-	-

3.4.1.3 Nutrient management

In a long-term integrated nutrient management study in groundnut at Anantapur, treatment with 100% RDF + $ZnSO_4$ @ 50 kg/ha (once in 3 years) recorded significantly higher pod yield (305 kg/ha) which was closely followed by application groundnut shells @ 4 t/ha (298 kg/ha). However, higher groundnut mean pod yield (937 kg/ha) was recorded with application of 50% RDF + FYM @ 4 t/ha. In depletion studies, non-significant yields were observed. Higher B:C ratio of 0.74 and 0.72 were recorded with treatment 50% RDF (10-20-20 NPK kg/ha, and groundnut shells @ 4 t/ha, respectively. Slightly increase in soil pH towards neutral was observed in treatments applied with organics alone or in combination of organics with inorganics. Higher soil available phosphorous (107 kg/ha) was recorded with application of 100% RDF + $ZnSO_4$ @ 50 kg/ha (once in 3 years). The lower bulk density was recorded with application of 100% RDF + $ZnSO_4$ @ 50 kg/ha (once in 3 years) in treated (1.42 Mg/m^3) and depleted (1.56 Mg/m^3) treatments compared to other treatments (Table 3.238 a & b).

Table 3.238a: Effect of long-term integrated nutrient management on yield and economics of groundnut - Anantapur

Treatment	Pod yield (kg/ha) (2014)		Mean pod yield (kg/ha) (30 years)		Haulm yield (kg/ha)		Cost of Cultivation (Rs/ha)		NMR (Rs/ha)		B:C ratio		RWUE (kg/ha-mm)	
	T	D	T	D	T	D	T	D	T	D	T	D	T	D
Control	164		713	582	761		21708		-11338		0.48		0.74	
100% RDF (20:40:40 NPK kg/ha)	291	217	920	660	1079	833	25014	1.31	1.31	-12153	0.68	0.51	1.31	0.97
50% RDF (10:20:20 NPK kg/ha)	294	271	855	622	1086	871	23361	1.32	1.32	-8163	0.74	0.65	1.32	1.22
Groundnut shells @ 4 t/ha	298	196	819	649	1129	889	24508	1.34	1.34	-12208	0.72	0.50	1.34	0.88
FYM @ 4 t/ha	232	220	879	675	1097	855	26508	1.04	1.04	-13420	0.56	0.49	1.04	0.99
50% RDF + groundnut shells @ 4 t/ha	295	239	850	635	1125	897	26161	1.32	1.32	-12107	0.67	0.54	1.32	1.07
50% RDF + FYM @ 4 t/ha	262	203	937	658	1096	880	28161	1.18	1.18	-15626	0.57	0.45	1.18	0.91
100% RDF + $ZnSO_4$ @ 50 kg/ha (once in 3 years)	305	225	896	631	1076	837	25014	1.37	1.37	-11822	0.70	0.53	1.37	1.01
FYM @ 5 t/ha	246	202	874	662	1020	784	27708	1.10	1.10	-15695	0.54	0.43	1.10	0.91
100% RDF + groundnut shells @ 4 t/ha	249	179	-	-	935	808	27814	1.12	1.12	-16595	0.53	0.40	1.12	0.80
CD at 5%	48.9	NS	-	-	159.8	NS	-	-	-	-	-	-	-	-

T: Treated; D: Depleted

Table 3.238b: Effect of long-term integrated nutrient management on physical and chemical properties of soil – Anantapur

Treatment	Bulk density (Mg/m^3)		pH		OC (%)		Available nutrients (kg/ha)						DTPA extractable micronutrient (ppm)							
							N		P_2O_5		K_2O		Zn		Fe		Cu		Mn	
	T	D	T	D	T	D	T	D	T	D	T	D	T	D	T	D	T	D	T	D
Control	1.53		5.67		0.21		200		23		210		0.93		7.25		0.67		4.61	
100% RDF (20-40-40 NPK kg/ha)	1.57	1.57	5.03	5.73	0.39	0.31	263	250	103	27	382	246	1.08	1.03	12.70	10.2	2.12	2.12	4.77	5.30
50% RDF (10-20-20 NPK kg/ha)	1.58	1.63	5.37	5.70	0.36	0.28	229	217	80	25	345	248	0.98	0.97	9.84	9.06	1.94	1.94	5.54	5.33
Groundnut shells @ 4 t/ha	1.55	1.66	5.67	5.87	0.39	0.37	275	221	46	26	355	289	1.23	0.70	8.20	5.57	1.57	1.57	4.68	3.90
FYM @ 4 t/ha	1.51	1.66	6.43	5.90	0.42	0.36	154	217	48	26	409	303	1.26	0.97	8.15	3.63	1.11	1.11	3.63	3.82
50% RDF + groundnut shells @ 4 t/ha	1.52	1.65	5.30	5.73	0.32	0.28	196	225	83	27	494	306	0.99	0.75	10.49	8.87	2.69	2.69	4.53	4.92
50% RDF + FYM @ 4 t/ha	1.48	1.66	6.50	5.80	0.55	0.39	233	167	85	24	393	270	1.39	0.86	8.49	2.98	1.14	1.14	3.18	3.67
100% RDF + $ZnSO_4$ @ 50 kg/ha (once in 3 years)	1.42	1.56	5.63	5.57	0.39	0.35	225	221	107	24	388	201	1.41	1.30	11.08	10.2	1.95	1.95	4.53	5.69
FYM @ 5 t/ha	1.51	1.60	6.07	5.87	0.51	0.39	300	258	47	26	433	316	1.38	0.93	7.90	2.14	1.16	1.16	4.38	3.78
100% RDF + groundnut shells @ 4 t/ha	1.59	1.61	6.10	5.60	0.48	0.44	258	229	72	35	424	416	1.28	1.27	13.01	7.96	1.52	1.52	5.77	6.23
CD at 5%	0.06	0.08	0.89	NS	0.20	NS	NS	NS	17.2	NS	66.08	73.33	NS	NS	2.90	NS	0.96	NS	--	--
Initial values (1985)			6.6	7.4	0.30	0.36	--	--	44	80	155	261	--	--	--	--	--	--	--	--

T: Treated; D: Depleted

In a study on response of castor to different nutrient levels at Anantapur, the treatment T_2 i.e. application of 75:50:40 kg/ha N, P_2O_5 & K_2O recorded higher castor seed yield (560 kg/ha) during year 2014 and 590 kg/ha over mean of two years, with higher net returns (Rs.4885/ha) and B:C ratio (1.29) compared to other treatments. However, maximum RWUE (2.23 kg/ha-mm) was observed with soil test based fertilizer application for treatment T_1. In case of soil status, soil test based fertilizer application T_1 (60:40:30 kg/ha N, P_2O_5 & K_2O) resulted in higher available nitrogen (191 kg/ha) and available phosphorus (73 kg/ha), while higher available potassium was recorded with T_3 treatment (45-30-20 (N, P_2O_5 & K_2O) (457 kg/ha) (Table 3.239a & b).

Table 3.239a: Effect of nutrient management on yield and economics of rainfed castor -Anantapur

Treatment	Seed yield (kg/ha)		Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	2014	Mean (2 yrs)				
T_1: 60:40:30 (N, P_2O_5 & K_2O)	386	437	16071	-1017	0.94	1.66
T_2: 75:50:40 (N, P_2O_5 & K_2O)	447	520	17001	432	1.03	2.02
T_3: 45:30:20 (N, P_2O_5 & K_2O)	411	434	15222	807	1.05	1.63
Soil test based fertilizer application for T_1	407	474	16050	-177	0.99	2.23
Soil test based fertilizer application for T_2	560	590	16955	4885	1.29	1.98
Soil test based fertilizer application for T_3	490	477	15145	3965	1.26	1.96
CD at 5%	NS	-	-	-	-	-

Table 3.239b: Soil fertility status in rainfed castor -Anantapur

Treatment	pH	OC (%)	Available nutrients (kg/ha)			DTPA extractable micronutrient (ppm)			
			N	P_2O_5	K_2O	Zn	Fe	Cu	Mn
T_1: 60:40:30 (N, P_2O_5 & K_2O)	5.27	0.30	150	63	423	0.52	14.94	0.72	9.73
T_2: 75:50:40 (N, P_2O_5 & K_2O)	5.16	0.30	131	64	443	0.62	11.00	0.71	8.87
T_3: 45:30:20 (N, P_2O_5 & K_2O)	5.39	0.25	172	57	457	0.66	10.99	0.63	10.66
Soil test based fertilizer application for T_1	5.47	0.27	191	73	436	0.44	14.34	0.61	13.90
Soil test based fertilizer application for T_2	5.37	0.29	175	69	426	0.48	13.65	0.59	10.43
Soil test based fertilizer application for T_3	5.32	0.41	138	72	422	0.48	13.55	0.59	9.66
CD at 5%	NS	NS	NS	NS	NS	NS	NS	NS	--
Initial values	5.85	0.38	164	54	268	-	-	-	-

In a field experiment on nutrient management in groundnut at Anantapur, treatment T_9 (STBF with PSB + PSF + AM fungi) recorded highest pod yield (479 kg/ha) followed by T_7 (STBF + PSB + AM fungi) with pod yield of 452 kg/ha compared to all other treatments. The higher mean pod yield (693 kg/ha) was recorded with T_9 (STBF with PSB + PSF + AM fungi) followed by T_5 (50% RDF + PSB + PSF + AM fungi) with mean pod yield of 650 kg/ha. Higher net returns of Rs. 5329/ha was recorded with application of PSB + PSF + AM fungi (T_{10}) followed by application of STBF + PSB + AM fungi (T_7). Application of PSB + PSF + AM fungi recorded highest B:C ratio (1.24) as compared to other treatments. Whereas, higher RWUE of 2.15 kg/ha-mm was recorded with treatment T_9 (STBF with PSB + PSF + AM fungi) followed by T_7 (STBF + PSB + AM fungi) (Table 3.240). There were no significant differences in different soil parameters across the treatments (Table 3.241).

Table 3.240: Effect of nutrient management practices on groundnut – Anantapur

Treatment	Yield (kg/ha)		Haulm yield (kg/ha)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Pod yield (kg/ha)	Mean (2 yrs)					
Control (T_1)	331	485	1466	21708	-713	0.97	1.49
50% RDF (T_2)	436	623	1475	23361	1896	1.08	1.96
T_2 + PSB+AM fungi (T_3)	450	640	1551	24061	2146	1.09	2.02
T_2 + PSF+AM fungi (T_4)	451	610	1473	24061	1784	1.07	2.02
T_2 + PSB+PSF+AM fungi (T_5)	421	650	1502	24261	543	1.02	1.89
STBF (T_6)	402	571	1544	23294	971	1.04	1.80
T_6 + PSB+AM fungi (T_7)	452	641	1704	23994	3128	1.13	2.03
T_6 + PSF+AM fungi (T_8)	444	616	1577	23994	2129	1.09	1.99
T_6 + PSB + PSF+AM fungi (T_9)	479	693	1650	24894	3017	1.12	2.15
PSB + PSF + AM fungi (T_{10})	444	606	1543	22608	5329	1.24	1.99
CD at 5%	85.84	-	34.64	-	-	-	-

STBF : Soil test based fertilizer application; PSB: *Bacillus megatherium var. phosphoticum* @ 5 kg/ha
PSF: *Aspergillus awamori* @ 5 kg/ha AM Fungi: *Arbuscular mycorrhiza* @ 12.5 kg/ha

Table 3.241: Soil fertility as influenced by different treatments - Anantapur

Treatment	pH	OC (%)	Available nutrients (kg/ha)			DTPA extractable micronutrients (ppm)			
			N	P_2O_5	K_2O	Zn	Fe	Cu	Mn
Control (T_1)	6.17	0.33	171	54	336	1.09	6.04	0.46	7.06
50% RDF (T_2)	5.97	0.35	179	69	421	1.01	8.88	0.43	7.41
T_2 + PSB+AM fungi (T_3)	6.07	0.40	192	50	432	0.99	8.13	0.39	7.36
T_2 + PSF+AM fungi (T_4)	5.93	0.39	192	60	426	1.48	7.74	0.43	6.88
T_2 + PSB+PSF+AM fungi (T_5)	5.67	0.35	204	55	449	0.88	8.17	0.47	11.27
STBF (T_6)	5.70	0.39	183	51	345	0.99	8.10	0.43	8.42
T_6 + PSB+AM fungi (T_7)	5.53	0.32	163	52	367	1.36	9.96	0.54	10.75
T_6 + PSF+AM fungi (T_8)	5.60	0.41	188	37	367	2.19	7.95	0.45	8.47
T_6 + PSB + PSF+AM fungi (T_9)	6.03	0.47	179	61	475	0.83	7.03	0.35	9.20
PSB + PSF + AM fungi (T_{10})	6.13	0.44	183	66	372	1.61	7.05	0.42	7.45
CD @ 5 %	NS	NS	NS	NS	NS	-	-	-	-
Initial values	6.2	0.5	142	52	261	-	-	-	-

In a study on effect of P and K application on enhancement of nutrient use efficiency in groundnut at Anantapur, among various levels of K_2O, application of K_2O @ 60 kg/ha as basal recorded higher pod and haulm yield (239 and 703 kg/ha), respectively over all other levels of K_2O. Similarly, higher B:C ratio (0.58) and RWUE (1.07 kg/ha-mm) were recorded with K_2O @ 60 kg/ha. Among different magnesium levels, higher dose i.e. $MgSO_4$ @ 30 kg/ha as basal recorded higher pod and haulm yield (219 and 701 kg/ha) in groundnut, respectively. With higher B:C ratio (0.53) and RWUE (0.98 kg/ha-mm) (Table 3.242a). There were no significant differences in case of soil chemical properties (Table 3.242b).

Table 3.242a: Response of groundnut to various levels of potassium and magnesium - Anantapur

Treatment	Yield (kg/ha)		Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Pod	Haulm				
Potassium levels						
Control	194	697	21708	-10463	0.52	0.87
20 kg K_2O as basal	210	701	22032	-10127	0.54	0.94
40 kg K_2O as basal	202	692	22356	-10816	0.52	0.91
60 kg K_2O as basal	239	703	22680	-9605	0.58	1.07
CD at 5%	NS	NS	-	-	-	-
Magnesium levels						
Control	209	696	21708	-9868	0.55	0.94
10 kg $MgSO_4$ as basal	208	698	22128	-10318	0.53	0.93
20 kg $MgSO_4$ as basal	210	697	22548	-10663	0.53	0.94
30 kg $MgSO_4$ as basal	219	701	22968	-10703	0.53	0.98
CD at 5%	NS	NS	-	-	-	-

Table 3.242b: Soil chemical properties as influence by various levels of potassium and magnesium - Anantapur

Treatment	pH	OC (%)	Available nutrients (kg/ha)			DTPA extractable micronutrients (ppm)			
			N	P_2O_5	K_2O	Zn	Fe	Cu	Mn
Potassium levels									
Control	5.60	0.37	153	65	173	1.17	11.60	0.56	8.06
20 kg K_2O as basal	5.78	0.40	165	57	259	1.70	12.62	0.83	10.40
40 kg K_2O as basal	5.79	0.45	156	60	269	1.66	10.91	0.81	11.54
60 kg K_2O as basal	5.73	0.36	163	69	349	1.32	12.59	0.84	10.78
CD at 5%	NS	NS	NS	NS	93	0.51	NS	0.13	1.78
Magnesium levels									
Control	5.78	0.40	155	48	219	1.48	11.07	0.68	9.58
10 kg $MgSO_4$ as basal	5.83	0.39	164	76	272	1.23	12.95	0.72	9.77
20 kg $MgSO_4$ as basal	5.60	0.37	161	63	288	1.28	11.46	0.84	10.30
30 kg $MgSO_4$ as basal	5.69	0.43	157	65	270	1.85	12.24	0.79	11.13
CD at 5%	NS	NS	NS	NS	NS	-	-	-	-
Initial values	5.42	0.38	165	62	264	1.18	11.84	0.62	10.25

In an experiment on effect of different foliar sprays on performance of groundnut at Anantapur, higher pod yield (497 kg/ha) and haulm yield (2008 kg/ha) were recorded with application of soil test based fertilizer (STBF) + 1% KCl spray (2 times) followed by application of STBF + water spray with pod yield of 452 kg/ha and haulm yield of 1858 kg/ha, respectively. However, higher net returns (Rs.3517/ha) and BC ratio (1.15) were recorded with application of STBF + water spray. The higher rainwater use efficiency was recorded with (STBF) + 1% KCl spray (2 times) followed by application of STBF + water spray (2.02 kg/ha-mm) (Table 3.243a). There were no significant differences with various foliar sprays on soil chemical properties (Table 3.243b).

Table 3.243a: Response of groundnut to various foliar sprays – Anantapur

Treatment	Yield (kg/ha)		Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Pod	Haulm				
STBF + no spray	370	1575	23855	-1178	0.95	1.66
STBF + water spray	452	1858	23855	3517	1.15	2.02
STBF + KNO_3 (1% spray - 2 sprays)	365	1605	32455	-9841	0.70	1.63
STBF + KCl (1% spray - 2 sprays)	497	2008	27255	2680	1.10	2.23
STBF + Thiourea @ 250 g/ha	443	1778	24275	2342	1.10	1.98
STBF + $ZnSO_4$ (0.2% spray - 2 sprays)	438	1716	24335	1757	1.07	1.96
CD at 5%	NS	145	--	--	--	--

STBF: Soil test based fertilizer

Tableb 3.243b: Effect of various foliar sprays on chemical properties of soil - Anantapur

Treatment	pH	OC (%)	Available nutrients (kg/ha)			DTPA extractable micronutrients (ppm)			
			N	P_2O_5	K_2O	Zn	Fe	Cu	Mn
STBF + no spray	6.33	0.45	150	64	487	0.75	9.88	0.58	15.33
STBF + water spray	6.00	0.49	183	70	515	1.09	14.09	0.82	16.32
STBF + KNO_3 (1% spray - 2 sprays)	5.80	0.43	188	53	483	1.14	11.29	0.68	16.43
STBF + KCl (1% spray - 2 sprays)	6.40	0.54	183	73	542	0.75	10.02	0.54	16.59
STBF + Thiourea @ 250 g/ha	6.37	0.55	175	67	517	0.69	10.64	0.57	15.88
STBF + $ZnSO_4$ (0.2% spray - 2 sprays)	6.30	0.54	175	65	450	1.28	12.21	0.88	17.20
CD at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS
Initial values	6.2	0.51	175	62	488	0.84	10.24	0.54	15.54

STBF: Soil test based fertilizer

In a study on response of sesame to phosphorus management at Rajkot, application of 50 kg P_2O_5/ha through SSP was superior with higher seed yield (995 kg/ha), mean seed yield (753 kg/ha), stalk yield (2963 kg/ha), net returns (Rs.65812/ha) and RWUE (2.06 kg/ha-mm) as compared to other treatments. However, the highest B:C ratio (5.16) was recorded with application of RDN + S equal to 25 kg SSP through gypsum compared all other treatments (Table 3.244).

Table 3.244: Effect of phosphorus management on yield and economics of sesame - Rajkot

Treatment	Yield (kg/ha)			Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Seed (2014)	Mean seed yield (2 yrs)	Stalk				
Absolute control	713	660	2377	14000	47080	4.36	1.48
25 kg P_2O_5/ha through DAP	846	714	2562	15822	56600	4.58	1.75
25 kg P_2O_5/ha through SSP	887	769	2778	17014	58937	4.46	1.84
25 kg P_2O_5/ha through rock phosphate	770	605	2469	14950	50994	4.41	1.59
25 kg P_2O_5/ha through rock phosphate + PSM	778	669	2500	15070	51560	4.42	1.61
50 kg P_2O_5/ha through DAP	852	675	2562	16987	55945	4.29	1.76

Treatment	Yield (kg/ha)			Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Seed (2014)	Mean seed yield (2 yrs)	Stalk				
50 kg P_2O_5/ha through SSP	995	753	2963	19356	65812	4.40	2.06
50 kg P_2O_5/ha through rock phosphate	788	634	2500	15228	52252	4.43	1.63
50 kg P_2O_5/ha through rock phosphate + PSM	824	650	2500	16576	53964	4.26	1.71
RDN + S equal to 25 kg SSP through gypsum	868	645	2654	14408	59903	5.16	1.80
RDN + S equal to 50 kg SSP through gypsum	870	714	2777	14479	60027	5.15	1.80
RDN + 40 kg K_2O/ha	831	721	2531	15128	56013	4.70	1.72
CD at 5%	138	-	NS	-	-	-	-

In a study on effect to foliar nutrition on groundnut at Rajkot, the maximum pod yield (279 kg/ha) was recorded with foliar spray of 1% each of Fe and Zn at 30 to 35 DAS. However, higher mean pod yield (900 kg/ha) was recorded with foliar spray of 2% KNO_3 at 60 DAS followed by foliar spray of 2% urea at 30 to 35 DAS + 2% KNO_3 at 60 DAS (894 kg/ha) and foliar spray of 2% urea at 30 to 35 DAS (880 kg/ha) as compared to other treatments. Highest mean haulm yield (3443 kg/ha) was recorded with foliar spray of 2% urea at 30 to 35 DAS followed by foliar spray of 2% urea at 30 to 35 DAS + 2% KNO_3 at 60 DAS (3419 kg/ha) compared to other treatments (Table 3.245).

Table 3.245: Response of groundnut to foliar nutrients - Rajkot

Treatment	Yield (kg/ha)				Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Pod (2014)	Mean pod yield (2 yrs)	Haulm (2014)	Mean haulm yield (2 yrs)				
Absolute control	271	747	2529	3181	25723	-2238	-0.087	0.57
Water spray (no nutrients)	177	742	2128	2995	25923	-8203	-0.316	0.37
Foliar spray of water soluble fertilizer @ 1% (NPK-19-19-19) at 30 to 35 DAS	183	800	2468	3290	26673	-7013	-0.263	0.38
Foliar spray of Fe & Zn @ 1% at 30 to 35 DAS	279	862	2674	3066	26223	-1693	-0.065	0.59
Foliar spray of water soluble fertilizer @ 1% and Fe & Zn @ 1% at 30 to 35 DAS	141	835	2294	2974	26973	-9863	-0.366	0.30
Foliar spray of selenium @ 20 g/ha at 30 to 35 DAS	116	794	1930	3042	26723	-12433	-0.465	0.24
Foliar spray of 2% urea at 30 to 35 DAS	203	880	2316	3443	25986	-6286	-0.242	0.43
Foliar spray of 2% KNO_3 at 30 to 35 DAS	190	776	2209	2994	27723	-9078	-0.327	0.40
Foliar spray of 2% KNO_3 at 60 DAS	188	900	2443	3250	27723	-7988	-0.288	0.39
Foliar spray of 2% urea at 30 to 35 DAS + 2% KNO_3 at 60 DAS	232	894	2532	3419	28223	-6283	-0.223	0.49

3.4.1.4 Energy management

In a tillage study in *kharif* groundnut with various implements at Anantapur, use of sub-soiler gave highest pod yield (210 kg/ha) and haulm yield (1900 kg/ha) during 2014, and highest mean pod yield (970 kg/ha) as compared to other treatments. Similarly, the maximum net returns (Rs.15080/ha), B:C ratio (0.72) and RWUE (0.94 kg/ha-mm) were recorded by tillage with sub soiler followed by M.B. plough (Table 3.246).

Table 3.246: Effect of different tillage implements on *kharif* groundnut - Anantapur

Treatment	Yield (kg/ha)			Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Pod yield (2014-15)	Mean pod yield (3 yrs)	Haulm yield				
Sub soiler	210	970	1900	21000	15080	0.72	0.94
M.B. plough	195	772	1716	21500	13993	0.65	0.87
Disc plough	194	606	1445	21500	13869	0.64	0.87
7 tyne duck foot cultivator	176	747	1855	21700	12691	0.58	0.79
5 tyne duck foot cultivator	173	606	1387	21350	12387	0.58	0.78
Spring tyne cultivator	154	543	1258	21500	11032	0.51	0.69

Sub soiler

Spring tyne cultivator

In a study on the performance of aqua planter for sowing groundnut at Anantapur, the higher pod yield (355 kg/ha) was recorded by groundnut sowing with aqua planter. The higher field efficiency (2.5 hr/ha) and higher output energy (21617 MJ/ha) was also recorded with aqua planter sowing of groundnut (Table 3.247).

Table 3.247: Performance of aqua planter in groundnut – Anantapur

Treatment	Yield (kg/ha)		Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)	Field efficiency (hr/ha)	Energy (MJ/ha)		Energy use efficiency
	Pod	Haulm						Input	Output	
Groundnut sown with aqua planter	355	1238.7	23000	24967	1.08	1.59	2.5	1403.47	21617	15.41

Aqua planter for groundnut sowing

The tractor drawn ananta planter was evaluated for sowing of castor and the castor planter gave higher field efficiency (1.42 hr/ha) as well as higher energy output (5758.2 MJ/ha) while maintaining the proper spacing and depth of sowing (Table 3.248).

Table 3.248: Performance of tractor drawn Ananta planter on castor yield and economics - Anantapur

Treatment	Yield (kg/ha)		Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)	Field efficiency (hr/ha)	Energy (MJ/ha)		Energy use efficiency
	Seed	Stalk						Input	Output	
Castor sown with Ananta castor planter	1026	1717	7000	51300	7.33	4.61	1.42	478.47	5758.2	12.03

In a study on feasibility testing of tractor drawn intercultivation implement in castor, the seed yield of 693 kg/ha and stalk yield of 1662 kg/ha were recorded with intercultivation practice. The higher field efficiency (2.22 hr/ha) and higher energy output (47251 MJ/ha) were recorded with intercultivation implement in castor (Table 3.249).

Table 3.249: Performance of castor with intercultivation - Anantapur

Treatment	Yield (kg/ha)		Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)	Field efficiency (hr/ha)	Energy (MJ/ha)		Energy use efficiency
	Seed	Stalk						Input	Output	
Castor with intercultivation	693.4	1662	7000	34670	4.95	3.11	2.22	478.47	47251	98.7

Intercultivation operation in castor

3.4.1.5 Evaluation of improved varieties

During *kharif* 2014, fourteen entries of groundnut were tested for their performance at Anantapur. Due to severe drought, the yields were extremely low and the experiment was vitiated. From the mean data of two years the entry No. MLTG (SG)-11 recorded highest pod yield (1193 kg/ha), net returns (Rs. 36050/ha), B:C ratio (2.54) and RWUE (3.50 kg/ha-mm) followed by MLTG (SG)-2 and MLTG(SG) -10 as compared to other entries of groundnut tested (Table 3.250).

Table 3.250: Performance of groundnut genotypes in multilocation trial on groundnut (SB) - Anantapur

Entry	Pod yield (kg/ha)	Haulm yield (kg/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
MLTG(SG)-11	1193	2213	36050	2.54	3.50
MLTG(SG)-2	1144	2175	33889	2.45	3.35
MLTG(SG)-10	1110	1928	31202	2.33	3.25
MLTG(SG)-13	1101	1993	31184	2.33	3.23
MLTG(SG)-3	1060	1842	28744	2.23	3.11
MLTG(SG)-6	1054	1866	28654	2.22	3.09
MLTG(SG)-5	1045	1801	27927	2.19	3.06
MLTG(SG)-12	991	1889	26236	2.12	2.90
MLTG(SG)-9	888	1465	19869	1.85	2.60
MLTG(SG)-14	837	1523	18136	1.78	2.45
MLTG(SG)-8	817	1572	17613	1.75	2.40
MLTG(SG)-1	809	1447	16613	1.71	2.37
MLTG(SG)-4	778	1556	15968	1.68	2.28
MLTG(SG)-7	753	1414	14198	1.61	2.21

Cost of cultivation: Rs. 23396/ha

In an evaluation of twelve entries of groundnut at Anantapur, entry MLTG (VG)-9 gave maximum pod yield (1297 kg/ha), haulm yield (2577 kg/ha), NMR (Rs.42119/ha) with B:C ratio of 2.80 and RWUE of 3.80 kg/ha-mm. MLTG(VG)-12 (1261 kg/ha) and MLTG (VG)-7 (1213 kg/ha) were the next best entries (Table 3.251).

Table 3.251: Performance of groundnut genotypes in multilocation trial on groundnut (VB) - Anantapur

Entry	Pod yield (kg/ha)	Haulm yield (kg/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
MLTG(VG)-9	1297	2577	42119	2.80	3.80
MLTG(VG)-12	1261	2326	39349	2.68	3.70
MLTG(VG)-7	1213	2311	37370	2.60	3.56
MLTG(VG)-5	1066	1859	29077	2.24	3.12
MLTG(VG)-2	1046	1885	28415	2.21	3.07
MLTG(VG)-11	1041	1994	28790	2.23	3.05
MLTG(VG)-4	1038	2010	28777	2.23	3.04
MLTG(VG)-8	712	1464	12841	1.55	2.09
MLTG(VG)-1	705	1430	12360	1.53	2.07
MLTG(VG)-10	695	1473	12211	1.52	2.04
MLTG(VG)-3	686	1555	12263	1.52	2.01
MLTG(VG)-6	684	1174	10166	1.43	2.00

Cost of cultivation: Rs. 23396/ha

In an evaluation of twelve entries of horsegram at Anantapur, entries HG-6, HG-9 and HG-1 were superior with a significantly higher seed yield of 690,634 and 612 kg/ha, respectively. Similarly higher net returns (Rs.6800, 5680 and 5240/ha), B:C ratios (1.97, 1.81 and 1.75) and RWUE (3.33, 3.06 and 2.95 kg/ha-mm) were also recorded with HG-6, HG-9 and HG-1 entries of horsegram, respectively compared to other entries (Table 3.252).

Table 3.252: Performance of drought tolerant horsegram varieties – Anantapur

Entry	Seed yield (kg/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
HG-6	690	6800	1.97	3.33
HG-9	634	5680	1.81	3.06
HG-1	612	5240	1.75	2.95
HG-2	546	3920	1.56	2.64
HG-8	524	3480	1.50	2.53
ATPHG-11(C)	507	3140	1.45	2.45
HG-7	491	2820	1.40	2.37
HG-5	474	2480	1.35	2.29
HG-3	453	2060	1.29	2.19
HG-4	442	1840	1.26	2.13

Cost of cultivation: Rs. 7000/ha

In a cowpea advanced varietal trial with twenty eight entries at Anantapur, the entry CP-31 recorded highest seed yield (814 kg/ha) with a net returns of Rs.25544/ha, B:C ratio of 2.89 and RWUE of 4.08 kg/ha-mm as compared to all other entries (Table 3.253).

Table 3.253: Performance of high yielding drought tolerant cowpea varieties – Anantapur

Entry	Seed yield (kg/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
CP-31	814	25544	2.89	4.08
CP-25	726	21320	2.58	3.64
CP-32	718	20936	2.55	3.60
CP-33	702	20168	2.49	3.52
CP-36	697	19928	2.47	3.49
CP-35	660	18152	2.34	3.31
CP-38	636	17000	2.26	3.19
CP-12	630	16712	2.24	3.16
CP-40	622	16328	2.21	3.12
CP-28	621	16280	2.20	3.11
CP-41	567	13688	2.01	2.84
CP-17	562	13448	1.99	2.82
CP-39	562	13448	1.99	2.82
CP-37	472	9128	1.67	2.36
CP-13	461	8600	1.64	2.31
CP-23	461	8600	1.64	2.31
CP-22	449	8024	1.59	2.25
CP-19	445	7832	1.58	2.23

Entry	Seed yield (kg/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
CP-34	441	7640	1.56	2.21
CP-29	408	6056	1.45	2.04
CP-20	405	5912	1.44	2.03
CP-30	330	2312	1.17	1.65
CP-27	308	1256	1.09	1.54
CP-24	299	824	1.06	1.50
CP-18	296	680	1.05	1.48
CP-14	275	-328	0.98	1.38
CP-16	272	-472	0.97	1.36
CP-26	267	-712	0.95	1.34

Cost of cultivation: Rs.13528/ha

In a guar initial varietal trial with fifteen entries at Anantapur, GR-13 recorded highest seed yield of 253 kg/ha with net returns of Rs.587/ha, B:C ratio of 1.04 and RWUE of 1.27 kg/ha-mm. The entry GR-4 was the next best entry (Table 3.254).

Table 3.254: Performance of guar genotypes in initial varietal trial of guar - Anantapur

Entry	Seed yield (kg/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
GR-13	253	587	1.04	1.27
GR-4	247	257	1.02	1.24
GR-1	241	-73	0.99	1.21
GR-2	237	-293	0.98	1.19
GR-3	206	-1998	0.85	1.03
GR-9	203	-2163	0.84	1.02
GR-5	199	-2383	0.82	1.00
GR-11	196	-2548	0.81	0.98
GR-12	164	-4308	0.68	0.82
GR-6	162	-4418	0.67	0.81
GR-10	144	-5408	0.59	0.72
GR-8	122	-6618	0.50	0.61
GR-14	122	-6618	0.50	0.61
GR-7	103	-7663	0.43	0.52
GR-15	99	-7883	0.41	0.50

Cost of cultivation: Rs. 13328/ha

In a groundnut varietal trial at Rajkot, genotype JSP-51 gave maximum pod yield (1250 kg/ha), while the genotype JSP-57 gave maximum mean pod yield (2688 kg/ha). The higher haulm yield (5608 kg/ha) was recorded by Somnath (C) genotype, followed by JSP-55 (5139 kg/ha) and JSP-58 (5104 kg/ha) compared to other genotypes. However, higher net returns (Rs.32216/ha), B:C ratio (2.17) and RWUE (2.63 kg/ha-mm) were recorded with JSP-51 as compared to all other genotypes (Table 3.255).

Table 3.255: Performance of groundnut genotypes in varietal trial (VR) - Rajkot

Genotype	Pod yield (kg/ha)		Haulm yield (kg/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	2014	Mean (3 yrs)				
JSP-51	1250	1491	4809	32216	2.17	2.63
JSP-52	660	1368	4306	11029	1.40	1.39
JSP-55	961	1645	5139	24144	1.87	2.02
JSP-56	1103	1577	4826	27507	1.99	2.32
JSP-57	824	2688	4566	17399	1.63	1.73
JSP-58	1165	1165	5104	30634	2.11	2.45
GJG-11 (C)	979	1582	5069	24449	1.88	2.06
GG-13 (C)	987	1771	4844	23809	1.86	2.07
GG-17 (C)	776	2088	4844	16951	1.61	1.63
Somnath (C)	1057	2392	5608	29140	2.05	2.22
CD at 5%	201	-	550	-	-	-

Cost of cultivation: Rs. 27732/ha

In another varietal trial of groundnut at Rajkot, the highest mean pod yield (1543 kg/ha) was recorded with genotype JSSP-46 which was 31, 83 and 108% more over check varieties GG-20, GJG-22 and Kadiri-3, respectively. However, Kadiri-3 gave highest haulm yield (4583 kg/ha) followed by genotypes JSSP-46 (4566 kg/ha), JSSP-50 (4167 kg/ha), JSSP-47 (4010 kg/ha), JSSP-42 (3979) and GJG-22 (c) (3924) (Table 3.256).

Table 3.256: Performance of groundnut genotypes in varietal trial (VB) -Rajkot

Genotype	Pod yield (kg/ha)		Haulm yield (kg/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	2014	Mean (3 yrs)				
JSSP-42	839	822	3976	15527	1.56	1.76
JSSP-43	793	807	3620	12608	1.46	1.67
JSSP-44	1118	1288	2413	18342	1.66	2.35
JSSP-45	931	1302	3898	18205	1.66	1.96
JSSP-46	1543	1667	4566	40767	2.47	3.24
JSSP-47	807	938	4010	14623	1.53	1.70
JSSP-49	1148	1148	2995	21645	1.78	2.41
JSSP-50	828	828	4167	15933	1.58	1.74
JVB-2260	582	714	3906	6894	1.25	1.22
JVB-2261	656	837	3863	9127	1.33	1.38
JVB-2263	821	855	3229	11953	1.43	1.72
GJG-20 (c)	1181	1563	3854	26152	1.95	2.48
GJG-22(c)	842	1008	3924	15413	1.56	1.77
Kadiri-3(c)	740	855	4583	14733	1.53	1.55
CD at 5%	173	-	670	-	-	-

Cost of cultivation: Rs. 27645/ha

High yielding groundnut genotype JSSP-46

Check variety GG-20

At Rajkot, in a varietal trial of sesame, among the four genotypes tested with four checks, maximum seed yield (1750 kg/ha), net returns (Rs.160283/ha), B:C ratio (11.89) and RWUE (3.68 kg/ha-mm) were recorded with AT-282 but was at par with check varieties G.Til-10, G.Til-4 and G.Til-3. The maximum mean seed yield (725 kg/ha) was recorded with AT-265 genotype followed by variety G.Til.4 (667 kg/ha) compared to other genotypes (Table 3.257).

Table 3.257: Performance of sesame genotypes - Rajkot

Genotype	Seed yield (kg/ha)		NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	2014	Mean (4 yrs)			
AT-249	1451	313	130383	09.86	3.05
AT-253	1476	562	132883	10.03	3.10
AT-265	1295	725	114783	08.80	2.72
AT-282	1750	516	160283	11.89	3.68
G.Til-2(C)	1477	502	132983	10.04	3.10
G.Til-3(C)	1521	507	137383	10.33	3.19
G.Til-4(C)	1597	667	144983	10.85	3.35
G.Til-10(C)	1647	486	149983	11.19	3.46
CD at 5%	251	-	-	-	-

Cost of cultivation: Rs.14717/ha

High yielding seame genotype AT-282

Check variety G.Til-4

At Rajkot, in a varietal trial of greengram, the highest seed yield (1272 kg/ha), net returns (Rs.57336/ha), B:C ratio (5.54) and RWUE (2.67 kg/ha-mm) were recorded by GJM-1111 genotype followed by GJM-1105 and SKNM 06-08. The increase in yield by GJM-1111 was 14 and 24% over GM-4 and Meha varieties, respectively (Table 3.258).

Table 3.258: Performance of greengram genotypes - Rajkot

Genotype	Seed yield (kg/ha)		NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	2014	Mean (3 yrs)			
GM-4 (c)	1120	869	48976	4.88	2.35
Meha (c)	1028	521	43916	4.48	2.16
SKNM 04-02	1165	1165	51451	5.08	2.45
SKNM 05-08	1070	1070	46226	4.66	2.25
SKNM 06-08	1205	1205	53651	5.25	2.53
SKNM 07-08	950	950	39626	4.14	2.00
SKNM 08-06	1015	1015	43201	4.42	2.13
SKNM 11-02	947	947	39461	4.13	1.99
GJM-11-01	1096	1096	47656	4.78	2.30
GJM-1103	1187	1187	52661	5.17	2.49
GJM-1104	1128	1128	49416	4.91	2.37
GJM-1111	1272	1272	57336	5.54	2.67
GJM-1112	1049	1049	45071	4.57	2.20
GJM-1118	910	910	37426	3.96	1.91
VMS-6	1097	522	47711	4.78	2.30
VMS-12-7	1024	1024	43696	4.46	2.15
GJM-1105	1237	1237	55411	5.39	2.60
CD at 5%	182	-	-	-	-

Cost of cultivation: Rs.12624/ha

High yielding greengram genotype GJM-1111

Check variety GM-4

In an experiment on groundnut at Rajkot, significant differences were observed among varieties and nutrient management treatments. The highest pod yield (1959 kg/ha) and RWUE (4.11 kg/ha-mm) were recorded with treatment TG-37A with RDF + 50 kg K_2O/ha + 500 kg/ha gypsum followed by treatment GG-7 with RDF + 50 kg K_2O/ha + 500 kg/ha gypsum (1871 kg/ha) with RWUE of 3.93 kg/ha-mm as compared to other treatments. The higher net returns (Rs.53769/ha) and B:C ratio (2.89) were recorded with treatment GG-7 with RDF + 50 kg K_2O/ha + 500 kg/ha gypsum compared to other treatments (Table 3.259).

Table 3.259: Performance of groundnut varieties as influenced by nutrient management - Rajkot

Treatment	Pod yield (kg/ha)		Haulm yield (kg/ha)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	2014	Mean (3 yrs)					
GG-2 with RDF (12.5 N, 25 P, 0 K kg/ha)	824	873	5062	27600	19428	1.70	1.73
GG-5 with RDF (12.5 N, 25 P, 0 K kg/ha)	1056	1188	5048	27600	26912	1.98	2.22
GG-7 with RDF(12.5 N, 25 P, 0 K kg/ha)	1761	1280	5309	27600	50869	2.84	3.70
GG-20 with RDF (12.5 N, 25 P, 0 K kg/ha)	686	748	5898	27600	18287	1.66	1.44
TG-37A with RDF (12.5 N, 25 P, 0 K kg/ha)	1462	1070	4733	27600	38847	2.41	3.07
GG-2 with RDF + 25 kg K_2O/ha	1281	860	4801	27900	32937	2.18	2.69
GG-5 with RDF + 25 kg K_2O/ha	1726	1305	4678	27900	46907	2.68	3.63
GG-7 with RDF + 25 kg K_2O/ha	1723	1235	5720	27900	50978	2.83	3.62
GG-20 with RDF + 25 kg K_2O/ha	774	712	5364	27900	18711	1.67	1.63
TG-37A with RDF + 25 kg K_2O/ha	1517	1046	4156	27900	38027	2.36	3.19
GG-2 with RDF + 50 kg K_2O/ha+ 500 kg/ha gypsum	1155	804	4870	28495	28523	2.00	2.43
GG-5 with RDF + 50 kg K_2O/ha + 500 kg/ha gypsum	1772	1316	4746	28495	48079	2.69	3.72
GG-7 with RDF + 50 kg K_2O/ha + 500 kg/ha gypsum	1871	1369	5364	28495	53769	2.89	3.93
GG-20 with RDF + 50 kg K_2O/ha + 500 kg/ha gypsum	988	832	5281	28495	24739	1.87	2.08
TG-37A with RDF + 50 kg K_2O/ha + 500 kg/ha gypsum	1959	1336	4609	28495	53609	2.88	4.11

Variety TG37-A under RDF

Variety GG-5 under RDF

3.4.1.6 Alternate land use/ Integrated farming systems

In an experiment on alternate land use system, groundnut recorded higher pod (607 kg/ha) and stalk yield (1139 kg/ha) followed by groundnut + simarouba agroforestry system with 27 and 321 kg/ha, respectively. However, the maximum main crop equivalent yield (739 kg/ha) was also recorded with groundnut alone as compated to other agroforestry systems (Table 3.260).

Table 3.260: Performance of different agroforestry systems - Anantapur

Treatment	Yield (kg/ha)			MCEY (kg/ha)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio
	Main crop (fruit/ plantation)	Intercrop (annual crop)	Stover/ stalk yield				
Groundnut alone	-	607	1139	739	23396	6921	0.29
Groundnut + amla	25	52	104	64	29500	-20141	-0.68
Groundnut + subabul	-	101	185	101	29500	-20141	-0.68
Groundnut + simarouba	27	106	321	106	29500	-20141	-0.68
Groundnut + custard apple	15	97	284	103	29500	-20141	-0.68

MCEY: Main crop equivalent yield

In an integrated farming system experiment involving agroforestry systems, sheep rearing and groundnut at Anantapur, higher main crop equivalent yield (823 kg/ha), net returns (Rs. 24445/ha) and B:C ratio (0.51) were recorded with groundnut as sole crop with rearing of 10 sheep compared to other systems (Table 3.261).

Table 3.261: Performance of different IFS modules - Anantapur

Farming system	Productivity (kg/ha)		System productivity (MCEY) (kg/ha)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	Employment generation (man-days/ha/yr)
	Crop	Livestock					
Groundnut sole	607	-	607	23396	6921	0.29	110
Groundnut + aonla	179	-	179	29500	-20141	- 0.68	110
Groundnut + aonla + 10 sheep	179	26.6	395	53500	-2196	-0.04	200
Groundnut sole + 10 sheep	607	26.6	823	47396	24445	0.51	200

In an experiment on integrated farming system at Rajkot, higher net returns of Rs.112272/ha was recorded with integrated farming system (various field crops with animal component) compared to farmer's practice of cotton cultivation. The employment generation under IFS module was 365 man-days/ha/yr compared to 165 man-days/ha/yr under farmer's practice of cotton cultivation (Table 3.262).

Table 3.262: Economics of integrated farming system under rainfed condition - Rajkot

Farming system	Component		System productivity (MCEY) (kg/ha)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	Employment generation (man-days/ha/yr)
	Crop	Livestock					
IFS	Cotton, pigeonpea, sorghum, maize, cowpea	Cow-1	4213	56265	112272	1.99	365
Main crop/ cropping system*	Cotton monocropping	-	3630	46365	98835	2.13	165

3.4.2 Soybean Based Production System

3.4.2.1 Rainwater management

In an experiment to study the effect of drip irrigation and mulching on growth and productivity of guava and *aonla* based agri-horti system at Indore, among the three mulches, plastic mulch was found to be best followed by organic residue and glyricidia mulch in guava, while glyricidia leaves mulch was found to be best followed by organic residue and plastic mulch on *aonla*. Guava plant height (380 and 315 cm) was maximum with plastic mulch under both drip and basin irrigation, respectively. However, *aonla* plant height (530 cm) and diameter (65 cm) was maximum with glyricidia leaves mulch with drip irrigation, while with basin irrigation, plastic mulch gave maximum plant height (420 cm) and organic residues mulch gave maximum diameter (55 cm). The survival percentage was 100% in both guava and *aonla* (Table 3.263).

Table 3.263: Effect of drip irrigation and mulching on growth of guava and *aonla* - Indore

Treatment	Drip irrigation			Basin irrigation		
	Height (cm)	Diameter (cm)	Survival (%)	Height (cm)	Diameter (cm)	Survival (%)
Guava (Allahabadi safeda)						
Plastic mulch	380	32	100	315	30	100
Organic residue mulch	370	35	100	280	28	100
Gliricidia leaves mulch	350	30	100	285	25	100
Control	325	29	100	280	22	93.25
***Aonla* (Narendra-7)**						
Plastic mulch	445	50	100	420	44	100
Organic residue mulch	480	56	100	330	55	100
Gliricidia leaves mulch	530	65	100	410	50	100
Control	315	40	100	330	38	100

The higher soybean seed yield (1229 and 1208 kg/ha) and straw yield (2500 and 2708 kg/ha) were recorded in both guava and *aonla* based agri-horti system with glyricidia leaves mulching. Higher NMR (Rs.30202 & Rs.29707/ha), B:C ratio (1.68 and 1.65) and RWUE (1.74 and 1.71 kg/ha-mm) were also recorded in both guava and aonla based system with glyricidia leaves mulch as compared to other mulches, respectively (Table 3.264).

Table 3.264: Performance of soybean with various mulches under different agri-horti systems - Indore

Treatment	Grain yield (kg/ha)	Straw (kg/ha)	Cost of cultivation (Rs./ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha- mm)
Guava (Allahabadi safeda)						
Plastic mulch	1146	2042	18000	25186	1.40	1.62
Organic Residue mulch	1104	2292	18000	25228	1.40	1.56
Gliricidia leaves mulch	1229	2500	18000	30202	1.68	1.74
Control	979	2083	18000	20436	1.14	1.38
***Aonla* (Narendra-7)**						
Plastic mulch	1104	2542	18000	25748	1.43	1.56
Organic Residue mulch	1187	2600	18000	28562	1.59	1.68
Gliricidia leaves mulch	1208	2708	18000	29707	1.65	1.71
Control	979	2083	18000	20437	1.14	1.38

Earthen pot for drip irrigation

Polythene mulch in Guava

Organic mulch in Aonla (N-7)

In an experiment on catchment-storage-command relationship for enhancing water productivity in a micro-watershed at Indore with different cropping systems, four cropping systems were evaluated using harvested rainwater. The bunds of farm pond were also used for growing of vegetable crops, which gave an additional income. Among various cropping systems, the highest NMR was obtained with sweet corn-vegetable cropping sequence (Rs.151646/ha). Traditional cropping sequence (soybean-chickpea) gave NMR of Rs.55008/ha, which was 175.67% lower than sweet corn-vegetable cropping sequence. All other cropping sequences gave higher NMR as compared to traditional system of soybean–chickpea sequence except soybean-potato. During *rabi* season, tomato gave highest yield (11660 kg/ha), followed by sponge gourd, potato and chickpea (Table 3.265).

Table 3.265: Performance of different crops in a micro-watershed - Indore

Cropping sequence	Crops	Yield (kg/ha)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio
Sweet corn-tomato	Sweet corn (K)	7737	25000	52370	3.09
	Tomato (R)	11660	45000	71600	2.57
Sweet corn-vegetable	Sweet corn (K)	7737	25000	52366	3.09
	Sponge gourd / Bottle gourd	6214	25000	99280	4.97
Soybean-potato	Soybean (K)	902	18000	18077	2.00
	Potato (R)	4595	25000	20953	1.84
Soybean- chickpea	Soybean (K)	902	18000	18077	2.00
	Chick pea (R)	1248	13000	36931	3.84

* (K) = *Kharif* ; (R) = *Rabi*

Fertigation unit

Water harvesting pond

At Indore, on an average 6 out of 13 storms occurred as erosive storms in July, 2014 followed by August and June. The amount of erosive rainfall from the month of October to May was negligible. The monthly distribution of kinetic energy (KE) is presented in table. Monthly normal values showed that K.E. of the rainfall was highest in July (298.70 m t/ha-cm) followed by August and September (279.97 and 260.58 m t/ha-cm). The results reveal that July and August are most erosive months of the rainy season which recorded highest erosion index of 25.86 and 17.53, respectively (Table 3.267).

Table 3.267: Effect of rainfall on kinetic energy and erosive index – Indore

Month	Rainfall (mm)	No. of rainy days	No. of erosive storms	Rainfall intensity/ hr	Average monthly kinetic energy (m t/ha-cm)	Average monthly erosion index
January	55.6	2	2	2.136	94.64	0.56
February	42.2	2	1	1.758	77.15	0.35
March	0.0	0	0	0.00	59.74	0.61
April	2.4	1	0	0.100	59.74	0.015
May	24.2	2	1	1.000	161.65	1.34
June	11.0	2	0	0.458	252.63	6.46
July	375.4	10	6	15.64	298.70	25.86
August	153.6	5	4	6.380	279.97	17.53
September	117.6	7	3	4.902	260.56	7.45
October	31.4	4	0	1.308	182.89	1.74
November	0.0	0	0	0.00	109.43	1.32
December	5.8	1	0	0.240	116.32	0.207

At Rewa, in a study on catchment-storage-command relationship for enhancing water productivity, blackgram was sown during *kharif* but due to continuous and excessive rains, blackgram gave very low yield of 77 kg/ha. During *rabi*, wheat performed better and yielded 2460 kg/ha, whereas chickpea and mustard gave yield of 1337 and 428 kg/ha yield, respectively. Among *rabi* crops, the higher NMR and B:C ratio were recorded with wheat (Rs.64300/ha and 7.77, respectively) (Table 3.268).

Table 3.268: Performance of different crops in a micro-watershed - Rewa

Crop	Yield (kg/ha)	NMR (Rs/ha)	B:C ratio
Wheat	2460	64300	7.77
Chickpea	1337	57450	7.12
Mustard	428	16200	4.12

3.4.2.2 Cropping systems

In an experiment on contingent crop planning at Indore, six *kharif*/late *kharif* crops *viz.*, maize (Patidar 999), sesamum (TKG-22), soybean (JS 95-60), clusterbean (HG-563), kidney bean (Local) and horsegram (BK-1) were evaluated to identify the suitable and remunerative *kharif* crop as an alternative to soybean. The maximum seed yield (2854 kg/ha), NMR (Rs.26812/ha) and B:C ratio (2.68) were recorded with maize (Patidar 999) followed by soybean cv. JS 95-60 (Rs.1072 kg/ha) with NMR of Rs. 14153/ha and B:C ratio of 1.79 (Table 3.269).

Table 3.269: Evaluation of alternate crops to soybean – Indore

Treatment	Seed yield (kg/ha)		Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio
	2014-15	Mean (5 years)			
Maize (Patidar 999)	2854	4034	16000	26812	2.68
Sesamum (TKG 22)	250	250	16000	1500	1.09
Soybean (JS 95-60)	1072	1086	18000	14153	1.79
Cluster bean (HG 563)	208	174	12000	-1583	0.87
Kidney bean/ Moth (Local)	178	190	12000	-1306	0.89
Horsegram / Kulthi (BK-1)	199	386	12000	-4037	0.66

At Indore, to mitigate the effect of moisture stress on soybean under aberrant weather condition, through foliar spray of 1% KNO_3 solution, 2% KCl and thiourea @ 250 g/ha alone and tank mix with Trizophos @ 600 ml/ha at the vegetative and reproductive stage (25-30 and 55-60 DAS) were studied. Results revealed that the treatment foliar spray of thiourea, KNO_3, KCl alone or mixed with trizophos @ 600 ml/ha at before flowering and pod initiation stage of soybean crop were found equally effective to combat the drought situation. The highest seed yield and B:C ratio (1653 kg/ha; 2.94) of soybean was recorded by the treatment spray of thiourea @ 250 g/ha + Trizophos @ 600 ml/ha, followed by the treatment foliar spray of 2% KCl + Trizophos @ 600 ml/ha (1623 kg/ha; B:C ratio 2.93) (Table 3.270).

Table 3.270: Effect of contingent practices in soybean to moisture stress - Indore

Treatment	Seed yield (kg/ha)	Straw yield (kg/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
Absolute control (T_1)	1108	2243	20765	2.15	1.57
Water Spray at 25-30 and 55-60 DAS (T_2)	1176	2563	22573	2.21	1.66
Foliar Spray of 1% KNO_3 solution at 25-30 and 55-60 DAS (T_3)	1464	2910	32495	2.73	2.07
Foliar spray of 2% KCl solution at 25-30 and 55-60 DAS (T_4)	1490	2848	33460	2.79	2.11
Foliar spray of thiourea @ 250 g/ha solution at 25-30 and 55-60 DAS (T_5)	1526	3201	34345	2.80	2.16
T_3 + Trizophos @ 600 ml/ha tank mix (T_6)	1570	3157	35548	2.83	2.22
T_4 + Trizophos @ 600 ml/ha tank mix (T_7)	1623	3016	37440	2.93	2.29
T_5 + Trizophos @ 600 ml/ha tank mix (T_8)	1653	3250	38139	2.94	2.33

At Indore, in a field experiment on different intercropping systems, the highest seed yield (899 kg/ha) was obtained with sole soybean at 45 cm spacing, followed by soybean + sunhemp (2:1) at 30 cm spacing (764 kg/ha), soybean + sunhemp (1:1) at 45 cm spacing (402 kg/ha). However, the highest seed yield, bundle weight and harvest index of maize (2657 kg/ha) was recorded with sole maize at 60 cm spacing, followed by maize + sunhemp (2:1) at 30 cm spacing (2309 kg/ha) (Table 3.271).

Table 3.271: Performance of different intercropping systems - Indore

Treatment	Seed yield (kg/ha)		Stover or biomass yield (kg/ha)		Harvest index (%)	
	Soybean	Maize	Soybean	Maize	Soybean	Maize
Soybean + sunhemp (2:1) at 30 cm	764	-	1339	-	43.15	-
Soybean + sunhemp (1:1) at 45 cm	402	-	686	-	41.25	-
Sole soybean at 45cm	899	-	1575	-	42.96	-
Maize + sunhemp (2:1) at 30 cm	-	2309	-	6536	-	64.12
Maize + sunhemp (1:1) at 45 cm	-	2161	-	7072	-	69.27
Sole maize at 60 cm	-	2675	-	7929	-	66.25
Soybean + maize (1:1) at 45 cm	419	2118	755	6643	44.71	67.95
Sole sunhemp at 30 cm	-	-	-	-	-	-

Incorporation of sunhemp in sole and intercropping systems of soybean and maize

At Rewa, in an evaluation of chickpea based intercropping systems during 2014-15, chickpea gave higher seed yield (328 kg/ha) with chickpea + linseed (4:2), while linseed gave higher yield of 369 kg/ha with chickpea + linseed (1:1). The higher chickpea equivalent yield (689 kg/ha), NMR (Rs.5839/ha) and B:C ratio (1.35) were recorded with intercropping of chickpea + linseed with row ratio of 4:2 (Table 3.272).

Table 3.272: Performance of chickpea + linseed intercropping - Rewa

Treatment	Yield (kg/ha)				Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio
	Chickpea	Linseed	Chickpea equivalent yield	Mean chickpea equivalent yield (3 years)			
Sole chickpea	285	-	285	713	15500	-5287	0.65
Chickpea + linseed (1:1)	231	369	663	966	16600	4865	1.29
Chickpea + linseed (2:1)	254	290	593	1023	16600	3037	1.18
Chickpea + linseed (2:2)	269	165	532	974	16600	547	1.06
Chickpea + linseed (4:2)	328	309	689	1091	16600	5839	1.35
Chickpea + linseed (6:2)	251	201	461	936	16600	-986	0.94
Chickpea + linseed (6:4)	205	239	487	1020	16600	006	1.00
Chickpea + linseed (8:4)	157	192	381	955	15250	-1866	0.87
Chickpea + linseed (mixed)	181	193	407	769	16230	-2500	0.84

In a study on effect of seed rate and varieties on soybean at Rewa, JS 95-60 gave higher yield (217 kg/ha) during 2014-15, while it was 713 kg/ha over three year mean. Seed rate of 100 kg/ha gave 222 kg/ha yield followed by seed rates of 80 and 70 kg/ha. The crop yield was low during 2014-15 due to excess rains during the season. Maximum B:C ratio (0.58) and RWUE (0.32 kg/ha-mm) were also recorded with seed rate of 100 kg/ha as compared to others treatments. Among varieties, JS 95-60 gave maximum B:C ratio (0.59) and RWUE (0.31 kg/ha-mm) (Table 3.273).

Table 3.273: Effect of seed rate and varieties on yield and economics of soybean – Rewa

Treatment	Yield (kg/ha)		NMR (Rs/ha)		B:C ratio		RWUE (kg/ha-mm)
	2014-15	Mean (3 yrs)	2014-15	Mean (3 yrs)	2014-15	Mean (3 yrs)	2014-15
Seed rate (kg/ha)							
70	198	570	-7317	1248	0.53	1.05	0.28
80	198	756	-7638	6447	0.52	1.35	0.28
100	222	740	-6930	6219	0.58	1.32	0.32
CD at 5%	NS	-	-	-	-	-	-
Variety							
JS 95-60	217	713	-6641	5617	0.59	1.29	0.31
JS 93-05	195	665	-7859	4013	0.51	1.20	0.28
CD at 5%	NS	-	-	-	-	-	-

Among rice varieties evaluated under different sowing methods at Rewa, Sahbhagi gave highest grain yield (4369 kg/ha) followed by Danteshwari (3449 kg/ha) with NMR of Rs. 34372/ha, B:C ratio (3.60) and RWUE of 6.35 kg/ha-mm. SRI method gave higher grain yield of 4477 kg/ha, NMR of Rs.34431/ha, B:C ratio (3.41) and RWUE of 6.50 kg/ha-mm compared to other sowing methods. Similarly, mean data of 4 years also recorded that Sahbhagi variety gave higher mean grain yield (3333 kg/ha) and SRI method of sowing gave higher mean grain yield (3625 kg/ha) (Table 3.274).

Table 3.274: Performance of rice varieties under different sowing methods – Rewa

Treatment	Yield (kg/ha)			Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Grain (2014-15)	Mean (4 yrs)	Straw (2014-15)				
Variety							
JR 201	1488	2016	3464	13174	2745	1.20	2.16
Vandana	2963	2298	8574	13174	19028	2.44	4.30
Danteshwari	3449	2868	10041	13174	24328	2.84	5.01
Sahbhagi	4369	3333	12855	13174	34372	3.60	6.35
Sowing method							
Dry sowing	4115	2590	12126	12237	32650	3.62	5.98
Direct sowing	2012	1946	5915	12733	9161	1.71	2.92
Lehi	1665	2354	4778	15582	4501	1.33	2.42
SRI	4477	3625	13126	14276	34431	3.41	6.50
CD at 5%	209	-	-	-	-	-	-

3.4.2.3 Nutrient management

In a long term manurial trial in Vertisols at Indore, mean soybean seed yield of last 22 years revealed that integrated nutrient management (FYM 6 t/ha + N_{20} P_{13}) gave highest yield (2015 kg/ha) and NMR (Rs.11218/ha). Similarly, in 2014, integrated nutrient management involving FYM 6 t/ha + N_{20} P_{13} gave higher seed yield (999 kg/ha), NMR (Rs.11218/ha) and B:C ratio (1.63) (Table 3.275).

Table 3.275: Effect of long term manurial trial on soybean yield and economics in soybean-chickpea system – Indore

Treatment	Soybean yield (kg/ha)		RWUE (kg/ha-mm)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio
	2014	Mean (22 yrs)				
Control (N_0P_0)	625	1228	0.99	11500	1764	0.25
N_{20} P_{13} (T_2)	646	1559	1.02	11900	3834	0.26
N_{30} P_{20}	839	1723	1.33	12100	6746	0.61
N_{40} P_{26}	848	1821	1.34	12400	6031	0.60
N_{60} P_{35}	749	1900	1.18	13600	3686	0.31
FYM 6 t/ha + T_2	999	2015	1.58	14900	11218	1.63
Residues 5 t/ha + T_2	896	1756	1.42	16200	4960	0.41
FYM 6 t/ha	840	1808	1.33	15200	4983	0.35
Residues 5 t/ha	968	1651	1.53	15800	6311	0.54
CD at 5%	145	214.7	0.23	-	1857	-

The data revealed that the uptake of N, P, K and S by soybean seed and straw and total uptake of these nutrients under different treatments was mainly governed by biomass yield. Treatment FYM 6 t/ha + $N_{20}P_{30}$ recorded higher uptake of N, P, K and S as compared to any level of application of fertilizer source. Lowest uptake of all the nutrients was recorded in the control (N_0P_0) (Table 3.277).

Table 3.277: Effect of different treatments on nutrient uptake by soybean - Indore

Treatment	Nutrient uptake by soybean (kg/ha)								Total nutrient uptake (kg/ha)			
	Seed				Stover							
	N	P	K	S	N	P	K	S	N	P	K	S
N_0P_0- Control	29.08	02.65	18.44	0.41	4.70	0.54	5.44	0.61	33.78	03.19	23.88	01.02
$N_{20}P_{13}$ (T_2)	43.86	03.12	24.24	0.77	5.67	0.57	5.46	2.13	49.53	03.69	29.70	02.90
$N_{30}P_{20}$	51.80	05.18	29.97	2.33	6.72	1.26	7.31	4.20	58.52	06.44	37.28	06.53
$N_{40}P_{26}$	52.62	05.26	30.07	2.95	7.20	0.72	6.93	4.05	59.82	05.98	37.00	07.00
$N_{60}P_{35}$	50.11	05.18	28.80	3.46	5.66	1.06	6.16	3.54	55.77	06.24	34.96	07.00
FYM 6 t/ha + T_2	78.39	11.32	45.29	6.10	8.35	2.30	7.31	5.22	86.74	13.62	52.60	11.32
Residues 5 t/ha + T_2	62.04	07.75	34.55	3.53	7.28	1.13	5.75	3.24	69.32	08.88	40.30	06.77
FYM 6 t/ha	58.55	06.73	34.32	3.43	7.55	1.76	5.88	4.20	66.10	08.49	40.20	07.63
Residues 5 t/ha	63.38	08.84	35.38	3.54	5.91	1.10	5.32	4.22	69.29	9.94	40.70	07.76

During *rabi*, significantly higher seed yield of chickpea (973 kg/ha), NMR (Rs.31663/ha) and B:C ratio (1.90) was recorded with the application of FYM @ 6 t/ha together with 20 kg N and 13 kg P/ha (Table). Application of residues at 5 t/ha was the next best treatment which gave a seed yield of 936 kg/ha. (Table 3.278).

Table 3.278: Chickpea yield and economics in long term manurial trial in soybean-chickpea system - Indore

Treatment	Yield (kg/ha)	GMR (Rs/ha)	NMR (Rs/ha)	B:C ratio
Control (N_0P_0)	606	30318	15729	1.10
$N_{20}P_{13}$ (T_2)	640	32023	16534	1.10
$N_{30}P_{20}$	841	42060	26271	1.70
$N_{40}P_{26}$	858	42902	26813	1.70
$N_{60}P_{35}$	769	38471	22082	1.30
FYM 6 t/ha + T_2	973	48652	31663	1.90
Residues 5 t/ha + T_2	746	37300	19911	1.10
FYM 6 t/ha	727	36341	19552	1.20
Residues 5 t/ha	936	46783	30194	1.80
CD at 5%	76	-	-	-

At Indore, in a field experiment on integrated nutrient management in soybean, the highest soybean seed yield (1803 kg/ha) was obtained due to application of 50% RDF through chemical fertilizer + 50% through organics, followed by RDF through chemical fertilizer (40 N + 60 P_2O_5 + 20 K_2O kg/ha). Similarly, mean data of 9 years revealed that during *kharif* maximum mean soybean seed yield (1974 kg/ha) and during *rabi*, maximum mean safflower seed yield (1530 kg/ha) were also recorded with integrated nutrient management i.e. application of 50% of RDF through chemical fertilizer + 50% through organics as compared to other treatments (Table 3.279 a, b & c).

Table 3.279a: Effect of integrated nutrient management on Soybean - Indore

Treatment	Seed yield (kg/ha)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
Control	882	15050	11421	0.76	1.39
10 t/ha organic manure for cropping sequence	1506	18500	26684	1.44	1.78
RDF through chemical fertilizer (40 N + 60 P_2O_5 + 20 K_2O/ha)	1718	17860	33684	1.89	2.04
INM (50% RDF through chemical fertilizer + 50% through organics)	1803	16000	38099	2.38	2.14
Farmers' practice (50 kg DAP/ha)	1366	14500	26493	1.83	1.62
CD at 5%	213.31	-	-	-	0.34

Table 3.279b: Performance of soybean under different treatments during 2006-2014 - Indore

Treatment	Seed yield (kg/ha)									
	2006	2007	2008	2009	2010	2011	2012	2013	2014	Mean
Control	1921	2792	2201	1808	648	1103	1392	669	882	1491
10 t/ha organic manure for cropping sequence	2348	3223	2596	2211	951	1403	1784	884	1506	1878
RDF through chemical fertilizer (40N + 60 P_2O_5 + 20 K_2O/ha)	2298	3340	2711	2203	857	1368	1820	889	1718	1912
INM (50% RDF through chemical fertilizer + 50% through organics)	2592	3487	2569	2200	851	1519	1791	950	1803	1974
Farmers practices (50 kg DAP/ha)	2050	2970	2482	1821	658	1189	1417	688	1366	1627
CD at 5%	235	470	265	345	94.9	186.0	168	131	213	234

Table 3.279c: Performance of safflower under different treatments during 2006-2014 - Indore

Treatment	Seed yield (kg/ha)									
	2006	2007	2008	2009	2010	2011	2012	2013	2014	Mean
Control	947	828	690	559	463	571	788	-	692	947
10 t/ha organic manure for cropping sequence	1167	1346	1098	826	1010	978	1010	-	1062	1167
RDF through chemical fertilizer (40N + 60 P_2O_5 + 20 K_2O/ha)	1425	1373	1125	841	1163	1043	970	-	1134	1425
INM (50% RDF through chemical fertilizer + 50% through organics)	1530	1374	1188	939	1481	1203	1128	-	1263	1530
Farmers practices (50 kg DAP/ha)	1319	889	921	710	717	783	809	-	878	1319
CD at 5%	NS	NS	NS	198	312	255	209.44	-	-	NS

Crop performance under RDF and INM treatments

In a study at Rewa with different combinations of N sources for rice-wheat, blackgram-chickpea; and rice + blackgram-wheat + chickpea in separate blocks, application of 100% N through compost was superior in all the blocks (Table 3.280 a, b & c). Application of 100% N through compost in rice-wheat system gave higher net returns (Rs.6982 and Rs.37838/ha, respectively) compared to other treatments. However, all the treatments recorded negative net returns in blackgram-chickpea system due to very low yields.

Table 3.280a: Effect of integrated nutrient management on rice-wheat cropping system - Rewa

Treatment	Yield (kg/ha)				Cost of cultivation (Rs/ha)		NMR (Rs/ha)		B:C ratio		RWUE (kg/ha-mm)
	Rice		Wheat		Rice	Wheat	Rice	Wheat	Rice	Wheat	
	Grain	Straw	Grain	Straw							
Control (No nitrogen)	764	2140	1943	2085	14000	15500	-706	21985	0.95	2.42	1.11
100% N through fertilizer	1262	3155	2454	2571	16500	18500	5080	28594	1.31	2.55	1.83
100% N through compost	1446	3470	3010	2797	17600	18500	6982	37838	1.40	3.05	2.10
50% N (fert) + 50% N (compost)	1153	2885	2561	2561	17050	18500	2669	30159	1.16	2.63	1.67
50% N (fert) + 25% N (compost)	902	2300	2489	2612	16150	18500	-681	29283	0.96	2.58	1.31
25% N (fert) + 50% N (compost)	942	2545	2642	2682	16450	18500	-152	31858	0.99	2.72	1.36
50% N (fert) + 25% N (compost) + *Azotobacter*	1152	3165	2561	2576	16250	18600	3734	30119	1.23	2.62	1.67
25% N (fert) + 50% N (compost) + *Azotobacter*	1256	3265	2740	2657	16550	18600	5053	33128	1.31	2.78	1.82
50% N (fert) + 50% N (compost) + *Azotobacter*	1398	3425	2758	2622	17150	18600	6686	33258	1.39	2.79	2.03

Table 3.280b: Effect of integrated nutrient management on blackgram-chickpea system - Rewa

Treatment	Yield (kg/ha)		Cost of cultivation (Rs/ha)		NMR (Rs/ha)		RWUE (kg/ha-mm)
	Blackgram	Chickpea	Blackgram	Chickpea	Blackgram	Chickpea	
Control (No nitrogen)	40	193	7500	15500	-5668	-4267	0.05
100% N through fertilizer	62	226	9500	19000	-6674	-5898	0.09
100% N through compost	84	296	10500	19000	-6687	-1811	0.12
50% N (fert) + 50% N (compost)	65	245	10000	19000	-7035	-4769	0.09
50% N (fert) + 25% N (compost)	51	234	9250	19000	-6919	-5404	0.07
25% N (fert) + 50% N (compost)	56	255	9500	19000	-6944	-4174	0.08
50% N (fert) + 25% N (compost) + *Azotobacter*	54	252	9350	19100	-6873	-4445	0.07
25% N (fert) + 50% N (compost) + *Azotobacter*	57	266	9600	19100	-6995	-3624	0.08
50% N (fert) + 50% N (compost) + *Azotobacter*	68	265	10100	19100	-7002	-3691	0.09

Table 3.280c: Effect of integrated nutrient management on rice + blackgram - wheat + chickpea system - Rewa

Treatment	Yield (kg/ha)		Cost of cultivation (Rs/ha)		NMR (Rs/ha)		B:C ratio		RWUE (kg/ha-mm)
	Rice + BG	Wheat + CP	Rice + BG	Wheat + CP	Rice + BG	Wheat + CP	Rice + BG	Wheat + CP	Rice + BG
Control (No nitrogen)	347+36	821+93	10750	15500	-3070	5775	0.71	1.37	0.5+0.5
100% N through fertilizer	623+56	1134+110	13000	18750	110	9401	1.01	1.50	0.9+0.08
100% N through compost	679+61	1534+145	14100	18750	193	18817	1.01	2.00	0.98+0.08
50% N (fert) + 50% N (compost)	613+57	1301+119	13500	18750	-631	13164	0.95	1.70	0.89+0.08
50% N (fert) + 25% N (compost)	480+41	1294+114	12700	18750	-2745	12832	0.78	1.68	0.69+0.05
25% N (fert) + 50% N (compost)	560+46	1343+125	13000	18750	-1526	14127	0.88	1.75	0.81+0.06
50% N (fert) + 25% N (compost) + *Azotobacter*	523+53	1317+123	12800	18850	-1282	13369	0.90	1.71	0.76+0.07
25% N (fert) + 50% N (compost) + *Azotobacter*	591+56	1371+129	13100	18850	-363	14814	0.97	1.79	0.85+0.08
50% N (fert) + 50% N (compost) + *Azotobacter*	647+58	1436+130	13650	18850	74	15985	1.00	1.85	0.94+0.08

BG: Blackgram; CP: Chickpea

At Rewa, in the study on organic farming treatments for rice-chickpea system, maximum rice yield (1087 kg/ha) was recorded with 100% NPK + secondary and micronutrients with a net income of Rs. 1369/ha with B:C ratio of 1.08. However, all other treatments recorded negative returns due to very low yields of rice. Similarly, the same treatment gave higher yield of chickpea (2044 kg/ha) with a net income of Rs.97738/ha compared to all other treatments (Table 3.281).

Table 3.281: Organic farming package for rice-chickpea system - Rewa

Treatment	Yield (kg/ha)		Cost of cultivation (Rs/ha)		NMR (Rs/ha)		RWUE (kg/ha-mm)	
	Rice	Chickpea	Rice	Chickpea	Rice	Chickpea	Rice	Chickpea
T_1	991	1865	17200	19000	-126	89170	1.44	22.20
T_2	887	1678	17600	20000	-2335	77540	1.28	19.49
T_3	851	1517	18150	21500	-3480	66666	1.23	18.05
T_4	769	1454	18150	21000	-4962	63416	1.11	17.30
T_5	922	1735	16500	19500	-514	81235	1.34	20.65
T_6	893	1683	16400	20200	-952	77771	1.30	20.03
T_7	1087	2044	17600	21000	1369	97738	1.58	24.33
T_8	691	1150	14300	17000	-2504	49700	1.00	13.69
CD at 5%	11	13	-	-	-	-	-	-

T_1 : 50% recommended NPK + 50% N as FYM; T_2 : Different organic sources each equivalent to 1/3 recommended (FYM + vermicompost + non edible oil cake); T_3 : T_2 + interculture/intercropping of chickpea with mustard; T_4: T_2 + Agronomic practices for weed and pest control (no chemical pesticides and herbicides); T_5 : 50% N as FYM/other organic sources + biofertilizer for N + rock phosphate to substitute the P requirement of crop + PSB; T_6 : T_2 + biofertilizer containing N and P carriers; T_7 : 100% NPK + secondary and micronutrients; T_8 : Control

3.4.2.4 Energy management

In an experiment on effect of tillage on resource conservation and yield of soybean at Indore, low tillage + 4 t/ha of straw + hand weeding resulted in highest seed yield (1408 kg/ha) with higher NMR (Rs.27634/ha), B:C ratio (2.89) and RWUE (1.67 kg/ha-mm). The growth parameters and test weight significantly varied with tillage treatment (Table 3.282a). However, averaged across 15 years, conventional tillage + off-season tillage + hand weeding twice produced marginally higher yields (1571 kg/ha) compared to low tillage + 4 t/ha of straw + hand weeding (1555 kg/ha). The highest energy balance was recorded under low tillage + 4 t/ha straw + herbicide (39317 MJ/ha) which was closely followed by low tillage + 4 t/ha compost + hand weeding (38769 MJ/ha). However, the lower input energy was recorded under low tillage treatments than T_1 and T_2. The highest output energy (42725 MJ/ha) was recorded under low tillage + 4 t/ha straw + herbicide followed by T_5, T_3, T_8, T_7, respectively (Table 3.282b).

Table 3.282a: Effect of tillage on soybean yield and economics – Indore

Treatment	Seed yield (kg/ha)		RWUE (kg/ha-mm)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio
	2014	Mean over 15 yrs				
CT + RF (-OT) + HW (T_1)	703	1443	1.11	14050	7055	0.50
CT + RF (+OT) + HW (T_2)	1262	1571	1.50	15150	22712	1.50
LT + 4 t /ha straw + HW (T_3)	1408	1555	1.67	14600	27634	2.89
LT + 4 t /ha straw + Herbicide (T_4)	905	1172	1.07	13500	13662	1.01
LT + 4 t/ha compost + HW (T_5)	1200	1480	1.42	13500	22515	1.67
LT + 4 t/ha compost + Herbicide (T_6)	1068	1250	1.27	12950	19091	1.47
LT + 2 t/ha *glyricidia* green leaves + Herbicide (T_7)	1024	1064	1.21	10300	20425	1.98
LT + 2 t/ha *glyricidia* green leaves + HW (T_8)	1143	1386	1.35	10800	23475	2.17
CD at 5%	118	234	-	-	-	-

CT: conventional tillage; LT: low tillage; OT: Off-season tillage; HW: Hand weeding; RF: Rainfall

Table 3.282b: Effect of tillage on energy input and output in soybean - Indore

Treatment	Input energy (MJ/ha)	Output energy (MJ/ha)	Energy balance (MJ/ha)	Energy use efficiency
CT + RF (-OT) + HW (T_1)	5874	34562.5	28688	0.1667
CT + RF (+OT) + HW (T_2)	6442	35037.5	28595	0.1795
LT + 4 t /ha straw + HW (T_3)	3444	38837.5	35394	0.3810
LT + 4 t /ha straw + Herbicide (T_4)	3409	42725.0	39317	0.1552
LT + 4 t/ha compost + HW (T_5)	3444	42212.5	38769	0.3208
LT + 4 t/ha compost + Herbicide (T_6)	3409	33862.5	30454	0.2537
LT + 2 t/ha *glyricidia* green leaves + Herbicide (T_7)	2809	35587.5	32779	0.1310
LT + 2 t/ha *glyricidia* green leaves + HW (T_8)	2844	36287.5	33444	0.2802

Crop performance in LTE under hand weeding and herbicide application

In a study on tillage and nutrient management in soybean-wheat system at Rewa, significantly higher seed yield of soybean (387 kg/ha) was recorded with conventional tillage (CT) + interculture, while higher grain yield of wheat (2095) was recorded with low tillage (50% CT) + herbicide + interculture. In soybean, higher RWUE of 0.56 was recorded with conventional tillage (CT) + interculture, while RWUE of 24.94 kg/ha-mm was recorded with LT (50% of CT) + herbicide + interculture in wheat (Table 3.283). In case of nutrient management, application of 100% of organic source (8 t FYM/ha) gave higher soybean yield (378 kg/ha) and wheat yield (2246 kg/ha) followed by application of 100% inorganic fertilizer. Maximum NMR of Rs.27479/ha, B:C ratio of 2.94 and RWUE of 26.73 kg/ha-mm were recorded with 100% of organic sources (8 t FYM/ha).

Table 3.283: Effect of low till farming strategies on soybean-wheat system - Rewa

Treatment	Yield (kg/ha)				Cost of cultivation (Rs/ha)		NMR (Rs/ha)		B:C ratio		RWUE (kg/ha-mm)	
	Seed/grain		Stalk/straw									
	Soy bean	Wheat	Soy bean	Wheat	Soy bean	Wheat	Soy bean	Wheat	Soy bean	Wheat	Soy bean	Wheat
Tillage management												
Conventional tillage (CT) + interculture	387	2072	1282	4761	20263	14651	-3501	23570	0.82	2.60	0.56	24.66
Low tillage (50% of CT) + interculture	345	2078	1240	4904	19266	13129	-4226	25397	0.78	2.93	0.50	24.73
Low tillage (50% CT) + herbicide + interculture	286	2095	1178	4578	21421	14129	-8803	24163	0.58	2.71	0.41	24.94
CD at 5%	78.78	209	-	607	-	-	-	-	-	-	-	-
Nutrient management												
100% of organic sources (8 t FYM/ha)	378	2246	1260	5292	19982	14129	-3602	27479	0.81	2.94	0.54	26.73
50% of organic + 50% of inorganic	311	1943	1230	4676	20406	14129	-6736	15730	0.66	2.11	0.45	23.13
100% inorganic	328	2246	1250	4274	20649	14129	-6279	25472	0.69	2.83	0.47	26.73
CD at 5%	78.78	196	-	375	-	-	-	-	-	-	-	-

3.4.2.5 Evaluation of improved varieties

Among four varieties of soybean viz., JS 95-60, JS 93-05, JS 335 and RVS 2001-4 evaluated at on-station trial at Indore, RVS 2001-4 was superior with a maximum yield of 2000 kg/ha with 2.83 kg/ha-mm of RWUE, net returns of Rs.49000/ha and B:C ratio of 5.45. JS-335 was the next best variety with a seed yield of 1800 kg/ha and NMR of Rs.43000/ha (Table 3.284).

Table 3.284: Evaluation of soybean - Indore

Variety	Yield (kg/ha)	RWUE (kg/ha-mm)	NMR (Rs/ha)	B:C ratio
JS-335	1800	2.55	43000	4.91
JS 95-60	1000	1.41	19000	2.73
JS 93-05	1000	1.41	19000	2.73
RVS 2001-4	2000	2.83	49000	5.45

JS 95-60

RVS 2001-4

Performance of soybean varieties at farmers' field

Among 25 selections, 5 advanced entries and 5 check entries of pigeonpea evaluated at Indore, averaged across last 5 years, the entry JKE -114E (1919 kg/ha), ICP 8863-08-38 (1812 kg/ha), ICP 8863-08-40 (1757 kg/ha) and JA 4 08-20 (1703 kg/ha) were found to be promising as they recorded higher yield and were medium maturing (170-175 days) (Table 3.285).

Table 3.285: Evaluation of pigeonpea lines for rainfed conditions - Indore

Entry	Seed yield (kg/ha)	Mean seed yield over 5 years (kg/ha)	NMR (Rs/ha)	RWUE (kg/ha-mm)	B:C ratio
ICPL 88039 08-01	2240	1475	98000	2.67	8.00
ICPL 88039 08-02	1830	1484	77500	2.18	6.54
ICPL 88039 08-03	2010	1342	86500	2.40	7.18
ICPL 88039 08-05	1520	1397	62000	1.81	5.43
ICPL 88039 08-06	1790	1394	75500	2.14	6.39
ICPL 88039 08-07	1560	1256	64000	1.86	5.57
ICPL 88039 08-08	980	1186	35000	1.17	3.50
JA 4 08-10	1810	1496	76500	2.16	6.46
JA 4 08-11	1660	1559	69000	1.98	5.93
Selection Panod	1280	1418	50000	1.53	4.57
Sel. Badnawar	1010	984	36500	1.21	3.61

Entry	Seed yield (kg/ha)	Mean seed yield over 5 years (kg/ha)	NMR (Rs/ha)	RWUE (kg/ha-mm)	B:C ratio
JA 4 08-14	1270	1366	49500	1.52	4.54
JA 4 08-15	1280	1166	50000	1.53	4.57
JA 4 08-16	1940	1420	83000	2.32	6.93
JA 4 08-19	1430	1568	57500	1.71	5.11
JA 4 08-20	1960	1703	84000	2.34	7.00
JKM 189 –08-24	1330	1448	52500	1.59	4.75
JKM 189 –08-30	1550	1508	63500	1.85	5.54
JKM 189 –08-37	690	1154	20500	0.82	2.46
ICP 8863 –08-23	1180	1194	45000	1.41	4.21
ICP 8863 –08-38	1670	1812	69500	1.99	5.96
ICP 8863 –08-39	2570	1495	114500	3.07	9.18
ICP 8863 –08-40	2070	1757	89500	2.47	7.39
ICP 8863 –08-41	2820	1694	127000	3.37	10.07
ICP 8863 –08-42	2020	1441	87000	2.41	7.21
JKM 189 (check)	1950	1685	83500	2.33	6.96
JA – 4 (check)	1440	1625	58000	1.72	5.14
JIA – 65 (check)	1450	1308	58500	1.73	5.18
JKE - 114E	3250	1919	148500	3.88	11.61
JKE - 115E	1590	1262	65500	1.90	5.68
JKE - 116E	2280	1437	100000	2.72	8.14
DT - 501	1750	1386	73500	2.09	6.25
UPAS - 120	2050	1072	88500	2.45	7.32
MN - 5	1930	1164	82500	2.30	6.89
ICPL - 88039	2030	1373	87500	2.42	7.25

Two chickpea varieties (JG-16 and JAKI-9218) were tested at station and on farmers' field and the data are presented in Table 3.286. In the on-station trial, JG-16 produced higher seed yield (1850 kg/ha) followed by JAKI-9218 (1100 kg/ha). However, in an on-farm trial, the highest average yield of 1791 kg/ha was recorded by JAKI-9218 with net return of Rs.51685/ha and B:C ratio (5.70); followed by JG-16 (1620 kg/ha, net returns of Rs.45700/ha and B:C ratio (5.15). However, in another on-farm trial at Gaddukuedi, the maximum seed yield was recorded by JAKI-9218 (1485 kg/ha) followed by JG-16 (1402 kg/ha). The percent increased in yield by JAKI-9218 was 55% over JG-16 (Table 3.286).

Table 3.286: Performance of chickpea varieties - Indore

Variety	Maturity (days)	Seed yield (kg/ha)	Stalk yield (kg/ha)	NMR (Rs/ha)	B:C ratio
JG-16	120	1850	2800	144044	11.67
JAKI-9218	125	1100	1700	081200	07.01

JG-16

JAKI-9218

Field view of chickpea varieties

Blackgram varieties were evaluated for high yield and mosaic resistance at Rewa. Dry spell during physiological maturity affected the seed yield of blackgram during *kharif* 2014. The yield of tested genotypes ranged from 394 to 911 kg/ha. Out of sixteen tested genotypes of blackgram, the highest seed yield (911 kg/ha) was recorded by JU 3 followed by TU 57 (905 kg/ha) and TU 136 (861 kg/ha). The net income Rs. 41700 and B:C ratio of 3.78 was recorded by JU 3 followed by TU 57 (Rs.41254/ha and 3.75, respectively) (Table 3.287).

Table 3.287: Performance of blackgram varieties for high yield and mosaic resistance – Rewa

Variety	Yield (kg/ha)			GMR (Rs/ha)	NMR (Rs/ha)	B:C ratio
	Seed	Stalk	Mean seed yield (4 yrs)			
TU 94-2	711	2020	578	44276	29276	2.95
PDU 1	572	1544	699	35555	20555	2.37
PU 30	628	1770	672	39096	24095	2.60
TU 98-4	739	2114	661	46031	31031	3.06
JU 2	850	2295	678	52836	37836	3.52
JU 3	911	2550	679	57700	41700	3.78
TU 10	686	1886	637	42668	27668	2.84
TU 27	733	2015	567	45592	30592	3.03
PU 35	822	2137	708	51029	36029	3.40
TU 57	905	2443	650	56254	41254	3.75
TU 136	861	2153	517	53382	38382	3.55
IVU 466	756	2003	559	46962	31962	3.13
DU 4	783	2192	551	48733	33733	3.24
IVU 486	394	1142	399	24553	9553	1.63
IVU88-10	682	682	523	19025	4025	1.26
TU 47-4	447	1296	429	27856	12856	1.85
CD at 5%	43.64	-	-	-	-	-

In an assessment of twelve promising varieties of soybean at Rewa, the maximum seed yield (1250 kg/ha) was recorded by JS 20-29 followed by JS 95-60 (1215 kg/ha), JS 20-34 (1042 kg/ha) and JS 97-52 (1003 kg/ha). The maximum net returns of Rs.32500/ha and B:C ratio of 3.17 were recorded by variety JS 20-29. Out of twelve tested varieties only five soybean varieties, namely JS 20-29, JS 95-60,JS 20-34,JS 97-52 and JS 93-05 were significantly superior over check (Bragg) (Table 3.288).

Table 3.288: Performance of soybean varieties - Rewa

Variety	Yield (kg/ha)			NMR (Rs/ha)	B:C ratio
	Seed	Stalk	Mean seed yield (4 yrs)		
JS 335	538	3520	908	8260	1.55
JS 93-05	875	2540	1001	20282	2.35
JS 95-60	1215	3260	710	31170	3.25
JS 97-52	1003	5260	1276	23114	2.54
JS 90-41	399	1680	578	1506	1.10
JS 20-09	285	2370	1059	-2274	0.85
JS 20-29	1250	2650	1304	32500	3.17
JS 20-34	1042	2016	1290	26208	2.75
JS -20-35	208	1390	1019	-5984	0.60
JS 81-1504	146	1280	420	-9581	0.36
NRC 37	210	1575	513	-5760	0.32
Bragg	562	2130	734	8060	1.54
CD at 5%	92.12	-	-	-	-

At Rewa, due to dry spell during physiological maturity the seed yield of greengram varieties was poor and ranged from 107 to 651 kg/ha. The highest seed yield (651 kg/ha) was recorded by HUM 16 followed by HUM 12 (563 kg/ha) and HUM 1 (528 kg/ha). The maximum net income of Rs.32392/ha was recorded by HUM 16 followed by HUM 12 (Rs.25986/ha) and HUM 1 (Rs. 23713/ha). However, the mean higher seed yield of greengram (711 kg/ha) was recorded by variety HUM 16 over all other varieties (Table 3.289).

Table 3.289: Performance of greengram varieties for high yield and mosaic resistance - Rewa

Variety	Yield (kg/ha)			GMR (Rs/ha)	NMR (Rs/ha)	B:C ratio
	Seed	Stalk	Mean seed yield (2 yrs)			
HUM 1	528	2191	504	38713	23713	2.58
HUM 12	563	1970	681	40986	25986	2.73
HUM 16	651	2278	711	47392	32392	3.15
TARM 12	480	1708	365	35526	20526	2.36
TARM 18	445	2170	372	32886	17886	2.19
TARM 37	262	851	425	19221	4021	1.26
TJM 12	429	1716	524	31403	16403	2.09
TJM 15	262	1126	514	19241	4241	1.28
TJM 59	167	751	393	12291	-2709	0.82
TJM 65	143	791	255	10643	-4357	0.71
TJM 140	107	535	360	7918	-7082	0.53
TJM 230	155	775	245	11470	-3530	0.76
TJM 234	456	1969	438	33415	18415	2.23
MI 181-1	405	1620	419	29646	14646	1.97
MI 24-91	429	2145	361	31746	16746	1.12
SL 688	345	1680	360	25494	10494	1.70
Ganga 8	405	2020	417	29966	14966	1.99
TM 99-50	460	1836	370	33668	18668	2.24

At Rewa, out of twelve genotypes of mustard, highest seed yield (736 kg/ha) was recorded by Pusa Tarak followed by JM 3 (671 kg/ha) and Pusa Agahani (630 kg/ha). The maximum net income of Rs.17648/ha and B:C ratio of 2.26 was recorded by Pusa Tarak followed by JM 3 (Rs.14182/ha and 2.01, respectively) (Table 3.290).

Table 3.290: Performance of high yielding mustard varieties - Rewa

Variety	Yield (kg/ha)			GMR (Rs/ha)	NMR (Rs/ha)	B:C ratio
	Seed	Stalk	Mean seed yield (3 yrs)			
Teri Uttam	519	2850	406	21798	7798	1.57
Basanti	602	2702	626	25284	11284	1.81
JM 1	458	2501	588	19236	5236	1.37
JM 2	569	2380	576	23898	9898	1.71
JM 3	671	2472	622	28182	14182	2.01
JM 4	579	2480	589	24318	10318	1.71
Pusa Jagnnath	616	2540	563	25872	11872	1.82
ACN Satabdi	569	2530	645	23898	9898	1.71
Pusa Tarak	736	2490	675	31648	17648	2.26
Pusa Agahani	630	2750	617	26460	12460	1.89
Pusa Mahak	421	2440	603	17682	3682	1.26
Pusa Bold	528	3210	624	20176	8176	1.58

In an assessment of twelve promising varieties of chickpea at Rewa, the maximum seed yield (1433 kg/ha) was recorded by JG 130 followed by Jaki 9218 (1420 kg/ha), JG 74 (1417 kg/ha) and JG 218 (1300 kg/ha) which were significant over check JG 315 (1270 kg/ha). The maximum net income of Rs.60253/ha and B:C ratio of 4.31 was recorded by variety JG 130 (Table 3.291).

Table 3.291: Performance of high yielding chickpea varieties - Rewa

Variety	Yield (kg/ha)		GMR (Rs/ha)	NMR (Rs/ha)	B:C ratio
	Seed	Stalk			
JG 11	1083	2190	58944	40944	3.27
JG 12	1030	2460	56612	38612	3.13
JG 14	1080	2218	58821	40821	3.26
JG 16	1300	2730	70876	52876	3.93
JG 63	1193	2740	65324	47324	3.63
JG 74	1417	3050	77344	59344	4.30
JG 130	1433	3115	78253	60253	4.34
JG 218	1300	2840	71008	53008	3.94
JG 315	1270	3260	69952	51952	3.88
JG 322	1267	2702	65884	47884	3.66
Jaki 9218	1420	3120	77584	59584	4.31
JG 412	950	1915	51698	33698	2.81

3.4.2.6 Alternated land use

At Indore, the yield data computed in terms of soybean equivalent yield (SEY) revealed that among the cropping systems, sole pigeonpea recorded the highest mean SEY (1900 kg/ha) and net returns (Rs.38989/ha) followed by soybean + pigeonpea (4:2) with SEY of 1524 kg/ha and net returns of Rs.27730/ha. The seed yield of soybean was low due to continuous rains during the growth period. The fruit yield during the year (2014-15) was aonla (232 kg/ha), guava (1984 kg/ha), phalsa (154 kg/ha) and ber (471 kg/ha) and gave net returns of Rs.62957/ha (Table 3.292).

Table 3.292: Performance of agri-horticulture production systems under medium deep Vertisols - Indore

Fruit plant/crop	Fruit yield and seed yield (kg/ha)						Mean fruit/ seed yield (kg/ha)
	Custard Apple	Guava	*Phalsa*	Drum Stick	*Aonla*	Ber	
Soybean – chickpea	1018	1009	1046	1093	1370	1088	1104
	0	0	0	0	0	0	0
Soybean + pigeonpea (4:2)	509	574	481	491	556	528	523
	398	481	537	537	494	556	501
Sole pigeonpea	880	880	912	972	1056	1000	950
	Soybean equivalent yield (kg/ha)						Mean SEY (kg/ha)
Soybean – chickpea	1018	1009	1046	1093	1370	1088	1104
Soybean + pigeonpea (4:2)	1306	1537	1556	1565	1544	1639	1524
Sole pigeonpea	1759	1759	1824	1944	2111	2000	1900
	Net returns (Rs/ha)						Mean net returns (Rs/ha)
Soybean – chickpea	12555	12277	13388	14777	23110	14638	15124
Soybean + pigeonpea (4:2)	21166	28110	28665	28943	28332	31165	27730
Sole pigeonpea	34776	34776	36721	40332	45332	41998	38989
	B: C ratio						Mean B:C ratio
Soybean – chickpea	2.11	2.09	2.16	2.26	2.84	2.25	2.28
Soybean + pigeonpea (4:2)	2.70	3.18	3.22	3.24	3.20	3.39	3.15
Sole pigeonpea	3.64	3.64	3.77	4.02	4.37	4.14	3.93
	Fruit yield (kg/ha)						Total
Fruit yield	0	1984	154	0	232	471	
Gross income	0	39681	9264	0	4632	9420	62957
Fruit yield eq. to soybean (kg/ha)	0	1323	309	0	154	314	

3.5 Cotton Based Production System

3.5.1 Rainwater management

At Akola, total rainfall of 570 mm was received during crop growing period with two major runoff events which resulted in rainwater harvesting in the farm pond. From the stored farm pond water supplemental irrigation was given to soybean. Higher seed yield of soybean (1021 kg/ha) was obtained with two protective sprinkler irrigations from stored farm pond water at critical stages followed by one protective irrigation. The water use efficiency (1.79 kg/ha-mm) and B: C ratio (2.20) was also higher with two protective irrigations over one and no protective irrigation (Table 3.293).

Table 3.293: Yield and economics of soybean as influenced by protective irrigation - Akola

Treatment	Yield (kg/ha)	Mean yield (kg/ha) (3 yrs)	WUE (kg/ha-mm)	NMR (Rs/ha)	B:C ratio
One protective irrigation	474	1435	0.83	543	1.03
Two protective irrigations	1021	1647	1.79	20089	2.20
No protective irrigation	422	1441	-	-	-

At Akola, the runoff causing rainfall in the catchment area of 4 ha of farm pond-2 was 235.9 mm which helps in accumulation of 1776.96 m^3 runoff in the farm pond. The total runoff recorded was 44.41mm, which was 18.82% of the runoff causing rainfall. From the stored pond water (1776.96m^3) if protective irrigation of 5 cm is given, about 3.5 ha area can be irrigated (Table 3.294).

Table 3.294: Runoff during 2014 from catchment area of 4 ha in farm pond-2 - Akola

Date	Rainfall (mm)	Runoff	
		Accumulated in farm pond (m^3)	Recorded (mm)
12-06-2014	18.5	41.48	1.03
23-07-2014	136.4	1068.89	26.72
08-09-2014	81.0	666.59	16.66
Total	235.9	1776.96	44.41

During the *rabi* season, the stored farm pond water was used for supplemental irrigation to different vegetables by using micro-irrigation systems (MIS) and it was observed that B:C ratio was in the range of 1.26 (Indian round gourd) to 1.94 (Ladies finger) and water use efficiency was in the range of 1.03-4.35 kg/m^3. The computed total income from these vegetables was Rs.78092/ha (Table 3.295).

Table 3.295: Irrigation through micro-irrigation system from farm pond for different vegetable crops - Akola

Crop	Micro/Irrigation system	Total water applied through MIS (m^3)	Area (m^2)	Yield (kg/plot)	Computed yield (kg/ha)	NMR (Rs/ha)	B:C ratio	Water use efficiency (kg/m^3)
Lady's finger	Micro-sprinkler	21.6	280	94.00	3357	25638	1.94	4.35
Cowpea	In-line drip	7.0	100	15.00	1500	10627	1.89	2.14
Ridge gourd	In-line drip	7.0	100	12.75	1275	9600	1.60	1.82
Indian round gourd	In-line drip	7.0	100	12.50	1250	3950	1.26	1.78
Brinjal	Micro-sprinkler	13.2	150	57.25	3817	15953	1.86	4.33
Spinach	In-line drip	14.7	120	27.00	2250	8167	1.83	1.84
Fenugreek	In-line drip	12.6	120	13.00	1083	4157	1.62	1.03

At Kovilpatti, in an experiment on catchment-storage-command area relationship for enhancing water productivity in a micro-watershed, the runoff water collected from one hectare catchment was 215 m^3. It could be used for giving supplemental irrigation to an area of 0.4 ha. Water was available in the farm pond for a period of one month. Supplemental irrigation was given using rain gun from the harvested rainwater in farm pond during the seedling stage. Seepage losses accounted to 85% and evaporation losses 14%. There was no water available in the farm pond during January and February (Table 3.296).

Table 3.296: Rainfall - runoff - Kovilpatti

Date	Intensity of rainfall I_{30} (mm/h)	Depth of rainfall (mm)	Volume of water stored (m^3)
24.09.2014	64	21.2	81.25
30.09.2014	40	25.6	81.25
26.10.2014	40	16.8	37.50
Total			214.50

At Kovilpatti, in a study on different tillage methods for improving water use efficiency in cotton-greengram rotation, rotovator ploughing + chisel ploughing recorded the highest rainwater use efficiency of 2.36 kg/ha-mm inspite of 17.3% of rainwater being lost as runoff. This might be due to the fine tilth of the seed bed due to rotovator ploughing. Rotovator ploughing + chisel ploughing recorded the highest grain yield of greengram (908 kg/ha), with higher net returns (Rs.17580/ha) and B:C ratio (1.54) which was 10% higher than the conventional tillage (Table 3.297).

Table 3.297: Effect of tillage methods on yield and economics of greengram - Kovilpatti

Treatment	Yield (kg/ha)		Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Seed	Stalk				
Conventional tillage	825	1155	31860	13515	1.42	2.15
Rotavator ploughing once + chisel ploughing once	908	1362	32360	17580	1.54	2.36
Chisel ploughing once + tiller ploughing once	721	937.3	29360	10295	1.35	1.88
Conservation tillage	830	1162	31110	14540	1.47	2.16

At Parbhani, in a study on recharging of borewell/open well with runoff water, the filtration efficiency of primary filter was found to be in the range of 64 to 67% and hence, it is necessary to arrest the major silt component of the runoff water (Table 3.298).

Table 3.298: Filtration efficiency of primary filter - Parbhani

Sample No.	Inlet silt Composition (g)	Outlet silt composition (g)	Efficiency (%)
1	2.7	1.0	64.81
2	2.8	0.9	67.27
3	3.0	1.0	66.66
4	2.9	1.0	65.51
5	3.1	1.0	66.13
Mean 2014	2.9	1.0	66.07
Mean of 4 years	5.5	0.4	-

At Parbhani, during the year 2014, 184.5 mm of rainfall occurred which produced 90 mm of runoff. A well recharge model was constructed near the well located in the field of 1.8 ha. The total quantity of runoff water available from 1.8 ha field area was estimated as 7326 m^3 which was diverted to the well for well recharging through constructed well recharging model (Table 3.299).

Table 3.300: Runoff events during 2014 - Parbhani

Date	Rainfall	Runoff (mm)	Runoff from 1.8 ha field (m^3)
July 09	60.0	46.0	828
Aug 05	32.4	7.0	126
Aug 26	30.5	9.0	162
Aug 28	23.4	11.0	198
Aug 31	38.2	17.0	306
Total	184.5	90	1620

At Parbhani, due to late onset of monsoon, the water table in well started rising from July. Due to insufficient rainfall in the month of August and September, slow rise in water table was observed. Sufficient water potential was observed during January to May because of good rainfall received during 2013. The rise in water table was to tune of 0.5 m to 3 m due to well recharge technique (Table 3.302).

Table 3.302: Water level in the well (MSL) - Parbhani

Month	2011	2012	2013	2014	Increase in water level in 2013 compared to 2011	Increase in water level in 2014 compared to 2011
January	404.8	405.0	405.6	406.8	0.8	1.0
February	404.6	404.5	405.2	405.6	0.6	1.0
March	404.6	404.1	404.8	405.5	0.2	0.9
April	404.0	403.9	404.4	405.2	0.4	1.2
May	403.9	403.3	404.2	404.9	0.3	1.0
June	404.0	404.6	407.4	404.6	3.4	0.6
July	405.0	405.5	407.7	407.9	2.7	2.9
August	405.2	406.1	407.7	408.2	2.5	3.0
September	406.7	406.2	407.7	407.7	1.0	1.0
October	406.3	406.2	407.6	407.3	1.3	1.0
November	406.8	406.9	407.7	407.4	0.9	0.6
December	406.7	406.5	407.5	407.2	0.8	0.5

At Parbhani, silt deposition in various soil and water conservation structures *viz. nala* bund and cement plug and loose boulder structures was measured during 1997-98 to 2014-15. It was found that an amount of 1622.57, 1327.58 and 942.56 tonnes of soil was deposited at various points in an influence area of different structures, during 1997-98, 1998-99 and 1999-2000, respectively. Due to soil conservation works and watershed development programme, every year about 20 to 60% soil loss had been reduced by arresting the soil at different stages at different locations. However, during the year 2013-2014 total silt deposited in all structures was found to be 14733 tonnes. During the year 2014-15, it has been reduced to 450.73 tonnes indicating that the watershed is fully stabilized (Table 3.303).

Table 3.303: Silt deposition (tonnes) in various soil and water conservation structures - Parbhani

Structure	1997-98	1998-99	1999-2000	2013-14	2014-15
Diversion drain	33.38	24.30	20.48	184.50	18.24
Graded bund I	77.03	50.63	38.12	846.00	32.14
Graded Bund II	352.69	337.50	300.15	744.00	225.25
Nala Bund I	147.65	92.25	59.40	6662.10	46.36
Nala Bund II	18.90	15.75	9.40	2362.91	7.45
Cement plug I	7.20	5.40	4.37	1025.24	2.15
Cement plug II	190.28	156.00	99.25	1526.07	42.72
Loose boulder dam	382.50	333.00	199.65	Fully silted	Fully silted
Contour trenches	412.97	312.75	211.20	954.00	76.42
Total silt deposition	1622.58	1327.58	942.56	14733.31	450.73

At Parbhani, the present reduction in storage capacity of *nala* bunds was observed in the range of 11.48 to 11.64% and in cement plug, 12.02% reduction in storage capacity was recorded. Hence, it is necessary to avoid the flow of runoff through repairing the structures like loose boulders, continuous contour trenches and other structures (Table 3.304).

Table 3.304: Storage capacity of water harvesting structures - Parbhani

Structure	Catchment area (ha)	Designed storage capacity (m^3)	Volume of silt deposition (m^3)	Weight of Silt deposition (tonnes)	Erosion rate (t/ha/yr)	Current storage capacity (m^3)	Reduction in storage capacity (%)
NB-I	59.6	40000	4655.52	6052	111.78	35344	11.64
NB-II	41	15000	1723.20	2240	57.63	13277	11.48
CP-I	44	6800	818.10	1063	23.30	5982	12.02

NB: Nala bund; CP: Cement plug

At Parbhani, the expected life of continuous contour trenches is estimated to be 7 years considering the design return of 10 years and risk of 50%. As the structure is temporary, more risk is to be considered which may increase the expected life slightly. The expected life of loose boulder dam is estimated to be 15 years considering the design return period of 20 years and risk of 50%. The expected life of cement nala bund is estimated to be 25 years considering the design return period 50 years and risk of 40%. In order to have a better estimate of expected life, design return period and the risk involved from hydrological point of view following table will serve as a guideline (Table 3.305).

Table 3.305: Sustaining soil and water conservation structures - Parbhani

Sr. No.	Temporary structure (n=7)		Semi permanent structure (n=15)		Permanent structure (n=25)	
	R	T	R	T	R	T
01	1	1	0.96	05	0.63	25
02	0.99	02	0.79	10	0.39	50
03	0.94	03	0.64	15	0.28	75
04	0.86	04	0.53	20	0.22	120
05	0.79	05	0.45	25	0.18	125
06	0.72	06	0.39	30	0.15	150
07	0.66	07	-	-	0.33	175
08	0.60	08	-	-	0.11	200
09	0.56	09	-	-	-	-
10	0.52	10	-	-	-	-

At Parbhani, *in-situ* rainwater conservation practices had significant effect on seed yield of soybean. Significantly higher yield (624 kg/ha) was recorded with opening of furrow in soybean + pigeonpea (4:2) was carried out after every four rows 30 DAS during August 2014 compared to no furrow opening (527 kg/ha). Opening of furrow in pigeonpea crop increased the yield by 17.13%. Whereas the soybean yield was increased by 15.56%.

At Parbhani, in a study on catchment-storage-command relationship, of the total monsoon rainfall (398.1 mm), only 63 mm of runoff produced which was 15.52% of the monsoon rainfall. The maximum runoff was produced in the month of July (46 mm) from only one storm of 60 mm and thus contributed runoff water from 2.04 ha catchment area to farm pond. The evaporation loss from the farm pond for the period August, 2013 to January, 2014 was recorded as 778.8 mm while seepage loss was found to be 1073.9 mm (Table 3.306). The soybean seed yield (965 kg/ha) was significantly higher with one protective irrigation given from harvested

rainwater at branching with 64.57% increase over no protective irrigation. The crop without any protective irrigation produced seed yield of 586 kg/ha.

At Parbhani, the *in-situ* rainwater conservation practices showed significant differences in seed yield of soybean. Significantly higher yield (862 kg/ha) was recorded with opening of furrow after every 4 rows with higher RWUE (3.05 kg/ha-mm), net returns (Rs. 10211/ha) and B:C ratio (1.55), followed by tied ridging after every 4 rows (860 kg/ha) and conservation furrow at 2.7 m distance (834 kg/ha) (Table 3.307).

Table 3.306: Seasonal evaporation and seepage losses from farm pond - Parbhani

Date	Evaporation loss (mm)	Seepage loss (mm)
15-31 July, 2014	66.7	69.5
1-15 August, 2014	80.8	85.6
16-31 August, 2014	78.4	89.5
1-15 September, 2014	61.4	92.6
15-30 September, 2014	82.2	89.7
1-31 October, 2014	Farm pond dry	
Total	369.5	426.9

Table 3.307: Soybean yield and economics as affected by various *in-situ* rainwater conservation practices - Parbhani

Treatment	Seed yield (kg/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
Opening of furrow after every 4 rows	862	10211	1.58	3.05
Dead furrow after 10 m	755	6787	1.39	2.67
Tied ridging after every 4 rows	860	10147	1.58	3.04
Conservation furrow at 2.7 m distance	834	9315	1.53	2.95
Flat bed	632	2851	1.16	2.24
CD at 5%	138	4605	0.24	-

At Parbhani, the storm-wise runoff, soil loss and per cent moisture during the crop growth period and monsoon period was determined. The highest runoff of 63 mm was produced in the treatment of flat bed and minimum runoff of 26 mm was produced in the treatment of tied ridging which was 59% less than the flat bed treatment. Opening of furrow resulted in 28 mm of runoff which was 55% less than the flat bed treatment. At Parbhani, during 2014, the highest soil loss of 1.48 t/ha was produced in the treatment of flat bed and minimum soil loss of 0.5 t/ha was produced in the treatment of tied ridging which was 66 % less than the flat bed treatment. Opening of furrow resulted in 0.73 t/ha of soil loss which was 51% less than the flat bed treatment. The soil moisture was determined in every fortnight in every treatment and averaged as monthly soil moisture. Tied ridging and opening of furrow after every 4 rows conserved higher moisture in soil compared to flat bed method (Table 3.308).

Table 3.308: Storm-wise runoff, soil loss and soil moisture as influenced by various treatments – Parbhani

Date	Rainfall (mm)	Opening of furrow after every 4 rows T_1	Dead furrow after 10 m T_2	Tied ridging after every 4 rows, T_3	Conservation furrow at 2.7 m distance, T_4	Flat bed T_5
Runoff (mm)						
July 9	60.00	26	37	24	28	46
Aug 31	38.2	2	10	2	4	17
Total		28	47	26	32	63
% less than T_5		55	25	59	50	
Soil loss (t/ha)						
June 7	60.00	0.61	0.72	0.40	0.36	1.02

Date	Rainfall (mm)	Opening of furrow after every 4 rows T_1	Dead furrow after 10 m T_2	Tied ridging after every 4 rows, T_3	Conservation furrow at 2.7 m distance, T_4	Flat bed T_5
July 9	38.2	0.12	0.31	0.10	0.16	0.46
Total		0.73	1.03	0.50	0.52	1.48
% less than T_5		51	30	66	56	
Soil moisture %						
July		28	27	29	28	22
August		29	28	29	26	21
September		28	24	28	26	21
October		20	17	21	20	15

3.5.2 Cropping systems

At Akola, in a study on performance of intercrops on growth and yield of cotton, sole cotton recorded significantly higher seed cotton yield (1266 kg/ha). However among intercropping systems, cotton + clusterbean (1:1) system recorded significantly higher seed cotton yield (1139 kg/ha) and was at par with rest of the intercropping systems. Intercropping of cotton + cowpea and cotton + clusterbean were at par and recorded significantly higher cotton equivalent yield (1958 and 1931 kg/ha), net returns (Rs.34066 and 33361/ha), B:C ratio (1.81 and 1.80) and RWUE (2.97 and 2.85 kg/ha-mm), respectively over rest of the treatments (Table 3.309).

Table 3.309: Crop yield and economics as influenced by intercropping systems - Akola

Treatment	Yield (kg/ha)				Cotton equivalent yield (kg/ha)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C Ratio	RWUE (kg/ha-mm)
	Cotton	Stalk	Intercrop	Stalk					
Sole cotton (AKH-9916)	1266	1898	-	-	1266	32334	17672	1.55	1.99
Sole greengram	-	-	2090	802	880	24147	10301	1.43	1.38
Sole blackgram	-	-	493	712	787	15855	10212	1.64	1.23
Sole soybean	-	-	1086	902	915	30699	5202	1.17	1.43
Sole clusterbean	-	-	3346	931	1409	34030	20669	1.61	2.21
Sole cowpea	-	-	3466	934	1460	35612	21017	1.59	2.29
Cotton + greengram (1:1)	1048	1319	872	455	1484	35621	20056	1.56	2.33
Cotton + blackgram (1:1)	1033	1325	343	345	1494	32719	25815	1.79	2.34
Cotton + soybean (1:1)	992	1178	492	466	1406	35219	19970	1.57	2.20
Cotton + clusterbean (1:1)	1139	1317	1881	458	1931	41914	33361	1.80	2.85
Cotton + cowpea (1:1)	1114	1354	2004	435	1958	42237	34066	1.81	2.97
CD at 5%	126.8	361.6	-	-	136.1	870	5138	-	0.17

At Akola, in another study on effect of per-monsoon sowing of cotton under high density planting system, the sole *deshi* cotton genotype (AKA-7) registered the highest seed cotton yield (999 kg/ha), net returns and B:C ratio and the lowest seed cotton yield was recorded in sole American cotton genotype (AKH-081) (891 kg/ha). Among the cotton + soybean (6:6) - mustard mixed cropping system same trend of results were observed. Sole crops of soybean and mustard also registered higher seed yield (864 and 412 kg/ha, respectively). *Deshi* cotton

genotype (AKA-7) recorded significantly higher cotton equivalent yield compared to other treatments but was and par with American cotton genotype AKH-081 and *Bt. Cotton* genotype Ankur-651. Among the mixed cropping system, *deshi* cotton (AKA-7) + soybean (6:6) – mustard recorded significantly higher cotton equivalent yield (1343 kg/ha), net returns (Rs.18163/ha) and B:C ratio (1.34) followed by *deshi* cotton genotype AKH-081 + soybean (6:6) - mustard mixed cropping system (Table 3.310).

Table 3.310: Crop yield and economics as influenced by intercropping systems - Akola

Treatment	Seed cotton yield (kg/ ha)	Soybean yield (kg/ha)	Mustard yield (kg/ha)	Cotton equivalent yield (kg/ha)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio
Sole American cotton (AKH-081) (45 cm x 15 cm)	891	-	-	891	26880	8671	1.22
Sole Bt. cotton (Ankur -651) (45 cm x 60 cm)	953	-	-	953	36413	1528	1.03
Sole *deshi* cotton (AKA-7) (45 cm x 15 cm)	999	-	-	999	24926	14089	1.39
Sole soybean - mustard (45 cm x 15 cm)	-	864	412	1107	29691	13910	1.31
American cotton (AKH-081) + soybean (6:6) -mustard (45 cm x 15 cm)	562	474	217	1161	36214	9774	1.24
Bt. cotton (Ankur-651) + soybean (6:6) - mustard	575	478	221	1181	39632	7139	1.17
Deshi cotton (AKA-7) + soybean (6:6) - mustard	730	484	223	1343	34346	18163	1.34
CD at 5%	-	-	-	111	350	4345	-

At Akola, in a study on diversification in cotton based cropping systems, higher seed cotton yield (985 kg/ha) and yield of soybean (945 kg/ha) were recorded in sole cropping system than intercropping of cotton + soybean (4:10). Application of 100% RDF recorded higher seed cotton and soybean yield (374 and 811 kg/ha). Sole cotton and cotton + soybean (4:10) in *kharif* season were at par in respect of cotton equivalent yield than sole soybean (*rabi* crops of safflower/linseed/chickpea were not sown due to less moisture in the soil). Application of 100% RDF recorded higher cotton equivalent yield (959 kg/ha) than 50% RDF + *Gliricidia* + biofertilizer (875 kg/ha). Significantly higher NMR (Rs.10020/ha) and B:C ratio (1.33) were recorded with cotton + soybean (4:10) than sole cotton and soybean. 100% RDF recorded significantly higher NMR (Rs.7779/ha) and B:C ratio (1.25) than 50% RDF + 50% N through *Gliricidia* + biofertilizer (Table 3.311).

Table 3.311: Crop yield and economics as influenced by cropping systems and nutrient management - Akola

Treatment	Yield (kg/ha)				Cotton equivalent yield (kg/ha)		NMR (Rs/ha)		B:C ratio	
	Seed cotton		Soybean		2014-15	Mean (2 yrs)	2014-15	Mean (2 yrs)	2014-15	Mean (2 yrs)
	2014-15	Mean (2 yrs)	2014-15	Mean seed (2 yrs)						
Cropping pattern										
Sole cotton	985	1237	-	-	985	1237	6793	31012	1.22	2.15
Soybean - chickpea	-	-	945	1702	795	1392	2093	31854	1.07	1.74
Soybean - linseed	-	-	945	1702	795	1198	2093	26277	1.07	1.78
Soybean - safflower	-	-	945	1702	795	1509	2093	39533	1.07	2.00
Cotton + soybean (4:10) - chickpea	489	723	611	1047	1003	1617	9648	45458	1.32	2.21
Cotton + soybean (4:10) - linseed	485	719	641	1075	1025	1491	10020	41772	1.33	2.32
Cotton + soybean (4:10) - safflower	487	722	634	1067	1021	1637	9837	47206	1.32	2.33
CD at 5%					39.1	-	1460	-	-	-

Treatment	Yield (kg/ha)				Cotton equivalent yield (kg/ha)		NMR (Rs/ha)		B:C ratio	
	Seed cotton		Soybean		2014-15	Mean (2 yrs)	2014-15	Mean (2 yrs)	2014-15	Mean (2 yrs)
	2014-15	Mean (2 yrs)	2014-15	Mean seed (2 yrs)						
Nutrient management										
100 % RDF	655	912	811	1423	959	1237	7779	40394	1.25	2.17
50 % RDF + *Gliricidia* + biofertilizers	568	828	763	1341	875	1392	4386	34780	1.14	1.98
CD at 5%					13.09	-	499	-	-	-

At Kovilpatti, in a study on different crop geometry, fertility and moisture conservation practices in cotton, among the crop geometry, 45 cm x 15 cm recorded higher yield parameters such as no. of sympodia, no. of bolls/plant and boll weight. There was no significant difference among moisture conservation practices (Table 3.312a). Among the fertility levels 125% RDF (50:25:50) maintained higher yield parameters as compared to 100% and 150% RDF. High density planting 45 cm x 15 cm with BBF and 125% RDF recorded significantly higher seed cotton yield (1011 kg/ha), net returns (Rs.12099/ha), B:C ratio (1.52) and RWUE (3.36 kg/ha-mm) compared to other treatments (Table 3.312b).

Table 3.312a. Effect of crop geometry, fertility levels and moisture conservation practices on plant growth and yield of cotton - Kovilpatti

Treatment	Plant height (cm)	No. of sympodia/ plant	No. of bolls/ plot	Boll weight (g)	Seed cotton yield (kg/ha)
Crop geometry					
P_1 : 45 cm x 15 cm	96.5	11.7	4.3	3.9	838
P_2 : 45 cm x 10 cm	92.0	10.7	3.0	3.3	748
CD at 5%	NS	0.6	0.4	0.4	39
Moisture conservation					
M_1- Broad bed furrow	95.2	11.4	3.8	3.7	829
M_2 -Compartmental bunding	93.2	11.0	3.5	3.5	757
CD at 5%	NS	NS	NS	NS	NS
Nutrient levels: NPK/ha					
F_1: 100% RDF (40:20:40)	93.5	11.0	3.4	3.4	744
F_2: 125% RDF (50:25:50)	94.6	11.3	4.0	3.9	837
F_3: 150% RDF (60:30:60)	94.5	11.3	3.7	3.5	799
CD at 5%	NS	NS	NS	NS	NS

Table 3.312b. Effect of crop geometry, fertility levels and moisture conservation practices on yield and economics of cotton - Kovilpatti

Treatment	Yield (kg/ha)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
$M_1P_1F_1$	804	22668	5472	1.24	2.67
$M_1P_1F_2$	1011	23286	12099	1.52	3.36
$M_1P_1F_3$	886	23903	7107	1.30	2.94
$M_1P_2F_1$	735	22818	2907	1.13	2.44

Treatment	Yield (kg/ha)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
$M_1P_2F_2$	767	23436	3409	1.15	2.55
$M_1P_2F_3$	776	24053	3107	1.13	2.58
$M_2P_1F_1$	727	22418	3027	1.14	2.42
$M_2P_1F_2$	808	23036	5244	1.23	2.68
$M_2P_1F_3$	793	23653	4102	1.17	2.63
$M_2P_2F_1$	709	22568	2247	1.10	2.36
$M_2P_2F_2$	760	23186	3414	1.15	2.52
$M_2P_2F_3$	743	23803	2202	1.01	2.47

BBF with 125% RDF

Compartmental bunding with 100% RDF

At Parbhani, in a study on tillage practices in different cropping systems, cotton + soybean system gave maximum seed cotton equivalent yield (1658 kg/ha), net returns (Rs.32644/ha) and B:C ratio (1.97) compared to other intercropping systems. Among tillage practices, shallow tillage with bullock drawn implements recorded maximum seed cotton equivalent yield (1534 kg/ha), net returns (Rs.27684/ha) and B:C ratio (1.82) while tillage with rotary tiller gave lowest cotton equivalent yield of 1446 kg/ha, net returns of Rs.24164/ha and B:C ratio of 1.71 (Table 3.313).

Table 3.313: Crop yield and economics as affected by cropping systems and tillage practices - Parbhani

Treatment	Yield (kg/ha)		Seed cotton equivalent yield (kg/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Main crop	Inter crop				
Cropping system						
Sorghum +pigeonpea	2076	560	1452	23604	1.70	5.10
Soybean + pigeonpea	865	576	1498	26244	1.77	5.01
Cotton + soybean	1070	735	1658	32644	1.97	5.75
CD at 5%			126	4907	0.18	-
Tillage practice						
Shallow tillage with bullock drawn implements.	-	-	1534	27684	1.82	5.43

Treatment	Yield (kg/ha)		Seed cotton equivalent yield (kg/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Main crop	Inter crop				
Conventional tillage with bullock drawn implements	-	-	1486	25764	1.76	5.26
Shallow tillage with tractor drawn implements	-	-	1522	27204	1.81	5.39
Conventional tillage with tractor drawn implements	-	-	1484	25684	1.76	5.25
Tillage with rotary tillers	-	-	1446	24164	1.71	5.12
CD at 5%	-	-	81	1626	0.045	-
Interaction (C x T)						
CD at 5%	-	-	177	7155	0.21	-

At Parbhani, in a study on land configuration and fertilizer management, BBF gave maximum soybean yield (1179 kg/ha), net returns (Rs. 10147/ha), B:C ratio (1.35) and RWUE (4.16 kg/ha-mm) compared to other land configurations. Among fertilizer management practices, RDF + foliar application of KNO_3 recorded maximum seed yield (1119 kg/ha), net returns (Rs.8405/ha), B:C ratio (1.29) and RWUE (3.96 kg/ha-mm) compared to other treatments (Table 3.314).

Table 3.314: Soybean yield and economics as influenced by nutrient management - Parbhani

Treatment	Seed yield (kg/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
Land configuration				
Flat bed	911	1836	1.07	3.22
Broad bed & furrow (BBF)	1179	10147	1.35	4.16
Ridges & furrow	1046	5791	1.20	3.69
CD at 5%	121.42	1162.33	-	-
Fertilizer cum stress management practice				
RDF (30:60:30 NPK kg/ha)	975	6961	1.27	3.45
RDF + foliar application of KNO_3	1119	8405	1.29	3.96
RDF + foliar application of NPK (19:19:19)	1099	7407	1.25	3.89
RDF + foliar application of MoP	1039	7294	1.27	3.68
RDF + foliar application of micronutrients mixture	1063	5469	1.18	3.76
RDF + straw mulch	1032	5842	1.20	3.66
RDF + foliar application of kaolin	1051	2982	1.09	3.72
RDF + water sprays (35 & 60 DAS)	984	5657	1.21	3.48
CD at 5%	84.98	1147	-	-

At Parbhani, in a study on land configuration and fertilizer management, BBF gave maximum seed cotton yield (1144 kg/ha), net returns (Rs. 3975/ha), B:C ratio (0.87) and RWUE (2.01 kg/ha-mm) compared to other land configurations. Among fertilizer management practices, RDF 75% + GM + foliar application of KNO_3 recorded maximum yield (1108 kg/ha), net returns (Rs.1939/ha), B:C ratio(0.89) and RWUE (2.36 kg/ha-mm) compared to other treatments (Table 3.315).

Table 3.315: Cotton yield and economics as influenced by nutrient management - Parbhani

Treatment	Seed cotton yield (kg/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
Land configuration				
Flat bed	903	-5529	0.75	1.72
BBF	1144	3975	0.87	2.01
Ridges & furrow	1013	-1117	0.78	1.81
CD at 5%	72.19	2613.89	-	-
Fertilizer cum stress management practice				
RDF (120:60:120 NPK kg/ha)	916	-274	0.84	1.85
RDF + foliar application of KNO_3	1046	237	0.73	1.92
RDF + foliar application of micronutrients mixture	1039	922	0.60	1.53
RDF 75% + GM + foliar application of KNO_3	1108	1939	0.89	2.36
RDF 75% + GM + foliar application of micronutrients mixture	1054	1048	0.65	1.68
RDF 75% + OM + foliar application of KNO_3	1006	-4994	0.71	2.10
RDF 75% + OM + foliar application of micronutrients mixture	978	-4913	0.51	1.48
CD at 5%	133.14	749.89	-	-

GM: Green manure; OM: Organic manure

3.5.3 Nutrient management

At Akola, in a study on INM in soybean, significantly highest seed yield (542.5 kg/ha) of soybean was recorded with the application of 50% N through glyricidia + 50% N through inorganics + biofertilizers + 25 kg K/ha. The pooled data (2009-2014) also indicated that the highest seed and stalk yield (157 and 2343 kg/ha) was recorded with the application of 100% RDF + 25 kg K/ha + biofertilizers and was on par with application of 50% N through glyricidia + 50% N through inorganics + biofertilizers + 25 kg K/ha and 100% RDF + 25 kg K/ha.

The highest net returns of Rs.20083/ha was obtained with the application of 50% N through green leaf manure + 50% N through inorganics + biofertilizers + 25 kg K/ha followed by 100% RDF + 25 kg K/ha + biofertilizers. The pooled data on RWUE indicated that higher RWUE (2.43kg/ha-mm) was recorded with the application of 100% RDF + 25 kg K/ha + biofertilizers closely followed by 50% N through glyricidia + 50% N through inorganics + biofertilizers + 25 kg K/ha. The highest productivity rating index (PRI) (63.5) was recorded with application of 100% RDF + 25 kg K/ha + biofertilizers followed by application of 50% N through glyricidia + 50% N through inorganics + biofertilizers + 25 kg K/ha. However, the highest SYI (0.33) was observed with the application of 50% N through glyricidia + 50% N through inorganics + biofertilizers + 25 kg K/ha followed by 100% RDF + 25 kg K/ha + biofertilizers (Table 3.316).

Table 3.316: Effect of integrated nutrient management on soybean yield and economics – Akola

Treatment	Soybean yield (kg/ha)				NMR (Rs/ha)	B:C ratio	RWUE (kg/ ha-mm)	PRI	SYI
	Seed (2014-15)	Stalk (2014-15)	Mean seed (2009-14)	Mean stalk (2009-14)					
Control	**220**	270	1207	1910	15288	1.90	1.87	48.3	0.23
100% RDF (30:75:00 NPK kg/ha)	334	410	1404	2127	16083	1.77	2.15	56.2	0.27
100% RDF + biofertilizers	364	447	1447	2176	16309	1.75	2.20	57.9	0.27
100% N through FYM + biofertilizers	292	358	1327	2057	8347	1.33	2.03	53.1	0.25
100% RDF + 25 kg K/ha	368	489	1505	2239	18420	1.86	2.29	60.2	0.28
100% RDF + 25 kg K/ha + biofertilizers	432	574	1587	2343	19557	1.88	2.43	63.5	0.31
50% N through green leaf manure + 50% N through inorganics	391	520	1430	2164	17471	1.83	2.21	57.2	0.28
50% N through green leaf manure + 50% N through inorganics + biofertilizers	421	560	1469	2159	17673	1.80	2.28	58.7	0.31
50% N through green leaf manure + 50% N through inorganics + biofertilizers + 25 kg K/ha	54	721	1557	2299	20083	1.90	2.41	62.3	0.33
CD at 5%	88.1	113.5	86	124	2223	-	-	-	-

PRI: Productivity rating index; SYI: Sustainable yield index

There was a buildup of organic carbon status of soil under soybean in all treatments except control over the initial status (5.2 g/ kg). Application of green leaf manuring of (glyricidia) resulted in improvement in the organic carbon content of the soil. The higher soil organic carbon content (6.31 g/kg) was recorded with the application of 50% N through glyricidia + 50% N through inorganics + biofertilizers + 25 kg K/ha. The treatment also recorded higher NPK contents in soil compared to the other treatments (Table 3.317). Similarly, significantly higher N, P and K uptake (36.63, 6.15 and 12.40 kg/ha) by soybean was recorded with application of 50% N through glyricidia + 50% N through inorganics + biofertilizers + 25 kg K/ha followed by application of 100% RDF + 25 kg K/ha + biofertilizers.

Table 3.317: Effect of integrated nutrient management on available nutrient status of soil and uptake by soybean - Akola

Treatment	OC (g/kg)	Available nutrients (kg/ha)			Nutrient uptake (kg/ha)			Nutrient balance (kg/ha)		
		N	P	K	N	P	K	N	P	K
Control	5.02	188	11.0	310	11.3	2.7	4.0	-6.64	-4.47	-8.76
100% RDF (30:75:00 NPK kg/ ha)	5.24	197	12.9	315	19.6	3.6	6.9	2.78	-2.61	-3.76
100% RDF + biofertilizers	5.38	199	14.6	317	22.0	4.2	7.7	4.03	-0.90	-1.59
100% N through FYM + biofertilizers	5.56	191	12.9	315	16.3	3.1	6.3	-3.91	-2.64	-3.16
100% RDF + 25 kg K /ha	5.78	208	13.7	346	23.3	4.5	8.3	13.65	-1.76	27.01
100% RDF + 25 kg K/ha + biofertilizers	6.13	210	16.8	351	28.5	5.4	9.5	15.74	1.27	32.38
50% N through green leaf manure + 50% N through inorganics	5.91	197	14.1	335	24.9	4.3	8.6	2.36	-1.39	16.03

Treatment	OC (g/kg)	Available nutrients (kg/ha)			Nutrient uptake (kg/ha)			Nutrient balance (kg/ha)		
		N	P	K	N	P	K	N	P	K
50% N through green leaf manure + 50% N through inorganics + biofertilizers	6.09	201	16.3	342	27.5	4.5	9.2	6.54	0.75	23.91
50% N through green leaf manure+ 50% N through inorganics + biofertilizers + 25kg K/ ha	6.31	215	17.1	359	36.6	6.2	12.4	20.76	1.64	40.82
CD at 5%	0.22	13.7	1.6	12	5.4	1.1	2.1			
Initial (2009-10)	5.2	195	15.5	319						

At Akola, in another experiment in INM in cotton, the highest seed cotton and stalk yield (607 and 1198 kg/ha) was recorded with application of 50% N through glyricidia + 50% N through inorganics + biofertilizers + 25kg K/ ha and was on par with application of 100% RDF + 25 kg K/ ha + biofertilizers. But the pooled data (2009-2014) indicated that highest seed cotton and stalk yield (842 and 2101 kg/ha) was recorded with application of 100% RDF + 25 kg K/ha + biofertilizers which was on par with application of 50% N through glyricidia + 50% N through inorganics + biofertilizers + 25 kg K/ha. The pooled data indicated that the higher NMR (Rs.17783/ha) was obtained with the application of 50% N through glyricidia + 50% N through inorganics + biofertilizers + 25kg K/ha. The effect of INM on sustainable yield index of cotton indicated that similar SYI (0.50 and 0.49) was observed with application of 50% N through glyricidia + 50% N through inorganics + biofertilizers + 25 kg K/ha and 100% RDF + 25 kg K/ha + biofertilizers (Table 3.318).

Table 3.318: Effect of integrated nutrient management on seed cotton yield and economics - Akola

Treatment	Seed cotton yield (2014-15)	Stalk yield (2014-15)	Mean seed cotton yield (2009-14)	Mean stalk yield (2009-14)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)	SYI	PRI
Control	247	474	582	1423	10311	1.63	0.85	0.31	48.5
100% RDF (50:25:00 NPK kg/ha)	321	615	679	1684	11642	1.61	0.98	0.35	56.6
100% RDF + biofertilizers	331	631	725	1779	13297	1.67	1.05	0.37	60.5
100% N through FYM + biofertilizers	260	498	621	1565	3270	1.15	0.90	0.32	51.8
100% RDF + 25 kg K/ha	400	790	772	1883	15123	1.75	1.12	0.41	64.4
100% RDF + 25 kg K/ha + biofertilizers	485	957	842	2101	17577	1.87	1.24	0.49	70.2
50% N through green leaf manure + 50% N through inorganics	334	658	699	1631	12426	1.65	1.03	0.39	58.3
50% N through green leaf manure + 50% N through inorganics + biofertilizers	355	702	726	1696	13509	1.67	1.07	0.39	60.5
50% N through green leaf manure + 50% N through inorganics + biofertilizers + 25 kg K/ha	607	1198	840	2007	17783	1.85	1.25	0.50	70.1
CD at 5%	159	314	58	177	2602	-	-	-	-

At Akola, after six years of the experimentation, there was improvement in the available N, P, K and organic carbon content over the initial status of the soil with INM. The higher soil organic carbon (6.19 g/kg) was recorded with the application of 50% N through glyricidia + 50% N through inorganics + biofertilizers + 25 kg K/ha which was on par with application of 100% RDF + 25 kg K/ha + biofertilizers and 50% N through glyricidia + 50% N through inorganics + biofertilizers. Similarly, the highest (215, 16 and 350 kg/ha) available N, P and K and nutrient balance in soil was recorded with 50% N through glyricidia + 50% N through inorganics + biofertilizers + 25 kg K/ha compared to other treatments (Table 3.319).

Table 3.319: Effect of integrated nutrient management on available nutrient status of soil and uptake by cotton - Akola

Treatment	OC (g/kg)	Available nutrients (kg/ha)			Nutrient uptake (kg/ha)			Nutrient balance (kg/ha)		
		N	P	K	N	P	K	N	P	K
Control	4.93	189	10.3	307	8.9	2.3	6.3	-6.00	-5.18	-11.6
100% RDF (50:25:00 NPK kg/ha)	5.23	196	13.4	316	14.9	4.2	9.4	1.52	-2.07	-2.9
100% RDF + biofertilizers	5.29	197	14.1	317	16.5	4.6	10.7	2.78	-1.39	-1.4
100% N through FYM + biofertilizers	5.47	192	13.3	314	11.4	2.8	7.8	-2.24	-2.18	-4.2
100% RDF + 25 kg K/ha	5.69	197	14.2	336	21.2	6.0	12.5	2.36	-1.30	17.4
100% RDF + 25 kg K/ha + biofertilizers	6.04	211	16.7	347	29.5	8.5	17.3	16.58	1.21	28.4
50% N through green leaf manure + 50% N through inorganics	5.91	202	13.7	332	18.7	5.3	11.2	7.38	-1.76	136.
50% N through green leaf manure + 50% N through inorganics + biofertilizers	6.09	206	15.9	336	21.1	6.1	12.5	11.56	0.40	17.6
50% N through green leaf manure + 50% N through inorganics + biofertilizers + 25 kg K/ha	6.19	215	16.9	350	38.4	10.8	22.1	20.34	1.38	31.9
CD at 5%	0.16	6.4	2.4	6.8	9.6	2.5	5.4	-	-	-
Initial(2009-10)	5.2	195	15.5	319	-	-	-	-	-	-

In an INM study in cotton + greengram intercropping system at Akola, the greengram crop suffered due to water stress and damaged by wild animals hence yield is not reported. Long term application of 25 kg N/ha (50% RDN) through organic source (FYM) in combination with 25 kg N + 25 kg P_2O_5/ha through urea and SSP recorded significantly higher seed cotton yield (807.8 kg/ha) followed by application of 50% N fertilizers + 50% N glyricidia + 100% P_2O_5/ha fertilizers (Table 3.320).

Table 3.320: Effect of integrated nutrient management on yield of cotton + greengram (1:1) intercropping system - Akola

Treatment	Yield (kg/ha)		Pooled (3 yrs)	RWUE (kg/ha-mm)
	Seed cotton	Stalk		
Control	54	101	471	0.09
100% N + 100% P_2O_5/ha fertilizers	80	123	692	0.13
50% N + 50% P_2O_5/ha fertilizers	79	144	626	0.13
50% N/ha glyricidia	65	150	598	0.11
50% N/ha FYM	76	156	643	0.13
50% N fertilizers + 50% N glyricidia + 100% P_2O_5/ha fertilizers	132	259	747	0.22
50% N fertilizers + 50% N/ha FYM + 100% P_2O_5/ha fertilizers	154	302	807	0.26
100% N/ha glyricidia + 100% P_2O_5/ha fertilizers	102	2001	696	0.17
CD at 5%	31	61	31	-

At Kovilpatti, among different land configuration methods and nutrient management practices, flat bed method of land configuration resulted in highest sorghum grain yield (1943 kg/ha), net returns (Rs.8507/ha), B:C ratio (1.50) and RWUE (6.46 kg/ha-mm). Among fertilizer treatments, 40 kg N: 20 kg P as EFYM: 20 kg K registered highest yield (2000 kg/ha), net returns (Rs.12510 kg/ha), B:C ratio (1.94) and RWUE (6.64 kg/ha-mm). Among the interaction effects the broad bed furrow method along with application of 20 kg N as a urea + 20 kg P through EFYM as a basal and 10 kg K and top dressing of 20 kg N as a urea + 10 kg K recorded higher available nutrient status when compared to other treatments (Table 3.321a & b).

Table 3.321a. Effect of moisture conservation and nutrient management on crop yield and economics of sorghum - Kovilpatti

Treatment	Yield (kg/ha)			Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Grain	Mean grain yield (2 yrs)	Stover				
Moisture conservation/land configuration							
M_1	1943	1560	5839	16752	8507	1.50	6.46
M_2	1951	1600	6164	17489	7874	1.45	6.48
M_3	1965	1637	6345	17502	8043	1.45	6.53
CD at 5%	8.5	-	54.9	-	-	-	-
Fertilizer application							
S_1	1983	1442	5948	13528	11302	1.84	6.59
S_2	1910	1642	5790	13586	12297	1.91	6.35
S_3	1984	1467	6330	13639	12361	1.91	6.59
S_4	1914	1586	6000	13545	11337	1.84	6.36
S_5	2000	1838	6560	13282	12510	1.94	6.64
S_6	1997	1697	6410	13350	12429	1.93	6.63
S_7	1883	1487	5773	12689	11790	1.93	6.26
CD at 5%	57.0	-	142.9	-	-	-	-

M_1: Flat bed; M_2: Ridges & furrows; M_3: Broad bed and furrow; S_1: FYM @ 12.5 t/ha; S_2: FYM @ 5 t/ha + NPK 4:10:0; S_3: NPK 40:20:0 ; S_4 : NPK 8:20:0; S_5 : NPK 20:20 as EFYM:10 ; S_6 : FYM 5 t/ha + NPK 4:10:0 ; S_7 : Control ; Top dressing T_1 : - ; T_2: NPK 16:0:0; T_3: - ; T_4: NPK 32:0:10; T_5: NPK 20:0:10; T_6: NPK 16:0:10; T_7: - .

Table 3.321b. Effect of moisture conservation and nutrient management on soil chemical properties - Kovilpatti

Treatment	pH	Organic C (%)	Available nutrients (kg/ha)		
			N	P	K
Moisture conservation/land configuration					
M_1	8.05	0.34	138	11.4	428
M_2	8.22	0.36	140	11.6	436
M_3	8.08	0.39	142	12.1	429
CD at 5%	NS	0.018	NS	0.36	NS
Fertilizer applications					
S_1	7.81	0.39	129	11.0	428
S_2	7.91	0.39	135	11.4	424
S_3	8.22	0.35	139	12.1	388
S_4	8.25	0.31	147	11.2	456
S_5	8.13	0.42	162	12.5	476
S_6	8.21	0.39	154	12.2	463
S_7	8.29	0.33	115	11.5	383
CD at 5%	0.23	0.010	4.7	0.4	108.6
M x S	0.193	-	-	-	-
S x M	0.191	-	-	-	-

At Kovilpatti, in an experiment on foliar nutrition in cotton in Vertisols, the yield attributes and yield were significantly influenced by foliar nutrition. RDF + 1.25% cotton plus at square formation and flowering stages recorded significantly higher seed kapas yield (1723 kg/ha), with higher net returns (Rs.28237/ha), B:C ratio (1.88) and RWUE (5.72 kg/ha-mm) (Table 3.322).

Table 3.322: Effect of nutrient management on yield and economics of cotton - Kovilpatti

Treatment	Yield (kg/ha)			Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Seed cotton 2014	Mean seed cotton (2 yrs)	Stalk yield				
RDF @ 60:30:30 kg/ha	1463	312	3365	30000	21197	1.71	4.86
RDF + 0.5% urea + 1% KCl at square formation and flowering stages	1604	331	3689	31688	24448	1.77	5.33
RDF + 1.25% cotton plus at square formation and flowering stages	1723	322	3963	32060	28237	1.88	5.72
RDF + 1% $MgSO_4$ + 0.5% $ZnSO_4$ + 0.2% B at square formation and flowering stages	1573	348	3618	33418	21629	1.65	5.23
RDF + 0.5% $ZnSO_4$ spray thrice at 45, 60 & 75 DAS	1531	338	3521	32715	20874	1.64	5.09
RDF + 0.2% $CuSO_4$ + $ZnSO_4$ 0.5% at 45, 60 and 75 DAS	1437	344	3305	33285	17018	1.51	4.77
RDF + TNAU Panchakavya spray @ 3% at square formation and flowering stages	1518	326	3491	36020	17102	1.47	5.04
RDF + 0.2% B + Se (20 g/ha) on 45 & 60 DAS	1524	325	3505	32382	20954	1.65	5.06
CD at 5%	205	81	193.2	-	-	-	-

Different foliar nutrient treatments among the RDF + 1.0% $MgSO_4$ + 0.5% $ZnSO_4$ + 0.2% B at square formation and flowering stages had no significant effect on soil pH. Whereas, significant difference had on organic carbon (0.45%), available N (168 kg/ha), P (14.9 kg/ha) & K (497 kg/ha). There was build up of organic carbon and available NPK content in all the foliar nutrition applied treatments as compared to RDF (Table 3.323).

Table 3.323: Effect of nutrient management on soil chemical properties - Kovilpatti

Treatment	pH	Organic C (%)	Available nutrients (kg/ha)		
			N	P	K
RDF @ 60:30:30 kg/ha	8.12	0.37	127	13.1	413
RDF + 0.5% urea + 1% KCl at square formation and flowering stages	8.25	0.44	133	14.2	438
RDF + 1.25% cotton plus at square formation and flowering stages	8.21	0.42	159	13.6	421
RDF + 1% $MgSO_4$ + 0.5% $ZnSO_4$ + 0.2% B at square formation and flowering stages	8.29	0.45	168	14.9	497
RDF + 0.5% $ZnSO_4$ spray thrice at 45, 60 & 75 DAS	8.30	0.43	144	14.7	468
RDF + 0.2% $CuSO_4$ + $ZnSO_4$ 0.5% at 45, 60 and 75 DAS	8.35	0.44	154	14.9	473
RDF + TNAU Panchakavya spray @ 3% at square formation and flowering stages	8.27	0.41	123	13.4	456
RDF + 0.2% B + Se (20 g/ha) on 45 & 60 DAS	8.22	0.39	128	14.0	425
CD at 5%	NS	0.0123	8.0	0.68	22.93
Initial values	8.20	0.31%	123	11.9	390

At Kovilpatti, in a study on INM in maize, application of manures and fertilizers significantly influenced the yield attributes and yield of maize. Application of urea (N 60) + DAP (P_{40}) + MOP (K_{20}) + 25 kg $ZnSO_4$/ha recorded significantly higher grain yield (2351 kg/ha) with higher net returns (Rs.10313/ha), B:C ratio (1.51) and RWUE (7.81 kg/ha-mm) compared to other treatments (Table 3.324).

Table 3.324: Effect of INM on yield and economics of maize in Alfisols - Kovilpatti

Treatment	Yield (kg/ha)			Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Grain (2014)	Mean grain (2012-13)	Stover				
Control	1747	185.0	3144	21000	1711	1.08	5.80
Urea (N_{60}) + DAP (P_{40}) + MOP (K_{20})	1813	192.4	3263	19870	3699	1.19	6.02
Urea (N_{30}) + on-farm residue (N_{30}) + DAP (P_{20}) + MOP (K_{10})	2021	211.2	3638	19542	6731	1.34	6.71
30 kg N (crop residue)	1995	193.1	3591	19892	6043	1.30	6.63
30 kg N (FYM)	2106	213.6	3790	19946	7432	1.37	7.00
30 kg N (urea) + 30 kg N (crop residue) + 20 kg P + 10 kg K/ha	2263	232.8	4073	20017	9402	1.47	7.52
30 kg N (urea) + 30 kg N (FYM) + 20 kg P + 10 kg K/ha	1937	167.6	3487	18750	6431	1.34	6.44
Urea (N_{60}) + DAP (P_{40}) + MOP (K_{20}) + 25 kg $ZnSO_4$/ha	2351	242.6	4231	20250	10313	1.51	7.81
FYM 12.5 t/ha (100% organic)	1901	205.5	3422	20620	4093	1.20	6.32
CD at 5%	313.9	31.3	174.4	-	-	-	-

At Kovilpatti, among different treatments, urea (N_{60}) + DAP (P_{40}) + MOP (K_{20}) + 25 kg $ZnSO_4$/ha recorded higher available N (144 kg/ha) and K (454 kg/ha). However, available P was highest (18.1 kg/ha) in the plots under 30 kg N(urea) + 30 kg N (FYM) + 20 kg P+ 20 kg K/ha whereas organic C content was higher (0.42%) in the plots under FYM @ 12.5 t/ha (Table 3.325).

Table 3.325: Effect of INM on soil chemical properties gram - Kovilpatti

Treatment	pH	Organic C (%)	Available nutrients (kg/ha)		
			N	P	K
Control	8.21	0.16	105	10.8	363
Urea (N_{60}) + DAP (P40) + MOP (K_{20})	8.22	0.23	125	15.0	402
Urea (N_{30}) + on farm residue (N_{30}) + DAP (P_{20}) + MOP (K_{10})	8.24	0.15	129	15.1	395
30 kg N (crop residue)	8.13	0.35	120	14.7	404
30 kg N (FYM)	7.90	0.32	137	17.6	414
30 kg N (urea) + 30 kg N (crop residue) + 20 kg P + 10 kg K/ha	8.01	0.36	139	17.9	431
30 kg N (urea) + 30 kg N (FYM) + 20 kg P + 10 kg K/ha	8.16	0.29	139	18.1	408
Urea (N_{60}) + DAP (P_{40}) + MOP (K_{20}) + 25 kg $ZnSO_4$/ha	8.31	0.39	144	17.9	454
FYM 12.5 t/ha (100% organic)	7.86	0.42	133	16.8	394
CD at 5%	NS	0.012	3.9	0.31	11

At Kovilpatti, in a similar study under Vertisols, application of manures and fertilizers significantly influenced the yield attributes and yield of maize. Application of urea (N_{60}) + DAP (P_{40}) + MOP (K_{20}) + 25 kg $ZnSO_4$/ha recorded significantly higher grain yield (3438 kg/ha) with higher net returns (Rs.24748/ha), B:C ratio (2.24) and RWUE (11.4 kg/ha-mm) followed by 30 kg N (urea) + 30 kg N (crop residue) + 20 kg P + 10 kg K/ha compared to other treatments. There was 23% deficit of North east monsoon rainfall (Table 3.326).

Table 3.326: Effect of INM on yield and economics of maize CO(H)M6 in Vertisols - Kovilpatti

Treatment	Yield (kg/ha)			Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Grain (2014)	Mean grain (2012-13)	Stover				
Control	2821	174	6419	20620	16053	1.78	9.4
Urea (N_{60}) + DAP (P_{40}) + MOP (K_{20})	3019	189	7620	19870	19377	1.98	10.0
Urea (N_{30}) + on farm residue (N_{30}) + DAP (P_{20}) + MOP (K_{10})	3216	198	7094	19542	22266	2.14	10.7
30 kg N (crop residue)	3006	182	7649	19892	19186	1.96	10.0
30 kg N (FYM)	3090	196	7744	20017	20153	2.01	10.3
30 kg N (urea) + 30 kg N (crop residue) + 20 kg P + 10 kg K/ha	3278	223	7819	18750	23864	2.27	10.9
30 kg N (urea) + 30 kg N (FYM) + 20 kg P + 10 kg K/ha	2986	157	7523	21000	17818	1.85	9.9
Urea (N_{60}) + DAP (P_{40}) + MOP (K_{20}) + 25 kg $ZnSO_4$/ha	3438	238	7823	19946	24748	2.24	11.4
FYM 12.5 t/ha (100% organic)	2909	192	7373	20250	17567	1.87	9.7
CD at 5%	220.9	29.9	632.9				

At Kovilpatti, among different treatments urea (N_{60}) + DAP (P_{40}) + MOP (K_{20}) + 25 kg $ZnSO_4$/ha recorded higher soil pH, organic carbon and available NPK compared to other treatments (Table 3.327).

Table 3.327: Effect of INM on soil chemical properties - Kovilpatti

Treatment	pH	Organic C (%)	Available nutrients (kg/ha)		
			N	P	K
Control	8.02	0.19	111.7	10.6	374.8
Urea (N_{60}) + DAP (P_{40}) + MOP (K_{20})	8.10	0.19	120.2	14.9	422.5
Urea (N_{30}) + on farm residue (N_{30}) + DAP (P_{20}) + MOP (K_{10})	8.05	0.19	118.9	16.2	411.7
30 kg N (crop residue)	7.94	0.18	115.0	13.2	404.4
30 kg N (FYM)	7.88	0.19	130.5	16.6	428.4
30 kg N (urea) + 30 kg N (crop residue) + 20 kg P + 10 kg K/ha	8.01	0.20	144.6	18.1	449.7
30 kg N (urea) + 30 kg N (FYM) + 20 kg P + 10 kg K/ha	8.11	0.19	128.7	14.1	440.7
Urea (N_{60}) + DAP (P_{40}) + MOP (K_{20}) + 25 kg $ZnSO_4$/ha	8.26	0.22	146.7	18.3	453.3
FYM 12.5 t/ha (100% organic)	7.83	0.21	122.7	15.4	431.7
CD at 5%	NS	0.006	3.53	0.54	14.91

At Parbhani, in a study on fertilizer management and foliar spray, application of RDF + foliar spray of KNO_3 @ 1 & 2% (35 & 65 DAS) gave maximum seed cotton yield (1237 kg/ha), net returns (Rs.12705/ha), B:C ratio (1.33) and RWUE (4.38 kg/ha-mm) compared to treatments (Table 3.328).

Table 3.328: Cotton yield and economics as influenced by different treatments - Parbhani

Treatment	Seed cotton yield (kg/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
RDF	791	1345	1.06	2.80
RDF + straw mulch @ 3 t/ha (35 & 65 DAS)	1052	7057	1.19	3.73
RDF + foliar spray of kaolin @ 7% (35 & 65 DAS)	1029	4452	1.11	3.64
RDF + foliar spray of KNO_3 @ 1 & 2 % (35 & 65 DAS)	1237	12705	1.33	4.38
RDF + application of NPK (19:19:19) @ 0.5 & 1% (35 & 65 DAS)	1177	10931	1.29	4.17
RDF + foliar application of MOP @ 1 & 2% (35 & 65 DAS)	1037	8044	1.23	3.67
RDF + foliar application of DAP @ 1 & 2% (35 & 65 DAS)	1157	11911	1.34	4.10
RDF + foliar spray of thiourea @ 250 g/ha at 35 & 65 DAS)	826	978	1.02	2.98
RDF + micronutrient mixture spray @ 0.5% (35 & 65 DAS)	1046	5792	1.15	3.70
RDF + water sprays (35 & 65 DAS)	808	895	1.02	2.86
RDF 75% + 25% through organic matter	978	1708	1.04	3.46
RDF 75 %+ 25% through organic matter + foliar application of KNO_3 (35 & 65 DAS)	1089	1854	1.04	3.86
CD at 5%	262.6	1487.2	-	-

Fertilizer management and foliar spray treatments had no significant effect on soil pH and EC. Application of RDF + foliar spray of KNO_3 @ 1 and 2% recorded higher organic C (0.59%), N (215 Kg/ha) and K (623 Kg/ha) compared to other treatment (Table 3.329).

Table 3.329: Effect of nutrient management on physico-chemical properties of soil - Parbhani

Treatment	pH	EC (dS/m)	OC (%)	$CaCO_3$ (%)	N (kg/ha)	P (kg/ha)	K (kg/ha)
RDF	7.99	0.34	0.48	3.7	144	10.8	518
RDF + straw mulch @ 3 t/ha (35 & 65 DAS)	7.98	0.367	0.53	3.8	191	14.7	573
RDF + foliar spray of kaolin @ 7% (35 & 65 DAS)	7.99	0.35	0.50	3.9	173	16.8	559
RDF + foliar spray of KNO_3 @ 1 & 2 % (35 & 65 DAS)	7.97	0.37	0.59	4.1	215	16.2	623
RDF + application of NPK (19:19:19) @ 0.5 & 1% (35 & 65 DAS)	8.00	0.38	0.56	3.9	206	15.6	598
RDF + foliar application of MOP @ 1 & 2% (35 & 65 DAS)	7.99	0.41	0.50	3.7	148	14.3	521
RDF + foliar application of DAP @ 1 & 2% (35 & 65 DAS)	8.01	0.39	0.49	3.6	148	11.3	521
RDF + foliar spray of thiourea @ 250 g/ha at (35 & 65 DAS)	7.99	0.37	0.51	3.8	190	14.1	570
RDF + micronutrient mixture spray @ 0.5% (35 & 65 DAS)	8.00	0.37	0.51	3.9	168	13.6	551
RDF + water sprays (35 & 65 DAS)	7.98	0.38	0.58	3.9	211	16.0	620
RDF 75% + 25% through organic matter	7.98	0.36	0.55	3.7	198	15.2	591
RDF 75 %+ 25% through organic matter + foliar application of KNO_3 (35 & 65 DAS)	7.99	0.35	0.49	3.8	147	12.0	527
CD at 5%	NS	NS	0.07	0.26	7.21	2.6	6.05
Initial status	8.00	0.32	0.47	3.8	142	10.2	512

At Parbhani, in a permanent manurial trial, the cropping system of soybean + pigeonpea produced significantly higher cotton equivalent yield (1510 kg/ha) with highest net returns (Rs.39437/ha), B:C ratio (2.2) and RWUE (5.3 kg/ha-mm) compared to cotton + pigeonpea intercropping system. Among nutrient sources, 75% RDF + 5 t/ha FYM recorded significantly higher cotton equivalent yield (1657 kg/ha) over all other treatments except N4 (1626 kg/ha). Whereas 100% RDF for both the crops recorded significantly higher net returns (Rs.43836/ha) and B:C ratio (2.16) than rest of the treatments (Table 3.330).

Table 3.330: Cotton equivalent yield and economics as affected by intercropping system and PMT - Parbhani

Treatment	Cotton equivalent yield (kg/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
Cotton + pigeonpea	1347	29033	1.27	4.7
Soybean + pigeonpea	1510	39437	2.2	5.3
CD at 5%	116.90	6741	--	--
FYM 15 t/ha for cotton. FYM 10 t/ha for soybean (N_1)	1349	27622	0.99	4.7
FYM 10 t/ha + 50% RDF for cotton FYM 7.5 t/ha + 50% RDF for Soybean (N_2)	1466	32748	1.56	5.19
FYM 5 t/ha + 75% RDF for cotton FYM 5 t/ha + 75% RDF for soybean (N_3)	1657	41892	1.99	5.8
RDF 100% (100:50:50 NPK kg/ha) for cotton RDF 100% (30:60:30 NPK kg/ha) for soybean (N_4)	1626	43836	2.16	5.7
Absolute control (N_5)	1048	25075	1.68	3.7
CD at 5%	159.33	7959	-	-

In the study, soybean + pigeonpea (4:2) intercropping system with application of FYM @ 5 t/ha + 75% RDF recorded significantly higher cotton equivalent yield (1788 kg/ha) and was significantly superior over all other treatments except soybean + pigeonpea (4:2) intercropping system with RDF application for both the crops (Table 3.331).

Table 3.331: Interaction effect of cropping systems and PMT on cotton equivalent yield - Parbhani

Cropping system/nutrient level	N_1	N_2	N_3	N_4	N_5
Cotton + pigeonpea	1299.87	1381.47	1525.36	1553.70	976.66
Soybean + pigeonpea	1397.51	1549.93	1788.29	1698.54	1118.40
Interaction (C x N)			-		
CD at 5%	94.68		-		

The effect of various treatments on physico-chemical properties of the soil showed that the higher organic carbon and NPK content was observed in soybean + pigeonpea (4:2) intercropping system than that of cotton + pigeonpea intercropping system at flowering as well at harvesting stage. Whereas, among nutrient levels FYM 10 t/ha + 50% RDF recorded higher NPK content at flowering stage and it was higher in 100% RDF at harvestring stage. However the organic carbon content was higher in plots under FYM 15 t/ha for cotton & FYM 10 t/ha for soybean (Table 3.332).

Table 3.332: Effect of cropping systems and PMT on soil properties - Parbhani

Treatment	pH	EC (dS/m)	OC (%)	$CaCO_3$ (%)	N (kg/ha)	P (kg/ha)	K (kg/ha)
Cotton + pigeonpea	7.97	0.31	0.39	3.4	159	9.6	622
Soybean + pigeonpea	8.00	0.30	0.51	3.5	164	14.0	669
FYM 15 t/ha for cotton FYM 10 t/ha for soybean	7.98	0.29	0.58	3.6	160	11.6	661
FYM 10 t/ha + 50% RDF for cotton FYM 7.5 t/ha + 50% RDF for soybean	8.00	0.35	0.57	3.7	198	17.3	761
FYM 5 t/ha + 75% RDF for cotton FYM 5 t/ha + 75% RDF for soybean	7.99	0.41	0.50	3.6	179	17.0	769
RDF 100% (100:50:50 NPK kg/ha for cotton RDF 100% (30:60:30 NPK kg/ha for soybean	7.98	0.40	0.46	3.6	188	16.0	691
Absolute control for cotton and soybean	7.99	0.29	0.39	36.0	155	14.0	706

3.5.4 Energy management

At Kovilpatti, in an experiment on evaluation of tractor operated air assisted seed drill for sowing minor millets, line sowing of minor millets with air assisted seed drill resulted in 30 to 40% saving in seed rate. Cost of sowing with air assisted seed drill was Rs.750/hr which was 11.76 and 6.25% less than that of *gorru* sowing (Rs.850/ha) and broadcasting (Rs. 800/ha), respectively. The time taken for sowing one hectare was 1.24, 2.81 and 3.00 hours with air assisted seed drill, tractor drawn *gorru* and broadcasting, respectively. Plant population/ m^2 was highest in broadcasting followed by *gorru* sowing and seed drill sowing. The number of tillers/plant was not significantly influenced by the method of sowing excepting in kodomillet. The effect of treatments on yields were on par in barnyardmillet, foxtailmillet and little millet. In kodomillet, sowing with air assisted seed drill registered 4.6 and 4.0% higher yield than *gorru* sowing and broadcasting (Table 3.333).

Table 3.333: Effect of different sowing methods on yield and RWUE of minor millets - Kovilpatti

Treatment	Air assisted seed drill	Tractor drawn *gorru*	Broad-casting
Seed rate (kg/ha)			
Barnyardmillet	7.0	8.5	10
Foxtailmillet	6.5	8.0	10
Littlemillet	5.0	8.0	10
Kodomillet	5.0	8.0	10
Plant population/m^2			
Barnyardmillet	31.9	39.2	44.6
Foxtailmillet	32.1	41.7	39.7
Littlemillet	29.3	28.0	35.3
Kodomillet	19.8	38.1	42.1
No. of tillers/plant			
Barnyardmillet	3.3	2.6	3.4
Foxtailmillet	4.6	4.7	5.8
Littlemillet	4.8	5.1	5.4
Kodomillet	16.7	9.9	10.5
Yield (kg/ha)			
Barnyardmillet	1013	1232	1326
Foxtailmillet	1053	1158	1231
Littlemillet	191	277	325
Kodomillet	1807	1727	1737
B:C ratio			
Barnyardmillet	1.23	1.48	1.41
Foxtailmillet	1.28	1.39	1.31
Littlemillet	0.23	0.33	0.34
Kodomillet	2.19	2.07	1.86
Barnyardmillet	3.36	4.09	4.40
Foxtailmillet	3.49	3.84	4.08
Littlemillet	0.63	0.92	1.08
Kodomillet	6.00	5.73	5.76

In a tillage and nutrient management study on soybean + pigeonpea intercropping system at Parbhani, among tillage methods, conventional tillage recorded maximum seed yield (1070 kg/ha) of cotton and soybean (756 kg/ha) with NMR of Rs.35386/ha, B:C ratio of 2.12 and RWUE of 2.36 kg/ha-mm. Among nutrient sources, recommended RDF (50%) + FYM (2.5 t/ha) gave maximum seed cotton equivalent yield of 1662 kg/ha (1063 kg/ha of cotton and 749 kg/ha of soybean) with maximum NMR of Rs. 34198/ha and B:C ratio of 2.06, while application of vermicompost @ 3 t/ha gave lowest seed cotton equivalent yield of 1295 kg/ha and NMR of Rs.24655/ha with B:C ratio of 1.91 (Table 3.334).

Table 3.334: Crop yield and economics affected by tillage and nutrient management sources - Parbhani

Treatment	Yield (kg/ha)		Seed cotton eqt yield (kg/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Cotton	Soybean				
Tillage method (T)						
Conventional tillage	1070	756	1675	35386	2.12	4.56
Reduced tillage + interculture	892	704	1455	27820	1.91	4.21
Reduced tillage + herbicide	765	713	1335	21987	1.70	4.19
CD at 5%			228	8205	0.23	-
Nutrient sources (N)						
FYM @ 5 t/ha	785	714	1356	21312	1.65	3.96
Vermicompost @ 3 t/ha	733	703	1295	24655	1.90	3.93
RDF (50%) + FYM (2.5 t/ha)	1063	749	1662	34198	2.06	4.50
RDF (50%) + vermicompost (1.5 t/ha)	1045	734	1632	33689	2.06	4.53
RDF	990	755	1594	30044	1.89	4.69
CD at 5%	-	-	243	8831	0.27	-
Interaction (T x N)						
CD at 5%	-	-	117	6522	0.18	-

In the study, interaction between tillage methods and nutrient sources with respect to seed cotton equivalent yield was found significant. Conventional tillage with RDF + FYM gave significantly higher yield (1668 kg/ha), net returns (Rs. 34772/ha) and B:C ratio (2.09) over rest of the treatment combinations but was at par with conventional tillage with RDF + vermicompost, RDF and reduced tillage + interculture with RDF + FYM, RDF + vermicompost & RDF (Table 3.335).

Table 3.335: Interaction effect of tillage and nutrient management on cotton equivalent yield and economics -Parbhani

Treatment	FYM	Vermi-compost	RDF + FYM	RDF + vermicompost	RDF	Mean
Seed cotton equivalent yield (kg/ha)						
Conventional tillage	1515	1485	1668	1653	1634	1591
Reduced tillage + interculture	1405	1375	1558	1543	1524	1481
Reduced tillage + herbicide	1345	1315	1498	1483	1464	1421
Mean	1422	1392	1575	1560	1541	1498
CD at 5% 117						
Net returns (Rs/ha)						
Conventional tillage	28329	30017	34772	34518	32699	32067
Reduced tillage + interculture	24538	26225	30981	30727	28908	28275

Treatment	FYM	Vermi-compost	RDF + FYM	RDF + vermicompost	RDF	Mean
Reduced tillage + herbicide	21618	23305	28061	27806	25988	25356
Mean	24828	26516	31271	31017	29198	28566
CD at 5% 6522						
B:C ratio						
Conventional tillage	1.88	2.01	2.09	2.09	2.00	2.01
Reduced tillage + interculture	1.78	1.90	1.98	1.98	1.90	1.91
Reduced tillage + herbicide	1.67	1.8	1.88	1.88	1.79	1.80
Mean	1.78	1.9	1.98	1.98	1.90	1.91
CD at 5% 0.18						

On an average maximum infiltration rate of 7.76 cm/hr was observed in conventional tillage whereas minimum of 5.94 cm/hr was observed in reduced tillage + interculture. Among nutrient sources, maximum infiltration rate of 8.00 cm/hr was observed in FYM, whereas minimum of 5.53 cm/hr was observed in RDF treatment. Among tillage methods, minimum bulk density of 1.27 Mg/m^3 was observed in reduced tillage + herbicide treatment, whereas among the nutrient sources, minimum bulk density of 1.28 Mg/m^3 was recorded in FYM (Table 3.336).

Table 3.336: Infiltration rate and bulk density as affected by tillage and nutrient management - Parbhani

Treatment	FYM	Vermicompost	RDF + FYM	RDF + vermicompost	RDF	Mean
Infiltration rate (cm/hr)						
Conventional tillage	12.0	7.8	7.7	5.3	6.0	7.76
Reduced tillage + interculture	5.0	6.5	6.6	6.4	5.2	5.94
Reduced tillage + herbicide	7.0	7.6	8.6	8.7	5.4	7.42
Mean	8.00	7.3	7.63	6.80	5.53	7.04
Bulk density (Mg/m^3)						
Conventional tillage	1.25	1.37	1.34	1.22	1.42	1.32
Reduced tillage + interculture	1.20	1.39	1.40	1.41	1.26	1.33
Reduced tillage + herbicide	1.38	1.26	1.20	1.25	1.26	1.27
Mean	1.28	1.34	1.31	1.29	1.31	1.31

Among the tillage practices, reduce tillage + interculture recorded highest N, P and K as well as organic carbon compared to other treatment. Among the nutrient sources, application of RDF (50%) + vermicompost (1.5 t/ha) recoded highest N, P and K as well as organic carbon followed by treatment of RDF (50%) + FYM (2.5 t/ha) (Table 3.337).

Table 3.337: Soil chemical properties as influenced by tillage and nutrient management - Parbhani

Treatment	pH	EC (dS/m)	OC (%)	$CaCO_3$ (%)	N (kg/ha)	P (kg/ha)	K (kg/ha)
Conventional tillage	7.97	0.28	0.37	3.0	165	8.15	408
Reduced tillage + interculture	7.98	0.33	0.40	3.6	199	10.04	525
Reduced tillage + herbicide	7.97	0.31	0.38	3.3	160	9.13	479
FYM @ 5 t/ha	7.98	0.31	0.40	3.0	197	9.19	511
Vermicompost @ 3 t/ha	8.00	0.38	0.45	3.2	203	11.73	533
RDF(50%) + FYM (2.5 t/ha)	8.01	0.40	0.49	3.2	204	12.13	619
RDF (50%) + vermicompost (1.5 t/ha)	8.01	0.39	0.55	3.8	219	13.05	603
RDF	797	0.29	0.41	3.5	212	10.13	525

3.5.5 Evaluation of improved varieties

At Akola, among the soybean varieties evaluated, MAUS 71 (864 kg/ha) and JS 335 (800 kg/ha) recorded highest yield compared to other varieties. Six varieties were found to be statistically at par for root length and canopy temperature. The highest SCMR reading was noted in the TAMS 38 and JS 9560 (Table 3.338).

Table 3.338: Performance of different varieties of soybean - Akola

Variety	Plant height (cm)	No. of branches/ plant	No. of pods/ plant	Root length (cm)	Canopy temp (˚c)	SCMR readings	Seed yield (kg/ha)
MAUS 158	20.93	3.73	30.47	13.40	1.44	38.72	629.81
JS 9560	25.80	1.93	15.60	13.53	1.23	44.07	496.30
JS 93-05	27.20	2.33	17.93	11.67	1.17	40.64	205.86
MAUS 71	26.20	2.93	27.07	13.00	1.90	38.00	864.32
MACS 162	33.33	4.00	35.73	13.33	1.90	34.21	534.01
JS 335	27.73	3.80	37.67	13.80	1.72	38.36	800.93
AGRANI	29.20	2.93	28.13	13.53	1.94	36.96	700.12
TAMS 38	22.40	3.00	32.07	11.53	1.82	45.06	533.33
TAMS 98-21	24.07	2.27	24.67	11.87	1.81	36.11	633.52
CD at 5%	6.55	0.63	7.24	1.62	0.43	1.12	152.10

SCMR: SPAD Chlorophyll Meter Reading

3.5.6 Alternate land use

In drumstick based agri-horti system at Parbhani, the yield of intercrops in drumstick, was greengram (1361 kg/ha), blackgram (1349 kg/ha), soybean (1430 kg/ha) and sunhemp (1421 kg/ha). The drumstick sole (3 x 3 m) recorded the higher yield of 1837 kg/ha followed by drumstick + sunhemp (1:6) (Table 3.339).

Table 3.339: Performance of agri-horti systems - Parbhani

Treatment	Drumstick yield (kg/ha)	Intercrop yield (kg/ha)
Drumstick sole (3 m x 3 m)	1837	-
Drumstick + greengram (1:6)	1361	263.88
Drumstick + blackgram (1:6)	1349	202.4
Drumstick + soybean (1:6)	1430	397.65
Drumstick + sunhemp (1:6)	1421	-

In an agri-horti system evaluated under CCT treated catchment at Akola, the total (104 and 58 kg) and per plant yield (2.42 and 1.49 kg) of custard apple and Hanuman *Phal* were more in CCT treated catchment as compared to untreated catchment (44 and15 kg) and (1.39 and 0.52 kg), respectively (Table 3.340).

Table 3.340: Performance of custard apple and Hanuman *Phal* – Akola

Plot	Yield of custard apple (kg)		Yield of hanuman phal (kg)	
	CCT treated catchment (43 plants)	Untreated catchment (32 plants)	CCT treated catchment (39 plants)	Untreated catchment (30 plants)
I	8.34	1.37	5.29	2.10
II	20.50	9.50	24.87	6.35
III	18.70	5.80	14.39	3.97
IV	28.15	16.47	5.09	1.34
V	28.58	11.34	8.51	1.86
Total	104.27	44.48	58.15	15.62
Yield/Plant	2.42	1.39	1.49	0.52

The increase in groundwater recharge of CCT treated catchment over untreated catchment was more in June (71.05%) followed by July (62.50%) and May (47.76%). It was also observed that the groundwater levels were more in CCT treated catchment compared to non treated catchment in all the months on an average during twelve months the ground water recharge in the CCT treated catchment was more by 33.97% compared to the non treated catchment and this will clearly indicate the benefits of continuous contour trenches for small catchment (Table 3.341).

Table 3.341: Average monthly groundwater levels in the observation wells - Akola

Month	Average groundwater levels (m)						Increase in GW levels of CCT treated over untreated catchment (%)
	CCT treated catchment		Untreated catchment		Average of CCT treated catchment	Average of untreated catchment	
	OW-1	OW-3	OW-2	OW-4			
January	3.78	4.61	2.99	4.09	4.19	3.54	18.36
February	3.31	3.61	2.52	3.61	3.46	3.06	13.07
March	2.88	3.69	2.11	3.19	3.28	2.65	23.77
April	2.26	3.05	1.47	2.56	2.65	2.01	31.84

Month	Average groundwater levels (m)						Increase in GW levels of CCT treated over untreated catchment (%)
	CCT treated catchment		Untreated catchment		Average of CCT treated catchment	Average of untreated catchment	
	OW-1	OW-3	OW-2	OW-4			
May	1.58	2.38	0.81	1.88	1.98	1.34	47.76
June	0.91	1.70	0.33	1.19	1.30	0.76	71.05
July	0.65	1.44	0.37	0.92	1.04	0.64	62.50
August	1.99	2.79	1.17	2.20	2.39	1.68	42.26
September	4.01	4.76	3.21	4.00	4.38	3.60	21.66
October	3.91	4.74	3.05	4.05	4.32	3.55	21.69
November	3.16	3.97	2.34	3.35	3.56	2.84	25.35
December	2.73	3.52	1.92	2.94	3.12	2.43	28.39

OW: Open well: CCT: Continuous contour trench; GW: Groundwater

3.5.7 Integrated farming system

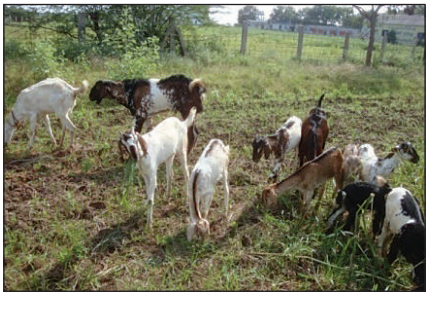
At Kovilpatti, in a study on integrated farming system, the mean system productivity and mean system income in IFS were 12870 kg/ha and Rs.116098/ha whereas in conventional system the values were 1071 and 10445 kg/ha. The mean employment generation was 174 and 410 man days/year due to cropping alone and integration of crops, livestock and goat rearing, respectively. Considering the individual animal component, 4909 kg of cattle manure (five year mean) was obtained from 1 cow + 1 calf milch animal with the nutrient potential of 10.3, 7.9 and 12.7 kg NPK, respectively. The goat unit also produced 3997 kg manure/year (10 + 1) with nutrient potential of 47.9, 27.9 and 30.7 kg NPK, respectively which could be effectively recycled to the crop component. Under IFS, an additional net returns of Rs.91052/ha was received from other components like milch animal and goat rearing (Table 3.342).

Table 3.342: System productivity and economics under integrated farming system - Kovilpatti

Farming system	Productivity (kg/ha)			System productivity (kg/ha)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	Employment generation (man-days/ha/yr)
	Crop	Livestock (milch animal)	Any other Enterprise (goat rearing)					
Cropping alone*	2511	-	-	2511	17500	15143	1.86	206
Integrated farming system	6704	5391	4883	16978	89920	91052	2.01	416

Cropping alone: Sorghum - 0.6 ha; Greengram: 0.4 ha; Cotton + blackgram - 0.6 ha; Integrated farming sysem: Sorghum + cowpea - 0.4 ha; Maize + greegram - 0.1 ha; Cotton + blackgram - 0.6 ha; Clusterbean - 0.1 ha; Fodder crops - 0.4 ha; Goat unit - 10 + 1; Milch animal - 1

Maize + greengram intercropping



Goat unit

Greengram sole

4. Operational Research Projects

During 2014-15, the on-farm assessment/demonstration of technologies/ practices were conducted in the adopted villages of ORP centres (Table 4.1).

Table 4.1: Details of ORP villages

Centre	Adopted village	District	State
Anantapuram	Girigetla	Karnool	Andhra Pradesh
Arjia	Lapsiya	Rajsamand	Rajasthan
	Kochariya	Bhilwara	Rajasthan
Ballowal Saunkhri	Naude Majra	Rupnagar	Punjab
Bangalore	Alanatha cluster	Ramanagara	Karnataka
Hisar	Chhapar jogiyan	Bhiwani	Haryana
Indore	Gaddukhedi	Dewas	Madhya Pradesh
Solapur	Maniknal	Sangli	Maharashtra

4.1 Anantapur

(Girigetla, Kurnool district, Andhra Pradesh)

4.1.1 Cropping systems

In demonstrations on improved production technologies of groundnut, maximum groundnut pod yield was recorded with improved dryland technology (405 kg/ha) along with higher net returns (Rs.1813/ha) and B:C ratio (1.0) as compared to farmers' practice (pod yield of 384 kg/ha, net returns Rs.-3252/ha and B:C ratio 0.86) (Table 4.2). Improved production system recorded 122 kg/ha lower yield than mean (5 years) yield of 527 kg/ha, due to long dry spells prevailed during pod development stage in 2014.

Table 4.2: Pod and haulm yield of groundnut as influenced by improved production technology - Anantapur

Treatment	Yield (kg/ha)			Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Pod (2014)	Mean pod (5 yrs)	Haulm				
Improved production systems	405	527	1090	21050	1813	1.00	1.9
Farmers' practice	384	475	975	24875	-3252	0.86	1.8

In an on-farm assessment of different intercropping systems groundnut + pigeonpea intercropping system (15:1) recorded higher net returns (Rs.7886/ha). Rainwater use efficiency was also higher (2.4 kg/ha-mm) with groundnut + pigeonpea intercropping system, compared to castor + pigeonpea intercropping (Table 4.3).

Table 4.3: Yield and economics of intercropping systems - Anantapur

Treatment	Yield (kg/ha)		Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Main crop	Intercrop				
Groundnut + pigeonpea (15:1)	491	92	24875	7886	1.3	2.4
Groundnut	365	-	24875	-950	0.9	1.8
Castor + pigeonpea (10:1)	394	85	10000	6765	1.6	1.1
Castor	343	-	10000	2005	1.2	0.9

Groundnut + pigeonpea intercropping system (15:1)

Castor + pigeonpea intercropping system (10:1)

In on-farm assessment on groundnut–bengalgram double cropping system, groundnut pod yield of 479 kg/ha & haulm yield of 1238 kg/ha was recorded. However, after harvesting of groundnut, bengalgram was not taken up as a catch crop due to non-receipt of rain. In another demonstration of groundnut and sorghum under double cropping system, groundnut pod yield of 406 kg/ha & haulm yield of 1145 kg/ha was recorded and after harvesting of groundnut, sorghum was taken up as a catch crop but the crop failed due to moisture stress at knee high stage and stover yield recorded was 1170 kg/ha (Table 4.4).

Table 4.4: Yield of groundnut and sorghum under double cropping system - Anantapur

Farmer	Groundnut yield (kg/ha)		Sorghum yield (kg/ha)	
	Pod	Haulm	Seed	Stover
Location -1 (N. Veerendra)	410	1180	Crop failed due to moisture stress	1250
Location -2 (K. Chandrasekhar)	391	1060		1100
Location -3 (K. Nagappa)	398	1110		1190
Location -4 (G. Balaramudu)	427	1230		1140
Mean	406	1145		1170

4.1.2 Nutrient management

The results of on-farm assessment of soil test based fertilizer (STBF) application revealed that all the yield attributes and yield of groundnut were improved with fertilizer application based on soil test values compared to farmers' practice of fertilizer application. Pod and haulm yields were higher with soil test based (STB) fertilizer (425 and 1071 kg/ha) compared to farmers' practice (404 and 979 kg/ha). Net returns were higher (Rs.838/ha) with soil test based fertilizer application where as negative net returns were recorded in farmers' practice. This might be due to reduced cost on fertilizer through balanced fertilizer use and improved pod and haulm yield of groundnut. The B:C ratio (1.04) was also higher with STB fertilizer compared to farmers' practice (Table 4.5).

Table 4.5: Yield and economics of groundnut as influenced by soil test based fertilizer application - Anantapur

Treatment	Yield (kg/ha)			Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Pod (2014)	Mean (5 yrs)	Haulm				
STBF	425	540	1071	22868	838	1.04	2.0
Farmers' practice (FP)	404	478	979	24875	-2377	0.90	1.9

FP-Blanket fertilizer application

On-farm demonstrations (9 farmers' fields) were conducted on foliar application of different micro-nutrients in rainfed cotton. The reddening of leaves was reduced by 51% and thus resulted in yield improvement of 11% with foliar spray of 2% $ZnSO_4$; 1% $MgSO_4$; 0.15% Boron and 1% 19:19:19 at flowering and 20 days after flowering. The micronutrient spray gave highest yield (908 kg/ha) with RWUE (2.49 kg/ha-mm) and B:C ratio

of 1.7. The net returns were Rs 7605/ha with the foliar spray of micronutrient compared to control (Rs 5855/ha). Micronutrient spray was effective even during dryspells in cotton in reducing the reddening of leaves and improved kapas yield (Table 4.6).

Table 4.6: Yield and economics of rainfed cotton as influenced by foliar spray of micronutrients - Anantapur

Treatment	Yield (kg/ha)		NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Yield in 2014	Mean yield (5 years)			
Foliar spray of micronutrients	908	503	7605	1.7	2.49
Farmers' practice (no spray)	865	453	5855	1.5	2.37

In another on-farm assessment of foliar application of micronutrients in eight farmers' fields, $ZnSO_4$ (2%) and boron (0.2%) at before flowering and fruit formation stage in rainfed tomato resulted in 11.6% higher yield with RWUE of 11.3 kg/ha-mm and B:C ratio of 1.68. The net returns were Rs.28730/ha with the use of micronutrient sprays compared to control (Rs.27451/ha) (Table 4.7).

Table 4.7: Tomato yield and economics as influenced by foliar spray of micronutrients - Anantapur

Treatment	Yield (kg/ha)		Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Yield in 2014	Mean yield (4 years)				
Foliar spray of micronutrients	4104	4019(4)	17100	28730	1.68	11.3
Farmers' practice (no spray)	3921	3570(4)	16500	27451	1.66	10.8

4.1.3 Energy management

In an assessment of mechanization in groundnut production system at four locations, pod yield (397 kg/ha) and haulm yield (1102 kg/ha) were higher with mechanized cultivation when compared to farmers' practice. Net returns (Rs.1279/ha), RWUE (2.1 kg/ha-mm) and B:C ratio (1.04) were also higher with mechanized cultivation when compared to farmers' practice (Table 4.8).

Table 4.8: Yield and economics of groundnut as influenced by mechanization - Anantapur

Treatment	Yield (kg/ha)			Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Pod yield in 2014	Pod yield (4 years)	Haulm yield				
Mechanized cultivation of groundnut	397	569	1102	21050	1279	1.04	2.1
Farmers' practice	362	534	1002	24875	-3854	0.80	1.9

In an assessment of Ananta Aqua planter for groundnut sowing, Ananta Aqua planter gave highest pod and haulm yield (451 and 1201 kg/ha) with B:C ratio of 1.12 and RWUE of 2.2 compared to farmers' practice. Use of Ananta Aqua planter is advantageous in extending time of sowing when insufficient rainfall for sowing is received (Table 4.9).

Table 4.9: Yield and economics of groundnut as influenced by sowing with Ananta aqua planter - Anantapur

Treatment	Yield (kg/ha)		Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Pod	Haulm				
Ananta aqua planter	451	1201	21050	2701	1.12	2.2
Farmers' practice	397	1102	24875	-3927	0.8	1.9

The field efficiency i.e. the time taken for operation was higher with farmer's practice of using bullock drawn implements than tractor drawn implements, thus saving time and labour for sowing of groundnut. The energy output and energy use efficiency with tractor drawn implements for groundnut sowing was higher compared to bullock drawn implements (Table 4.10).

Table 4.10: Energy use efficiency with various sowing implements - Anantapur

Treatment	Field efficiency (hr/ha)	Energy (MJ/ha)		Energy use efficiency
		Input	Output	
Groundnut sowing with tractor drawn Ananta aqua planter	2.12	2505.26	11721	4.6
Groundnut sowing with tractor drawn Ananta planter	2.12	2505.26	10452	4.1
Farmers' practice	4.2	3042.5	9522	3.13

Tractor drawn Ananta groundnut planter

Traditional method of groundnut sowing

4.1.4 Evaluation of improved varieties

Among the four improved groundnut varieties evaluated (4 locations), K9 (501 kg/ha) was found superior followed by Dharani (499 kg/ha) and K-6 (491 kg/ha) compared to popular variety (TMV-2) (365 kg/ha) (Table 4.11).

Table 4.11: Performance of varieties in terms of groundnut pod and haulm yield during the year 2014-15 – Anantapur

Variety	Yield (kg/ha)			NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Pod yield in 2014	Mean pod yield*	Haulm yield			
K-6	491	748(4)	1228	3538	1.8	2.5
K-9	501	957(2)	1167	3827	1.8	2.5
Dharani	499	1145(1)	1189	3779	1.8	2.5
Narayani	---	593(2)	890	5880	1.3	1.6
TMV-2 (farmers' variety)	365	672(4)	1150	-950	1.3	1.8

* No. of years given in parentheses

Groundnut - Dharani

Groundnut- K-9

Groundnut- Local

4.1.5 Integrated farming systems

At Anantapur, in poultry based farming system, the growth rate of rajasri birds increased from 0.21 kg (initial weight) to about 2.2 kg after 7 months. No. of eggs per hen ranged from 32 to 45 and gross returns for the farmers from four rajasri birds ranged from Rs. 1056 to Rs. 2512. Thus, a landless labour could get an amount of Rs. 1297 from 4 rajasri birds in addition to his regular labour wages (Table 4.12).

In another trial, the results revealed that growth rate of rajasri birds increased from 0.23 kg (initial weight) to about 2.5 kg after 7 months. No. of eggs per hen ranged from 34 to 60 and gross returns for the farmers from four rajasri birds ranged from Rs. 1072 to Rs. 3920. Thus, a landless labour could get an amount of Rs. 2282 from 5 rajasri birds in addition to his regular labour wage (Table 4.12).

Table 4.12: Growth and economics of rajasri birds - Anantapur

Farmer	Initial wt (kg)	Eggs			Live birds		Gross returns (Rs.)
		No. of eggs/hen	Total eggs	Returns (Rs.)	No. and weight	Expected returns (Rs.)	
Y. Akambaram	0.20	38	228(6)	912	8 and 16.1	1600	2512
Y. Venkataramudu	0.23	45	90(2)	360	4 and 11.2	800	1160
A. Basanna	0.22	32	64(2)	256	4 and 11.0	800	1056
C. Rangamuni	0.21	34	102(3)	408	5 and 12.1	1000	1408
Mean	0.21	37	121	484	21 and 50.4	1200	1297
K. Basavaraju	0.24	40	540 (6)	2160	8 and 17.6	1600	3760
S.K. Basha	0.22	55	110(2)	440	4 and 10.4	800	1240
P. Balaramudu	0.23	34	68(2)	272	4 and 12.0	800	1072
T. Hanumanthu	0.26	35	105(3)	420	5 and 15.5	1000	1420
K. Ramachandraiah	0.23	60	480(8)	1920	10and 27	2000	3920
Mean	0.23	49	260	1040	31 and 82.5	1240	2282

In an on-farm assessment of integrated farming system (IFS) involving groundnut cultivation and rearing of ramlands (5), the IFS module improved system productivity (32320 kg/ha) besides improving net returns compared to groundnut cultivation alone (Table 4.13).

Table 4.13: Performance of integrated farming system - Anantapur

Farming system	Productivity (kg/ha)		System productivity (crop equivalent yield) (kg/ha)	Cost of cultivation (Rs/ha)	B:C ratio
	Crop	Livestock			
Groundnut + ramlambs (5 No.)	540	5	32320	28875	1.2
Groundnut	461	--	16135	14875	1.0

4.2 Arjia

(Lapsiya, Rajsamand district; Kochariya, Bhilwara district, Rajasthan)

4.2.1 Rainwater management

At Arjia, in an assessment demonstration on maize + blackgram (2:2) intercropping, very low maize grain yield was obtained due to drought followed by continuous rainfall in the operational area. Similarly, blackgram also produced low seed yield. However, the results revealed that improved moisture conservation practices in maize + blackgram (2:2) intercropping system gave higher maize grain equivalent yield (1504 kg/ha) as compared to farmers' practice (1092 kg/ha) with higher net returns (Rs.14537/ha) and B:C ratio (2.20) (Table 4.14).

Table 4.14: Yield and economics of maize + blackgram intercropping systems under moisture conservation practices - Arjia

Treatment	Yield (kg/ha)		Maize equivalent yield (kg/ha)		Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio
	Grain/seed	Stalk	Grain	Stalk			
Improved practice	1207 (87)	2183 (220)	1504	2482	12100	14537	2.20
Farmers' practice	903 (55)	1867 (173)	1092	2102	11200	8815	1.79

Figures in parentheses are yields of blackgram

In an on-farm assessment of supplemental/protective irrigation in maize + blackgram and groundnut + sesame intercropping systems, protective irrigation gave higher maize equivalent yield (1450 kg/ha) in maize + blackgram (2:2) intercropping system as compared to control (780 kg/ha). It was also observed that protective irrigation gave higher groundnut pod equivalent yield (1150 kg/ha) in groundnut + sesame (6:2) intercropping system as compared to control (660 kg/ha). Groundnut + sesame (6:2) intercropping system gave higher net return (Rs. 28708/ha) and B:C ratio (3.13) as compared to maize + blackgram (2:2) intercropping system (Table 4.15 a & b).

Table 4.15a: Performance of maize + blackgram intercropping under supplemental irrigation - Arjia

Treatment	Maize equivalent yield (kg/ha)		Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio
	Grain	Fodder			
Supplemental irrigation	1450	3750	14200	11638	1.82
Rainfed	780	2450	12500	2373	1.19

Table 4.15b: Groundnut equivalent yield and economics with supplemental irrigation - Arjia

Treatment	Groundnut equivalent yield (kg/ha)		Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C Ratio
	Pod	Fodder			
Supplemental irrigation	1150	2150	13500	28708	3.13
Rainfed	660	1800	13150	12800	1.97

In an assessment of foliar application of brassinosteroid and thiourea in maize, very low maize grain yield was obtained due to drought in the operational area. However, the results revealed that foliar spray of thiourea @ 500 ppm at pre-flowering and 50% silking stages gave higher maize yield (1323 kg/ha) followed by foliar spray of brassinosteroid @ 400 ppm at knee height stage (1233 kg/ha) as compared to control (917 kg/ha) (Table 4.16).

Table 4.16: Effect of foliar spray on productivity and economics of maize - Arjia

Treatment	Seed yield (kg/ha)	Stover yield (kg/ha)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio
Foliar spray of brassinosteroid @ 400 ppm at knee height stage	1233	2167	11725	10417	1.89
Foliar spray of thiourea @ 500 ppm at pre-flowering and 50% silking stage	1323	2333	11950	11827	1.99
Control (no foliar spray)	917	1850	11200	5796	1.52

In an on-farm assessment of seed priming in sorghum, priming of seed with thiourea (0.1%) for 8-12 hours gave higher sorghum grain yield (1380 kg/ha) followed by seed soaking with water for 8-12 hours (1233 kg/ha) as compared to control (960 kg/ha). It was also observed that priming of seed with thiourea (0.1%) for 8-12 hours gave higher net returns (Rs.13260/ha) and B:C ratio (2.15) as compared to control (1.68) (Table 4.17).

Table 4.17: Effect of seed priming on productivity and economics of sorghum - Arjia

Treatment	Seed yield (kg/ha)	Stover yield (kg/ha)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio
Priming of seed with thiourea (0.1%) for 8-12 hours	1380	3667	11550	13260	2.15
Seed soaking with water for 8-12 hours	1233	3383	11200	11213	2.00
Control (no seed priming)	960	2717	10500	7133	1.68

4.2.2 Cropping systems

In an on-farm assessment of suitability of maize + blackgram (2:2) intercropping system, very low maize grain yield was obtained due to drought in the operational area. Similarly, blackgram gave low yield in the intercropping and mixed cropping system. Maximum maize grain equivalent yield was obtained in maize + blackgram (2:2) intercropping system (1476 kg/ha) as compared to mixed cropping (1068 kg/ha). The mean of five years study indicated that intercropping system of maize + blackgram (2:2) performed better at farmers' fields and gave 18.91% higher maize equivalent yield over mixed cropping of maize + blackgram (Table 4.18).

Table 4.18: Assessment of intercropping system of maize + blackgram (2:2) - Arjia

Treatment	Yield (kg/ha)		Maize equivalent yield (kg/ha) 2014		Maize equivalent yield (kg/ha) Mean of 2010-14	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio
	Grain/ seed	Stover	Grain	Stover				
Intercropping system	1230 (72)	2300 (223)	1476	2603	1867	11550	14966	2.30
Mixed cropping	913 (45)	2017 (207)	1068	2297	1514	11150	8965	1.80
Sole cropping-maize	1180	2350	1180	2350	1525	10800	11008	2.02

Figures in parentheses are yields of blackgram

In an on-farm assessment of suitability of groundnut + sesame (6:2) intercropping system, very low pod yield was obtained during this year and sesame also gave low seed yield in intercropping system due to dry spells. Maximum groundnut pod equivalent yield was obtained in groundnut + sesame (6:2) intercropping system (661 kg/ha) as compared to mixed cropping (523 kg/ha). Combined results of five years study indicated that intercropping system of groundnut + sesame (6:2), performed better at farmers' fields gave the 23.6% higher groundnut equivalent yield over mixed cropping of groundnut and sesame (Table 4.19).

Table 4.19: Assessment of intercropping system of groundnut + sesame (6:2) - Arjia

Treatment	Yield (kg/ha)		Groundnut equivalent yield (kg/ha) 2014		Groundnut equivalent yield (kg/ha) Mean of 2010-14	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio
	Pod/ seed	Haulm/stover	Pod	Haulm				
Intercropping system	480 (53)	950 (150)	661	975	801	13500	9953	1.74
Mixed cropping	398 (37)	913 (100)	523	930	648	13150	5884	1.45
Sole cropping-groundnut	467	937	467	937	580	12900	4424	1.34

* Figures in parentheses are yields of sesame

In another on-farm assessment of suitability of sorghum + greengram (2:1) intercropping system, maximum grain yield (1367 kg/ha) of sorghum and greengram (65 kg/ha), net returns of Rs. 18485/ha and B:C ratio of 2.53 were attained in sorghum + greengram (2:1) intercropping system. The mixed cropping of sorghum and greengram gave a sorghum yield of 1183 kg/ha, greengram yield of 48 kg/ha, net returns of Rs. 13870/ha and B:C ratio of 2.18. Combined results of five years study indicated that intercropping system of sorghum + greengram (2:1), performed better at farmers' fields and gave the 19.8% higher sorghum equivalent yield over mixed cropping of sorghum and greengram (Table 4.20).

Table 4.20: Assessment of sorghum + greengram (2:1) intercropping system - Arjia

Treatment	Yield (kg/ha)		Sorghum equivalent yield (kg/ha) 2014		Sorghum equivalent yield (kg/ha) Mean of 2010-14	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio
	Grain/ seed	Stover	Grain	Stover				
Intercropping system (Sorghum + greengram (2:1))	1367 (65)	4133 (143)	1724	4375	2265	12050	18485	2.53
Mixed cropping of sorghum + greengram	1183 (48)	3500 (107)	1449	3680	1891	11800	13870	2.18
Sole cropping-sorghum	1380	4347	1380	4347	1843	11600	14740	2.27

Figures in parentheses are yields of greengram

Similarly, in an on-farm assessment of blackgram + sesame (2:2) intercropping system, though yields were low, higher blackgram yield of 380 kg/ha and sesame 65 kg/ha, net returns of Rs. 17135/ha and B:C ratio of 2.69 were attained in blackgram + sesame (2:2) intercropping system. The mixed cropping of blackgram and sesame gave a blackgram yield of 260 kg/ha, sesame yield of 53 kg/ha, with net returns of Rs. 10098/ha and B:C ratio of 2.06. Over of five years of study, blackgram + sesame (2:2) intercropping system, performed better at farmers' fields and gave 34.7% higher blackgram equivalent yield over mixed cropping of blackgram and sesame (Table 4.21).

Table 4.21: Assessment of of blackgram + sesame (2:2) intercropping system – Arjia

Treatment	Yield (kg/ha)		Blackgram equivalent yield (kg/ha) 2014		Blackgram equivalent yield (kg/ha) Mean (2010-14)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio
	Seed	Stover	Seed	Stover				
Blackgram + sesame (2:2) intercropping system	380 (65)	600 (210)	522	634	605	10150	17135	2.69
Mixed cropping of blackgram + sesame	260 (53)	445 (170)	375	473	449	9550	10098	2.06

Figures in parentheses are yields of sesame

In an assessment of various rainfed crops during pro-active monsoon management, sorghum under sorghum + greengram (2:1) intercropping performed better under delayed sowing at all locations. During the year, sesame gave the highest mean sorghum equivalent yield (2030 kg/ha) and highest net returns (Rs. 16196/ha) under delayed sowing followed by sole sorghum (1338 kg/ha and net returns of Rs. 15781/ha) (Table 4.22).

Table 4.22: Assessment of different crops under proactive monsoon management - Arjia

Location	Sorghum equivalent yield (kg/ha)				
	Sorghum + greengram (2:1) intercropping	Sorghum	Greengram	Horsegram	Sesame
I	1500	1250	880	887	1050
II	1665	1250	1320	1615	963
III	1568	1240	880	1108	2363
IV	1890	1540	1155	1298	2713
V	1840	1410	1320	1298	3063
Mean	1693	1338	1111	1241	2030
Cost of cultivation (Rs/ha)	11150	10900	8600	7100	8400
Net returns (Rs/ha)	20298	15781	6438	9700	16196
B:C ratio	2.82	2.45	1.75	2.37	2.93

4.2.3 Nutrient management

In an assessment of nutrient management in maize, application of zinc sulphate @ 25 kg/ha gave 26.12% higher maize yield (1317 kg/ha) over farmers practice (973 kg/ha) with B:C ratio of 1.58 (Table 4.23). Foliar spray of $ZnSO_4$ @ 0.5% was also effective in enhancing maize yield.

Table 4.23: Yield and economics of maize in response to zinc application - Arjia

Treatment	Yield (kg/ha) 2014		Maize grain yield (kg/ha) mean of 2010-14	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio
	Grain	Stover				
Farmers' practice	973	1833	1311	11200	6552	1.58
IP + 25 kg $ZnSO_4$/ha	1317	2147	1634	12100	11163	1.92
IP + Spray of $ZnSO_4$ @ 0.5%	1237	1963	1525	11900	9831	1.83

IP: Improved practice

In an assessment of effect of site-specific nutrient management (SSNM) on yield of sorghum, fertilizer dose based on SSNM gave the highest sorghum yield (1513 kg/ha), net returns (Rs.14948/ha) and B:C ratio (2.25) closely followed by recommended dose of NP (net returns of Rs.10898/ha, B:C ratio of 1.92 from a yield of 1273 kg/ha) as compared to farmers' practice (1030 kg/ha) (Table 4.24).

Table 4.24: Yield and economics of sorghum under site-specific nutrient management – Arjia

Treatment	Grain yield (kg/ha) 2014	Sorghum grain yield (kg/ha) Mean of 2011-13	Stover yield (kg/ha)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio
Farmers' practice	1030	1329	2267	10900	6560	1.60
Recommended dose of NP	1273	1520	3297	11800	10898	1.92
Fertilizer dose based on SSNM	1513	1723	3883	11950	14948	2.25

4.2.4 Energy management

To improve the timelines of intercultural operations and reduce the cost of field operations, a demonstration on Arjia wheel hoe was conducted on farmers' maize fields. The field capacity of the Arjia wheel was found to be 7.37 manday/ha as compared to the farmers' practice with 23.58 manday/ha (Table 4.25). On an average, use of wheel hoe resulted in saving of time and cost by 68.7 and 63%, respectively.

Table 4.25: Performance evaluation of Arjia wheel hoe in maize - Arjia

Location	Time of operation for 250 m² plot (min)		Field capacity (man days/ha)		Cost of operation (Rs)		Saving (%)	
	Wheel hoe	Kudali	Wheel hoe	Kudali	Wheel hoe	Kudali	Time	Cost
I	90	295	7.50	24.58	1590	4425	69.5	64.1
II	94	265	7.83	22.08	1650	3975	64.5	58.5
III	88	300	7.33	25.00	1560	4500	70.7	65.3
VI	84	285	7.00	23.75	1500	4275	70.5	64.9
V	86	270	7.17	22.50	1530	4050	68.1	62.2
Mean	88.40	283.00	7.37	23.58	1566.00	4245.00	68.67	63.01

To improve the timeliness of intercultural operations and reduce the cost of operation in maize, an assessment power weeder was conducted on farmers' fields and results revealed that the power weeder (31 cc) recorded a saving of 93.2% in labour and 74.1% in time as compared to *Kudali* (farmers' practice) (Table 4.26). The cost of operation was Rs. 1266/ha with a field capacity of 15.6 hrs/ha. Similarly, a power weeder (70 cc, four stroke) was also tested in cotton crop and data are presented in Table 4.27. The results revealed that the power weeder (70 cc) recorded a saving of 92.8% in cost and 70.3% in cost as compared to farmers' practice. Thus, timeliness in intercultural operation can be achieved through mechanization, which also considerably reduces the cost of operation.

Table 4.26: Evaluation of single row power weeder for intercultural operation in maize - Arjia

Location	Power weeder (2500 m²)					Farmers' practice (*Kudali*)			Saving (%)	
	Petrol used (liter)	Time required (hrs)	Labour required (Man days)	Maintenance cost (Rs.)	Total cost (Rs.)	Labour required (Man days)	Cost (Rs.)	Time required (hrs)	Cost	Time
1	2	3.7	0.4625	123.6	313.85	8	1360	64	94.2	76.9
2	1.8	4.1	0.5125	116.4	297.25	6	1020	48	91.5	70.9
3	2.1	3.8	0.475	127.2	325.9	6.5	1105	52	92.7	70.5
4	2.2	3.9	0.4875	130.8	337.95	7.5	1275	60	93.5	73.5
5	1.9	4	0.5	120	306.8	8.5	1445	68	94.1	78.8
Mean	2.0	3.9	0.488	123.6	316.4	7.3	1241.0	58.4	93.2	74.1

Table 4.27: Evaluation of single row power weeder for intercultural operation in cotton - Arjia

Location	Power weeder (2500 m²)					Farmers' practice (*Kudali*)			Saving (%)
	Petrol used (litre)	Time required (hrs)	Labour required (Man days)	Maintenance cost (Rs.)	Labour required (Man days)	Cost (Rs.)	Time required (hrs)	Labour	Time
1	1.65	3.6	0.45	102.4	5.5	770	44	91.8	65.4
2	1.75	3.7	0.4625	106	6.5	910	52	92.9	69.4
3	1.45	3.4	0.425	95.2	6	840	48	92.9	71.2
4	1.55	3.8	0.475	98.8	7.5	1050	60	93.7	75.4
5	1.85	4.1	0.5125	109.6	7	980	56	92.7	70.0
Mean	1.7	3.7	0.465	102.4	6.5	910	52.0	92.8	70.3

A demonstration was carried out on farmers' fields to improve the timeliness and precision of sowing operation of maize and reduce the cost of operation using Arjia two row bullock drawn seed drill. It was found that the field capacity of seed drill was 6.87 hr/ha as against 12.93 hr/ha for country plough (Table 4.28).

Table 4.28: Evaluation of Arjia two row bullock drawn seed drill in maize - Arjia

Location	Time of operation for 2500 m² (hr)		Field capacity (hr/ha)	
	Arjia two row bullock drawn seed drill	Country plough	Arjia two row bullock drawn seed drill	Country plough
I	1.7	3.4	6.8	13.6
II	1.65	3.1	6.6	12.4
III	1.8	3.2	7.2	12.8
Mean	1.72	3.23	6.87	12.93

The Arjia tractor drawn seed drill was assessed for its performance and results indicated that improved seed drill had a field capacity of 1.60 hr/ha as compared to 12.67 hr/ha with country plough. The saving of 87.38 and 24.91% was recorded in time and cost. This saving in time is very crucial for sowing operation (Table 4.29).

Table 4.29: Evaluation of Arjia tractor drawn intercropping seed drill in maize - Arjia

Location	Time of operation for 2500 m² (hr)		Field capacity (hr/ha)		Cost of operation for 2500 m² (hr)		Saving (%)	
	Intercropping seed drill	Country plough	Intercropping seed drill	Country plough	Intercropping seed drill	Country plough	Time	Cost
I	0.35	3	1.40	12.00	300	380	88.3	21.1
II	0.45	3.2	1.80	12.80	310	420	85.9	26.2
III	0.40	3.3	1.60	13.20	290	400	87.9	27.5
Mean	0.40	3.17	1.60	12.67	300.00	400.00	87.38	24.91

4.2.5 Evaluation of improved varieties

At Arjia, in a participatory evaluation of maize verities, variety PM-3 performed better at farmers' field (1353 kg/ha) with a B:C ratio of 2.39 followed by Navjot (1143 kg/ha) and local (780 kg/ha) (Table 4.30).

Table 4.30: Yield and economics of maize varieties - Arjia

Variety	Yield (kg/ha)		Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio
	Grain	Stover			
PM-3	1353	2683	10475	14509	2.39
Navjot	1143	2217	10250	10744	2.05
Local	780	1857	9850	5248	1.53

In an on-farm assessment of horsegram varieties, AK-53 variety gave maximum yield of 400 kg/ha, net returns of Rs. 9503/ha and B:C ratio of 2.26, while local variety gave a yield of 185 kg/ha, net returns of Rs. 849/ha and B:C ratio of 1.12 (Table 4.31).

Table 4.31: Yield and economics of horsegram varieties - Arjia

Variety	Yield (kg/ha)		Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio
	Seed	Fodder			
AK-21	277	527	7550	4306	1.57
AK-42	337	612	7550	6803	1.90
AK-53	400	727	7550	9503	2.26
Local	185	403	7210	849	1.12

In an on-farm evaluation of sesame cultivars, PT 10 gave maximum seed yield of 198 kg/ha, net returns of Rs. 13467/ha and B:C ratio of 2.78, while local variety gave a yield of 94 kg/ha, net returns of Rs. 2858/ha with B:C ratio of 1.40 (Table 4.32).

Table 4.32: Yield and economics of sesame varieties - Arjia

Variety	Yield (kg/ha)		Sesame seed yield (kg/ha) Mean of 2012-14	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio
	Seed	Stalk				
PT-1	154	363	112	7550	8837	2.17
PT- 10	198	453	153	7550	13467	2.78
RT-127	161	403	135	7550	9522	2.26
RT-46	142	310	135	7550	7480	1.99
Local	94	277	75	7150	2858	1.40

In an on-farm evaluation of sorghum cultivars, sorghum grain yield was very low due to terminal drought in the operational area. CSV-15 variety gave the highest grain yield (1457 kg/ha) as compared to local cultivars (1043 kg/ha) with net returns of Rs. 5993/ha and B:C ratio of 2.49. The yield increased by 28.41% as compared to local cultivar (Table 4.33).

Table 4.33: Yield and economics of sorghum varieties - Arjia

Variety	Yield (kg/ha)		Sesame grain yield (kg/ha) Mean of 2010-14	Cost of Cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio
	Grain	Fodder				
CSV-15	1457	4117	2615	10750	15993	2.49
CSV-17	1390	2633	1977	10750	11855	2.10
Local	1043	2150	2860	10240	7118	1.70

In an on-farm evaluation of groundnut cultivars, groundnut pod yield was very low due to terminal drought in the operational area. TG 37 A variety gave the highest pod yield (533 kg/ha) as compared to local cultivars (270 kg/ha) with net returns of Rs. 7252/ha and B:C ratio of 1.59. The yield increased by 49.34 % as compared to local cultivar (Table 4.34).

Table 4.34: Yield and economics of groundnut varieties - Arjia

Variety	Yield (kg/ha)		Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio
	Pod	Haulm			
TG 37 A	533	973	12250	7252	1.59
TAG 24	443	870	12250	4147	1.34
Local	270	700	11400	-895	0.92

In a demonstration of improved sorghum production technologies, the improved variety (CSV-15) gave maximum mean net returns of Rs.13576/ha with B:C ratio of 2.12 compared to farmer's practice with Rs. 9603/ha and B:C ratio of 1.83. The improved variety gave a mean yield of 1414 kg/ha compared to local variety with a yield of 1144 kg/ha (Table 4.35).

Table 4.35: Seed yield and economics of sorghum (CSV-15) under different demonstrations - Arjia

Location	Yield (kg/ha)				Cost of cultivation (Rs/ha)		NMR (Rs/ha)		B:C ratio	
	Improved practice		Farmers' practice							
	Seed	Stover	Seed	Stover	IP	FP	IP	FP	IP	FP
I	1240	3700	980	2950	12100	11550	11105	6848	1.92	1.59
II	1460	3800	1250	3200	12100	11550	13970	10650	2.15	1.92
III	1350	3950	1080	3550	12100	11550	12988	9398	2.07	1.81
IV	1550	4100	1230	3550	12100	11550	15725	11198	2.30	1.97
V	1470	3800	1180	3250	12100	11550	14090	9923	2.16	1.86
Mean	1414	3870	1144	3300	12100	11550	13576	9603	2.12	1.83

4.2.6 Alternate land use system

In an on-farm assessment of horti-pasture model, improved grasses like *Cenchrus setigerus* and *Stylosanthus hamata* performed better and gave the highest dry grass yield (5200 kg/ha) as compared to local grass (1450 kg/ha). After sixth year of assessment, the improved practice gave higher net returns (Rs.11250/ha) and B:C ratio (3.59) compared to farmers' practice (Table 4.36).

Table 4.36: Grass yield under improved silvi-pasture model on non-arable land - Arjia

Treatment	Dry matter yield (kg/ha)	Dry matter yield (kg/ha) Mean of 6 years (2009-14)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio
Farmers' practice	1450	1220	1950	950	1.49
Improved practice	5200	3991	4350	11250	3.59

Improved practice: *C. setigerus* and *S. hamata*; Farmers practice: Local grass

4.3 Ballowal Saunkhri

(Naude Majra, Rupnagar district, Punjab)

4.3.1 Rainwater management

In an assessment of the comparative performance of different planting methods in maize, the grain yield of maize with ridging was 14% higher than that of flat sowing. Ridge sowing of maize gave maximum net returns of Rs. 31826/ha, RWUE of 274 kg/ha-mm and B:C ratio of 2.15 from a yield of 3447 kg/ha, while flat sowing of maize gave minimum net returns of Rs. 24235/ha, B:C ratio of 1.87 and RWUE of 239.9 kg/ha-mm from a yield of 3018 kg/ha (Table 4.37).

Table 4.37: Effect of different sowing methods of maize - Ballowal Saunkhri

Treatment	Grain yield (kg/ha)	RWUE (kg/ha-mm)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio
Ridge sowing	3447	274.0	27755	31826	2.15
Flat sowing	3018	239.9	27932	24235	1.87

Rainfall (mm): 113.8

On-farm trials were conducted during *rabi* 2014-15 to assess the performance of pre-sowing irrigation on wheat cultivar (PBW-644). Due to long dry spell during the *rabi* season, pre sowing irrigation was provided to wheat (PBW-644) from the harvested rainwater, which gave highest grain yield of 3326 kg/ha, which was 51% higher over the rainfed wheat. The net return and B:C ratio with pre-sowing irrigation was Rs.34242/ha & 2.26, respectively (Table 4.38).

Table 4.38: Productivity and economics of wheat (PBW-644) under pre-sowing irrigation conditions - Ballowal Saunkhri

Treatment	Grain yield (kg/ha)	RWUE (kg/ha-cm)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio
Pre-sowing irrigation	3326	138	27258	34242	2.26
Rainfed	2208	133	24760	17312	1.70

* Depth of irrigation water i.e. 75 mm per irrigation + rainfall (166.6 mm) used to calculate water/rainwater use efficiency.

4.3.2 Cropping systems

Among the two raya cultivars, RLM-619 intercropped in wheat recorded highest WEY of 3046 kg/ha, which was 16 and 22% higher over raya intercropping in wheat with PBR-97 (WEY) and sole wheat, respectively. It gave extra benefit of Rs. 4676/ha over the sole wheat crop. Thus, raya variety RLM-619 was found more suitable for intercropping over PBR-97 cultivar and gave highest net return of Rs. 30,392/ha with B:C ratio of 2.21 (Table 4.39).

Table 4.39: Productivity and economics of wheat and raya intercropping (10:1) - Ballowal Saunkhri

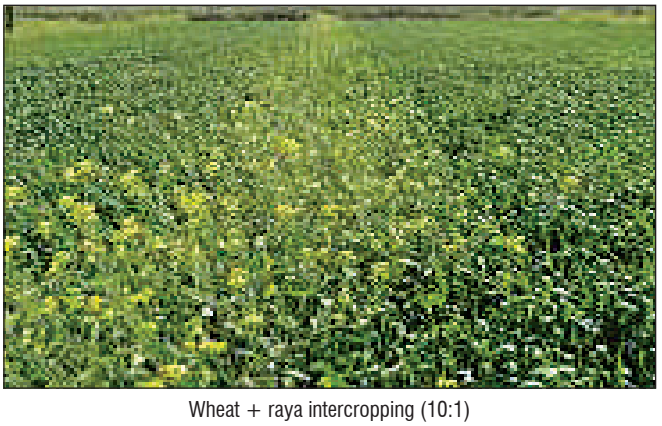
Crop	Yield (kg/ha)	WEY (kg/ha)	RWUE (kg/ha-cm)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio
Sole wheat	2628	2490	158	25471	25716	2.01
Wheat + raya (Cv PBR-97)	2330 + 160	2628	150	24995	25188	2.01
Wheat + raya (Cv RLM-619)	2515 + 220	3046	151	25193	30392	2.21

Intercropping of toria and gobhi sarson (1:1) gave 827 kg/ha seed yield, which was 24% higher than sole gobhi sarson (665 kg/ha). Intercropping recorded net returns of Rs. 9201/ha over the sole cultivation of gobhi sarson (Table 4.40).

Table 4.40: Productivity and economics of toria + gobhi sarson intercropping (1:1) – Ballowal Saunkhri

Treatment	Grain yield (kg/ha)	RWUE (kg/ha-cm)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio
Sole gobhi sarson	665	41.8	17971	5304	1.41
Toria + gobhi sarson	827	52.0	19744	9201	1.47

Rainfall (mm): 159.1 for gobhi sarson



Wheat + raya intercropping (10:1)

Toria + gobhi sarson intercropping (1:1)

Among the various double cropping system, economic analysis showed that maize-wheat cropping system gave highest net returns of Rs. 69381/ha and B:C ratio of 2.28 from maize equivalent yield (MEY) of 6741 kg/ha followed by sesame-wheat system (net returns of Rs.58114/ha with B:C ratio 2.40), pearlmillet - wheat (net returns of Rs. 57667/ha with B:C ratio 2.52), maize-chickpea (net returns of Rs. 57417/ha with B:C ratio 2.11)

and minimum net returns of Rs. 26,890/ha and B:C ratio (1.97) was recorded with pearlmillet - taramira cropping system. The sesame based double cropping system proved to be highly profitable due to high price of sesame and with less cost of cultivation (Table 4.41).

Table 4.41: Productivity and economics of double cropping system – Ballowal Saunkhri

Treatment	Grain/seed yield (kg/ha)		MEY (kg/ha)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio
	Kharif	*Rabi*				
Maize - wheat	3570	3062	6741	54103	69,381	2.28
Maize - raya	3570	950	6284	51790	57,417	2.11
Maize - gobhi sarson	3570	576	5627	47865	42,642	1.89
Maize - taramira	3570	883	5778	46060	46,552	2.01
Blackgram - wheat	3570	900	5820	46916	46,291	1.99
Blackgram - raya	3570	516	4860	43753	38,594	1.88
Blackgram - taramira	796	3062	5730	46531	53,040	2.14
Sesame - wheat	420	3062	6171	41463	58,114	2.40
Sesame - chickpea	420	950	3984	39150	46,150	2.18
Sesame - lentil	420	883	3915	33420	35,285	2.06
Sesame - raya	420	900	3932	34276	35,024	2.02
Sesame - taramira	420	516	3534	31113	27,327	1.88
Pearlmillet (fodder) - wheat	22583	3062	4784	37975	57,677	2.52
Pearlmillet (fodder) - raya	22583	950	2597	35662	45,713	2.28
Pearlmillet (fodder) - taramira	22583	576	2210	31737	30,938	1.97

The demonstration of improved practices in maize gave net returns of Rs. 32271/ha and B:C ratio of 2.10 from a yield of 3570 kg/ha, while farmers' practices gave Rs.17564/ha, yield of 2580 kg/ha. In blackgram, the improved practices gave a yield of 796 kg/ha, net returns of Rs.15930/ha and B:C ratio of 1.73, while the farmers' practice gave a yield of 544 kg/ha. In sesame, improved practices resulted in seed yield of 420 kg/ha with net returns of Rs.21004/ha, however yield under farmers' practices was 287 kg/ha. In pearlmillet, the improved practices gave green fodder yield of 22583kg/ha, net returns of Rs. 20567/ha and B:C ratio of 2.55. Adoption of improved practices gave 38, 46, 46 and 20% higher grain/fodder yield over the farmers' practices in maize, blackgram, sesame and pearlmillet fodder, respectively (Table 4.42).

Table 4.42: Performance of improved practices of *kharif* crops - Ballowal Saunkhri

Crop	Intervention	Grain/ Seed/Fodder yield (kg/ha)	RWUE (kg/ha-cm)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio
Maize	Improved practices	3570	148.75	29436	32271	2.10
	Farmers' practices	2580	107.5	27032	17564	1.65
Black gram	Improved practices	796	33.03	21864	15930	1.73
	Farmers' practices	544	22.57	21384	4445	1.21
Sesame	Improved practices	420	17.43	16796	21004	2.25
	Farmers' practices	287	11.91	15291	10539	1.69
Pearl-millet (green fodder)	Improved practices	22583	961.0	13308	20567	2.55
	Farmers' practices	18729	797.0	12956	15138	2.17

During *rabi* season, demonstration of the improved practices of wheat gave net returns of Rs.37110/ha and B:C ratio of 2.50 from a yield of 3062 kg/ha. In chickpea demonstration, the improved practices gave net returns of Rs.25146/ha and B:C ratio of 2.12 from a yield of 950 kg/ha. Under drought conditions the improved practices in lentil gave a yield of 576 kg/ha with net returns of Rs.10371/ha and B:C ratio 1.56. In raya, the improved practices gave net returns of Rs.14281/ha and B:C ratio of 1.86 from a yield of 883 kg/ha. In gobhi-sarson, the improved practices gave net returns of Rs. 14020/ha and B:C ratio of 1.80 from seed yield of 900 kg/ha. In case of taramira, the improved practices gave seed yield of 516 kg/ha, net returns of Rs. 6323/ha and B:C ratio of 1.44. In linseed, the improved practices gave net returns of Rs. 5361/ha and B:C ratio of 1.54 from seed yield of 688 kg/ha. Improved practices in wheat, chickpea, lentil, raya, gobhi sarson, taramira and linseed resulted in 25, 27, 27, 51, 53, 39 and 29% higher grain/seed yield than farmers practices (Table 4.43).

Table 4.43: Field demonstration of improved practices of *rabi* crops - Ballowal Saunkhri

Crop	Intervention	Grain/ seed yield (kg/ha)	RWUE (kg/ha-cm)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio
Wheat	Improved practices	3062	183.8	24667	37110	2.50
	Farmer's practices	2447	146.9	21783	29200	2.34
Chickpea	Improved practices	950	57.02	22354	25146	2.12
	Farmer's practices	750	45.02	19406	18094	1.93
Lentil	Improved practices	576	34.6	18429	10371	1.56
	Farmer's practices	455	27.3	16477	1723	1.10
Raya	Improved practices	883	53.2	16624	14281	1.86
	Farmer's practices	586	35.3	13116	7394	1.56
Gobhi sarson	Improved practices	900	54.2	17480	14020	1.80
	Farmer's practices	587	35.4	16233	4312	1.27
Taramira	Improved practices	516	31.1	14317	6323	1.44
	Farmer's practices	370	22.3	12960	1840	1.14
Linseed	Improved practices	688	41.3	20088	10872	1.54
	Farmer's practices	532	31.9	18579	5361	1.29

4.3.3 Nutrient management

In an on-farm assessment of nutrient management in maize, maximum maize grain yield of 3601 kg/ha was recorded with application of N through combination of 75% inorganic + 25% organic source, which was 3, 8 and 10% higher over application of N through combination of 50% inorganic + 50% organic (3508 kg/ha), 100% inorganic source (3321 kg/ha), and 100% organic source (3261), respectively, with maximum net returns of Rs. 27792/ha and B:C ratio of 1.91 (Table 4.44).

Table 4.44: Effect of different nitrogen sources on the yield and economics of maize - Ballowal Saunkhri

Treatment	Grain yield (kg/ha)	RWUE (kg/ha-cm)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio
100% inorganic	3321	130.2	28692	25075	1.87
50% organic + 50% inorganic N	3508	137.6	32268	24527	1.76
75% inorganic + 25% organic N	3601	141.2	30508	27792	1.91
100% organic	3261	127.9	35741	17054	1.48

In an on-farm assessment of seed treatment and nutrient management in chickpea, the maximum seed yield of 974 kg/ha was obtained with seed inoculated with *rhizobium* + application of recommended N with 10 kg P_2O_5/ha, with B:C ratio of 1.42, which was 12% higher over recommended N with 20 kg P_2O_5/ha. The higher RWUE of 58.46 kg/ha-mm was also obtained in seed inoculated with *rhizobium* + recommended N with 10 kg P_2O_5/ha compared to un-inoculated seed + recommended N with 20 kg P_2O_5/ha (Table 4.45).

In case of lentil, maximum seed yield of 565 kg/ha was obtained with the application of seed inoculated with *rhizobium* + application of recommended N with 10 kg P_2O_5/ha, which was 24% higher over recommended N with 20 kg P_2O_5/ha. The seed inoculated with *rhizobium* + recommended N with 10 kg P_2O_5/ha treatment gave 110 kg/ha higher seed yield with net return of Rs. 9165/ha and B:C ratio of 1.48 compared to untreated treatment with yield of 455 kg/ha with net returns of Rs.5040/ha and B:C ratio of 1.28 (Table 4.45).

Table 4.45: Effect of *rhizobium* inoculation and P application on yield and economics of chickpea and lentil - Ballowal Saunkhri

Treatment	Grain yield (kg/ha)	RWUE (kg/ha-cm)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio
Chickpea					
Inoculated seed + Rec. N with 10 kg P_2O_5/ha	974	58.46	19245	19715	2.02
Un-inoculated seed + Rec. N with 20 kg P_2O_5/ha	870	52.22	19678	15122	1.77
Lentil					
Inoculated seed + Rec. N with 10 kg P_2O_5/ha	565	33.91	19085	9165	1.48
Un-inoculated seed + Rec. N with 20 kg P_2O_5/ha	455	27.31	17710	5040	1.28

4.3.4 Energy management

In order to conserve soil moisture just after harvesting of maize, one ploughing with rotavator and one ploughing with cultivator just before sowing gave wheat grain yield of 3165 kg/ha, which was 19% higher as compared to 4 ploughings with cultivator (2 cross ploughings just after harvesting of *kharif* crop and 1 before sowing). The planking was done after each operation in both the cases. The net returns of Rs. 36768/ha and B:C ratio of 2.56 was obtained with rotavator as compared to the net returns of Rs 27948/ha and B:C ratio of 2.18 in case of cultivator. Therefore, seed bed preparation with rotavator gave additional net returns of Rs. 8820/ha over cultivator treatment with RWUE of 190.0 kg/ha-cm (Table 4.46).

Table 4.46: Effect of seedbed preparation methods on yield and economics of wheat - Ballowal Saunkhri

Treatment	Grain yield (kg/ha)	RWUE (kg/ha-cm)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio
Cultivator	2660	159.7	23694	27948	2.18
Rotavator	3165	190.0	23614	36768	2.56

Similarly, seed yield of raya increased by 20% (net returns of Rs.17793/ha) with B:C ratio of 2.27 due to field preparation with rotavator as compared to cultivator. The planking was done after each operation in both the cases. In case of taramira, one ploughing with rotavator followed by planking gave seed yield of 456 kg/ha, which was 7% higher as compared to cultivator treatment. The rotavator treatment also gave higher net returns of Rs.4429/ha as compared to cultivator treatment with B:C ratio of 1.38 (Table 4.47).

Table 4.47: Effect of different seed bed preparation methods on yield and economics of raya and taramira - Ballowal Saunkhri

Crop	Treatment	Seed yield (kg/ha)	RWUE (kg/ha-cm)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio
Raya	Cultivator	760	45.6	14680	11920	1.81
	Rotavator	910	54.6	14057	17793	2.27
Taramira	Cultivator	426	25.6	12153	2757	1.23
	Rotavator	456	27.4	11531	4429	1.38

In another study, sowing of wheat with seed cum fertilizer drill gave net returns of Rs.44985/ha and grain yield of 3295 kg/ha which was 11 and 20% higher over wooden plough method (2960 kg/ha) and broadcasting method of sowing (2756 kg/ha), respectively. The mechanized sowing clearly indicated the superiority, which gave additional net returns of Rs.6620 and Rs.10651/ha over wooden plough and broadcasting method of sowing, respectively. Sowing of raya with seed drill resulted in maximum seed yield of 737 kg/ha, which was 16% higher than broadcasting methods of sowing under low seed zone moisture. Maximum net returns of Rs.11852/ha and B:C ratio of 1.85 was obtained with seed drill compared to broadcasting method of sowing (Table 4.48).

Table 4.48: Effect of sowing methods on productivity and economics of wheat and raya– Ballowal Saunkhri

Crop	Treatment	Grain/seed yield (kg/ha)	RWUE (kg/ha-cm)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio
Wheat	Seed drill	3295	197.8	23666	44985	2.90
	Wooden plough	2960	177.7	23306	38365	2.65
	Broadcasting	2756	165.4	23087	34334	2.49
Raya	Seed drill	737.0	46.1	13943	11852	1.85
	Broadcasting	633.0	39.6	13632	8523	1.63

4.3.5 Evaluation of improved varieties

In an evaluation of maize cultivars, PMH 1 hybrid gave maximum yield of 4008 kg/ha, net returns of Rs.42701/ha and B:C ratio of 2.38 followed by PMH 2 with grain yield 3844 kg/ha, net returns of Rs.40392/ha and B:C ratio of 2.31 (Table 4.49).

Table 4.49: Performance of maize hybrids - Ballowal Saunkhri

Hybrid	Grain yield (kg/ha)	RWUE (kg/ha-cm)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio
PMH 2	3844	160.2	30818	40392	2.31
PMH 1	4008	167.0	30946	42701	2.38
Parkash	3317	138.2	30408	30243	1.99

In an evaluation of different blackgram cultivars (Mash-114 and Mash-338), Mash-114 recorded seed yield of 676 kg/ha, which was 6% higher over the Mash 338. Consequently, Mash-114 cultivar gave higher net returns of Rs.20047/ha and B:C ratio of 2.17, respectively (Table 4.50).

Table 4.50: Performance of blackgram varieties – Ballowal Saunkhri

Variety	Seed yield (kg/ha)	RWUE (kg/ha-cm)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio
Mash-114	676	28.0	17133	20047	2.17
Mash-338	640	26.6	17132	18068	2.05

Among the sesame varieties (RT 346 and local), RT 346 recorded highest seed yield of 388 kg/ha, which was 76% higher than the local cultivar (yield 220 kg/ha) with net returns of Rs. 21722/ha and B:C ratio 2.27 (Table 4.51).

Table 4.51: Performance of sesame varieties – Ballowal Saunkhri

Variety	Seed yield (kg/ha)	RWUE (kg/ha-cm)	Cost of cultivation (Rs/ha)	Net returns (Rs/ha)	B:C ratio
RT 346	388	16.10	17078	21722	2.27
Local	220	9.13	16326	5674	1.35

Sesame cv. RT346

In an assessment of pearlmillet cultivars for fodder yield, cv FBC-16 recorded green fodder yield of 26667 kg/ha, which was 54% higher over the local cultivar. Further, FBC-16 gave higher net returns of Rs.16607/ha and B:C ratio of 2.65 (Table 4.52).

Table 4.52: Performance of pearlmillet cultivar FBC-16 – Ballowal Saunkhri

Cultivar	Green fodder yield (kg/ha)	RWUE (kg/ha-cm)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio
FBC-16	26667	1147	10060	16607	2.65
Local	17333	746	8886	8447	1.95

Among different wheat varieties, WH 1105 gave maximum net returns of Rs.30053/ha with B:C ratio of 2.20 from a yield of 2830 kg/ha followed by HD 2967 with net returns of Rs. 29113/ha and B:C ratio of 2.17 from yield of 2760 kg/ha. Wheat cultivars WH 1105, HD 2967, PBW 644 and PBW 600 gave 26, 25, 23 and 19% higher yield over local cultivar (Table 4.53).

Table 4.53: Varietal performance of wheat - Ballowal Saunkhri

Variety	Grain yield (kg/ha)	RWUE (kg/ha-cm)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio
PBW 660	2660	159.7	24863	25359	2.02
PBW 644	2790	167.5	25003	28430	2.14
HD 2967	2760	165.7	24971	29113	2.17
WH 1105	2830	169.9	25046	30053	2.20
Local	2240	134.5	22596	20537	1.91

Among chickpea varieties, PBG 7 recorded maximum seed yield of 958 kg/ha, which was 3% higher over local cultivar with highest B:C ratio of 2.34. Likewise highest RWUE of 57.50 kg/ha-cm was recorded with PBG-5 cultivar (Table 4.54).

Table 4.54: Varietal performance of chickpea – Ballowal Saunkhri

Variety	Seed yield (kg/ha)	RWUE (kg/ha-cm)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio
PBG-5	926	55.58	20434	25866	2.27
PBG-7	958	57.50	20434	27466	2.34

Among different raya cultivars, the seed yield of RLC1 was higher by 7% over local cultivar. Variety RLC1 gave maximum net returns of Rs. 7016/ha, RWUE of 47.30 kg/ha-cm and B:C ratio of 1.42 from a yield of 788 kg/ha (Table 4.55).

Table 4.55: Yield and economics of raya cultivars - Ballowal Saunkhri

Cultivar	Seed yield (kg/ha)	RWUE (kg/ha-cm)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio
PBR-91	736	44.18	16624	5456	1.33
RLC 1	788	47.30	16624	7016	1.42

4.3.6 Alternate land use

To evaluate the suitability of *kharif* season crops in wild animal damage prone area, maize and sesame trials were conducted in remote pockets of the village. It was observed that damage by wild and stray animals was more to maize than the sesame crop. Maize gave average yield of 1450 kg/ha in the area having problems of wild and stray animals with net returns of Rs.5784/ha and B:C ration of 1.22. However in the same areas, sesame gave average yield of 320 kg/ha with net returns of Rs.16090/ha with B:C ratio of 2.01. Hence sesame has potential for its cultivation in areas adjoining to forest and prone to stray/wild animal damage (Table 4.56).

Table 4.56: Performance of sesame and maize in wild animal damage prone area - Ballowal Saunkhri

Crop	Grain/seed yield (kg/ha)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio
Sesame	320	15,910	16090	2.01
Maize	1450	26,067	5784	1.22

To evaluate the suitability of *rabi* season crops in wild animal damage prone area, wheat and taramira trials were conducted in remote pockets of the village. It was observed that wild and stray animals' damage to wheat was much more than the taramira crop. Long dry spell at the time of sowing and more rainfall in February and March adversely affected the yield of oilseed crops in the area. Inspite of that taramira and wheat gave similar net returns (Rs.3697/ha in wheat & Rs. 3476/ha in taramira) with B:C ratio of 1.34 and 1.16. Hence taramira has potential for its cultivation in areas adjoining to forest and prone to stray/wild animal damage (Table 4.57).

Table 4.57: Performance of wheat and taramira in wild animal damage prone area - Ballowal Saunkhri

Crop	Grain yield (kg/ha)	RWUE (kg/ha-cm)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio
Wheat	1020	63.1	23093	3697	1.16
Taramira	390	24.1	10174	3476	1.34

4.4 Bangalore

(Alanatha cluster, Ramanagara district, Karnataka)

4.4.1 Rainwater management

At Bangalore, opening of moisture conservation furrow between paired rows of pigeonpea in fingermillet + pigeonpea (8:2) intercropping system recorded higher finger millet grain equivalent yield (2289 kg/ha) with RWUE of 5.25 kg/ha-mm, net returns (Rs.35179/ha) and B:C ratio (2.37). The fingermillet grain equivalent yield increased by 66% as compared to farmers' practice (1378 kg/ha) (Table 4.58).

Table 4.58: Yield and economics of fingermillet + pigeonpea (8:2) cropping system as influenced by soil and moisture conservation practice - Bangalore

Treatment	Fingermillet (kg/ha)		Pigeonpea seed yield (kg/ha)	Fingermillet equilent yield (kg/ha)	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Grain	Straw						
Fingermillet (MR-1) + pigeonpea (TTB-7) in 8:2	1979	4740	180	2289	25591	35179	2.37	5.25
Farmers' practice (Fingemillet + *Akkadi*)	1287	2565	PP:17 Castor:12 Sorghum:8 Fieldbean:18	1378	26666	9704	1.36	3.49

Fingermillet + pigeonpea (8:2)

Akkadi system (Farmers practice)

4.4.2 Cropping systems

Groundnut + pigeonpea intercropping (8:2) with moisture conservation furrow between paired rows of pigeonpea recorded higher groundnut equivalent yield (CEY) 953 kg/ha with RWUE of 2.14 kg/ha-mm, net returns of Rs. 22914/ha and B:C ratio 1.46 followed by groundnut + castor (8:1) (430 kg/ha, 1.49 kg/ha-mm, Rs. 5796/ha and 1.41, respectively) compared to farmers' practice (Table 4.59).

Table 4.59: Yield and economics of groundnut based production systems - Bangalore

Treatment	Yield (kg/ha)		CEY	LER	MAI	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Main crop	Intercrop						
Groundnut + pigeonpea (8:2)	600	492	953	1.51	9.12	22914	1.66	2.14
Groundnut + castor (8:1)	611	84	667	1.06	2.31	5796	1.17	1.49
Groundnut + *Akkadi*	570	P. Pea 30 Castor 20 Sorghum 16 Fieldbean 23	629	-	-	2513	1.07	1.41

Groundnut + pigeonpea (8:2)

Groundnut + *Akkadi* (Farmers' practice)

Groundnut + castor (8:2)

Introduction of pigeonpea + fieldbean inter cropping system (1:1) resulted in lower pigeonpea equivalent yield (1756 kg/ha) with RWUE (3.97 kg/ha-mm), net returns (Rs. 51034/ha) and B: C ratio (2.76) compared to sole crop of pigeonpea yield (1823 kg/ha) and yield was 6% higher than the pigeonpea + fieldbean intercropping system (1:1). Fieldbean sole was vitiated because of poor germination associated with failure of follow-up rains (Table 4.60).

Table 4.60: Yield and economics of pigeonpea based production systems - Bangalore

Treatment	Yield (kg/ha)		PEY	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Main crop	Intercrop					
Pigeonpea + fieldbean {BRG-1 + HA-4 (1:1) }	1756	Vitiated	1756	29072	51034	2.76	3.97
Pigeonpea sole (BRG-1)	1823	Vitiated	1823	26542	54294	2.87	4.12

In an on-farm demonstration of weed management in groundnut + pigeonpea intercropping (8:2), application of alachlor followed by one hand weeding recorded lower weed dry weight (185 kg/ha) and higher groundnut equivalent yield (893 kg/ha) with RWUE of 2.00 kg/ha-cm, net returns of Rs. 24027/ha and B:C ratio (1.79) compared to farmers' practice (320 kg/ha, 0.72 kg/ha-mm, Rs. 2513/ha and 1.07),respectively (Table 4.61).

Table 4.61: Weed management in groundnut + pigeonpea intercropping system - Bangalore

Treatment	Yield (kg/ha)			GEY	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Main crop	Intercrop						
Alachlor + 1 HW	526	512		893	30348	24027	1.79	2.00
Groundnut + *akkadi*	321	Pigeonpea	67	320	34763	2513	1.07	0.72
		Castor	13					
		Sorghum	23					
		Fieldbean	19					

4.4.3 Nutrient management

In an assessment of nutrient management in fingermillet + pigeonpea intercropping system, 50% N through organic source + 50% N & 100% PK through inorganic + 12.5 kg zinc sulphate + 10 kg borax/ha (T_2) recorded maximum fingermillet grain equivalent yield (2446 kg/ha) with RWUE (5.79 kg/ha-mm), net returns (Rs. 38068/ha) and B:C ratio (2.49) followed by RDF alone compared to farmers' practice of fingermillet + *akkadi* (1280 kg/ha, 3.21kg/ha-mm, Rs.10228/ha and 1.67 respectively) (Table 4.62).

Table 4.62: Yield and economics of fingermillet + pigeonpea cropping system under integrated nutrient management - Bangalore

Treatment	Yield (kg/ha)		Yield (kg/ha)			Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Fingermillet in 2014	Stover	Pigeonpea	Akkadi crop	Fingermillet equivalent				
T_1	1987	3240	145	-	2236	25591	32749	2.28	5.30
T_2	2150	3351	172	-	2446	25591	38068	2.49	5.79
T_3	1292	2493	Pigeonpea	10	1358	25591	10228	1.34	3.21
			Castor	11					
			Sorghum	9					
			Fieldbean	12					

T_1: RDF; T_2: 50% N through organic + 50% N & 100% PK through inorganic + 12.5 kg $ZnSO_4$ + 10 kg borax/ha; T_3: Farmers practice

In an assessment of site specific nutrient management (SSNM) practice for groundnut + pigeonpea intercropping system, SSNM + zinc sulphate (12.5 kg/ha) + borax (10 kg/ha) + biofertilizer recorded higher groundnut equivalent yield (1048 kg/ha) and B:C ratio (1.73) compared to farmers' practice (groundnut + *Akkadi* crops) (346 kg/ha and 0.79, respectively) (Table 4.63).

Table 4.63: Assessment of SSNM in groundnut + pigeonpea (8:2) intercropping system - Bangalore

Treatment	Yield (kg/ha)				Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Grain/seed in 2014	GNEY * 2014	Mean pod yield (4 yrs)	Stover/ haulm				
RDF (25:50:25 NPK kg/ha)	513	872	562	1533	34763	18327	1.53	1.95
SSNM + Zinc sulphate (12.5 kg/ha) + borax (10 kg/ha) + bio-fertilizer	620	1048	689	1865	36938	26866	1.73	2.35
Farmers' practice (groundnut + *Akkadi* crops)	320	346	423	1011	32582	-6968	0.79	0.84

*GNEY: Groundnut equivalent yield

4.4.4 Energy management

In an on-farm demonstration of use of hand weeder for weed control in fingermillet, labour requirement for weed control was 4 mandays/ha with hand weeder compared to 30 mandays/ha with hand weeding. The grain yield and net returns were higher with hand weeder (2123 kg/ha, Rs. 37763/ha), compared to farmers' practice of hand weeding (Table 4.64).

Table: 4.64 Comparative performance of hand weeder with hand weeding in fingermillet - Bangalore

Particulars	Hand weeder	Hand weeding
Width coverage (cm)	20	-
Field capacity (ha/day)	0.27	0.03
Labour requirement (Man days/ha)	4	30
Labour saving (%)	85	-
Operational cost (Rs./ha)	720	5400
Grain yield (kg/ha)	2123	2025
Straw yield (kg/ha)	5098	5045
Net returns (Rs./ha)	37763	30593
B:C ratio	2.97	2.28

4.4.5 Evaluation of improved varieties

Among the four fingermillet varieties, ML-365 produced higher grain yield (2423 kg/ha) with higher RWUE (5.56 kg/ha-mm), net returns (Rs.40058/ha) and B:C ratio (2.68) followed by MR-1 (2300 kg/ha), GPU-28 (2260 kg/ha) and GPU-48 (2193 kg/ha) compared to local variety (1597 kg/ha). The yield increased by 52, 44, 42 and 37%,respectively compared to local variety (Table 4.65).

Table 4.65: Performance of different fingermillet varieties - Bangalore

Variety	Yield (kg/ha)			Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Grain (2014)	Mean grain yield (2 yrs)	Stover				
MR-1	2300	2666	5781	23816	38020	2.59	5.27
GPU-28	2260	2390	3516	23816	35321	2.48	5.18
ML-365	2423	2616	4398	23816	40058	2.68	5.56
GPU-48	2193	2155	3315	23816	33495	2.40	5.03
Farmers' variety local	1597	1360	3012	22125	18368	1.77	3.66

In an assessment of improved chilli variety on farmers' fields, samrudhi chillies recorded higher green chilli yield (4598 kg/ha) with RWUE of 10.67 kg/ha-mm, net returns of Rs.108574/ha and B:C ratio (4.70) as compared to local variety (2430 kg/ha, 5.64 kg/ha-mm, Rs. 43,534/ha and 2.48, respectively) (Table 4.66).

Table 4.66: Yield and economics of green chillies - Bangalore

Variety	Yield (kg/ha)		Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Green chilli yield in 2014	Mean chilli yield (2 yrs)				
Samruddhi	4598	5274	29366	108574	4.70	10.67
Chikaballapura local	2430	2976	29366	43534	2.48	5.64

Among the 3 pigeonpea varieties, BRG-2 recorded higher seed yield (830 kg/ha) with RWUE of 1.86 kg/ha-mm, net returns of Rs. 10708/ha and B:C ratio (1.40) followed by BRG-1 with seed yield of (815 kg/ha) and B:C ratio of 1.38 followed by TTB-7 which recorded seed yield of 738 kg/ha and B:C ratio of 1.25 (Table 4.67).

Table 4.67: Yield and economics of pigeonpea varieties - Bangalore

Variety	Yield (kg/ha)			Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Seed yield in 2014	Mean seed yield (4 years)	Stalk yield				
BRG-1	815	879	3094	26542	10050	1.38	1.83
BRG-2	830	857	3121	26542	10708	1.40	1.86
TTB-7	738	913	2997	26542	6690	1.25	1.66

4.5 Hisar

(Chhapar jogiyan, Bhiwani district, Haryana)

4.6.1 Rainwater management

In an on-farm demonstration of *in-situ* moisture conservation in chickpea, higher seed yield was recorded when moisture was conserved by disc harrow (433 kg/ha) as compared to country plough (384 kg/ha). Consequently the B:C ratio was higher (0.82) with disc harrow as compared to country plough. RWUE was also higher bringing out the superiority of disc harrow over conventional plough (Table 4.68).

Table 4.68: Yield and economics of chickpea (C-235) as affected by moisture conservation through different implements - Hisar

Treatment	Yield (kg/ha)		Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Seed	Stalk yield				
Disc harrow	433	544	18070	-3234	0.82	6.66
Farmers' practice	384	484	18070	-4910	0.73	5.93

Demonstrations were conducted at three sites on farmers' fields using disc harrow and country plough for moisture conservation during *kharif* 2014 for raising mustard (RH 30) in *rabi*, 2014-15. Higher mean seed yield of mustard (1360 kg/ha) was recorded when soil moisture was conserved by disc harrow as compared to country plough (1175 kg/ha). The B:C ratio under disc harrow treatment was also higher (2.79) as against 2.41 attained with country plough (Table 4.69).

Table 4.69: Yield and economics of mustard (RH-30) as affected by moisture conservation with different implements - Hisar

Treatment	Yield (kg/ha)		Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Seed	Stalk				
Disc harrow	1360	4270	18900	33935	2.79	25.8
Farmers' practice	1175	3673	18900	26707	2.41	22.3

In an assessment of effect of pond silt application @ 40 t/ha on performance of mustard, the maximum seed yield (1453 kg/ha) was recorded with pond silt application compared to untreated treatment (1300 kg/ha) with RWUE of 27.60 kg/ha-mm. Addition of pond silt @ 40 t/ha recorded 11.8% higher seed yield of mustard as compared to untreated plot (Table 4.70). Similarly, application of pond silt also gave higher net returns (Rs.35063/ha) and B:C ratio (2.64) compared to untreated plots.

Table 4.70: Yield and economics of mustard (RH-30) as affected by pond silt application - Hisar

Treatment	Yield (kg/ha)		Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Seed	Stalk				
Pond silt (40 t/ha)	1453	4568	21400	35063	2.64	27.60
Farmers' practice	1300	4074	18900	31585	2.68	24.35

An on-farm assessment of pearlmillet sole (45 cm) and its every 3rd row harvesting for fodder (30 DAS) in case of drought was carried out. The *kharif* 2014 was a drought, harvesting of every third row for green fodder (30 DAS) proved economically better and recorded slightly higher net returns of Rs. 520/ha. and B:C ratio 1.03 as compared to non-harvesting of every third row (Table 4.71).

Table 4.71: Yield of pearlmillet in relation to drought management practices - Hisar

Treatment	Yield (kg/ha)		NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Grain	Stalk			
Every 3rd row harvesting	665 + 4670 (green fodder) pearlmillet eq. yield: 1194	1800	520	1.03	10.65 19.10
Farmers' practice	840	2131	-3674	0.79	13.45

Harvesting of every 3rd row of pearlmillet

4.6.2 Cropping systems

The effect of adoption of improved package of practices on performance of clusterbean was assessed in selected farmers' fields. The results indicated that there was a 27.8% increase in seed yield of clusterbean with adoption of package of practices (566 kg/ha) over farmers' practice (443 kg/ha) with RWUE of 7.10 kg/ha-mm. Net returns and B:C ratio were also higher with package of practices (Rs.10707/ha and 1.58) as compared to farmers' practice (Rs.6396/ha and 1.39), respectively. Similarly, 28% additional seed yield of mungbean was recorded with adoption of full package of practices over farmers' practices. Consequently, higher B:C ratio (1.34) and net returns (Rs.5627/ha) were obtained by adopting full package of practices in mungbean as compared to farmer's practices (1.13 and Rs.1947/ha), respectively. In chickpea, a 16.9% increase in seed yield was recorded under package of practices (435 kg/ha) over farmers' practices (372 kg/ha). Consequently, B:C ratio was also high with adoption of package of practice (0.83) as compared to farmers' practices (0.76) with a RWUE of 6.70 kg/ha-mm. About 13.3% increase in yield of mustard was recorded with full package of practices (1384 kg/ha) over farmers' practices (1222 kg/ha). Higher net returns (Rs. 26068/ha) and B:C ratio (2.38) was obtained with adoption of package

of practices as compared to farmers' practices with net returns of Rs.22097/ha and B:C ratio of 2.25. In barley, about 22.3% increase in grain yield was recorded with full package of practices (2192 kg/ha) over farmers' practices (1792 kg/ha). Further, adoption of full package of practices also gave higher net returns (Rs.17838/ha and B:C ratio of 1.79 (Table 4.72).

Table 4.72: Demonstration of improved practices of different crops - Hisar

Crop	Treatment	Yield (kg/ha)		Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
		Seed/grain	Stover/stalk				
Clusterbean	Improved practices	566	1394	18290	10707	1.58	7.10
	Farmers' practices	443	1092	16300	6396	1.39	5.36
Mungbean	Improved practices	460	1854	16460	5627	1.34	7.45
	Farmers' practices	360	1435	15330	1947	1.13	5.75
Chickpea	Improved practices	435	559	18070	-3141	0.83	6.70
	Farmers' practices	372	478	16820	-4053	0.76	5.76
Mustard	Improved practices	1384	4129	18900	26068	2.38	26.26
	Farmers' practices	1222	3630	17640	22097	2.25	23.20
Barley	Improvedof practices	2192	6128	22690	17838	1.79	41.60
	Farmers' practices	1792	4994	20890	12203	1.58	33.96

In a demonstration on strip intercropping systems, pearlmillet + greengram (8:4) intercropping system recorded higher pearlmillet equivalent yield (2421 kg/ha) as compared to sole pearlmillet (940 kg/ha). As a result, higher B:C ratio of 1.02 was obtained with pearl millet + greengram (8:4) intercropping system as against 0.89 with pearlmillet sole. Strip cropping of greengram reduced the potential yield of pearlmillet to the extent of 18.7% whereas pearlmillet equivalent yield was 25.6% higher compared to sole pearlmillet (Table 4.73).

Table 4.73: Performance of strip cropping of pearlmillet + greengram system (8:4) - Hisar

Treatment	Yield (kg/ha)		PEY	Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Main crop	Intercrop					
Pearlmillet + greengram	764	1200	2421	18300	297	1.02	38.74
Sole pearlmillet	940	-	-	18000	-1914	0.89	15.4

Pearlmillet + greengram (8:4) strip cropping

4.6.3 Nutrient management

In demonstrations on nutrient management in pearlmillet, the maximum grain yield (914 kg/ha) was recorded with application of 20 kg N/ha + *Azotobacter*. However, only 3.4% increase in grain yield of pearlmillet was observed when 20 kg N/ha + *Azotobacter* was applied over 20 kg N only and there was almost no difference in B:C ratio. Similarly, the highest mustard seed yield (1290 kg/ha) and net returns (Rs.31170/ha) was recorded with application of 20 kg N + *Azatobacter* as compared to 20 kg N/ha (1260 kg/ha). Only 2.4% increase in seed yield of mustard was recorded when 20 kg N + *Azotobacter* was applied over 20 kg N alone (Table 4.74)

Table 4.74: Effect of nutrient management on yield and economics of pearlmillet and mustard - Hisar

Crop	Treatment	Yield (kg/ha)		Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
		Grain/seed	Stover/stalk				
Pearlmillet	20 kg N/ha + *Azotobacter*	914	2342	17950	-2327	0.87	14.62
	20 kg N/ha	884	2261	17900	-2796	0.84	14.14
Mustard	20 kg N/ha + *Azotobacter*	1290	4012	18850	31170	2.65	24.50
	20 kg N/ha	1260	3915	18800	30047	2.60	23.90

In an assessment of nutrient management in mustard, the highest mustard seed yield (1473 kg/ha) was recorded with application of 60 kg N + 30 kg P_2O_5 + 20 kg K_2O compared to 40 kg N + 20 kg P_2O_5 + 20 kg K_2O (1285 kg/ha). Application of 60 kg N + 30 kg P_2O_5 + 20 kg K_2O recorded 14.6% higher seed yield over control (1285 kg/ha) (Table 4.75).

Table 4.75: Effect of high nutrient management on mustard yield - Hisar

Treatment	Yield (kg/ha)		Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Seed	Stalk				
60 kg N + 30 kg P_2O_5 + 20 kg K_2O	1473	4623	19880	37340	2.88	28.90
40 kg N + 20 kg P_2O_5 + 20 kg K_2O	1285	4040	19000	30935	2.63	24.35

4.6.4 Evaluation of improved varieties

In an on-farm demonstration of improved clusterbean variety, HG 563 recorded marginally higher yield (550 kg/ha), net returns (Rs.9886/ha) and B:C ratio (1.54) as compared to HG 365 (524 kg/ha) with net returns of Rs. 8553/ha and B:C ratio of 1.47. The improved greengram variety MH-421 recorded higher seed yield (453 kg/ha), net returns (Rs.5284/ha) and B:C ratio (1.32) as compared to Basanti (426 kg/ha; Rs.4016/ha and 1.24, respectively) (Table 4.76).

Table 4.76: Performance of improved varieties of *kharif* crops - Hisar

Crop	Variety	Yield (kg/ha)		Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
		Seed	Stalk				
Clusterbean	HG-563	550	1352	18290	9886	1.54	9.50
	Farmers' variety (HG- 365)	524	1286	18290	8553	1.47	6.66
Grengram	MH-421	453	1812	16460	5284	1.32	7.26
	Farmers' variety (Basanti)	426	1600	16460	4016	1.24	6.80

Greengram Cv.MH 421

Farmers' variety - Basanti

Demonstrations were conducted on improved varieties of *rabi* crops. The mustard variety RH 119 recorded highest seed yield (1411 kg/ha) and B:C ratio (2.87) followed by variety RH 406 (1379 kg/ha) with B:C ratio of 2.81, whereas RH 30 recorded the lowest seed yield (1332 kg/ha) and B:C ratio (2.74). Among the two chickpea varieties evaluated at farmers' fields, C-235 performed better and gave higher seed yield (425 kg/ha) compared to HC-1 (398 kg/ha) (Table 4.77).

Table 4.77: Performance of improved varieties of *rabi* crops - Hisar

Crop	Variety	Yield (kg/ha)		Cost of cultivation (Rs/ha)	Net return (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
		Seed	Stalk				
Mustard	RH-406	1379	4177	18900	34291	2.81	26.20
	RH-119	1411	4180	18900	35291	2.87	26.75
	Farmers' variety (RH-30)	1332	4179	18900	32839	2.74	25.25
Chickpea	C-235	425	537	18070	-3502	0.81	6.56
	HC-1	398	501	18070	-4432	0.75	6.13

Mustard cv. RH-406

Mustard cv. RH-119

Mustard cv. RH-30 (check)

4.6.5 Energy management

In demonstrations on use of wheel hand hoe for weed control in mustard, weeding with wheel hand hoe at 20 days after sowing, recorded almost comparable yields (1363 kg/ha) with that of *kasola* (1370 kg/ha). However, higher net returns of Rs.36293/ha and higher B:C ratio of 3.20 was recorded with wheel hand hoe as compared to weeding with *kasola* (Table 4.78).

Table 4.78: Mustard yield and economics as affected by mechanical weed control - Hisar

Treatment	Yield (kg/ha)		Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Seed	Stalk				
Wheel hand hoe	1363	4224	16520	36293	3.20	25.85
Farmers' practice (*kasola*)	1370	4245	17650	35432	3.01	26.00

4.6 Indore

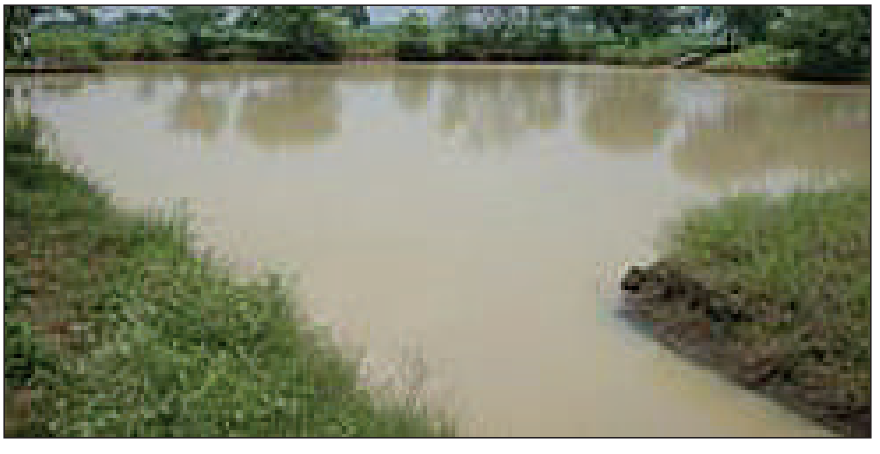
(Gaddukhedi, Dewas district, Madhya Pradesh)

4.7.1 Rainwater management

During 2014-15, though delayed and scanty monsoon was recorded, the runoff during *kharif* itself filled the tank to its capacity (0.56 ha-m) and the stored water was utilized for pre sowing irrigation for *rabi* crops mainly to wheat. Further, it was also observed that due to unusual rainfall during *rabi* season, heavy runoff took place and again the empty tank got filled and sufficient water was available for further irrigation (Table 4.79).

Table 4.79: Studies on catchment-storage-command relationship for enhancing water productivity in a micro watershed - Indore

S.No.	Parameter	Observed value
1	Weather aberration/extreme events	Delayed monsoon followed by high intensity rainfall events
2	Soil loss	NA
3	Rainwater use efficiency (kg/ha-mm)	0.8 for soybean, 19.3 for wheat
4	Crop seasonal rainfall (mm)	626 monsoon and 81.5 post-monsoon
5	No. of runoff events	5
6	Water stored in the tank	5684 cu.m.
7	Duration of availability of water	November end
8	Efficacy of silt trap	Not provided, already cultivated fields with almost no soil loss
9	Quality of irrigation water	Good
10	No. of irrigations	1 in 8 ha area
11	Stage of crop	Pres-sowing irrigation
12	Method of irrigation	Flood irrigation
13	Quantity of each irrigation water	7 cm
14	Cost of irrigation	5500/- for 3HP pump for three months
15	Catchment area	20 ha



Tank full with harvested rainwater

4.7.2 Evaluation of improved varieties

To evaluate the performance of different promising varieties of soybean, on-farm at ten locations were conducted. Despite delayed monsoon, the seed yields recorded by all varieties were statistically at par but superior to local. However, overall the farmers prefer JS 9560 due to its four seeded pods and short duration and also higher net income and B:C ratio (Rs.41700/ha and 3.7). The farmers also liked a new variety RVS 2001-04 due to its four seeded pods (more than 50% pods having four seed), higher productivity, net return and B: C ratio (1570 kg/ha, Rs.38880/ha and 3.5, respectively). JS 9560 also possess four seeded pods, high yielding (1650 kg/ha) and matures 7 to 8 days earlier than local varieties and thus making it suitable for the farmers willing to grow potato after soybean (Table 4.80).

Table 4.80: Performance of soybean varieties - Indore

Variety	Yield (kg/ha)		Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	Mean yield (2010-14) (kg/ha)
	Seed	Stover				
JS 93-05	1528	2028	15500	37352	3.4	1520
JS 95-60	1650	2150	15500	41700	3.7	1438
RVS 2001-4	1570	2070	15500	38880	3.5	1340
Local	790	1290	15000	12860	1.85	740
CD at 5%	43.36	-	-	710	0.104	-

Field demonstrations on chickpea varieties conducted at ten locations revealed that all the improved varieties gave significantly higher yield as compared to local varieties grown by the farmers. The highest seed yield was obtained in variety Jaki 9218 (1485 kg/ha) followed by JG-6 (1402 kg/ha) as against local check (960 kg/ha), and the yield increased by 54.68 and 46.06% as compared to local check. However, local variety fetched higher market value than the other varieties due to bold seeded nature (Table 4.81).

Table 4.81: Performance of different varieties of chickpea - Indore

Variety	Yield (kg/ha)		Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	Mean yield (2010-14) (kg/ha)
	Seed	Stover				
JG 6	1402	2223	13500	50345	4.73	1421
JG 412	-	-	-	-	-	1590
Jaki 9218	1485	2113	13500	46821	4.47	1518
Local	960	1435	13000	28270	3.17	960
CD at 5%	25	36.70	-	-	-	-

4.7 Solapur

(Maniknal, Sangli district, Maharashtra)

4.8.1 Rainwater management

In an assessment of *in-situ* moisture conservation measures on the yield of *rabi* sorghum at during four years (2011-14), a higher mean grain yield of 911 kg/ha, stover yield of 2660 kg/ha and B:C ratio of 1.98 were attained with ridges and furrows treatment. Compared to this, the farmers' practice gave a grain yield of 560 kg/ha, fodder yield of 1680 kg/ha and B:C ratio of 1.69 (Table 4.82).

Table 4.82: Effect of *in-situ* moisture conservation practices on the performance of *rabi* sorghum - Solapur

Treatment	Grain yield (kg/ha)			Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	2014	Mean (4 yrs)	Stover yield				
Opening of ridges and furrows (*kharif*)	1040	911	2660	13080	12900	1.98	12.43
Farmers' practice (harrowing)	863	560	1680	11102	7680	1.69	10.32

Opening of ridges and furrows in *kharif* season

Rabi sorghum under ridger and furrow treatment

In an assessment of *in-situ* moisture conservation measures on the yield of pigeonpea at Maniknal, during *kharif* season in four years, a higher mean seed yield of 810 kg/ha, stalk yield of 2010 kg/ha and B:C ratio of 2.66 were attained with ridges and furrows treatment. Compared to this, the farmers' practice gave a seed yield of 720 kg/ha, fodder yield of 1860 kg/ha and B:C ratio of 2.24 (Table 4.83).

Table 4.83: Effect of *in-situ* moisture conservation practices on the performance of pigeonpea - Solapur

Treatment	Seed yield (kg/ha)			Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	2014	Mean (4 yrs)	Stalk yield				
Opening of ridges and furrows 30 days after sowing of pigeonpea	824	810	2010	15700	26100	2.66	1.54
Two harrowings	741	720	1860	13300	16600	2.24	1.30

Opening of ridges and furrows 30 days after pigeonpea sowing

Preparation of compartment bund during *kharif* season gave maximum sorghum grain and fodder yield (1193 and 2528 kg/ha), respectively, with net returns and B:C ratio of Rs.14197/ha and 1.85. The percentage of grain yield increased by 19% as compared to two harrowings (1002 kg/ha) (Table 4.84).

Table 4.84: Effect of compartment bunding in *kharif* on *rabi* sorghum - Solapur

Treatment	Yield (kg/ha)		NMR (Rs/ha)	B:C ratio
	Grain	Stover		
Compartmental bunding	1193	2528	14197	1.85
Two harrowings	1002	2287	12432	1.62

Preparation of compartmental bunds in *kharif*

4.8.2 Cropping systems

In an assessment of suitability of sunflower + pigeonpea and pearlmillet + pigeonpea intercropping with 2:1 ratio conducted at three and four locations, respectively at Maniknal, pearlmillet (Shanti) + pigeonpea (Vipula) (2:1) gave mean equivalent yield of 3315 kg/ha, with B:C ratio of 2.85. Sunflower + pigeonpea (2:1) gave only pigeonpea yield (670 kg/ha) and sunflower crop failed due to excess rainfall and water stagnated condition (Table 4.85).

Table 4.85: Yield and economics of sunflower + pigeonpea and pearlmillet + pigeonpea intercropping on farmers' fields - Solapur

Treatment	Yield (kg/ha)		Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Main crop	Intercrop				
Sole pearlmillet (Shanti)	550	-	7700	3700	1.48	0.91
Sole pigeonpea (Vipula)	670	-	8500	15950	2.75	1.11
Sunflower (SS-56) + pigeonpea (Vipula) (2:1)	-	670	8500	16388	2.75	1.12
Pearlmillet (Shanti) + pigeonpea (Vipula) (2:1)	510	640	8200	16441	2.85	1.92

Sunflower (SS-56) + pigeonpea (Vipula) (2:1)

Pearlmillet (Shanti) + pigeonpea (Vipula) (2:1)

In an assessment of the recommended package of practices of seed, seed treatment, fertilizer, spacing, disease and pest control on farmers' fields at Maniknal, maximum sorghum (Phule Revati) yield of 1250 kg/ha was attained as compared to farmer's practice with a yield of 990 kg/ha. In case of chickpea (Vijay) yield of 1050 kg/ha was recorded with recommended package of practices (Table 4.86).

Table 4.86: Assessment of production potential of *rabi* sorghum and chickpea with improved technology on farmers' field - Solapur

Treatment	Seed/grain yield (kg/ha)			Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	2014	Mean (2011-14)	Stover/ stalk				
Sorghum							
Full package of practices with improved variety) (Phule Revati)	1670	1250	2830	12260	15440	2.25	21.13
Farmers' practice (Local variety)	1340	990	2210	11500	12000	2.04	16.96
Chickpea							
Full package of practices with improved variety (Vijay)	1103	1050	2320	14600	19260	2.31	13.96
Farmers' practice (Local variety)	991	840	1960	12800	13960	2.09	12.54

In a demonstration seed treatment with biofertilizer (*Rhizobium*) for chickpea gave highest seed yield (1280 kg/ha) with a B:C ratio of 2.03. The seed yield increased by 14.29% over the control (1120 kg/ha) (Table 4.87).

Table 4.87: Demonstration of seed treatment on chickpea yield and economics - Solapur

Treatment	Seed yield (kg/ha)	NMR (Rs/ha)	B:C ratio
Seed treatment with *Rhizobium*	1280	8400	2.03
Control (no seed treatment)	1120	15600	1.86

4.8.3 Nutrient management

The demonstration-cum-verification trials on pearlmillet (cv. Shanti) were conducted at eight locations on Entisol with 50 kg N, 25 kg P_2O_5 and 25 kg K_2O/ha and without potassium. Initial soil properties were pH - 7.8 to 8.10, EC - 0.13 to 0.18 dS/m, organic C - 0.48 to 0.53%, available N - 145 to 173, P - 8.40 to 9.14 and K - 180 to 188 kg/ha. The variety Shanti produced 670 kg/ha grain yield with B:C ratio of 1.67 due to application of 25 kg K_2O with recommended dose of N:P. The yield increased by 21.8% as compared to without potash application (Table 4.88).

Table 4.88: Response of pearlmillet to fertilizer application on farmers' fields - Solapur

Treatment	Grain yield (kg/ha)			Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	2014	Mean (2009-14)	Stover				
50 kg N + 25 kg P_2O_5 + 25 kg K_2O/ha	624	670	1720	12100	8200	1.67	1.04
50 kg N + 25 kg P_2O_5/ha	586	550	1360	8900	3900	1.43	0.97

In an assessment of response of *rabi* sorghum to fertilizer application on eleven farmers' fields maximum mean grain yield of 1090 kg/ha and stover yield of 2420 kg/ha with highest B:C ratio of 2.02 was attained during the four years with fertilizer application as per soil test value (N : P_2O_5 75:31 + 15 kg $ZnSO_4$/ha) over control (Table 4.89).

Table:4.89 Response of *rabi* sorghum to fertilizer application as per soil test under dryland condition - Solapur

Treatment	Grain yield (kg/ha)			Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	2014	Mean (2011-14)	Stover				
Soil test based fertilizer application	1425	1090	2420	12600	12880	2.02	18.03
Farmers' practice	1041	880	1920	10600	7296	1.68	13.77

Sorghum under fertilizer use as per soil test value

Sorghum without fertilizer

In an assessment of use of crop residues on performance of *rabi* sorghum on farmers' fields, maximum mean grain yield of 1108 kg/ha and stover yield of 2860 kg/ha, with B:C ratio of 2.24 was obtained due to application of 25 kg N/ha through crop residue and 25 kg N/ha through green lopping. The yield increased by 16.02% over control (955 kg/ha) (Table 4.90).

Table 4.90: Response of *rabi* sorghum to application crop residues under dryland condition - Solapur

Treatment	Grain yield (kg/ha)			Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	2014	Mean (2011-14)	Stover				
25 kg N/ha through crop residue and 25 kg N/ha through green leaf Loppings	1437	1108	2860	13960	14200	2.24	18.16
Farmers' practice	1082	955	2210	15440	19260	2.01	13.69

In an assessment of the effect of foliar application of nutrient on yield of chickpea on farmers' fields, application of 1% potassium sulphate at 30 and 45 days after sowing gave higher mean chickpea (cv. Vijay) yield of 760 kg/ha as compared to farmer's practice with a yield of 550 kg/ha, with highest net returns and B:C ratio of Rs. 14300/ha and 2.05. The yield increased by 38.18% over control (Table 4.91).

Table 4.91: Effect of foliar application of nutrient on yield of chickpea - Solapur

Treatment	Seed yield (kg/ha)			Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	2014	Mean (2012-14)	Stalk				
Foliar spray of K_2SO_4 @ 1% at 30 and 45 DAS	817	760	1920	13500	14300	2.05	10.34
Farmers' practice	622	550	1480	11900	8200	1.68	7.87

Chickpea with oliar spray of 1% K_2SO_4 at 30 and 45 DAS

Chickpea without foliar spary

4.8.4 Evaluation of improved varieties

In an assessment of production potential of improved sorghum cultivars for medium and medium deep soils, variety M.35-1 gave higher mean grain yield (800 kg/ha) than Phule suchitra (710 kg/ha) on medium soils with B:C ratio of 1.69. In medium deep black soils, cultivar Phule Revati recorded higher mean grain yield (1300 kg/ha) than M.35-1 (1190 kg/ha) with B:C ratio of 2.34 in four years (2010 - 2014) (Table 4.92).

Table 4.92: Assessment of production potential of improved sorghum cultivars on medium and medium deep soils on farmers' field - Solapur

Variety	Yield (kg/ha)			Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Grain yield in 2014	Mean grain yield (2010-14)	Stover				
Medium soil							
Phule Suchitra	767	710	1860	9660	2511	1.26	9.65
M35-1	885	800	1920	10100	6969	1.69	10.12
Medium deep soil							
Phule Revati	1406	1300	3140	12660	16964	2.34	16.45
M35-1	1303	1190	2680	11800	13688	2.16	15.06

Sorghum cv. Phule Suchitra

Sorghum cv. Phule Revati

In an assessment of performance of improved varieties of pigeonpea, pearlmillet and sunflower on farmers' fields at in pigeonpea, Vipula variety was found superior with a mean grain yield of 752 kg/ha as compared to farmer's local variety (639 kg/ha). The improved variety gave a B:C ratio of 2.26, while the local variety gave 1.80. Whereas in pearlmillet, variety Shanti was found superior with a mean grain yield of 607 kg/ha as compared to farmer's local variety (454 kg/ha). The improved variety gave a B:C ratio of 1.56, while the local variety gave 1.40. There was excess rainfall (420 mm) in seven rainy days in August which created water stagnated field condition for long time and the sunflower crop wilted. Hence the trials were vitiated in 2014. Among the three crops *viz.*, pigeonpea, pearlmillet and sunflower, pigeonpea (vipula) gave higher grain yield (708 kg) than local (600 kg) in three years (Table 4.93).

Table 4.93: Performance of improved varieties of pigeonpea, pearlmillet and sunflower - Solapur

Corp/variety	Yield (kg/ha)			Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Seed/grain yield in 2014	Mean seed/grain yield (2012-14)	Stover/ stalk yield				
Pigeonpea							
Vipula	752	708	1620	13200	16632	2.26	1.20
Local	639	600	1280	10300	8540	1.80	1.06
Pearlmillet							
Shanti	607	580	1380	3960	2217	1.56	1.10
Local	454	460	1220	3500	1400	1.40	0.75
Sunflower							
Bhanu	-	470	1180	4980	3984	1.80	0.78
Local	-	420	990	4580	2997	1.65	0.78

Shanti variety of pearlmillet

Local variety of pearlmillet

4.8.5 Energy management

In an evaluation of different implements for seeding and fertilization of *rabi* sorghum at Maniknal on three farmers' fields, two bowl ferti seed drill was found superior with maximum mean grain yield (910 kg/ha) and fodder yield (2260 kg/ha), with a B:C ratio of 2.40 in four years (2011 to 2014). The yield increased by 17% as compared to farmer's method (local seed drill) (Table 4.94).

Table 4.94: Performance of bullock drawn two bowl ferti seed drill in sorghum - Solapur

Treatment	Yield (kg/ha)			Cost of cultivation (Rs/ha)	NMR (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Grain yield in 2014	Mean grain yield (2011-14)	Stover				
Sowing with two bowl fertilizer seed drill	1010	910	2260	15440	19260	2.40	12.78
Farmers' method (Local seed drill)	820	780	1870	13960	14200	2.01	10.39

Sowing with two bowl ferti seed drill

Sowing with single bowl ferti seed drill

In demonstration on effect of hoeing on performance of *rabi* sorghum, hoeing at 3rd, 5th and 8th week after sowing (WAS) of sorghum gave maximum grain and fodder yield (980 and 2200 kg/ha), respectively, with a B:C ratio of 1.90. The yield increased by 16.33% over control (Table 4.95).

Table 4.95: Effect of hoeing on yield and economics of *rabi* sorghum - Solapur

Treatment	Yield (kg/ha)		NMR (Rs/ha)	B:C ratio
	Grain	Stover		
Three hoeings at 3rd , 5th and 8th WAS	980	2200	14581	1.90
Control	820	1820	13881	1.80

National Innovations on Climate Resilient Agriculture (NICRA)

The technology demonstration component (TDC) of NICRA, both on-station and on-farm, is being implemented at 23 AICRPDA centres including IGFRI, Jhansi since 2011. During 2014-15, the emphasis was on real time contingency crop plan implementation and preparedness to cope with weather aberrations with interventions such as rainwater harvesting (*in-situ* and *ex-situ*) and efficient use, drought tolerant cropping systems, resilient crop management practices, and efficient energy management. The risk resilient interventions were demonstrated in 3611 farmers' fields covering 898 ha in 33 villages (Table 5.1) in 24 districts across 15 states. The onset of monsoon was delayed by more than two weeks in NICRA villages of Agra, Akola, Bhilwara, Bijapur, Lakhimpur, Bhiwani, Indore, Parbhani, Jamnagar and Banaskantha districts. Further, there were 4 to 6 dry spells at different stages of crops in NICRA villages of Bhiwani, Agra, Kurnool, Bijapur, Thoothukudi, Bangalore Rural, Parbhani, Samba, Garhwa, Mirzapur, Lakhimpur and Kandhamal districts. The salient achievements are summarized below.

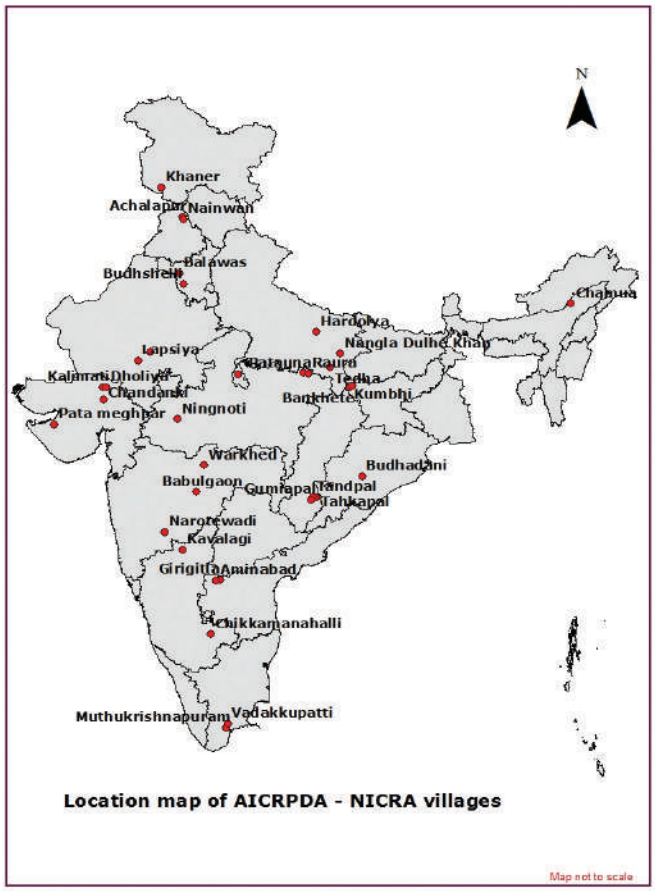


Table 5.1: AICRPDA-NICRA program- Details of villages

AICRPDA centre	Name of the villages	District	State
Agra	Nagla Duleh khan	Agra	Uttar Pradesh
Akola	Warkhed	Akola	Maharashtra,
Anantapur	Aminabad, Girigetla	Kurnool	Andhra Pradesh
Arjia	Kochariya Lapsiya	Bhilwara Rajsamand	Rajasthan
Ballowal Saunkhri	Naiwan, Achalpur	Hoshiarpur	Punjab
Bengaluru	Chikkamaranahalli	Bengaluru Rural	Karnataka
Biswanath Chariali	Chamua	Lakhimpur	Assam
Bijapur	Kavalagi	Bijapur	Karnataka (Gulbarga)
Chianki	Kumbhi & Bankheta	Garhwa	Jharkhand
Faizabad	Hardoiya	Faizabad	Uttar Pradesh
Hisar	Budhshelly Balawas	Bhiwani Hisar	Haryana
Indore	Ningnoti	Indore	Madhya Pradesh
Jagdalpur	Tahakapal, Tandapal and Gumiyapal	Bastar	Chittishgarh
Jhansi	Kadesara Kala	Lalitpur	Uttar Pradesh
Kovilpatti	Muthukrishnapuram, Vadakkupatti	Thoothukkudi	Tamil Nadu

AICRPDA centre	Name of the villages	District	State
Parbhani	Babhulgaon	Parbhani	Maharashtra
Phulbani	Budhadani	Kandhamal	Orissa
Rajkot	Pata meghapar	Jamnagar	Gujarat
Rakh Dhiansar	Khaner	Samba	Jammu & Kashmir
Rewa	Patauna, Raura	Rewa	Madhya Pradesh
SK Nagar	Kalimati/ Dholia, Chandanki	Banaskantha Mehasana	Gujarat
Solapur	Narotewadi	Solapur	Maharashtra
Varanasi	Tedha	Mizapur	Uttar Pradesh

I. Real time contingency planning

a. Delayed onset of monsoon

At Anantapur, under delayed onset of monsoon by 10 days, drought tolerant varieties gave additional seed/ pod/grain yield, net returns, B:C ratio and RWUE as compared to local checks viz. groundnut cv. Dharani (612 kg/ha, Rs.11256/ha, 1.54, 2.40 kg/ha-mm); pigeonpea cv. ICPH 40 (390 kg/ha, Rs.1245/ha, 1.10, 0.80 kg/ ha-mm); setaria cv. Prasad (529 kg/ha, Rs.23682/ha, 4.38, 3.66 kg/ha-mm). At Babulgaon village (Parbhani district, Maharashtra), under delayed onset of monsoon by 17 days, short duration variety of soybean MAUS 71 recorded higher yield (687 kg/ha) over local variety (532 kg/ha). At Kaulagi village (Bijapur district, Karnataka), under delayed onset of monsoon by 28 days, pearlmillet (ICTP-8203) gave 14% higher grain yield (2325 kg/ ha). At Nignoti village (Indore district, M.P.), under delayed onset of monsoon by 27 days, introduction of new soybean cv. RVS 2001-4 recorded higher seed yield (2000 kg/ha) with net returns of Rs.49000/ha, RWUE of 2.55 kg/ha-mm and B:C ratio of 4.91. In Kalimati/ Dholiya village (Banaskanta district, Gujarat), under delayed onset of monsoon by 25 days, castor hybrid GCH 7 recorded significantly higher seed yield of 1095 kg/ha over local variety (GHC 4).

Dharani variety of Groundnut - Anantapur

b. Early season drought

At Rajkot, timely interculture and weeding in groundnut increased the pod yield to the tune of 40% compared to no interculture and weeding. At Chamua village (Sonitpur district, Assam), potato tuber yield increased by 78% with mulching as compared to without mulching (3430 kg/ha). Further, with supplemental irrigation the increase in tuber yield was 188 to 203% in Kufri Pokhraj and Kufri Jyoti, respectively over no supplemental irrigation.

c. Midseason drought

At Pata Meghapar village (Jamnagar district, Gujarat), two supplemental irrigations in cotton each of 50 mm at flowering and boll formation stages, increased seed cotton yield by 42% with higher net return of Rs.58650/ha, B:C ratio of 2.80 and RWUE of 5.74 kg/ ha-mm as compared to without irrigation. At Bangalore, application of 2% KCl (MoP) during drought when the plants started expressing wilting symptom in fingermillet followed by application of thiourea @ 250 g/ha after retrieving drought recorded higher grain yield (4000 kg/ha), net returns (Rs.80200/ha), B:C ratio (4.11) and RWUE of 5.46 kg/ha-mm compared to no foliar spray.

Supplemental irrigation during flowering stage of cotton - Rajkot

At Warkhed village (Akola district, Maharashtra), opening of conservation furrow at 30 DAS in between two rows of soybean improved moisture conservation, resulted in mitigating the dry spells and gave higher seed yield of soybean (1021 kg/ha) with net returns of Rs.12428/ha and B:C ratio of 1.63 compared to farmers' practice (847 kg/ha). Similarly, foliar spray with thiourea @ 250 g/ha at late vegetative and early flowering stage of soybean gave higher seed yield of 964 kg/ha, with net returns of Rs.17929/ha, B:C ratio of 2.63 and RWUE of 1.36 kg/ha-mm.

Conservation furrow in Soybean - Akola

d. Terminal drought

At Rajkot, foliar spray with KNO_3 @ 2% at reproductive stage gave higher seed cotton yield (1570 kg/ha), net returns (Rs.32250/ha), B:C ratio (2.06) and RWUE (3.25 kg/ha-mm) as compared to no foliar spray. At SK Nagar, supplemental irrigation in castor recorded highest seed and stalk yields of 1350 and 2265 kg/ha, respectively over local practice (no supplemental irrigation). At Arjia, drip irrigation in maize gave grain yield of 4375 kg/ha with application of one irrigation (10 cm) during dry spell period, with B:C ratio of 3.12.

Supplemental irrigation in Castor - SK Nagar

II. Preparedness

In the beginning and during crop season, risk resilient technologies/practices were demonstrated as preparedness to cope with weather aberrations and the highlights are presented below.

a. Rainwater Management

At Kovilpatti, adoption of broad bed and furrows for *in-situ* moisture conservation resulted in 3.4, 19.5, 3.7, 33.1% increased yield over flat sowing in green gram (CO 6), sorghum (K 8), barnyard millet (CO 3) and onion (local), respectively. At Rajkot, the pod yield of groundnut was increased by 20% due to application *murrum* @ 20 t/ha with higher net returns (Rs.14375/ha), B:C ratio (1.59) and RWUE (2.30 kg/ha-mm) as compared to normal practice. At Anantapur, in groundnut (K-6), conservation furrows along the rows of groundnut at 20 DAS with tractor drawn intercultivation implement resulted in higher pod yield (439 kg/ha), net returns (Rs.4875/ha), B:C ratio (1.18) and RWUE of 2.2 kg/ha-mm, which was 20.2% higher yield compared to normal practice.

Groundnut with conservation furrows - Anantapur

b. Cropping systems

At Rajkot, cotton + sesame intercropping (1:1) recorded higher seed cotton equivalent yield (3090 kg/ha), net return (Rs.92350/ha), B:C ratio (3.96) and RWUE (6.40) compared to other cotton based intercropping systems. At Budhadani village (Kandhmal district, Odisha), in groundnut + castor intercropping system, groundnut pod equivalent yield (2330 kg/ha) was increased by 68 % compared to sole groundnut. At Chikkamaranahalli village (Bangalore Rural district, Karnataka), pigeonpea (BRG-1) + soybean recorded higher grain equivalent yield (1360 kg/ha), net returns (Rs.29862/ha), B:C ratio (2.04) and RWUE (1.69 kg/ha-mm) compared to other intercropping systems.

Cotton + sesame (1:1) - Rajkot

c. Nutrient management

At Rakh Dhiansar, maize sown by improved technique (maize planter) and application of recommended dose of fertilizers resulted in higher maize grain yield (1672 kg/ha), net returns (Rs.7832/ha) and B:C ratio (1.41) which was 27.6% increase in yield over the farmer's practice. At Chamua village (Lakhimpur district, Assam), balanced nutrient management in *sali* rice varieties i.e. Ranjit, Gitesh, TTB-404 and Mulagabharu gave higher yield (4589, 4712, 4920 and 4725 kg/ha) over without fertilizer (3445, 3574, 3000 and 3000 kg/ha, respectively).

d. Efficient energy management

At Chikkamaranahalli village (Bangalore Rural district, Karnataka), fingermillet sowing with modified bullock drawn seed drill recorded 44% higher grain yield (2950 kg/ha), net returns (Rs.49931/ha) and B:C ratio (3.10) as compared to farmer's practice of manual sowing. At Khaner village (Samba district, J&K), the maize grain yield increased by 30% when sown with maize planter as compared to broadcasting (farmers' practice). At Solapur, sowing of *rabi* sorghum with improved bullock drawn CRIDA planter gave higher energy output (22106 MJ/ha) and net return (Rs.14270/ha) than the farmers' practice.

e. Alternate land use

At Bangalore, higher amla equivalent yield was observed in intercropping of fingermillet (1845 kg /ha) and it was on par with fingermillet sole (1674 kg/ha). At Rakh Dhiansar, aonla + mixed fodder (maize + jowar + bajra) - gobhi sarson was demonstrated and the system recorded higher fodder yield (21200 kg/ha) with RWUE of 26 kg/ha-mm as compared to farmers' practice.

Mixed fodder in aonla orchard - Rakh Dhiansar

Village Climate Risk Management Committee (VCRMC): The VCRMCs in NICRA villages played a greater role in implementation of need based climate resilient interventions such as renovation and or establishing new farm ponds for creation of water assets for drought proofing, crop, land and soil based interventions, efficient functioning of custom hiring centre etc.

Meeting of VCRMC - Rajkot

Custom Hiring Centre (CHC): CHCs helped in hiring the need based implements/machinery by resource poor farmers at affordable cost and carrying out land preparation, timely and precision sowing covering large area in short time and other agricultural operations with high energy efficiency. A Custom Hiring Management Committee (CHMC) facilitated CHC activities and maintenance of implements from the income generated through hiring. CHCs significantly contributed to alleviate labour shortage during peak demand period.

Village Seed Bank: In Chamua Narayapur village, Lakhimpur district, Assam, a seed bank of the rice varieties of different duration which are suitable for aberrant weather situations like flood and drought has been established. The farmers were trained in seed production programme of 22 improved varieties and more than 30 local varieties and maintenance of seed of improved varieties of dominant rainfed crops. At Babhulgaon, Parbhani, the seed of varieties of soybean (MAUS 71 & MAUS 162), pigeonpea (BDN 711) was maintained at

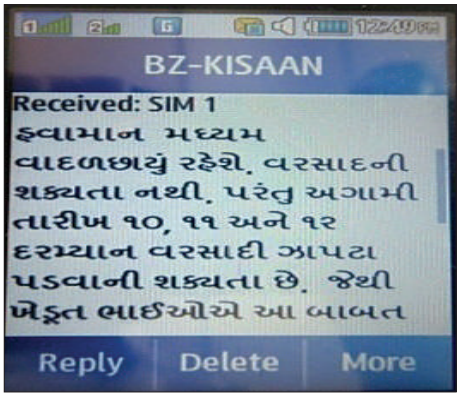
village level and sold to nearby farmers. At Nignoti village (Indore district), approximately 300 ton seed of improved varieties of soybean, pigeonpea and maize was produced out of which, 15 ton seed has been retained by the farmers for their own use in next *kharif* season.

Seed bank – Chamua village

Fodder Bank: A community fodder bank is maintained in Kochriya village of Arjia centre. Three species of perennial fodder varieties viz., hybrid napier (CO-2 and CO-4), congnosignal and setaria were planted in fodder bank at Chamua village, Lakhimpur district.

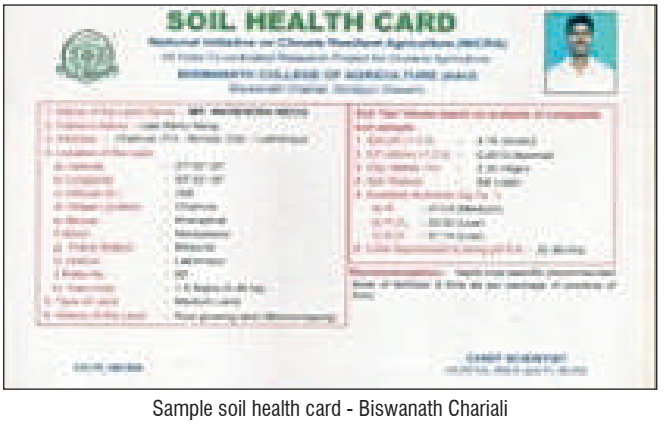
Hybrid napier - Chamua village

Agro-advisories: Real time contingency measures were advised for implementation in all the NICRA adopted villages. Besides display of weather information and agro-advisories on black boards in villages, the SMS service through mobiles was introduced for disseminating real time agro-advisories. During 2014-15, Rajkot, Biswanath Chariali, Bangalore, Solapur and Indore issued timely agro-advisories to farmers. At Bangalore, advisories and crop-weather bulletins were issued twice in a week (Tuesdays and Fridays) and message written in front of milk collection centres in Chikkaputtayyanapalya and Hosapalya and also broadcasted in the local radio "Neladhani" for benefits of village farmers.



SMS in farmer cell phone

Soil Health Cards: During 2014-15, the soil health cards were issued to 558 farmers viz., Anantapur (52 farmers), Arjia (80 farmers), Akola (108 farmers), Chianki (100 farmers), Hisar (26 farmers), Kovilpatti (28 farmers), Parbhani (59 farmers) and Rajkot (105 farmers).



Sample soil health card - Biswanath Chariali

Trainings/Field visits/Field days: During the year, different AICRPDA centers organized 42 trainings and field days/visits and about 2367 stakeholders including farmers were benefitted.

Farmers training organized - Rajkot

Tribal Sub-Plan (TSP)

The TSP program is being implemented by 7 network centers of AICRP-Dryland Agriculture (AICRPDA) in 22 villages (Fig 5.2) covering 8 districts (Bhilwara, Latehar, Jhabua, Dhar, Kandhamal, Dhenaji, Bastar and Narmada) in Rajasthan, Jharkhand, Madhya Pradesh, Odisha, Assam, Chhattisgarh and Gujarat. The details of the TSP villages are given below:

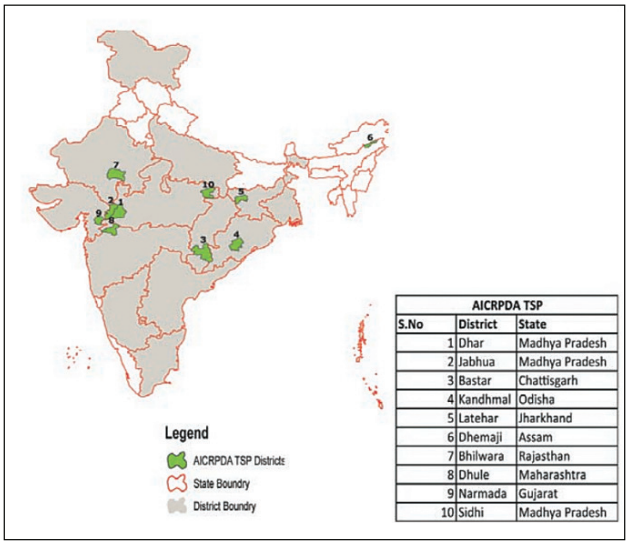


Fig. 5.1: Location map of TSP Villages

Table : Details of villages under AICRPDA-TSP programme

S.No.	Centre	TSP village	Block	District
1.	Arjia	Jallam ke Jhopdiya, Footwall, Patiyal, Mal ka Kuwa, Mohanpura, Annando ka Khera, Dol ji Khera, Himmatpura, Bheru ka Rada, Gadiya, Magadeh	Mandalgarh	Bhilwara
		Rawalkhera, Ramgarh, Tarniya khera, Chhabdia, Jalampura, Kuradiya, Dhandhola, Chhajlo ka khera, Mata ji ka khera	Jajpur	Bhilwara
2.	Chianki	Kechki	Barwadih	Latehar
3.	Indore	Ralyawan	Petlawad	Jhabua
		Jhandia, Golpura	Sardapur	Dhar
4.	Phulbani	Badaki	Alook	Kandhamal
5.	Biswanath Chariali	Jalakia Uta (Rupali Barbora)	Sisborgaon, Silapathar	Dhenaji
6.	Jagdalpur	Tahkapal, Gumiyapal, Tandpal	Tokapal	Bastar
7.	SK Nagar	Wadi, Zariya	Nandod	Narmada

Interventions implemented in TSP adopted villages: The major interventions in TSP villages were focused on improved rainfed technologies in thematic areas of rainwater management, drought tolerance, improved management practices, cropping systems, integrated nutrient management including foliar spray, farm mechanization with improved machinery and most important the need based trainings and capacity building programs both for tribal men and women. The livelihoods of the beneficiaries were improved through enhancing productivity, profitability and livelihood interventions.

The details of interventions during 2014-15 are given below.

Crop based interventions:

AICRPDA centre	TSP villages/ interventions
Arjia	**TSP villages**: Jallam ke Jhopdiya, Footwall, Patiyal, Mal ka Kuwa, Mohanpura, Annando ka Khera, Dol ji Khera, Himmatpura, Bheru ka Rada, Gadiya, Magadeh, Rawalkhera, Ramgarh, Tarniya khera, Chhabdia, Jalampura, Kuradiya, Dhandhola, Chhajlo ka khera, Mata ji ka khera (Rajasthan) • Improved varieties of maize, blackgram, groundnut, sorghum, sesame, and clusterbean and improved weed management practices
Indore	**TSP villages:** Ralyawan, Jhandia, Golpura (Madhya Pradesh) • Developed one agri-horti system • Improved practices in soybean, maize, cotton, papaya, mango, guava, tomato, and chillies • Improved varieties of chickpea and wheat
Chianki	**TSP village:** Kechki (Jharkhand) • Improved practices in wheat, chickpea, lentil, mustard and potato
Jagdalpur	**TSP villages:** Tahkapal, Gumiyapal, Tandpal (Chhattisgarh) • Improved practices of rainfed crops including vegetables
Biswanath Chariali	**TSP villages:** Jalakia Uta (Rupali barbora) (Assam) • Improved varieties of blackgram, banana, Assam lemon, pine apple, ginger, maize, potato, toria, tomato, peas, brinjal, pumpkin, cabbage, palak, coriander and capsicum • Introduction of sesame cultivation in 5 ha
Phulbani	**TSP villages:** Badaki (Odisha) • Improved varieties of rice and groundnut • Improved practices of onion, cauliflower, cowpea, cabbage, garden pea, brinjal, tomato and mustard
SK Nagar	**TSP villages:** Wadi, Zariya (Gujarat) • Improved practices of maize, clusterbean and castor

NRM interventions:

AICRPDA centre	TSP villages/ interventions
Indore	**TSP villages:** Ralyawan,Jhandia, Golpura (Madhya Pradesh) • Digging of one farm pond for rainwater harvesting
Chianki	**TSP village:** Kechki (Jharkhand) • Augmenting ground water recharge & water conservation • Well cleaning & repairing, hand pump repairing & repairing of gate of Damdaha Dam • Construction of cemented water tank (3 no.)
Jagdalpur	**TSP villages:** Tahkapal, Gumiyapal, Tandpal (Chhattisgarh) • Construction of 4 check dams, 1 embankment type pond, 16 sunken ponds, 2 zing terraces, and 15 gabion structures
Biswanath Chariali	**TSP villages:** Jalakia Uta (Rupali barbora) (Assam) • Construction of water harvesting structures (2 ha area)
Phulbani	**TSP villages:** Badaki (Odisha) • *In-situ* moisture conservation practices including hoeing and weeding, mulching etc in turmeric and field crops

Livelihood interventions:

AICRPDA centre	TSP villages/ interventions
Arjia	**TSP villages:** Jallam ke Jhopdiya, Footwall, Patiyal, Mal ka Kuwa, Mohanpura, Annando ka Khera, Dol ji Khera,Himmatpura, Bheru ka Rada, Gadiya, Magadeh,Rawalkhera, Ramgarh,Tarniya khera, Chhabdia, Jalampura, Kuradiya, Dhandhola, Chhajlo ka khera, Mata ji ka khera (Rajasthan) • Construction of 2 *Azolla* units
Indore	**TSP villages:** Ralyawan, Jhandia, Golpura (Madhya Pradesh) • Construction of poultry and goatery sheds (2 each)
Biswanath Chariali	**TSP villages:** Jalakia Uta (Rupali Barbora) (Assam) • Fishery in farm pond • Improved goat breed, dual purpose poultry, duck breed, pure betel buck • Low cost vermicompost units (32) and apiculture units (95) • Completed fish gate in the fisheries cum water harvesting structure • Distribution of 10 nos of pigs with feed and feed supplement

Capacity building:

AICRPDA centre	TSP villages/ interventions
Arjia	**TSP villages:** Jallam ke Jhopdiya, Footwall, Patiyal, Mal ka Kuwa, Mohanpura, Annando ka Khera, Dol ji Khera,Himmatpura, Bheru ka Rada, Gadiya, Magadeh,Rawalkhera, Ramgarh,Tarniya khera, Chhabdia, Jalampura, Kuradiya, Dhandhola, Chhajlo ka khera, Mata ji ka khera (Rajasthan) • Four pre-season trainings on improved production technologies were organized in which 310 farmers were benefited
Indore	**TSP villages:** Ralyawan,Jhandia, Golpura (Madhya Pradesh) • Two trainings on improved practices of chickpea, wheat, animal health and fodder cultivation about 370 farmers were benefitted
Chianki	**TSP village:** Kechki (Jharkhand) • Improved dryland practices, fertilizer management in *kharif* crops and commercial cultivation of vegetable crops benefitting 230 farmers • Three trainings conducted, one each on improved technologies of potato, wheat and *rabi* pulses about 300 farmers were benefitted • Three trainings were organized on: Water management in vegetable crops (70 beneficiaries), Care and maintenance of diesel engine (50 beneficiaries), and Post harvest management (114 beneficiaries)
Jagdalpur	**TSP villages:** Tahkapal, Gumiyapal, Tandpal (Chhattisgarh) • Improved practices of chickpea
Biswanath Chariali	**TSP villages:** Jalakia Uta (Rupali Barbora) (Assam) • Dietary management of life style related diseases • Eri Spinning • Integrated crop management for higher yield
Phulbani	**TSP villages:** Badaki (Odisha) • Post-harvest management, value addition, soil health management, improved crop management practices and organic farming (60 beneficiaries)
SK Nagar	**TSP villages:** Wadi, Zariya (Gujarat) • Pre *kharif* seasonal training programme on package of practices of Bt cotton, castor, maize, and pomegranate • Improved farm implements, micro irrigation system and improved crop management practices were organized; about 200 farmers attended. • Pre-seasonal summer training on rainwater management and improved crop production technologies in which 110 farmers participated

Other technology dissemination activities:

AICRPDA centre	TSP villages/ interventions
Arjia	**TSP villages:** Nala ka Kua (Panchayat - Barundani) (Rajasthan) • A field day was organized on 19.2.2015 wherein 475 farmers participated
Chianki	**TSP village:** Kechki (Jharkhand) • Field day on wheat (114 beneficiaries) • 10 farmers from the village participated in Kisan Mela at BAU, Ranchi
Biswanath Chariali	**TSP villages:** Jalakia Uta (Rupali Barbora) (Assam) • Exposure visit cum certificate course to four women farmers • Awareness cum exposure visit on "Gramin Mausam Seva"

Physical assets created:

AICRPDA centre	TSP villages/ interventions
SK Nagar	**TSP villages:** Wadi, Zariya (Gujarat) Insecticide sprayers - 10; Bund formers - 03; Dusters- 10; Electric operated winnowing pumps - 03; Bund former-1; Electric winnowing fan-1

Farmers training - Bhilwara

6. Publications

Research Papers Published in Journals

PC Unit AICRPDA

Gopinath KA, Srinivasarao Ch, Ravindra Chary G, Dixit S, Osman M, Raju BMK, Ramana DBV, Saroja DGM, Venkatesh G and Maheswari M. 2014. Improving the productivity of rainfed farming systems of small and marginal farmers in Adilabad district, Telangana. *Indian Journal of Dryland Agricultural Research and Development*, 29(1): 52-56.

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Ravindra Chary G, Srinivasa Rao Ch, Raju BMK, Vittal KPR and Suresh Babu V. 2014. Integrated land use planning for sustainable rainfed agriculture and rural development: A rainfed agro-economic zone approach. *Agropedology*, 24(2): 234-252.

Ravindra Chary G, Srinivasarao Ch, Maruthi Sankar GR, Patel PG, Singh RN, Mganvir M, Nagdeve MB, Mohod VD, Rajbir Singh, Rani N and Siddaram. 2014. Sustainability assessment of cotton based intercropping systems for productivity and profitability using different quantitative indices under semi-arid Vertisols. *Indian Journal of Agronomy*, 59 (4): 587-595.

Ravindra Chary G., Rao GR, Naidu LKG, Srinivas S, Sunil S, Maruthi Sankar S, Srinivasarao Ch, Ramamurthy V, Pratibha G and Rani N. 2014. Climate and site suitability criteria for *Jatropha curcas* L. cultivation under non-arable marginal lands in different agro-ecological regions of India. *Range Management and Agroforestry*, 35(2): 210-219.

Sharma KL, Kusuma Grace J, Suma Chandrika D, Vittal KPR, Singh SP, Nema AK, Chauhan SPS, Maruthi Sankar GR, Mandal UK, Korwar GR, Venkateswarlu B, Ramesh G, Ravindra Chary G, Madhavi M, Pravin G. Gajbhiye, Munna Lal, Satish, Kumar T and Usha Rani K. 2014. Effect of soil management practices on key soil quality indicators and indices in pearl millet (*Pennisetum americanum* (L.) Leeke) based system in hot semi-arid inceptisols. *Communications in Soil Science and Plant Analysis*, 45:785-809.

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Sharma KL, Sharma SC, Bawa SS, Sher Singh, Suma Chandrika D, Kusuma Grace J, Srinivasa Rao Ch, Maruthi Sankar GR, Ravindra Chary G, Munna Lal, Satish, Kumar T, Pravin G, Gajbhiye,K Usha Rani K and Indoria AK. 2014. Effect of conjunctive nutrient management on soil fertility and overall soil quality index in sub -mountainous Inceptisol soils under rainfed maize (*Zea mays* L.) – Wheat (*Triticum aestivum*) based system. *Communications in Soil Science and Plant Analysis*, 46(1): 47-61.

Srinivasarao Ch, Ramachandrappa BK, Vijay SJ, Sumanta K, Venkateswarlu B, Pharande AL, Manideep VR, Prakash Naik R and Venkanna K. 2014. Nutrient balance after thirteen years of organic and chemical nutrient management and yield sustainability of groundnut-finger millet rotation in rainfed Alfisols of semi-arid India. *Journal of Indian Society of Soil Science*, 62(3): 235-247.

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Srinivasarao Ch, Sharan Bhoopal Reddy and Sumanta Kundu. 2014. Potassium nutrition and management in Indian agriculture: Issues and strategies. *Indian Journal of Fertilisers* (Fertilizer News), 10(5): 51-80.

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Srinivasarao Ch, Sudha Rani Y, Girija Veni V, Sharma KL, Maruthi Sankar GR, Prasad JVNS, Prasad YG and Sahrawat KL. 2015. Assessing village level carbon balance due to greenhouse gas mitigation interventions using EX-ACT model. *International Journal of Environmental Science and Technology*, (DOI: 10.1007/s13762-015-0788-z).

Srinivasarao Ch, Sumanta Kundu, Ramachandrappa BK, Sharanbhoopal Reddy, Rattan Lal, Venkateswarlu B, Sahrawat KL, and Prakash Naik R. 2014. Potassium release characteristics, potassium balance, and fingermillet (*Eleusine coracana* G.) yield sustainability in a 27- year long experiment on an alfisol in the semi-arid tropical India. *Plant and Soil*, 374 (1-2): 315-330.

AICRPDA Centres:

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Dhakal Y, Meena RS, De Nirmal, Verma SK and Singh A. 2015. Growth, yield and nutrient content of mungbean (*Vigna radiata* L.) in response to INM in eastern Uttar Pradesh, India. *Bangladesh Journal of Botanay,* 44(3): 479-482.

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Dubey R, Sharma RS and Dubey DP. 2014. Effect of organic, inorganic and integrated nutrient management on crop productivity, water productivity and soil properties under various rice based cropping systems in Madhya Pradesh, India. *International Journal of Current Microbiology and Applied Science*, 3(2): 381-389.

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Ganvir MM, Nagdeve MB, Gabhane VV, Karunakar AP and Usha S. 2014. Influence of different row proportion of pigeonpea on productivity and economics in soybean + pigeonpea intercropping system. *Soybean Research* (special issue): 163-167.

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Patode RS, Nagdeve MB and Ramamohan Reddy K. 2015. Effect of continuous contour trenches on soil moisture and leaf area index of perennial plantation in small catchment. *International Journal of Scientific Research*, 8(2): 50-54.

Pendke MS, Bhuibhar BW and Kamble AM. 2014. Rainwater harvesting and recycling for sustainable agriculture in assured rainfall zone of Marathwada region of Maharashtra. *Indian Journal of Dryland Agriculture Research and Development*, 29(2): 08-12.

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Ramachandrappa BK, Sathish A, Dhanapal GN and Srikanth Babu PN. 2014. Nutrient management strategies for enhancing productivity of dryland crops in alfisols. *Indian Journal of Dryland Agriculture Research and Development*, 29(2): 49-55.

Ramachandrappa BK, Sathish A, Dhanapal GN, Balakrishna Reddy PC, Shankar MA and Srikanth Babu PN. 2014. Potassium nutrition on yield and economics of rainfed fingermillet in eastern dry zone of Karnataka. *Indian Journal of Soil Conservation*, 42(2): 188-195.

Ramachandrappa BK, Sathish A, Dhanapal GN, Shankar MA and Srikanth Babu PN. 2014. Moisture conservation and site specific nutrient management for enhancing productivity in rainfed finger millet + pigeonpea intercropping system in Alfisols of south India. *Indian Journal of Soil Conservation*, 42(3): 119-129.

Sarma D, Saikia P, Sarma PK, Hazarika M, Bhattacharya M, Sarma MK, Neog P and Srinivasrao Ch. 2014. Effect of seed priming of toria (*Brassica*

napus L. var. Napus L.) on drought tolerance and its yield performance. *Indian Journal of Dryland Agricultural Research and Development*, 29(1): 35-39.

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Shankar MA, Maruthi Sankar GR, Thimmegowda MN and Nagamani MK, 2014. Micronutrient management for soil fertility, nutrients uptake and productivity of greengram (*Vigna radiata* (L.) Wilczek) and finger millet (*Eleusine coracana* (L.) Gaertn.) under semi-arid alfisols. *Indian Journal of Agronomy*, 58(2): 1-11.

Sharma GK, Jha, Gunjan, Dwivedi RK, Chaudhary JL and Pali GP. 2012. Carbon sequestration under dryland farming systems for improving soil health, and crop productivity in undulated upland situation of Bastar plateau. *Journal of Agricultral Issues*, 17 (1& 2): 79-82.

Sharma KL, Kusuma grace J, Suma chandrika M, Vittal KPR, Singh SP and Nema AK**.** 2014. Effects of soil management practices on key soil quality indicator and indices in pearlmillet (*Pennisetum americanum* (L.) Leeke) - based system in hot semi-arid Inceptisols. *Communications in Soil Science and Plant Analysis,* 45(6): 785- 809.

Sharma KL, Sharma SC, Bawa SS, Sher Singh, Chandrika DS, Vivek Sharma, Anil Khokhar, Grace JK, Rao CS, Maruthi Sankar GR, Chary GR, Reddy KS, Munna Lal, Kumar TS, Rani U. 2015. Combined effect of tillage and organic fertilization on soil quality key indicators and indices in alluvial soils of Indo-Gangetic plains under raifed maize-wheat system. *Archives of Agronomy and Soil Science*, 61(3): 313-327.

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Sher Singh, Bawa SS, Satvinder Singh and Sharma SC. 2015. Evaluation of maize (*Zea mays*) based intercropping for productivity, resource-use efficiency and cometition indices in the rainfed foothills of Northwset Himalayas. *Indian Journal of Agricultural Scineces*, 85 (5): 614-621.

Sher Singh, Bawa SS, Satvinder Singh, Sharma SC and Vijay Kumar. 2014. Effect of seed priming with molybdenum on performance of rainfed chickpea (*Cicer arietinum* L.). *Journal of Research*, 51(2): 124-127.

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Tamboli BD, Bagwan IR, Pawar AB, Indi DV, Bhakare BD, Shelke SR and Kadam JR. 2014. Integrated nutrient management in non-spiny safflower on inceptisol under dryland condition. *Indian Journal of Dryland Agriculture Research and Development*, 29(2): 66-70.

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Vekariya PD, Khokhani MG, Gajera MS and Akbari KN. 2015. Production potential and economics of cotton (*Gossypium hirsutum*) - based intercropping systems under rainfed conditions of North Saurashtra Agro-climatic Zone of Gujarat. *Journal of Cotton Research and Development*, 29 (2): 264-267.

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Vijay Sankar Babu M, Parama VRR, and Vijaya Sai Reddy M. 2014. Microbial biomass and total nitrogen as affected by organic and conventional farming systems in soils of southern Karnataka, India. *International Journal of Agricultural Sciences,* 10(2): 506-511.

Vikas Abrol, Peeyush Sharma, Maruthi Sankar GR, Manish Sharma, Ramesh Chandra and Vikas Sharma. 2015. Soil management effects on soil quality and crop performance in dry sub humid inceptisols of India. *Indian Journal of Soil Conservation*, 43(1): 47-57

Vikas Gupta, Anil Kumar, Jai Kumar, Vikas Abrol, Brinder Singh and Mahender Singh. 2014. Effect of integrated nutrient managemant on growth and yield of maize (*Zea mays* L.) - gobhi sarson (*Brassica napus* L) cropping system in sub-tropical region under foothills of north-west Himalayas. *Bangladesh Journal of Botonay*, 43(2): 147-155.

Wane SS and Nagdeve MB. 2014. Estimation of evapotranspiration and effective rainfall using CROPWAT. *International Journal of Agricultural Engineering*, 7(1): 23-26.

ORP Centres

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Ranade DH. 2014. Utility and impact of supplemental irrigation from water harvesting tanks in Malwa region. *Journal of Agricultural Research and Technology*, 39(1): 123-128.

Ranade DH. 2014. Economic evaluation of irrigation through water harvesting tanks in Malwa region. *Indian Journal of Soil Conservation*, 42(2): 209-215.

Vijay Kumar, Vivek Sharma and Sharma SC. 2014. Impact of improved technologies on productivity enhancement of sesame (*Sesamum indicum* L.). *Indian Journal of Dryland Agriculture Research and Development*, 29(2): 41-44.

Vijay Kumar, Vivek Sharma, Anil Khokhar, Sher Singh, Satvinder Singh, Sharma SC and Bawa SS. 2014. Production potential and economic viability of maize based intercropping system in Kandi region of Punjab. *Journal of Research*, 51(1): 14-17.

Papers presented in seminars, symposium, conferences, workshops/meetings etc

PC Unit, AICRPDA

Centre/authors/title of the paper	Symposia/seminar/ conference	Venue and duration
Srinivasarao Ch, Gopinath KA, Venkatesh G and Jain MP. 2014. Climate change adaptation and mitigation strategies in rainfed agriculture.	National seminar on technologies for sustainable production through climate resilient agriculture	J.N. Krishi Vishwa Vidyalaya, Jabalpur, 8-9th Aug, 2014

AICRPDA Centres

Centre/authors/title of the paper	Symposia/seminar/ conference attended	Venue and duration
Agra		
Singh SP, Arvind Singh, Singh PK and Javed Ali: Productivity and profitability of mustard varieties as influenced by different planting time.	National conference on Reinvigorating Agricultural Innovation for Farmers Empowerment and Development	PJTSAU, Hyderabad, 3-4th May, 2015
Singh SP, Singh PK, Arvind Singh, Javed Ali and Rahul Singh: Effect of potassium fertilization with different fertility levels on mustard (*Brassica juncea* L.) in light textured soil of south - western zone of Uttar Pradesh.		
Singh SP, Singh PK, Arvind Singh, Javed Ali and Rahul Singh: Effect of moisture conservation practices and mode of nitrogen application on productivity and profitability of Pearl millet under semi-arid condition		
Akola		
Patode RS, Nagdeve MB and Ramamohan Reddy K: Continuous Contour Trenched – A useful measure for developing soil moisture regime in the catchment.	National Conference on Water, Environment and Society (NCWES-2014)	CWR, IST, JNTU, Hyderabad, 30th June - 1st July, 2014
Patode RS, Nagdeve MB and Ramamohan Reddy K: *In-situ* soil and water conservation measures for rainwater harvesting.		
Wane SS and Nagdeve MB: Study of water utilization of in pench irrigation project.		
Gabhane VV, Ikhe UD, Konde NM and Sonune BA: 'Climatic and soil site suitability evaluation for grapes in Buldana district of Maharashtra'.	International Symposium on New-Dimensions in Agrometeorology for Sustainable Agriculture.	GBPUA & T, Pantnagar, 16-18th October, 2014
Ganvir MM, Nagdeve MB, Karunakar AP, Gabhane VV, Patode RS and Sakhare SB: Productivity and sustainability of pearlmillet based intercropping system under dryland condition.		
Patode RS, Nagdeve MB and Ramamohan Reddy K: Overland flow and interception component for a catchment treated with continuous contour trenches.	4th International Conference on Hydrology and Watershed Management	CWR, IST, JNTU, Hyderabad, 29th Oct - 1st Nov, 2014
Patode RS, Nagdeve MB and Ramamohan Reddy K: Effect of continuous contour trenches on hydrological properties of soils in catchment.		
Nagdeve MB and Patode RS: Improvement in irrigation scheduling using water jelly crystals.		
Nagdeve MB, Wane SS and Patode RS: Study on characteristics of water jelly crystals.		
Nagdeve MB and Kale MU: Optimized irrigation planning using MIKE SHE.		

Centre/authors/title of the paper	Symposia/seminar/ conference attended	Venue and duration
Gabhane VV, Gite AD, Ganvir MM, Nagdeve MB and Patode RS: Effect of tillage and nutrient management on soil fertility and productivity of sorghum in inceptisols under semi arid conditions in Maharashtra.	2nd International Conference on Bio-Resource and Stress Management	PJTSAU & ANGRAU, Hyderabad, 7-10th Jan, 2015
Ganvir MM, Nagdeve MB, Karunakar AP, Gabhane VV, Patode RS, Sakhare SB and Vandana Mohod: Productivity and sustainability of cotton based intercropping system in different row proportions under dryland condition in Maharashtra.		
Gabhane VV, Rupali Ghogare, Nagdeve MB, Ganvir MM and Turkhede AB: Impact of land configuration and nutrient module on soil fertility and productivity of rainfed cotton in Vertisols.	National Conference on Sustainable management of land resources for livelihood security	NBSS & LUP, Nagpur, 28-30th Jan, 2015
Ganvir MM, Nagdeve MB, Karunakar AP, Gabhane VV, Patode RS, Sakhare SB, Vandana Mohod, Nagdeote VG and Damre PR: Sustainability of cotton based intercropping system under dryland condition in Vidarbha region of Maharashtra.	National Seminar on Dryland Agriculture in Vidarbha: Priorities and Development issues	Dr PDKV, Akola, 3-4th, March, 2015
Turkhede AB, Nagdeve MB, Gabhane VV, Anil Karunakar Ganvir MM and Damre PR: Productivity of soybean + pigeonpea intercropping system under dryland condition.		
Sakhare SB, Nagdeve MB, Turkhede AB, Gabhane VV, Patode RS, Mali RS, Nandapure SP and Chavan VK: GGE Biplot analysis in castor.	National Seminar on Dryland Agriculture in Vidarbha: Priorities and Development issues	Dr PDKV, Akola, 3-4th, March, 2015
Nagdeve MB and Patode RS. 2015. Farm pond for enhancing vegetable productivity in rainfed condition.		
Arjia		
Kumpawat BS and Balyan JK: Study the effect of weed management practices on yield of blackgram (*Vigna mungo*) in south east Rajasthan	Symposium on Agricultural Diversification for Sustainable Livelihood and Environmental Security	ISA,at PAU, Ludhiana, 18-20th November, 2014
Kumpawat BS and Balyan JK: Study the effect of weed management practices on yield of blackgram (*Vigna mungo*) in south east Rajasthan		
Ballowal Saunkhri		
Khokhar AK, Vijay Kumar SC, Sharma SS, Bawa, Satvinder Singh, and Vivek Sharma: Productivity and economic viability of maize based cropping systems under rainfed conditions in kandi region of Punjab	Natural Resource Management and Sustainable Hill Farming Syastem for Livelihood Security	SCSI, SKUAST-Jammu, 23 - 24th July, 2014

Centre/authors/title of the paper	Symposia/seminar/ conference attended	Venue and duration
Khokhar AK, Vijay Kumar, Satvinder Singh, Sharma SC and Vivek Sharma: Effect of seed soaking and foliar spray of thiourea on the productivity of rainfed wheat (*triticum aestivum*).	Symposium on Agricultural Diversification for Sustainable Livelihood and Environmental Security	ISA,at PAU, Ludhiana, 18-20 November, 2014
Sharma SC: Impact of varying climate on rainfed agriculture and its mitigation.	Symposium on weather and climate extremes	IMS & PAU Chandigarh, 15-18 Feb, 2015
Bangalore		
Sathish, A, Ramachandrappa BK and Shankar MA: Long term effect of different nutrient management practices for maintenance of soil fertility and crop productiviy of Alfisol under dryland condition in Karnataka	79th Annual Convention of Indian Society of Soil Science	ANGRAU, Hyderabad. 24-27 Nov, 2014
Vijaymahantesh, Nanjappa HV, Ramachandrappa BK and Sanjay MT: Influence of tillage and integrated nitrogen supply on weed flora and yield of pigeonpea.	Biennial conference of Indian society of weed science on Emerging Challenges in Weed Management	DWSR, Jabalpur, M.P, India. 15-17 Feb, 2014
Ramulu, Ramachandrappa BK and Sathish A. 2014. Alternative land uses and farm diversification strategies to strengthen the custard apple based agri-horti system in alfisols under dryland conditions.	National Conference on Emerging Challenges and Opportunities in Biotic and Abiotic Stress Management (ECOBASM-2014)	ICAR-DRR, Hyderabad 13-14th December, 2014
Biswanath Chariali		
Rajbongshi R, Neog P, Sarma PK, Sarma K, Sarma MK, Sarma D and Hazarika M: Thermal indicies in relation to crop phenology and seed yield of pigeonpea grown in the North Bank Plain Zone of Assam	International Symposium on New Dimensions in Agrometeorology for Sustainable Agriculture	GBPUAT, Pant-nagar and Assn. of Agrometeo-rologists, Anand 16-18 Oct, 2014
Sarma PK, Hazarika M, Borah P, Baruah S, Sarma D, Sarma MK and Bhattacherjee M. 2015. Long Term manurial Trial for Rice-Greengram-Toria system under rainfed situation of North Bank Plain Zone of Assam	International Conference on Tecnological Interventions in Agricultural Sciences for Enhanced Productivity, Nutritional Quality and Value Addition (TIAS-2014)	Central Institute of Horticulture, Department of Agriculture and Co-operation, Dimapur, Nagaland. 17-19th February, 2015
Sarma PK, Hazarika M, Borah P, Sarma D, Sarma MK and Neog P. 2015. Effect of foliar application of different plant nutrients on drought tolerance and yield of Toria var.TS-36		
Neog P, Rajbongshi R, Sarma PK, Sarma MK and Sarmah K: Comparision of the yield of potato under different microenvironment in the North Bank Plain Zone of Assam.		

Centre/authors/title of the paper	Symposia/seminar/ conference attended	Venue and duration
Neog P, Sarma PK, Sarma D, Sarma MK, Rajbongshi R, Sarmah K, Borah P and Chaudhury H: Growth, Yield and Disease Dynamics of Ginger as Influenced by Varying Microenvironments.	International Symposium on New-Dimensions in Agrometeorology for Sustainable Agriculture (NASA-2014)	GBPUAT, Pantnagar, 16-18th October, 2014
Roy AK, Sarma PK, Neog P, Sarma D, Moral G, Sarma MK, Gautam BP, Hazarika DN, Langthasa S and Goswami RK. 2014. Efficiency of harvested rainwater on potato under rainfed condition.	National Symposium on Dryland Farming and Food Security in India	RVSKVV, Gwalior 30-31August, 2014
Roy AK, Sarma PK, Neog P, Sarma D, Sarma MK, Moral G and Bora P. 2015. Studies on effectiveness of different lining materials on rainwater storage in farm pond.	International Conference on Technological Interventions in Agricultural Sciences for Enhanced Productivity, Nutritional Quality and Value Addition (TIAS-2014)	Central Institute of Horticulture, Medziphema, Dimapur, Nagaland-17-19th February, 2015
Borah R, Sarma MK, Roy AK, Baruah S, Sarma AA, Sarma D and Sarma PK. 2015. Studies on genetic parameters of variation and character association in sesame (*Sesamum indicum* L).		
Saikia P and Sarma MK: 2015. Study on Crop diversification through intercropping of Bamboo and other component crops		
Borah R, Sarma MK, Roy A, Baruah S, Sarma AA, Sarma D and Sarma PK: Studies on genetic parameters of variation and character association in sesame (*Sesamum indicum* L.)		
Sarma PK: Arsenic and Iron contamination in groundwater of Narayanpur Development Block of North Bank Plain Zone of Assam	National Seminar on Developments in Soil Science-2014	ANGRAU, Hyderabad24-27th Nov, 2014
Prasanta Neog**:** Growth, yield and disease dynamics of Ginger as influenced by varying microenvironments	New-Dimensions in Agrometeorology for Sustainable Agriculture (NASA-2014)	GBPUAT, Pantnagar, 16-18th October, 2014
Chianki		
Paul A, Ahmad E, Singh MK, Sah, Akhilesh Singh DN and Yadava MS: Evaluation of hybrid rice under rainfed condition for Western Plateau of Jharkhand.	National Symposium on Crop Improvement for Inclusive Sustainable Development	PAU, Ludhiana. 7-9th November, 2014
Ahmad E, Paul A, Singh MK, Ansari Abdul Mazid, Salam, N and Singh, DN: Evaluation of genotypes of horsegram (*Macrotyloma uniflorum*) under dryland condition of Jharkhand for a climate resilient crop.		
Singh DN, Singh E, Paul MKA: Evaluation of sesame genotypes under rainfed condition of Jharkhand.		
Prasad, Yogendra, Singh, D.N. Prasad, Krishna. Kumar, Kamleshwar, Kumar, Ravi. Kumar, Munish and Kumar, Sunil: Stability analysis for grain yield and its component traits in rice (*Oryza sativa* L.)		

Centre/authors/title of the paper	Symposia/seminar/ conference attended	Venue and duration
Singh DN, Singh Munish Kumar, Prasad Yogendra, Ahmad Ekhlaque, Paul A and Sah A: Evaluation of drought tolerant safflower (*Carthamus tinctorius* L.) genotypes	National Seminar on Dryland Agriculture in Vidarbha. Priorities and Development	Dr. Punjabrao Deshmukh Krishi Vidyapith, Akola, Maharastra, 3-4th March, 2015
Singh DN Singh Munish Kumar, Prasad Yogendra, Ahmad Ekhlaque, Paul A and Sah A: Evaluation of drought tolerant lentil (*Lens culinaris Medik*) genotypes under dryland condition of Sub Zone - V of Jharkhand.		
Ahmad Ekhlaque, Singh DN, Singh, Munish Kumar, Paul A, Ansari AM and Sah A: Genetic study of niger gentotypes under dryland condition of Western Plateau of Jharkhand.		
Indore		
Thakur HS, Girothia OP and Jain MP: Efficacy of post emergence herbicides on weed control and seed yield of Soybean (*Glycine max* L.)	International Soybean Research on Mitigating productivity Constraints in Soybean for sustainable Agriculture. SOYCON -2014	Directorate of Soybean Research, Indore. 22-24th February, 2014
Jain MP, Girothia OP and Thakur HS: Sustainable cropping system in vertisols of Malwa plateau of Madhya Pradesh.		
Thakur HS: Study on land configurations of pigeon pea and turmeric under sole and intercropped conditions grown and yieldd in black soils of western part of Madhya Pradesh.	National symposium on Dryland farming and Food Security in India.	RVSKVV, Gwalior, 30-3 August, 2014
Thakur HS, Girothia OP and Jain MP: Contingent crop production practices under aberrant monsoon condition of Malwa region.	National symposium on Dryland farming and Food Security in India.	RVSKVV, Gwalior, 30-3 August, 2014
Girothia OP, Thakur HS, Ramesh Mahajan and Shivam Patidar: Bio-efficacy of post emergence herbicides against the weeds in soybean [*Glycine max* (L.) Merrill] in vertisols.		
Aragal SK, Sharma SK and Jain MP: Erosion Index analysis for Indore district of Malwa region of Madhya Pradesh.		
Holkar S, Swaroop and Indu: Evaluation of pigeonpea genotypes in rainfed conditions.		
Swarup, Indu, Jain MP and Holkar, S: Assortment of chickpea (*Cicer arietinum* L.) genotypes for tolerance to drought stress.		
Singh, Jagdish and Indu S: Study on drought tolerance in Safflower (*Carthamus tinctorius* L.).		
Bharat Singh, Kiran Paliwal, Smriti S Chauhan and Upadhyay A: Assessment of nutrient availability in organic and inorganic amended vertisols soil for soybean cropping system.		

Centre/authors/title of the paper	Symposia/seminar/ conference attended	Venue and duration
Sharma S. K., Upadhyay,A., Singh Bharat Tomar S. S.: Evaluation of Low Till Farming Strategy for Rainfed Soyabean Production in Vertisols of Western Madhya Pradesh.	National Conference on Emerging Challenges and Opportunities in Biotic and Abiotic Stress Management ECOBASM - 2014	ICAR-DRR, Hyderabad 13-14th December, 2014
Kovilpatti		
Jawahar D, Elamathi S, Renukadevi A, Sanjivkumar V and Rajeswari M: Foliar fluid nutrition on the yield attributes and yield of cotton in Typic Haplusterts at southern agro-climatic Zone of Tamil Nadu state	National seminar on Soil Resilience-2015	AC&RI, Madurai, 21-22nd Jan, 2015
Jawahar D, Elamathi S, Sanjivkumar V, Rajeswari M and Marimuthu M: Bio mineralized crop residues for sustainable productivity in rainfed cotton on vertisols at southern agro-climatic Zone of Tamil Nadu.		
Elamathi S, Jawahar D, Renukadevi A, Rajeswari M and Sanjivkumar V: Effect of fertilizer and moisture conservation practices on yield of sorghum in rainfed vertisols of South India		
Phulbani		
Mishra A, Behera B, Mohanty SK, Subudhi CR, Rath BS and Mishra P J: Effect of potassium and lime on the traits related to soil conservation and yield of rainfed groundnut in N-E ghat zone of Odisha.	National Symposium on Management options for enhancing farm productivity and livelihood security under changing climate, Odisha Chapter, Indian Society of Agronomy, 2014	OUAT Bhubaneswar 29-31st October, 2014
Rath BS, Mishra A, Nayak B, Behera SS and Barik T: Nutrient management in groundnut under rainfed condition.		
Mishra A: Cultivation of rice by the tribals of Kandhamal, Odisha (with Oral presentation).	Global Social Science Conference on Management of Sustainable Livelihood Systems.	OUAT Bhubaneswar 14-17th Feb, 2014
Rajkot		
Akbari KN, Sutaria GS and Hirpara DS: Effect of integrated nutrient management on post harvest soil fertility in Bt cotton Under Rain fed Condition	National seminar on Development in Soil Science during 79th Annual Convention of Indian Society of Soil Science.	Acharya N.G. Ranga Agril.Uni., Rajendranagar, Hyderabad, 24-27th November, 2014

Centre/authors/title of the paper	Symposia/seminar/ conference attended	Venue and duration
Akbari KN and Sutaria GS: Potentiality of Bio-Fertilizer and Organic Resources for Sustaining Sesame Yield under Rain fed Condition		
Akbari KN, Sutaria GS and Hirpara DS: Influence of Cutting Schedule And Nutrient Management on Growth and Forage Yield of Oats (*Avena sativa* L.)		
Akbari KN and Sutaria GS: Effect of integrated nutrient management on dynamics of phosphorus in medium black calcareous soils under AICRP-LTFE.		
Nandaniya JK, Hirpara DS, Sutaria GS and Vora VD: Effect of irrigation and foliar fertilization on yield of chickpea (*Cicer arietinum* L.).	National Seminar on Water Management and Climate Smart Agriculture.	SWMRTTC, JAU, Junagad 13-14th Feb, 2015
Rakh Dhiansar		
Vikas Abrol, Sharma AK, Peeyush Sharma, Brinder Singh, Vikas Sharma and Jai Kumar: Improving rural livelihood security in resource poor kandi belt of Jammu through alternate landuse system	7th National Seminar on Sustainable Rural Livelihood: Technological and Institutional Perspective	SKUAST, Jammu, 8-10th January, 2015
Vikas Abrol, Brinder Singh, Sharma AK, Peeyush Sharma, Vikas Sharma and Jai Kumar: Water use efficiency and productivity of Aternate landuse system in Kandi belt of Jammu.	National Seminar on Technology and Management of Micro Irrigation in Floriculture	SKUAST-J Chatha, 19-20th March, 2015
Jai Kumar, Rai PK, Sharma AK, Vikas Abrol and Brinder Singh: Micro Irrigation Technology: A Boon to Horticulture.		
Vikas Abrol, Brinder Singh, Sharma AK, Peeyush Sharma, Vikas Sharma and Jai Kumar: Water use efficiency and productivity of Aternate landuse system in Kandi belt of Jammu		
Jai Kumar, Rai PK, Sharma AK, Vikas Abrol and Brinder Singh: Micro Irrigation Technology: A Boon to Horticulture		
Rewa		
Dubey DP, Dubey R, Tiwari RK and Kurmvanshi SM: Effect of various sowing methods and seed rates on growth and yield of soybean under rainfed vertisol of Kymore plateau of Madhya Pradesh.	National seminar on Challenges and opportunities under Climate Change.	JNKVV, College of Agriculture, Rewa (M.P.), 21-22nd September, 2014
Meena, AK and Dubey DP: Organic farming for Sustainable agriculture and its essentiality due to climate change.		
Tiwari P and Dubey DP: Integrated weed management in soybean.		
Kurmvanshi S.M, Dubey DP and Dwivedi VD: Comparative performance of rice varieties to different sowing methods under dryland condition.		

Centre/authors/title of the paper	Symposia/seminar/ conference attended	Venue and duration
Solapur		
Upadhye SK, Sthool VA, Atre AA, Sanglikar RV, Mane RV, Rathod RK,And Kadam JR: Storage life of cement nala bund in scarcity zone of Maharashtra – A Case study of Hanjagi watershed	4th International Conference on Hydrology and Watershed management with a focal theme on Ecosystem resilience – Rural and Urban Water Requirements (ICHWAM-2014)	CWR-IST, JNTU, Hyderabad, 29th Oct - 1st Nov, 2014
Amrutsagar VM and More NB: Rainwater management techniques for higher yield of *rabi* sorghum under dryland conditions	79th Annual Convension of Indian Society of Soil Science on Developments in Soil Science	PJTSAU (incollaboration with ANGRU), Hyderabad 24-27th November, 2014
More NB and Amrutsagar VM: Effect of pressmud cake on pigeonpea yield on Inceptisol under dryland condition		
More NB and Amrutsagar VM: Effect of pressmud cake on pigeonpea yield on inceptisolunder dryland condition		
More NB, pawar AB and Amrutsagar VM: Tillage and residue retention for resource conservation for soil fertility and productivity of blackgram – rabi sorghum sequence in inceptisol underdry land condition.	National seminar on Dryland Agriculture in Vidarbha Priorities and Development Issues	AICRPDA centre. PDKV, Akola 3-4th March, 2015
Amrutsagar VM and More NB: Dry land Technologies for Vidharbha region		
Jagdalpur		
Chaudhary JL, Sharma GK, Thakur DS, Verma PK and Manikandan N: Analysis of initial and conditional probabilities of rainfall for strategic crop planning in rainfed rice based cropping system in tribal region of Bastar.	International Conference on Emerging Challenges and Issues in Environmental Protection	CCST, Raipur, 23-24th January, 2014
Arjia (ORP)		
Sharma RK, Sharma SK, Dangi NL and Chhipa BG: Effect of different organic nutrient modules on aphids and lady bird beetle in cumin. Sources in Semi-Arid Region.	Changing Scenario of Pest Problems in Agri-horti Ecosystem and their management	RCA, Udaipur (Rajasthan), 27-29th Nov, 2014
Biswanath Chariali (ORP)		
Sharma RK, Sharma SK and Priyanka Pareek: Productivity and economics of mustard as influenced by different organic nutrient sources in semi-arid region.	Organic Agriculture (NSOA)-Challenges & Prospects	CSK HPKV, Palampur-(HP) 28-29th May, 2014

Centre/authors/title of the paper	Symposia/seminar/ conference attended	Venue and duration
Ballowal Saunkhri (ORP)		
Vivek Sharma, Vijay Kumar, SC Sharma, Satvinder Singh, Sukhvinder Singh and Anil Khokhar: Natural resource management and sustainable hill farming system for livelihood security	*In-situ* soil moisture conservation by tillage practices after *kharif* crops and its impact on productivity of *rabi* crops under rainfed conditions in sub mountainous zone of Punjab	SKUAST-Jammu, 23-24th July, 2014
A.K. Khokhar, Vijay Kumar, Satvinder Singh, S.C. Sharma and Vivek Sharma**:** Agriculture Diversification, for Sustainable Livelihood and Environmental Security	Effect of seed soaking and foliar spray of thiourea on the productivity of rainfed wheat (*Triticum aestivum*)	Punjab Agricultural University, Ludhiana, 18-20th Nov, 2014
Chianki (ORP)		
Paul A, Ahmad E, Singh MK, Sah Akhilesh, Singh DN and Yadava MS: Evaluation of hybrid rice under rainfed condition of Western Plateau of Jharkhand.	Crop Improvement for Inclusive Sustainable Development	Punjab Agricultural University, Ludhiana, 7-9th November, 2014
Ahmad E, Paul, A. Singh, MK. Ansari, Abdul Mazid, Salam N and Singh DN: Evaluation of genotypes of horsegram (*Macrotyloma uniflorum*) under dryland condition of Jharkhand for a climate resilient crop.		
Singh DN, Singh E, Paul MKA: Evaluation of sesame genotypes under rainfed condition of Jharkhand		
Singh DN, Singh, Munish Kumar, Prasad, Yogendra, Ahmad, Ekhlaque, Paul A and Sah, A: Evaluation of drought tolerant safflower (*Carthamus tinctorius* L.) genotypes under dryland condition of Sub Zone - V of Jharkhand.	Dryland Agriculture in Vidarbha: Priorities and Development	Dr. PDKV, Akola, 3-4th March, 2015
Singh DN, Singh, Munish Kumar, Prasad, Yogendra, Ahmad, Ekhlaque, Paul, A and Sah A: Evaluation of drought tolerant lentil (*Lensculinaris medik*) genotypes under dryland condition of Sub Zone - V of Jharkhand.		
Ahmad, Ekhlaque, Singh DN**,** Singh, Munish Kumar, Paul A, Ansari AM and Sah A: Genetic study of nigergentotypes under dryland condition of Western Plateau of Jharkhand.		

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Ravindra Chary G, Gopinath KA, Maruthi Sankar GR, Pratibha G, Venkatesh G, Ganesh Kute and Venkateswarlu B. 2014. Moisture stress and its management in pulses through resource s in rainfed areas. In Resource conservation technology in pulses. PK.Ghosh, Narendra Jumar, Venkatesh MS, Hazra KK and Nadarajan N (Eds.), Scientific Publishers, India, pp. 483-493.

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Srinivasarao Ch, Rattan Lal, Sumanta Kundu and Pravin Thakur B. 2015. Conservation agriculture and soil carbon sequestration, In Conservation Agriculture. Farooq M and Siddique K HM Eds.), Springer International Publishing, Switzerland, pp 479-524.

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Shankar MA, Ramachandrappa BK and Thimmegowda MN. 2015. Conservation of Soil and Water *vis-à-vis* Production Systems in Karnataka. Managing Natural Resources in the Drylands. Raizada A, Patil SL, Hritick Biswas, Reddy KK, Khola OPS, Chaturvedi OP and Mishra PK (Ed.), Pp. 37-38.

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7. Technologies Generated/Refined/Upscaled

A. Technologies upscaled with farmers' feedback

Activity	Attended by	Feedback for any refinement or up scaling
Arjia		
On-farm Demonstrations	599 farmers	Increase in crop yields by 10-27%
Kisan Gosthi	820 farmers	Discussed on crop production and allied subjects
Bengaluru		
On-farm demonstrations: Krishi Mela at UAS, GKVK, Bengaluru	Farmers from different districts of Karnataka (4-5 lakh)	Agriculture technology park on wide range of dryland technologies
Field visits to on-station and on farm trials / demonstrations	Scientists visited farm trails in 18 locations of eastern dry zone	Good crop stand and recommendation of technology with package of practices
Exhibition stalls during Kisan Melas/Agri-Fair	Farmers	-
Anantapur (ORP)		
Field visits during cropping season	Weekly visits to the fields during crop season and regular visits during off-season by farmers	-
Ballowal Saunkhri (ORP)		
Resource inventory & pre-season trainings	Farmers	Ensure the availability of quality seed (especially drought tolerant), fertilizers and pesticides. Subsidy on farm machinery
Brainstorming sessions/ focused group discussions	Farmers and line department officials	Soil testing for proper use of fertilizers. Drought mitigation strategies.
Agro-advisories & weather forecasting	Farmers and line department officials	Weather forecasting and agro-advisories should be sent frequently through mobile messages
Field visits during cropping season	Farmers, SAU scientists, officials from state agriculture department, district authorities	-
Field visits during cropping season	Farmers	Seed availability of maize hybrids.

Activity	Attended by	Feedback for any refinement or up scaling
Hisar (ORP)		
Brainstorming sessions/ focused group discussions	Farmers of ORP village and adjoining villages	Lack of availability of good water and amendments to improve the water quality, infestation of *Orobanche sp*. in mustard and recharging of well by canal water
Pre-season trainings		
Field visits during cropping season	Farmers	Farmers were convinced with the latest dryland technologies and were ready to adopt.
Participatory varietal selection	Farmers of the domain area	Farmers were convinced with the performance of improved verities
Indore (ORP)		
Participatory varietal selection	50 farmers	Long durational soybean varieties are not suitable for the region
Solapur (ORP)		
Focused group discussions	Farmers	Suitable implement is necessary for intercropping of sunflower + pigeonpea and pearlmillet + pigeonpea
Pre-seasonal trainings	Farmers	Proper awareness required for preparation of ridges and furrows and compartmental bunds

B. Participatory Technology Development /Refinement

Ananthapuramu:

- Identification of improved and drought tolerant groundnut varieties Kadiri-6 and Dharani.

Ballowal Saunkhri

- Identification of improved rainfed maize hybrids, non shattering varieties of raya, taramira and toria.

Solapur

a. Management of sugarcane trash as mulch in dryland horticulture to reduce the weed intensity

b. Intercropping of sunflower + pigeonpea (2:1) and pearlmillet + pigeonpea (2:1) in place of sole sunflower and pearlmillet.

Arjia

- Intercropping of maize + blackgram (3:2) in place of sole maize

a) Developing and dissemination of contingency crop plans

Centre	Participation in SAU level weather watch group meeting	Participation in State/ Distt level contingency plan meetings with line department	On station* demonstration of contingency plan on real time basis	On farm demonstration of contingency plans in ORP and other villages though line departments and KVK adopted villages	Dissemination of contingency plans through radio, television and press/Video conference	Contribution of weekly crop advisories/articles on cropping with drought in the local language news papers	Production and distribution of late planting varieties through seed project
Agra	√	√	---	√	√	√	√
Akola	-	-	√	-	-	-	-
Anantapur	√	√	√	√	√	√	-
Arjia	√	√	√	√	√	√	-
Bangalore	√	√	√	√	√	√	√
Vijayapura	√	√	√	√	-	√	√
B Saunkhri	√	√	√	√	√	√	-
Chianki	√	√	√	√	√	√	√
Faizabad	-	-	√	-	-	√	-
Hisar	√	√	√	√	√	√	√
Indore	√	√	√	√	√	√	√
Jagdalpur	-	-	-	-	-	-	-
B. Chariali	√	√					
Kovilpatti							
Parbhani	√	-	-	-	-	-	√
Phulbani	-	-	-	-	-	-	-
Rajkot	√	√	√	√	√	√	-
Rakh Dhiansar	-	-	-	-	-	-	-
Rewa	-	-	-	-	-	-	-
SK Nagar	-	-	-	-	-	-	-
Solapur	√	√	√	√	√	√	√
Varanasi	√	√	√	√	√	√	√
Anantapur (ORP)	√	√	√	√	√	√	-
Arjia (ORP)	√	√	√	√	√	√	√
Bangalore (ORP)	√	√	√	√	-	-	-
Hisar (ORP)	√	√	√	√	√	√	√
B Saunkhri (ORP)			√	√			-
Indore (ORP)	√	√		√	√	√	√
Chianki (ORP)	√	√	√	√	√	√	√
Solapur (ORP)		√	√		√	√	√

b) Radio talks:

Centre	Resource Person	No. of radio talks
Anantapur	C. Radha Kumari	5
	M. Vijaya Sai Reddy	2
	B. Sahadeva Reddy	1
	M. Vijaya Sankar Babu	2
	K. Madhu Sudhan Reddy	2
Bengaluru	M. Thimmegowda	1
Biswanath Chariali	P.K. Sarma	1
Chianki	Munish Kumar Singh	1
	D.N. Singh	3
Rajkot	K.N. Akbari	1
	G.S. Sutaria	1
Rakh Dhiansar	Vikas Abrol	2
	Jai Kumar	2
Solapur (MC)	B.R. Najan	1
	S.M. Dhadge	1
Chianki (ORP)	Munish Kumar Singh	1
	D.N. Singh	1
Indore (ORP)	D.H. Ranade	1
Solapur (ORP)	D.B. Bhanavase	2
	S.B. Thorve	5

c) TV talks:

Centre	Resource Person	No. of radio talks
Ananthapur	B. Sahadeva Reddy	2
	M. Vijay Sankar Babu	2
Bangalore	B.K. Ramachandrappa	6
	M.N. Thimmegowda	12
	A. Sathish	1
	K. Devaraja	2
	P.N. Srikanth Babu	1
	M. Anitha	1
	K.M. Prashanth	1
Biswanath Chariali	P. Neog	2
Chianki	D.N. Singh	7
	Akhilesh Sah	3
	Munish Kumar Singh	1
Kovilpatti	D. Jawahar	2
	M. Rajeswari	1
	S. Elamathi	2
Rajkot	V.D. Vora	1
Rakh Dhiansar	Jai Kumar	3
Solapur	B.R. Najan	1
Chianki (ORP)	D.N. Singh	7
	Akhilesh Sah	3
	Munish Kumar Singh	1
Indore (ORP)	D.H. Ranade	1
Solapur (ORP)	S.B. Thorve	1

9. Workshops and Trainings

A. Workshops/conference/trainings organized

Title	Date	Venue	Participants
Akola			
National seminar on dryland agriculture in Vidarbha: priorities and development issues	03-04 March, 2015	Dr. PDKV, Akola	M.B. Nagdeve, S.B. Sakhare, V.V. Gabhane, A.B. Turkhede, R.S. Patode and A.P. Karunakar
Arjia			
Kharif crops production technology & input distribution (TSP-Arid Legume)	29 July, 2015	Bhensakundal, Suwana	50 farmers
Improved dryland technology of *kharif* season	03 July, 2014	Tara ka kheda, Rejmagra	72 farmers
Improved dryland technology of *kharif* crop production (AICRP on ORP)	02 July, 2014	Lapsiya, Rejmagra	178 farmers
Bengaluru			
District level stakeholder consultation workshop for upscaling of rainfed technologies in the domain districts	21 October, 2014	AICRPDA Centre, Bengaluru	126 participants from different institutions/ line departments
Vijayapura (Bijapur)			
Drought management in agriculture and allied sectors	15-17 December, 2014	KSDA office	25 farmers
Indore			
XXIV Biennial workshop of the all India coordinated research project for dryland agriculture AICRPDA	26 -29 December, 2014	RVSKVV, Indore	All the scientists of the project
Kovilpatti			
Improved dryland technologies for obtaining higher yield	17 September, 2014	Thoppurediapatti, Muthukrishnapuram, Vadakupatti ARS, Kovilpatti	50 farmers
One day training on real time contingency measures under dryland condition	24 September, 2014	Thoppurediapatti, Muthukrishnapuram, Kovilpatti	28 farmers
Phulbani			
Nursery management in rice	03 June, 2014	Kandhamal	30 farmers
Significance of pest surveillance and importance of resistant varieties	26 August, 2014	Kandhamal	30 Agriculture officers
Organic farming practices for horticultural crops	12 November, 2014	Village-Lambagudri, (Block-Khajuripada)	100 farmers
Conservation of plant genetic resource and their maintenance	17 January, 2015	KVK, G.Udayagiri	200 farmers
Importance of organic farming	06 February, 2015	Dadki, Phulbani	50 farmers

Title	Date	Venue	Participants
Rakh Dhiansar			
Adaption of latest technologies in *kharif* crops	09 July, 2014	Directorate of Agriculture, Talab Tillo	55 farmers
Summer fodder crops and their cultivation	01 May, 2014	Gulab Garh and R.S. Pura	19 farmers
Nursery raising and its aftercare in rice	23 May, 2014	Vill. Majua	19 farmers
Scientific cultivation of basmati rice	05 June, 2014	Vill. Nai Basti, Gulabgarh	17 farmers
Improved cultivation practices for sesame	01 July, 2014	Vill. Sungal, Akhnoor	15 farmers
Scientific cultivation of wheat	23 September, 2014	Vill. Palwan, Akhnoor	17 farmers
Arjia (ORP)			
Pre-seasonal training	2 July, 2014	Lapsiya	178 farmers
Pre-seasonal training	3 July, 2014	Tara ka kheda	72 farmers
Anantapuram (ORP)			
Farmers awareness programme on weather based agro-advisories	22 August, 2014	ARS, Anantapuramu	5 farmers
Importance of dead furrows in castor	03 September, 2014	Aminabad	29 farmers
Nutrient management in castor	03 September, 2014	Aminabad and Girigetla	30 farmers
Micronutrient management in tomato	18 September, 2014	Aminabad	20 farmers
Nutrient deficiencies and corrective measures in cotton	30 September, 2014	Aminabad and Girigetla	28 farmers
Post harvesting technologies in groundnut	11 November, 2014	Aminabad	25 farmers
Package of practices for chickpea cultivation	17 November, 2014	Aminabad	28 farmers
Precautions while rearing the Khadaknath chicks	23 January, 2015	Aminabad	18 farmers
Chianki (ORP)			
Management of different *rabi* crops	14 February, 2015	Sua Panchayat	70 farmers
Management of different *rabi* crops after harvesting	11 March, 2015	ZRS, Chianki	55 farmers
Scientific cultivation of summer vegetables	30 March, 2015	Sua Panchayat	105 farmers
Indore (ORP)			
Soil management	12 September, 2014	Civil Engineering college, Indore	75 students
Solapur (ORP)			
Kharif pre-seasonal training	13 June, 2014	Maniknal, Sangli	150 farmers
Krishi din and *kharif* pre-seasonal training	01 July, 2014	Narotewadi, Solapur	120 farmers
Rabi pre-seasonal training	21 August, 2014	Jalihal, Sangli	200 farmers
Rabi pre-seasonal training	10 October, 2014	Narotewadi, Solapur	110 farmers
Fertilizer management as per soil test, cultivation of *kharif* crops and seed treatment, *in situ* soil and moisture conservation, seed treatment	13 June, 2014	ORP village, Maniknal, Sangli	150 farmers
Cultivation of *kharif* crops, *in-situ* moisture conservation & custom hiring of implements	01 July, 2014	Narotewadi, Solapur	100 farmers

B. Workshops/conference participated

Title	Date	Venue	Participants
Agra			
National Seminar on" Reinvigorating agricultural innovation for farmers empowerment and development	03-04 May, 2015	PJTSAU, Hyderabad	S.P. Singh
Akola			
International Conference on Hydrology and Watershed Management	29 October to 1 November, 2014	JNTU, Hyderabad	M.B. Nagdeve, R.S. Patode and V.K. Chavan
Second International Conference on Bio-Resource and Stress Management	07-10 January, 2015	PJTSAU & ANGRAU, Hyderabad	V.V. Gabhane
International Symposium on New-dimensions in Agrometeorology for Sustainable Agriculture (NASA-2014)	16-18 October, 2014	GBPUA & T, Pantnagar	
National Cconference on Sustainable Management of Land Resources for Livelihood Security	28-30 January, 2015	NBSS & LUP, Nagpur	
Vasanthrao Naik Seminar on "Conventional and Biotechnological Approaches in Crop Improvement"	19-20 March, 2015	Dr. P.D.K.V., Akola.	S.B. Sakhare
Anantapur			
Primary Sector Development Action Plan Preparatory Workshop	28-29 April, 2015	ICRISAT, Hyderabad	B. Sahadeva Reddy
Ballowal Saunkhri			
Brain Storming Workshop on 'Agenda for Rainfed Agriculture Research in India'	09-10 May, 2014	NAAS, New Delhi	S.C. Sharma
Bangalore			
Brain Storming Workshop on 'Agenda for Rainfed Agriculture Research in India'	09-10 May 2014	NAAS, New Delhi	B.K. Ramachandrappa
National Symposium on Agricultural Diversification for Sustainable Livelihood and Environmental Security	18 November, 2014	PAU, Ludhiana	B.K. Ramachandrappa
Sustainable Water Management in Agriculture at one day workshop on 'Hamara Jala - Hamara Jeevan'	13 March, 2015	SIT Tumkur	B.K. Ramachandrappa
Vijayapura			
Drought Management in Agriculture and Allied Sectors	15-17 December, 2014	RARS, Vijayapur	S.C. Alagundagi, S.T. Hundekar, V.S. Surakod, M.S. Shirahatti, Vijayakumar, A.G., Savita G. Kanthi, H.S. Patil and D.T. Kallesh

Title	Date	Venue	Participants
Biswanath Chariali			
Brainstorming Workshop on "Climate Resilient Villages"	29 November, 2014	CRIDA, Hyderabad	Pallab Kumar Sarma
Regional Seminar on Rainwater Harvesting	16-17 December, 2014	NERIWALM, Tezpur	
International Symposium on "New Dimension in Agro-meteorology"	14-20 October, 2014	GBPUA & T, Pantnagar	Prasanta Neog
Chianki			
National Conference on Emerging Challenges and Opportunities for Biotic and Abiotic Stress Management	13-14 December, 2014	Directorate of Rice Research, Hyderabad	D.N. Singh
Kovilpatti			
National Seminar on Soil Resilience	21-22 January, 15	AC &RI, Madurai	D. Jawahar, V. Sanjivkumar and S. Elamathi
Parbhani			
National Conference on Global Opportunity on Agriculture Entrepreneurship Development	15-16 January, 2015	Pune	A.K. Gore
Phulbani			
National Symposium on "Management Options for Enhancing Farm Productivity and Livelihood Security under Changing Climate"	29-31 October, 2014	OUAT, Bhubaneswar	A. Mishra
Ballowal Saunkhri (ORP)			
Natural Resource Management and Sustainable Hill Farming System for Livelihood Security	23-24 July, 2014	SKUAST- Jammu	Vivek Sharma, Vijay Kumar, SC Sharma, Satvinder Singh, Sukhvinder Singh and Anil Khokhar
Agriculture Diversification for Sustainable Livelihood and Environmental Security	18-20 November, 2014	PAU, Ludhiana	A.K. Khokhar, Vijay Kumar, Satvinder Singh, S.C. Sharma and Vivek Sharma
Seminar on Problems & Prospects of Economical and Ecological Developments in *Kandi* region of Punjab	3 November, 2014	Malewal Tehsil Balachaur	Vivek Sharma
Indore (ORP)			
All India Seminar on Engineering Technologies for Sustainable Agriculture through Natural Resource Management	8- 9 August, 2014	Institution of Engineers, Ahmednagar	D.H. Ranade
International Conference on Natural Resource Management for Farming Systems and Rural Livelihood	10-13 February, 2015	New Delhi	
National Symposium on Dryland Farming and Food Security in India	30-31 August, 2014	RVSKVV, Gwalior	D.H. Ranade, S. Mujalde and A.K. Sharma

C. Trainings attended

Title	Date	Venue	Participants
Biswanath Chariali			
Training on Agricultural Innovation Partnership	22-23 May, 2014	BNCA, AAU	Prasanta Neog
Training Programme for Village Level Climate Manager	18-20 September, 2014	AICRPDA, NICRA (GKMS), Sonitpur	Pallab Kumar Sarma
Parbhani			
10 Days Short Course on Integrated Farming System towards Livelihood Security	10-19 December, 2014	VNMKV, Parbhani	P.H. Gourkhede
Solapur			
Integrated Farming System towards Livelihood Security	10-19 December, 2014	VNMKV Parbhani	S.M. Dhadge
Small Millet Cultivation Practices	25 February, 2015	ADA, Kayathar	D. Jawahar and S. Elamathi

D. Meetings

Title	Date	Venue	Participants
Akola			
Meeting on Central /State Scheme for providing Farm Implements for the Farmers	21 April, 2014	Pune	M.B. Nagdeve
State Level Committee Meeting on "Dryland Agriculture Mission"	17 June, 2014	Pune	M.B. Nagdeve
Anantapuram			
Nutritionally Sensitive & Environmentally Sustainable Agriculture for India's Food & Nutritional Security- challenges	23 August, 2014	NAARM, Hyderabad	B. Sahadeva Reddy
Brain Storming Session on Watershed Management	20 October, 2014	CRIDA, Hyderabad	B. Sahadeva Reddy, K. Bhargavi, G. Narayanaswamy and K.C. Nataraja
CRP 1.1 Meeting on Dryland Resilient Systems, ICARDA	15-19 February, 2015	Dubai	B. Sahadeva Reddy
Arjia			
Interface Meeting on Enhancing the Preparedness of Agricultural Contingencies in *kharif* 2015 for Rajasthan	05 June, 2015	Pant Krishi Bhawan, Jaipur	A.K. Kothari, R.K. Sharma and J. K. Balyan
Biswanath Chariali			
Fourth Coordinator's Meet of Biotech Hubs of North East	18 to19 July, 2014	NEHU, Shillong	Monuj Kumar Sarma
8th Annual Review Meeting (ARM) of GKMS	10 to12 November, 2014	Birsa Agricultural University, Ranchi, Jharkhand	Prasanta Neog
Advisory Meeting of Atmospheric Sciences (PAC-AS), DST, Govt of India	27 to 28 March, 2015	KL University, Vijayawada	

Title	Date	Venue	Participants
Vijayapura			
CRP 1.1 Meeting on Dryland Resilient Systems, ICARDA	15-19 February, 2015	Dubai	S.C. Alagundagi
Chianki			
National Mission on Sustainable Agriculture (NMSA)	12 November, 2014	Directorate of Agriculture, Ranchi	D.K. Singh
Phulbani			
District Agricultural Strategy Committee Meeting	24 May, 2014	Collectorate, Kandhamal	A. Mishra
3rd District Mission Committee Meeting of MIDH (NHM)	04 July, 2014	Collectorate, Kandhamal	
District Level Technical Committee Meeting for the year 2015-16	10 March, 2015	Kandhamal	D.K. Bastia and A. Mishra
Chianki (ORP)			
District Task Force Meeting	26 August, 2014	DC office, District- Palamau	D.N. Singh
Review Committee of Genetic Manipulation (RCGM) Meeting for Formulating Biosafety Guidelines to Conduct and Monitor Confined Research Trials (CRTS) on Genetically Engineered (GE) SPT Rice.	29 January, 2015	DBT, New Delhi	D.N. Singh

E. Field days/Kisan Melas/Field visits

Title	Date	Venue	Participants
Arjia			
Farmers Field School on IPM Technology to Enhance the Productivity of Pulses	30 September, 2014 17 March, 2015	Birmiyas, Kotri	90 farmers
Field Day on Pulse Crop Production & Exhibition on Dryland Technology	22 May, 2014	Nahri	415 farmers
Field Day on Intercropping System	09 October, 2014	Lapsiya (Rajsamand)	52 farmers
Field Day on Potassium Nitrate Treatment in Maize	10 October, 2014	Kochariya	67 farmers
Field Day cum Farmers Training on *rabi* Crop Cultivation, Importance of Crop Rotation and Integrated Pest Management	13 October, 2014	Rerwas, Kotri	96 farmers
Bangalore			
Field day	26 September, 2014	Chickkaputtaihanapalya, Nelamangala	98 farmers
One day "Farmers Exposure Visit" of NICRA farmers	15 December, 2014	ORP villages, Kanakapura taluk, Ramanagara district	NICRA and ORP farmers
Arjia (ORP)			
Field day on Intercropping System	09 October, 2014	Lapsiya	52 farmers
Field day on Potassium Nitrate Treatment in Maize Crop	10 October, 2014	Kochariya	67 farmers
Field day on Intercropping System	14 October, 2014	Bagatpura	63 farmers

Ananthapur					
a. Supplemental Irrigation to Pigeonpea					
1	Name of the farmer		:	G.Anjaneyulu	
2	Address		:		
	i)	Village	:	Raminepalli	
	ii)	Post	:	Raminepalli	
	iii)	Tehsil	:	Rapthadu	
	iv)	District	:	Ananthapuramu	
	v)	State	:	Andhra Pradesh	
3	Contact details		:		
4	Details of the farm (size, location, water availability etc.)		:	0.1 acres	
5	Membership in Self-Help Group, Producers Cooperative/ Company, Cooperative Society, etc., (give details)		:	Co operative society	
6	Names of the Central Sector / State Schemes utilized by the farmer and the period		:	AF Ecology Centre, Anantapur (NGO)	
7	Technologies / Good Agricultural Practices / Facilities / Benefits obtained with details		:	One Supplemental Irrigation to Intercropped Pigeonpea	
8	Details of results obtained due to the adoption of technologies (Season-wise crops grown techniques adopted, results achieved etc.)		:	**Improved / present production technologies**	**Traditional / past production practices**
	i).	Productivity per hectare (kg)	:	375	188
	ii).	Cost of production per hectare	:	Rs.4000	Rs.3500
	iii).	Net income per hectare	:	Rs.14750	Rs.5900
	iv).	Price realized (Rs./ton)	:	Rs.50000	Rs.50000
	v).	Natural Resources saved /conserved like soil, water etc.	:		
	vi)	Product quality improvement	:	--	--
9	Marketing Strategy – Access to market (through private, cooperative, contract farming etc.) -Export market (details of exports made)		:	--	
10	Factors contributing to success		:	Investment on farm pond from NGO	
11	Any other relevant information		:	--	

b. Horsegram as contingent crop during delayed onset of monsoon.				
1	Name of the farmer	:	Group of 15 farmers in entire village	
2	**Address**	:		
	i). Village	:	Cholasamudram	
	ii). Post	:	Cholasamudram	
	iii). Tehsil	:	Kuderu	
	iv). District	:	Ananthapuramu	
	v). State	:	Andhra Pradesh	
3	Contact details	:		
4	Details of the farm (size, location, water availability etc.)	:	2.0 to 5.0 acres each farmer , total of 300 acres in entire village	
5	Membership in Self-Help Group, Producers Cooperative/ Company, Cooperative Society, etc., (give details)	:	Co operative society	
6	Names of the Central Sector / State Schemes utilized by the farmer and the period	:	AF Ecology centre , Anantapur (NGO)	
7	Technologies / Good Agricultural Practices / Facilities / Benefits obtained with details	:	Horsegram as contingent crop during delayed onset of monsoon.	
8	i). Details of results obtained due to the adoption of technologies (Season-wise crops grown techniques adopted, results achieved etc.)	:	**Improved / present production technologies**	**Traditional / past production practices (Groundnut)**
	Productivity per hectare (kg)	:	Rs.1600	Rs.400
	ii). Cost of production per hectare	:	Rs.5000	Rs.20000
	iii). Net income per hectare	:	Rs.35000	Rs.4000
	iv). Price realized (Rs./t)	:	Rs.25000	Rs.60000
	v). Natural Resources saved /conserved like soil, water etc.	:		
	vi). Product quality improvement	:	--	--
9	Marketing Strategy – Access to market (through private, cooperative, contract farming etc.) -Export market (details of exports made)	:	--	--
10	Factors contributing to success	:	Investment on seeds and Planters from NGO	
11	Any other relevant information	:	--	

Hisar				
1	Name of the farmer	:	Sh. Sumer Singh	
2	**Address**	:		
	i). Village	:	Ghanghala	
	ii). Post	:	Ghanghala	
	iii). Tehsil	:	Siwani	
	iv). District	:	Bhiwani	
	v). State	:	Haryana	
3	Contact details	:	Mob. No.: 9812163356	
4	Details of the farm (size, location, water availability etc.)		Land holding: 4 acres Undulating topography, dunal sand. One bore well was installed in 1998 and water quality was very poor due to salinity	
5	Membership in Self-Help Group, Producers Cooperative/ Company, Cooperative Society etc., (give details)	:	Nil	
6	Names of the Central Sector / State Schemes utilized by the farmer and the period	:	Panchayat Raj	
7	Technologies / Good Agricultural Practices / Facilities / Benefits obtained with details	:	Rain water harvesting and ground water recharge for irrigation of mustard. Initially a open channel carriage of 150' to drain out excess rain water from village pond was built by village Panchayat and thereafter, the farmer himself built a sediment trap and laid underground pipes of (6" dia.) 350 ' to carry water to his bore well for recharge	
8	Details of results obtained due to the adoption of technology.	:	**Improved / present production technologies**	**Traditional / past production practices**
	i) Productivity per hectare (q)	:	18-20	3-4
	ii) Cost of production per hectare (Rs.)	:	5880	3150
	iii) Net income per hectare (Rs.)	:	34000	4250
	iv) Price realized (Rs./ton)	:	-	-
	v) Natural Resources saved /conserved like soil, water etc.		Improvement in underground water quality as EC is 3630 dS/m	EC was initially 7200 dS/m
	vi) Product quality improvement		-	-
9	Factors contributing to success	:	Recharging of ground water from excess rain water. He is using all recommendations (Zn + gypsum) in harvesting good yields	
10	Details on the spread (area and or no. of farmers / villages) of the technology adopted by the successful farmer	:	Others adjoining farmers are willing but no water available	
11	Any other relevant information	:	Water table depth: 80', Cavity depth: 130'. He could use water for 4-5 irrigations by sprinkler in mustard and barley plus small kitchen garden. Enough forages are grown to feed milch cattle	

Kovilpatti

Tied ridges and furrows

1.	Name of the farmer	:	Mr. N. Selvaraj, S/o. Mr. Narayanasamy		
2.	Address	:			
	a. Village	:	Thoppureddipatti		
	b. Post	:	Elayarasenandal (P.O)		
	c. Tehsil	:	Kovilpatti		
	d. District	:	Thoothukudi		
	e. State	:	Tamil Nadu		
3.	Contact details	:	09486892861		
4.	Details of the farm (size, location, water availability etc.)	:	2 acres rainfed		
5.	Membership in Self-Help Group, Producers Cooperative/ Company, Cooperative Society etc., (give details)	:	-		
6.	Names of the Central Sector / State Schemes utilized by the farmer and the period	:	AICRPDA		
7.	Technologies / Good Agricultural Practices / Facilities / Benefits obtained with details	:	• Adoption of tied ridges and furrows for in-situ moisture conservation in maize • Based on the agro advisories from Agricultural Research Station, Kovilpatti, the forecast of rainfall was helpful in taking up timely operations and selection of appropriate herbicides and better nutrient management strategies (19:19:19 - NPK) foliar spray thus resulting in increase in yield		
8.	Details of results obtained due to the adoption of technology.	:	**Improved / technology adopted**	**Traditional / past production practices**	**Remarks**
	Productivity per hectare	:	4400 kg	3500 kg	In drought years with 38% deficit rainfall
	Cost of production per hectare (Rs)	:	28,000	28,000	
	Net income per hectare (Rs)	:	20,400	10,500	
	Price realized (Rs./ton)	:	11,000	11,000	
	Natural Resources saved /conserved like soil, water etc.	:	Conservation of rain water and soil	-	
	Product quality improvement		-	-	
9.	Factors contributing to success	:	During the year 2014-15, 299 mm of rainfall was received in 16 rainy days against the normal of 459 mm in 25 rainy days. Ridges and furrows were formed with tractor drawn ridges at a spacing of 60 cm. After formation of ridges in one direction, the ridges are tied at a spacing of 10 m in a crisscross manner. The tied inter rows serve as mini reservoirs for storing rain water. The mean soil moisture content in (0-45 cm) depth enhanced to the tune of 20 per cent resulting in an increase of yield of 900 kg/ha even with a deficit rainfall of 38 %		
10.	Details on the spread (area and or no. of farmers / villages) of the technology adopted by the successful farmer	:	Nearly 50 to 70 per cent of the NICRA village farmers adopt the practice of tied ridges and furrows for maize		
11.	Any other relevant information	:	-		

Ridges and furrows					
1.	Name of the farmer	:	Mr. P. Mannarsamy S/o. Mr. Pandiyasamy		
2.	Address	:			
	Village	:	Thoppureddipatti		
	Post	:	Elayarasenandal (P.O)		
	Tehsil	:	Kovilpatti		
	District	:	Thoothukudi		
	State	:	Tamil Nadu		
3.	Contact details	:	09566546426		
4.	Details of the farm (size, location, water availability etc.)	:	2 acres rainfed		
5.	Membership in Self-Help Group, Producers Cooperative/ Company, Cooperative Society etc., (give details)	:	-		
6.	Names of the Central Sector / State Schemes utilized by the farmer and the period	:	AICRPDA - NICRA		
7.	Technologies / Good Agricultural Practices / Facilities / Benefits obtained with details		• Adoption of ridges and furrow with TNAU cotton plus foliar spray (1.25 %) in cotton crop. • Based on the agro advisories from AICRPDA - NICRA, Agricultural Research Station, Kovilpatti, the forecast of rainfall was helpful in taking up timely operations and selection of appropriate herbicides and pesticides and nutrient management strategies resulting in increase yield		
8.	Details of results obtained due to the adoption of technology.	:	**Improved / technology adopted**	**Traditional / past production practices**	**Remarks**
	Productivity per hectare	:	1400 kg/ha	1200 kg/ha	In drought years with 33 % deficit rainfall 14 % yield increase over traditional practices
	Cost of production per hectare (Rs)	:	36,000	36,000	
	Net income per hectare (Rs)	:	13,000	6,000	
	Price realized (Rs./ton)	:	35,000	35,000	
	Natural Resources saved /conserved like soil, water etc.	:	Conservation of rainwater and soil	-	
	Product quality improvement	:	-	-	
9.	Factors contributing to success	:	During the year 2014-15, 318 mm of rainfall was received in 18 rainy days against the normal of 459 mm in 25 rainy days. Dry spell was observed in vegetative stage. Hence the treatment imposed foliar spray TNAU cotton plus 2.25 kg / ac. Cotton plus foliar spray maintained better osmoticom and drought tolerance capacity which resulted 14 per cent increase over traditional practices. Even with a deficit rainfall of 33%		
10.	Details on the spread (area and or no. of farmers / villages) of the technology adopted by the successful farmer	:	Nearly 40 to 60 per cent of the NICRA village farmers adopt the practice foliar spray TNAU cotton plus in cotton crop		
11.	Any other relevant information	:	-		

Solapur

I) Farm pond technology

1	Name of the farmer	:	Shri. Shrishail Laxman Bagali	
2	Address			
	i) Village	:	Maniknal	
	ii) Post	:	Maniknal	
	iii) Tehasil	:	Jath	
	iv) District	:	Sangli	
	v) State	:	Maharashtra	
3	Contact Details	:	9420453375	
4	Details of the farm (size, location, water availability, etc.)	:	Size = 10.60 ha, Location = Nearby village Source of irrigation = Farm Pond and tube well	
5	Membership in Self Help Group, producers co-operative/company, co-operative society, etc.	:	Member of co-operative society Hanjagi	
6	Names of the central sector / state scheme utilized by the farmer and the period	:	State Department of Agriculture, Operational Research Project 2010 onwards	
7	Technologies / good agricultural practices / facilities / benefits obtained with details	:	• Protective irrigation • Seed treatment : - Sorghum – *Azotobactor*, PSB, *Trichoderma* • Fertilizer ($N:P_2O_5:K_2O$ kg/ha) – 50:25:0 • IPM – Seed treatment, Feromen traps, Neem seed extract spray • Cultivars - Sorghum – Anuradha	
8	Details of results obtained due to adoption of technologies (season wise crop grown, techniques adopted, results achieved, etc.)	:	**Improved / present production technologies**	**Traditional / past production technologies**
i)	Productivity (q/ha) - Sorghum	:	12.80	5.43
ii)	Cost of production (Rs./ha)	:	13400	9800
iii)	Net income (Rs./ha)	:	15700	10200
iv)	Price realized (Rs./q)	:		
	- Sorghum - Grain	:	2000	--
	- Fodder		2500	--
v)	Natural resources saved / conserved like soil, water, etc.	:	Minimized risk under aberrant weather condition, erosion resistant system	--
vi)	Product quality improvement	:	--	--
9	Marketing strategy – Access to market (through private, co-operative, contract farming , etc.)	:	Private market	
10	Factors contributing to success	:	Sound technology, Motivation of the farmer, minimize risk under aberrant weather condition	
11	Any other relevant information	:		

II) *In-situ* moisture conservation (ridges and furrows) for 30 days sowing of pigeonpea				
1	Name of the farmer	:	Shri. Saybanna Dhulappa Kumbhar	
2	Address			
	i) Village	:	Maniknal	
	ii) Post	:	Maniknal	
	iii) Tehasil	:	Jath	
	iv) District	:	Sangali	
	v) State	:	Maharashtra	
3	Contact details	:		
4	Details of the farm (size, location, water availability, etc.)	:	Size = 2.40 ha, Location = Near Rajebagaswar Masjid Source of irrigation = Tube well	
5	Membership in Self Help Group, producers co-operative/company, co-operative society, etc.	:	Member of co-operative society Maniknal,	
6	Names of the central sector / state scheme utilized by the farmer and the period	:	• State Department of Agriculture, • Operational Research Project 2010-2014	
7	Technologies / good agricultural practices / facilities / benefits obtained with details	:	• *In-situ* rain water conservation i.e., opening of ridges and furrows 30 days after sowing. • Use of improved cultivar – Vipula • Fertilizer (N:P2O5:K_2O kg ha^{-1}) – 12.5:50 • Seed treatment : *Rhizobium*, PSB, *Trichoderma*	
8	Details of results obtained due to adoption of technologies (seasonwise crop grown, techniques adopted, results achieved, etc.)	:	**Improved / present production technologies**	**Traditional / past production technologies**
i	Productivity Grain (q/ha)	:	900	540
ii	Cost of production (Rs./ha)	:	15200	12900
iii	Net income (Rs./ha)	:	26120	16700
iv	Price realized (Rs./q)	:		
	- Grain		3200	3000
v	Natural resources saved / conserved like soil, water, etc.	:	• 35% more moisture conserved due to ridges and furrows	
vi	Product quality improvement	:	--	
9	Marketing strategy – Access to market (through private, co-operative, contract farming , etc.)	:	Private market	
10	Factors contributing to success	:	• *In-situ* moisture conservation (ridges and furrows) 30 Days after sowing • Use of improved cultivar and fertilizer • Timely interculturing	
11	Any other relevant information	:		

Varanasi				
1.	Name of the farmer	:	Rakesh Singh	
2.	Address	:		
	Village	:	R C Nagar	
	Post	:	Padari	
	Tehsil	:	Mirzapur	
	District	:	Mirzapur	
	State	:	Uttar Pradesh	
3.	Contact details	:	9936525591	
4.	Details of the farm (size, location, water availability etc.)	:	8.0 ha, one well	
5.	Membership in Self-Help Group, Producers Cooperative/ Company, Cooperative Society etc., (give details)	:	Bharpura Sadhan Sahkari Samiti	
6.	Names of the Central Sector / State Schemes utilized by the farmer and the period	:	-	
7.	Technologies / Good Agricultural Practices / Facilities / Benefits obtained with details	:	• Ridge forming machine for pulses, oilseeds (custom hiring) • Incorporation of greengram in alternate strips of rice saves 30 kg N/ha in cereal component	
8.	Details of results obtained due to the adoption of technology.	:	**Improved / technology adopted**	**Traditional / past production practices**
	Productivity per hectare (kg)	:	3125	1800
	Cost of production per hectare (Rs)	:	11000	11000
	Net income per hectare	:	35000	10875
	Price realized (Rs./ton)	:	33000	7000
	Natural Resources saved /conserved like soil, water etc.	:	-	-
	Product quality improvement	:	-	-
9.	Factors contributing to success	:	• Efficient management of soil and rainwater • Enhanced soil fertility	
10.	Details on the spread (area and or no. of farmers / villages) of the technology adopted by the successful farmer	:	Sixty famers and 40 ha area of R.C. Nagar, Shivgarh and Pathraha villages of Pahari block (Mirzapur) Uttar Pradesh	

Anantapuram (ORP)				
1.	Name of the farmer	:	Sri.T. Seetharami Reddy	
2.	Address	:		
	Village	:	Girigetla	
	Post	:	Girigetla	
	Mandal	:	Thuggali	
	District	:	Kurnool	
	State	:	Andhrapradesh	
3.	Contact details	:	--	
4.	Details of the farm (size, location, water availability etc.)	:	5 acres	
5.	Membership in Self-Help Group, Producers Cooperative/ Company, Cooperative Society, etc., (give details)	:	-	
6.	Names of the Central Sector / State Schemes utilized by the farmer and the period	:	--	
7.	Technologies / Good Agricultural Practices / Facilities / Benefits obtained with details	:	Groundnut sowing with ananta tractor drawn mechanical seed planter	
8.	Details of results obtained due to the adoption of technologies (Season-wise crops grown techniques adopted, results achieved etc.)	:	**Improved / present production technologies**	**Traditional / past production practices**
	Productivity per hectare	:	550 kg	420 kg
	Cost of production per hectare (Rs)	:	21875	24875
	Net income per hectare (Rs)	:	7125	(-)2375
	Price realized (Rs./q)	:	5000	5000
	Natural Resources saved /conserved like soil, water etc.	:	Conservation furrows to improve soil moisture	---
	Product quality improvement	:	---	---
9.	Marketing Strategy – Access to market (through private, cooperative, contract farming etc.) -Export market (details of exports made)	:	Private	
10.	Factors contributing to success	:	Sowing in right time leading to good germination, pre-emergence herbicide saving one weeding	
11.	Any other relevant information	:	Nil	

Ballowal Saunkhri (ORP)				
1.	**Name of the farmer**	:	Sh. Anant Ram S/o Sh. Paras Ram	
2.	Address	:		
	Village	:	Jhandiankalan	
	Post	:	Jhandian	
	Tehsil	:	Nurpur Bedi	
	District	:	Rupnagar	
	State	:	Punjab	
3.	Contact details	:	9501743198	
4.	Details of the farm (size, location, water availability etc.)	:	2.0 ha	
5.	Membership in Self-Help Group, Producers Cooperative/ Company, Cooperative Society, etc., (give details)	:	-	
6.	Names of the Central Sector / State Schemes utilized by the farmer and the period	:	Punjab Agricultural University through AICRPDA centre, Ballowal Saunkhri and KVK Rupnagar	
7.	Technologies / Good Agricultural Practices / Facilities / Benefits obtained with details	:	Integrated Farming System, Introduction of short duration Improved rainfed cultivars of maize (PMH-1, PMH-2,) Sesame (RT-346), Blackgram (mash 338), Raya (RLM 619) wheat (PBW-644, PBW 660), Toria (TL-17), Taramira (TMLC-2). Linseed (Lc 2023), Rotavator for seed bed preparation, Oilseed drill for taramira sowing	
8.	Details of results obtained due to the adoption of technologies (Season-wise crops grown techniques adopted, results achieved etc.)	:	**Improved / present production technologies**	**Traditional / past production practices**
	Productivity per hectare (kg/ha)	:	Maize: 3500-4000 Sesame: 350 Taramira: 400 Toria: 500 Wheat: 3000 Linseed: 600 Chickpea: 800	Maize: 2500-3000 Wheat: 1400-1600 Chickpea: 550 kg/ ha
	Net income per hectare (Rs)	:	Maize: 40,000 Sesame: 20,000 Wheat: 25,000 Chickpea: 25,000 Taramira: 10,000	Maize:15,000 Fodder :5,000 Wheat: 15,000 Chickpea:10,000
	Price realized (Rs. per ton)	:	-	-
	Natural resources saved /conserved like soil, water etc.	:	-	-
	Product quality improvement	:		
9.	Marketing Strategy – Access to market (through private, cooperative, contract farming etc.) -Export market (details of exports made)	:	Sold in district grain market through market committee	
10.	Factors contributing to success	:	Integrated farming system Improved variety, sowing time, seed treatment, weed control, pest and fertilizer management. Use of seed cum fertilizer drill for wheat & oilseed crops	
11.	Any other relevant information	:	Key strength is dairy component along with agriculture	

Bangalore (ORP)				
***In-situ* moisture conservation**				
1	Name of the farmer	:	Smt. Gauramma w/o Sri. Neelappa	
2	Address	:	Arjunahalli	
	Village	:		
	Post	:	Kanakapura	
	Tehsil	:	Ramanagara	
	District	:	Karnataka	
	State	:		
3	Contact details	:	--------	
4	Details of the farm (size, location, water availability etc.)	:	4.0 ha. Rainfed	
5	Membership in Self-Help Group, Producers Cooperative/ Company, Cooperative Society etc., (give details)	:	Milk Producers Co-operative society	
6	Names of the Central Sector / State Schemes utilized by the farmer and the period	:	----------	
7	Technologies / Good Agricultural Practices / Facilities / Benefits obtained with details	:	Opening of conservation furrow in fingermillet + pigeonpea (8:2) cropping system	
8	Details of results obtained due to the adoption of technologies (Season-wise crops grown techniques adopted, results achieved etc.)	:	**Improved / present production technologies**	**Traditional / past production practices**
	Productivity (kg/ha)	:	Fingermillet – 2606 Pigeonpea – 388	Fingermillet- 1304 Pigeonpea - 32
	Cost of production (Rs/ha)	:	25591	15300
	Net income (Rs/ha) B:C ratio	:	81834 3.19	31336 2.04
	Price realized (Rs./ton)	:	Fingermillet - 25000 Pigeonpea - 43000	Fingermillet – 24000 Pigeonpea – 42000
	Natural resources saved /conserved like soil, water etc.	:	-	-
	Product quality improvement	:	-	-
9	Marketing Strategy – Access to market (through private, cooperative, contract farming etc.) -Export market (details of exports made)	:	Private and Co-operative marketing	
10	Factors contributing to success	:	Opening conservation furrow between paired rows of pigeonpea, acts as *in-situ* water harvesting structure, better utilization of rainwater and serve as insurance during weather aberrations	
11	Any other relevant information	:	Nil	

Groundnut + pigeonpea (8:2) cropping system				
1	Name of the farmer	:	Sri. MadhuraNaik, S/o BalaNaik	
2	Address	:		
	Village	:	Arjunahalli thandya	
	Post	:	Kodihalli	
	Tehsil	:	Kanakapura	
	District	:	Ramanagara	
	State	:	Karnataka	
3	Contact details	:	--------	
4	Details of the farm (size, location, water availability etc.)	:	2.0 ha. Rainfed	
5	Membership in Self-Help Group, Producers Cooperative/ Company, Cooperative Society etc., (give details)	:	Nil	
6	Names of the Central Sector / State Schemes utilized by the farmer and the period	:	----------	
7	Technologies / Good Agricultural Practices / Facilities / Benefits obtained with details	:	Groundnut + pigeonpea (8:2) cropping system	
8	Details of results obtained due to the adoption of technologies (Season-wise crops grown techniques adopted, results achieved etc.)	:	**Improved / present production technologies**	**Traditional / past production practices**
	Productivity (kg/ha)	:	Groundnut - 712 Pigeonpea - 638	Groundnut - 696 Pigeonpea – 638
	Cost of production (Rs/ha)	:	34763	35763
	Net income (Rs/ha) B:C ratio	:	70154 2.02	42002 1.17
	Price realized (Rs./ton)	:	Groundnut - 60000 Pigeonpea – 43000	Groundnut - 58000 Pigeonpea - 43000
	Natural Resources saved /conserved like soil, water etc.	:	-	-
	Product quality improvement	:	-	-
9	Marketing Strategy – Access to market (through private, cooperative, contract farming etc.) -Export market (details of exports made)	:	Private and Co-operative marketing	
10	Factors contributing to success	:	Opening conservation furrow between paired rows of pigeonpea and intercropping system serves as insurance during weather aberrations	
11	Any other relevant information	:	Nil	

Improved fingermillet varieties				
1	Name of the farmer	:	Sri.Neelappa, S/o Channappa	
2	Address			
	Village	:	Arjunahalli	
	Post	:		
	Tehsil	:	Kanakapura	
	District	:	Ramanagara	
	State	:	Karnataka	
3	Contact details	:	--------	
4	Details of the farm (size, location, water availability etc.)	:	4.0 ha, Rainfed	
5	Membership in Self-Help Group, Producers Cooperative/ Company, Cooperative Society etc., (give details)	:	----------	
6	Names of the Central Sector / State Schemes utilized by the farmer and the period	:	----------	
7	Technologies / Good Agricultural Practices / Facilities / Benefits obtained with details	:	Improved fingermillet varieties	
8	Details of results obtained due to the adoption of technologies (Season-wise crops grown techniques adopted, results achieved etc.)			

Variety	Yield (kg/ha)		Returns (Rs/ha)		B:C ratio
	Grain	Straw	Gross	Net	
Long duration varieties					
1. MR-1	2300	5781	61,836	38,020	2.59
Medium duration varieties					
2. GPU-28	2260	3516	59,137	35,321	2.48
3. ML-365	2423	4398	63,874	40,058	2.68
Short duration variety					
4. GPU-48	2193	3315	57,311	33,495	2.40
5. Local	1597	3012	42,184	18,368	1.77

	Price realized (Rs./ton)	:	Fingermillet – 25000 Straw – 750	Fingermillet – 24000 Straw - 750
	Natural Resources saved /conserved like soil, water etc.	:	-	-
	Product quality improvement	:	-	-
9	Marketing Strategy – Access to market (through private, cooperative, contract farming etc.) -Export market (details of exports made)	:	Private and Co-operative marketing	
10	Factors contributing to success	:	Fingermillet varieties MR-1, GPU-28 nad GPU-48 are high yielding varieties suitable for early, mid and late sowing, respectively	
11	Any other relevant information	:	Nil	

Pigeonpea + field bean (1:1) cropping system				
1.	Name of the farmer	:	Shantaraju s/o veerabadraiah	
2.	Address	:		
	Village	:	Arjunahalli	
	Post	:	Kodihalli	
	Tehsil	:	Kanakapura	
	District	:	Ramanagara	
	State	:	Karnataka	
3.	Contact details	:	-	
4.	Details of the farm (size, location, water availability etc.)	:	0.4 ha, Rainfed	
5.	Membership in Self-Help Group, Producers Cooperative/ Company, Cooperative Society etc., (give details)	:	-	
6.	Names of the Central Sector / State Schemes utilized by the farmer and the period	:	-	
7.	Technologies / Good Agricultural Practices / Facilities / Benefits obtained with details	:	Pigeonpea + field bean (1:1) cropping system	
8.	Details of results obtained due to the adoption of technologies (Season-wise crops grown techniques adopted, results achieved etc.)	:	**Improved/present production technologies**	**Traditional/pastproduction practices**
	Productivity (kg/ha)	:	Pigeonpea - 1324 Fieldbean - 800	Fieldbean – 380
	Cost of production (Rs/ha)	:	14900	Fieldbean – 13200
	Net income (Rs/ha)	:	66032	Fieldbean sole – 1800
	Price realized (Rs./ton)	:	Pigeonpea – 43000 Fieldbean – 30000	Fieldbean sole – 30000
	Natural Resources saved /conserved like soil, water etc.	:	-	-
	Product quality improvement	:	-	-
9.	Marketing Strategy – Access to market (through private, cooperative, contract farming etc.)-Export market (details of exports made)	:	Private and Co-operative marketing	
10.	Factors contributing to success	:	The farmers realize higher returns besides staggered income from short duration cowpea	
11	Any other relevant information	:	Nil	

Indore (ORP)			
1	Name of the farmer		Mr. Bhagwat Singh
2	Address		
	Village		Panod
	Post		Panod
	Tehsil		Indore
	District		Indore
	State		Madhya Pradesh
	Contact details		-
3	Details of farm (size, location, water availability)		3 ha, Open well, Tube well
4	Membership		No
5	Names of central sector/state schemes utilized by the farmers and the period		ORP project
6	Technologies		Water harvesting tank for storing runoff water
7	The runoff potential of the soils of the experimental area is very high due to their low infiltration rate. The safe disposal/ storage of this runoff would be beneficial. The storage of the runoff water would help the farmer to utilize it during the moisture stress period.		
8	Details of results obtained due to the adoption of technologies		
	A suitable site in the field was selected considering all the hydrological aspects in January 2008 and an excavated tank has been developed in March 2008. Back hoe loader machine was used for the excavation purpose and dumper was used for transporting and spreading the excavated top black soil (available up to 2 m) in the nearby fields which was severely affected by rill and sheet erosion process. The farmers then engaged the tractor drawn levelers for spreading the excavated materials and making the fields almost leveled. The yellowish soil excavated beyond 2 m was also used for the construction of side bunds and peripheral bunds of the farmers and also for the construction of farm roads. The inlet of the tank is provided on the either side of bund facing the cultivated field. The outlet is constructed so that it safely drains off the excess water into a natural waterway. The excavated tank collected the runoff water in the following rainy season and farmer also filled it with available ground water in the nearby tubewell as its discharge was not sufficient enough to be used directly for pre sowing irrigation. Subsequently three irrigations were given to wheat grown in 4 ha and one irrigation to chickpea in 2 ha through conjunctive use of surface and ground water stored in the tank in the first year itself.		
9	Natural resources saved/conserved like soil, water.		Soil loss reduced drastically
	Product quality improvement		-
10	Marketing strategy – Access to market		Direct to mandi
	Factors contributing to success		Additional water availability and more area under irrigation.
11	Any other relevant information		-

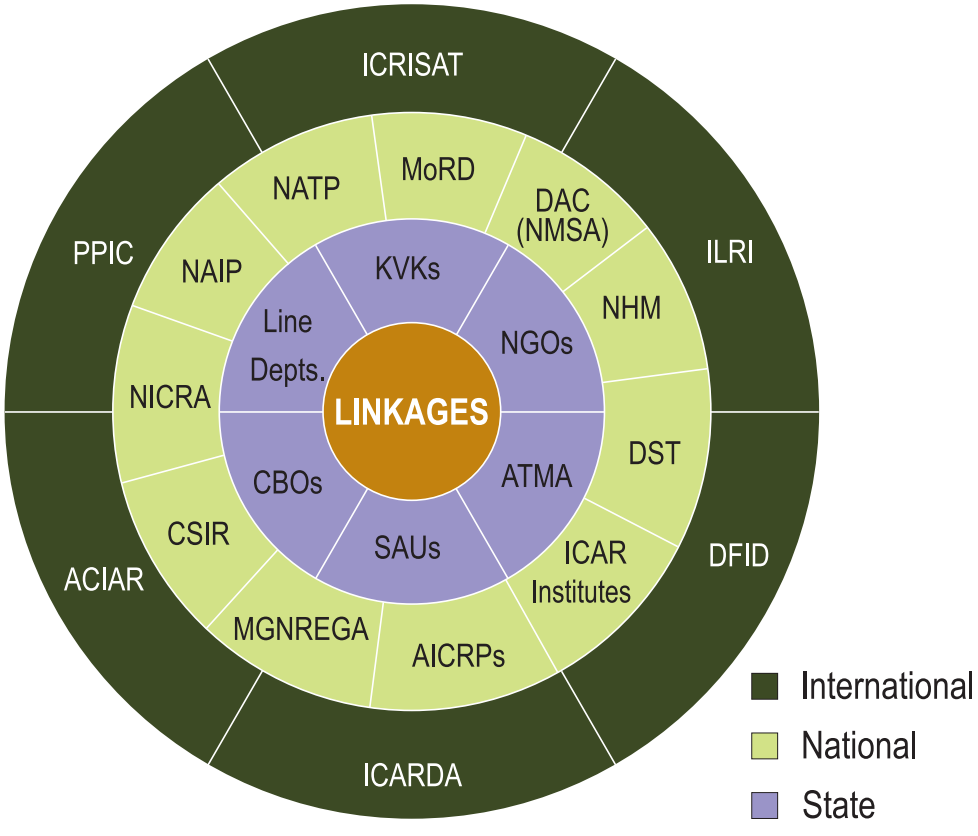
11. Documentation of ITKs

Anantapur (ORP)			
I.			
1	Name of Indigenous Technical Knowledge (ITK) (with local name)	:	Castor capsule removing
2	Photograph/ video clipping	:	
3	Location from where the above ITK has been collected (Please give information on agro-ecology, village, tehsil /district, name of the farmer)	:	Girigetla village, Thuggalimandal Kurnool district
4	Purpose of the ITK	:	Removing of capsule from spike
5	Theme area	:	Energy Management
6	Description of ITK	:	Harvested spikes made in to heaps sprinkling of water on spikes generate heat when the heap was covered with tarpaulinfor 3-4 days. In this process all the capsules come out with little bit of jerk
7	Advantage	:	Easily remove the capsule from spike, reduced the labour to pick capsule from spike.
8	Constraints in adoption	:	Reduce the time to pick capsules from spike
9	Scope for upscaling	:	Farmer to farmer adoption is in progress
10	Researchable issue	:	Development of machinery to thresh the fresh capsules from spikes is needed.
Indore (ORP)			
1	Name of Indigenous Technical Knowledge (ITK) (with local name)	:	Putting a iron nail in the trunk of Guava plants
2	Photograph		
3	Location from where the above ITK has been collected	:	Village Gaddukhedi Dist. Dewas, Vertisols, Mithun Jalam Singh

4	Purpose of the ITK	:	The fixing of iron nail in the trunk of the Guava tree provided micro nutrient to the plants as the citric acid in the tree dissolved iron and made available to plant. This enhanced the flowering and fruiting in the tree.
5	Theme area	:	INM
6	Description of ITK	:	
	Instead of using micronutrients for iron deficiency, putting a nail in the trunk of the tree may increase the flowering and fruiting in the guava plant.	:	
7	Advantage	:	• Reduces iron deficiency • Increases flowering • Increases fruiting
8	Constraints in adoption	:	Nil
9	Scope for up scaling	:	Can be adopted for Horticultural plants.
10	Researchable issue	:	
II)			
1	Name of Indigenous Technical Knowledge (ITK) (with local name)	:	Elevated water harvesting/storage tank for irrigating rabi crops
2	Photograph		
3	Location from where the above ITK has been collected	:	Village Kitoda, Dist. Ujjain, Gopal Patidar
4	Purpose of the Innovation/ITK	:	In addition to water harvesting tank or a tank for storage for the irrigation through gravity, elated masonry water storage is constructed and it is filled with pumped water from the WH tank so that an additional storage of rainwater is made for its utilization during rabi through gravity.
5	Theme area	:	NRM
6	Description of ITK	:	
	An elevated masonry tank of at least 1000 cu.m. is constructed and filled with runoff water either collected in the water harvesting tank or through tube wells.		
7	Advantage	:	• Increases additional runoff storage. • Provides irrigation to rabi crops through gravity. • Reduce the land loss for the construction of water storage tank for gravity irrigation. • Alternate to water storage structure for irrigation through gravity.
8	Constraints in adoption		• Higher cost
9	Scope for up scaling		Can be adopted in vertisol regions.
10	Researchable issue		Economical feasibility

12. Linkages Developed

AICRPDA network centres persistently developing linkages and collaborations with various stakeholders for i). research in thematic areas, ii). technology assessment and refinement, iii) upscaling of doable rainfed technologies, iv). operationalization of contingency plans on real-time basis and capacity building of primary and secondary stakeholders, both on-station and on-farm. The network has strong linkage/collaboration with national and international institutes, state/central government programmes, district level institutions and local PRIs.



13. Honors/Awards

Project Coordination Unit, AICRPDA

Dr. Ch Srinivas Rao, Director, CRIDA was awarded **National Academy of Agricultural Science (NAAS) Recognition Award** for 2013-14.

Dr. G. Ravindra Chary, Principal Scientist (Agronomy), AICRPDA, received **Fellow of Indian Society of Agronomy Award** for 2013-14.

Dr. K.A. Gopinath, Senior Scientist (Agronomy), AICRPDA received the **Best Editor Award** for outstanding contribution in bringing out "International Journal of Bio-resource and Stress Management" for the year 2013.

Er. R. Nagarjuna Kumar, Scientist (Comp applications in Agril) AICRPDA received the **Scientist of the Year Award** for outstanding contribution in computer applications in agriculture for the year 2013.

AICRPDA Centres

Akola

- Received **First Prize for Best Stall during Agrotech - 2014 held from 27-29**th December, 2014 at Dr. PDKV, Akola.
- Best **Oral Presentation Award (II**nd**)** by R.S. Patode, under the theme "Rain Water management".
- **Best Poster (I**st**) Award** by Usha Satpute, V.V. Gabhane, M.M. Ganvir and M.B. Nagdeve, under the theme "Enhancing Soil Fertility and Health & Organic Farming in Rainfed Agriculture".
- **Best Poster (II**nd**) Award** by B. Sakhare, M.B. Nagdeve, A.B. Turkhede, V.V. Gabhane, R.S. Patode, R.S. Mali, S.P. Nandapure and V.K. Chavan, under the theme "Crop Protection and Protected Agriculture, Crop Varieties and Diversification".

Anantapuramu

- **Distinguished Scientist award** of SS DAT at DRR, Hyderabad, by M. Vijay Sankar Babu.
- **A.V. Krishnaiah Memorial Prize for the year 2011** award by B.Sahadeva Reddy.
- **Dr. P.G. Krishna Memorial Gold Medal** award by M.Vijay Sankar Babu.
- **University Award of Research Scientist for the year 2011** by K. Madhusudhan Reddy.

Arjia

- **Best Oral Paper Presentation Award by B.S. Kumpawat and J.K. Balyan** for presenting the paper on "Study the effect of weed management practices on yield of blackgram (*Vigna mungo*) in south east Rajasthan" in International Conference on "Changing Scenario of Pest Problems in Agri-Horti Ecosystem and their Management" organized by the Entomological Research Association and Department of Entomology, RCA, Udaipur & MPUAT, Udaipur (Rajasthan) organized from 28 to 30th November, 2014 at RCA, Udaipur.

Bangalore

- **Best Demonstration Award** for the dryland technology park during Krishi Mela-2014, UAS, Bengaluru.
- **Best Poster Presentation Award** by M.N. Thimmegowda in the First poster conference of Master Degree Research Program, UAS, and Bengaluru held during 15-16th May, 2014.
- **Dr. P.S. Deshmukh Young Agronomist Award by** M.N. Thimmegowda from Indian Society of Agronomy.

- **Rtn. Sunderlal Bagai Young Scientist Award – 2014** by M.N. Thimmegowda from Rotary, Bengaluru South on 01.10.2014.
- **Certificate of incentive under Sujala III** world bank funded watershed project on foundation day of UAS, Bengaluru by A. Sathish.

Rakh Dhiansar

- **Best Paper Award-2015** by Vikas Abrol and co-scientists for "Improving rural livelihood security in resource poor kandi belt of Jammu through alternate landuse system" in 7th National Seminar on Sustainable Rural Livelihood: Technological and Institutional Perspective held on 8-10 Jan organized by Society for Community Mobilization, IARI, New Delhi.
- **Postdoctoral Research Fellowship** by Vikas Abrol for one year by Government of Israel at Agricultural Research Organization, Institute of Soil, Water and Environment Sciences, The Volcani Centre, Bet Dagan, Israel to pursue research entitled **"Biochar: Mechanism of action in agricultural soils"**.

Solapur

- **Best Oral Presentation Award** by V.M. Amrutsagar, N.B. More and A.B. Pawar during National Seminar on dryland Agriculture organized by PDKV Alola on 3-4 March 2015.

Arjia (ORP)

- **Best Oral Presentation Award** by R.K. Sharma, International Conference: Changing Scenario of Pest Problems in Agri-horti Ecosystem and Their Management on the paper "Effect of different Organic Nutrient modules on aphids and lady bird beetle in cumin. Sources in Semi-Arid Region" organized by Entomological Research Association from 27-29 November, 2014 at RCA, Udaipur (Rajasthan)

Solapur (ORP)

- **Best Poster Presentation Award** to the poster of the paper entitled 'Agro advisories and crop planning on weather basis in Scarcity zone of Maharashtra' authored by J.R. Kadam, J.D. Jadhav, R.V. Sanglikar, S.K. Upadhye, S.B. Thorve and D. B. Bhanavase at National Convention of Agrometerology organized by Association of Agrometeorologists, A.P. Chapter & CRIDA, Hyderabad at CRIDA, Hyderabad during 22-23 January 2013.

Best AICRPDA centre awards and best ORP awards 2014

- **Best AICRPDA Centre Award for 2014 was received** by Biswanath Chariali, Bengaluru and Indore.
- **Best ORP Centre Award for 2014 was received** by Ballowal Saunkhri and Solapur.

Best Dryland Farmer awards 2014 for adaptation and popularization of dryland technology. The awards were received by farmers during XXIV Biennial Workshop AICRPDA held at RVSKVV, Indore on 27th December, 2014.

Name of the farmer	For adaptation and popularization of dryland technology
Sri Pundalik Kisan Chavan, Kajleshwar Village, Akola, District	*In-situ* moisture conservation for higher productivity of soybean
Sri Girish Manikrao Pardhe, Babulgaon Village, Parbhani District	Chickpea + safflower (6:3) intercropping with protective irrigation (sprinkler) from harvested rainwater in farm pond
Sri N. Selvaraj, Thoppureddipatti Village, Thoothukudi District	Tied ridges and furrows for *in-situ* moisture conservation and higher productivity in cotton
Sri Diwakar Chowdary, Girigetla Village, Kurnool District	Rainfed tomato cultivation with *in-situ* moisture conservation
Rakesh Kumar Sharma, Nagla Dulhe Khan Village, Agra District	Ridge planting with ridger seeder for higher productivity of pearlmillet
Smt Kesar Devi, Kochariya Village, Bhilwara District	Rainwater harvesting in farm pond and efficient utilization for higher water productivity
Sri Sukhvinder Singh, Naude Majra Village, Rupnagar District	Improved rained technologies and village seed bank concept
Sri Ishwarappa Mallappa Herkal, Hullur Village, Gadag District	*In-situ* moisture conservation and farm mechanization
Sri Sumer Singh, Ghangala Village, Bhiwani District	Rainwater harvesting and ground water recharge for supplemental irrigation to *rabi* crops
Sri Chaturbhai L Kalola, GadhakaVillage, Rajkot District	*In- situ* incorporation of cotton stalks for better soil health and higher productivity
Sri Harendra Neog, Chasmua Village, Lakhimpur District	crop diversification in rainfed uplands for higher productivity and profitability
Sri Man Singh, Tahkapal Village, Bastar District	Soil and water conservation and dryland horticulture in *Marhan* lands for higher productivity and profitability
Sri Rakesh Singh, RC Nagar Village, Mirzapur District	*In- situ* moisture conservation with ridge and furrow system and green manuring
Sri A.N. Shadakshari, Alanatha Village, Ramanagara District	*In -situ* incorporation of horsegram as green manure crop using rotavator for better soil health and higher productivity
Sri Shrishailya Sudhakar Umbare, Narotewadi Village, Solapur District	Ridge and furrow system for *in situ* moisture conservation for higher productivity of *rabi* sorghum
Sri Om Prakash Singh, Sua Village, Palamau District	Integrated rained farming system for higher productivity and profitability
Sri Prakash Singh Solanki, Ningnoti Village, Indore District	Rainwater harvesting in water tank and efficient utilization for higher productivity and profitability

14. Visitors

Visitors to AICRPDA centres

Name of the visitor	Date of visit
Akola	
P.G. Ingole, Director of Research, Dr. PDKV, Akola	18 July, 2014
B.G. Bathkal, Ex Vice Chancellor, Dr. PDKV, Akola	22 July, 12 September, & 20 October, 2014
R.G. Dani, Hon'ble Vice- Chancellor	29 July &14 August, 2014
R.G. Dani, Hon'ble Vice-Chancellor, P.G. Ingole, Director of Research, V.K. Mahorkar, Director of Extension Education, V.M. Bhale, Dean Agriculture, Dr. PDKV, Akola	20 October, 2014
Akola, Amravati, Washim, Buldhana & Nagpur Districts, Farmers (850)	19-21 October, 2014
David C. Weindorf, Associate Dean for Research and Dov Rober, Citrus expert, College of Agriculture Sciences and Natural Resources Texas Tech University, USA & MASAW, Israel	4 December, 2014
Farmers (50)	22 December, 2014
Farmers (1356)	27-29 December, 2014
Arjia	
O.P. Gill, Vice Chancellor, MPUAT, Udaipur	29 April & 22 August, 2014
P.L. Maliwal, Director of Research, MPUAT, Udaipur	30 June & 18 September, 2014
I.J. Mathur, Director Extension, MPUAT, Udaipur	29 April & 22 August, 2014
S.K. Sharma, Zonal Director of Research, MPUAT, Udaipur	28-29 April, 22 August, 18 September & 15 November, 2014
S.N. Lathi, Registrar, MPUAT, Udaipur	22 August, 2014
G.R. Bunker, Plant Protection Officer, DPPQRS, Sriganganagar	10 October, 2014
G. Ravindra Chary, Project Coordinator, CRIDA, Hyderabad	19 February, 2015
PRI Team, Director of Research, Director Extension, ZDR, KVK PC Chittorgarh & Bhilwara	19 April, 2015
A. Henary, Project Coordinator, Arid Legume (Horsegram), CAZRI, Jodhpur	13 October, 2014
Anuj Kantiya, NABARD & Saraswati Bal Seva Samitee, Sahpura (SHG & *Kisan Klub*)	07 November, 2014
A.K. Sharma, Joint Director, Ag Department, Rampal Khatik, Deputy Director, Ag. Department, Inder Singh Sancheti, P.D., ATMA	05 June, 2014

Chianki	
Hon. K.N. Tripathi, Minister of Rural Development, labour Panchayati Raj and Director Agriculture, Govt. of Jharkhand	22 August, 2014
R.P. Singh, Director of Extension, BAU, Ranchi	13 February, 2015
Phulbani	
David Lin, Research Scientist, Global Foot Print Network, USA, Tapan Patnaik, Chief Manager, IDE (I), Bhubaneswar	14 September, 2014
Vaibhav Bhamoriya, Professor, Centre for Management in Agriculture, IIM, Ahmedabad, Tapan Patnaik, Chief Manager, IDE (I), Bhubaneswar	15 October, 2014
Arjia (ORP)	
O.P. Gill, Vice Chancellor, MPUAT, Udaipur	29 April, 2014 & 22 August, 2014
P.L. Maliwal, Director Research, MPUAT, Udaipur	30 June, 2014 & 18 September, 2014
I.J. Mathur, Director of Extension, MPUAT, Udaipur	29 April, 2014 & 22 August, 2014
S.K. Sharma, Zonal Director Research, MPUAT, Udaipur	28 -29 April, 22 August, 18 September & 15 November, 2014
S.N. Lathi, Registrar, MPUAT, Udaipur, Rajasthan	22 August, 2014
G.R. Bunker, Plant Protection Officer, DPPQRS, Sriganganagar, Rajasthan	10 October, 2014
A. Henary, Project Coordinator, Arid Legume (Horsegram), CAZRI, Jodhpur	13 October, 2014
Anuj Kantiya, NABARD & Saraswati bal Seva Samitee, Sahpura (SHG & Kisan Klub)	07 November, 2014
G. Ravindra Chary, Project Coordinator, CRIDA, Hyderabad	19 February, 2015
Ballowal Saunkhri (ORP)	
G. Ravindra Chary, Project Coordinator, AICRPDA, Hyderabad	20 November, 2014
R.K. Sidhu, Director of Extension, PAU, Ludhiana Harinder Singh, Deputy Director, KVK Rupnagar	09 April, 2015
Chianki (ORP)	
Hon. K.N. Tripathi, Minister of Rural Development, labour Panchayati Raj and Director Agriculture,Govt. of Jharkhand.	22 August, 2014
Georg John, Hon'ble Vice Chancellor, BAU, Ranchi	14 January, 2015
R.P. Singh, Director Extension, BAU	13 February, 2015

15. Project Team

Designation	Name	Tel/Fax/Mobile/E-mail
Director, CRIDA Project Coordinator 1.4.2014 to 31.12.2014)	Ch. Srinivasa Rao	Telefax : 040-24530177 Mobile: 09848848453 E-mail : director@crida.in; cherukumalli2011@gmail.com
Project Coordination Unit, AICRPDA, CRIDA, Hyderabad		
Project Coordinator (Dry land Research) I/c (1.1.2015 to 31.3.2015)	G. Ravindra Chary	Telefax : 040-24530828 Mobile : 09494232600 E-mail pc-dryland@crida.in; rcgajjala@crida.in; gcravindra@gmail.com
Senior Scientist (Agronomy)	K.A. Gopinath	Mobile: 09177506238 E-mail: gopinath@crida.in
Scientist (Computer Application)	R. Nagarjuna Kumar (1.4.2014 to 30.11.2014)	Mobile: 09390288999, 09848848453 E-mail : rnkumar@crida.in; rnagarjunakumar@yahoo.com
Technical Staff		
Chief Technical Officer (Computers)	A. Girija	Mobile: 09849044027 E-mail : agirija@crida.in
Chief Technical Officer (Agronomy)	D. Anantha V. Rao (31.10.2014 to till date)	Mobile: 09291203346 E-mail : anantha@crida.in
Administrative Staff		
Administrative Officer	P. Prakash Babu (1.4.2014 to 31.1.2015)	Mobile: 09441176907 E-mail : ao@crida.in
Lower Division Clerk	V. Venunath (1.4.2014 to 10.12.2014)	Mobile: 09052220008 E-mail : venunath@crida.in
Personal Secretary	N. Lakshmi Narasu	Mobile: 08106413596 E-mail: lakshmin@crida.in
Skilled Support Staff	K. Shankar Reddy	Mobile : 08686199737
	N. Manikya Rao	Mobile : 09246521137

Name of the Centre	Name of the staff	Address
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Name of the Centre	Name of the staff	Address
Maize based production system		
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Ballowal Saunkhri	S.C. Sharma, Chief Scientist Anil Khokhar, Agronomist Satvinder Singh, SWC Engineer Vijay Kumar, Plant Breeder	AICRP for Dryland Agriculture ZRS for Kandi Area Ballowal-Saunkhri P.O. Takarla, (Via) Balachaur, Dist. Hoshiarpur144 521 Punjab Fax: 01885-241601 (O): 01885-241607 Mobile: 09417241604 E-mail: subhash38@yahoo.com
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Sorghum based production system		
Vijayapura	S.C. Alagundgi, Chief Scientist VS. Surakod, Agronomist MS. Shirahatti, SWC Engineer S.T Hundekar, Soil Scientist A.G.Vijayakumar, Plant Breeder	AICRP for Dryland Agriculture Regional Agricultural Research Station UAS Campus, P.B.No.18, Bijapur - 586 101. Karnataka Fax:08352-230545/08352- 230534 (O): 08352-230545R) 08352-267029 Mobile : 09449119087 E-mail: csaicrpdab@gmail.com
Solapur	V.M. Amrutsagar, Chief Scientist B.R. Najan, Plant Breeder N. B. More, Soil Scientist S. M. Dhadge, Agronomist	AICRP for Dryland Agriculture Krishak Bhavan, Near Dayanand College, PB.No.207, Solapur -413 002, Maharashtra Fax: 0217-2373209/2373047 (O): 0217-2373209 (R): 0217-2376988, Mobile: 09421558867 E-mail: zarssolapur@rediffmail.com vijayamrutsagar@rediffmail.com
Pearlmillet based production system		
Agra	S.P. Singh, Chief Scientist Rajesh Kumar Yadav, Soil Scientist PK. Singh, Plant Breeder Md Tahir, SWC Engineer	AICRP for Dryland Agriculture RBS College, Bichpuri, Agra- 283 105 Uttar Pradesh Fax: 0562-2636449 (O): 0562-2636449 (R): 0562-6540634 Mobile: 09997820202 E-mail: spsingh408@gmail.com

Name of the Centre	Name of the staff	Address
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SK Nagar	G.N Patel, Chief Scientist R.N. Singh, SWC Engineer N.I. Patel, Agronomist J.J. Patel, Soil Scientist	AICRP for Dryland Agriculture CWMPR&RE, Sardar Krushinagar Dantiwada Agrl. University, Sardar Krishinagar (SK Nagar) -385 506 Fax: 02748-278397 (O): 02748-278471 (R) 02742-25044, Mobile: 09427065189 E-mail: gnpatelsarsav@gmail.com
Fingermillet based production system		
Bengaluru	B..K. Ramachandrappa, Chief Scientist B.N. Jagdeesh, Plant Breeder A. Sathish, Soil Scientist M.N. Thimmegowda, Agronomist	AICRP for Dryland Agriculture University of Agrl. Sciences GKVK Campus Bengaluru- 560 065, Karnataka Fax : 080-23620795/23330153-348 (O) : 080-23330277 Mobile: 09448936449 E-mail: bkr_agron@yahoo.co.in drylandgkvk@yahoo.co.in
Soybean based production system		
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Statement showing the remittance, expenditure and closing balances for AICRPDA Centres for the year 2014-15

Sl. No.	Name of the Centre	RE for 2014-15	Opening balance as on 1.4.2014	Remittance	Revenue Receipts	Expenditure upto 31.3.2014 (as per AUC for 2014-15)									Closing balance as on 31.3.2015
						Pay & Allow.	TA	RC	NRC	IT	NEH	TSP		Total	
											RC	RC	NRC		
1	Akola (MC)	7315000	-2235467	7315000	0	8899025	59483	578564	0	0	0	0	0	9537072	-4457539
2	Anantapur (MC)	5632000	-1503753	5632000	0	7794650	138147	677389	0	0	0	0	0	8610186	-4481939
3	Arjia (MC)	7143000	-1357619	7143000	0	8294201	57407	214643	0	0	0	831000	0	9397251	-3611870
4	B.Saunkhri (MC)	7315000	-968521	7315000	0	9776448	37982	526498	0	0	0	0	0	10340928	-3994449
5	Bangalore (MC)	7220000	-4024243	7220000	0	7571190	63635	471199	0	0	0	0	0	8106024	-4910267
6	Bijapur (MC)	7420000	-3862876	7420000	0	8936685	114010	446747	0	0	0	0	0	9497442	-5940318
7	S.K.Nagar (MC)	7960000	-238942	7960000	0	8397900	30000	80000	0	0	0	617619	0	9125519	-1404461
8	Hisar (MC)	6907000	-5059240	6907000	0	8071875	32270	71175	0	0	0	0	0	8175320	-6327560
9	Indore (MC)	10306000	-3533500	10306000	0	10966907	59515	411771	0	0	0	537619	0	11975812	-5203312
10	Jagdalpur (MC)	6690000	-205553	6690000	0	5043156	136683	791506	0	0	0	2169953	0	8141298	-1656851
11	B. Chariali (MC)	13640000	-3834955	13640000	0	7354120	105285	494779	0	0	5403402	1978041	499122	15834749	-6029704
12	Kovilpatti (MC)	7105000	-1772845	7105000	0	7802617	34804	401639	0	0	0	0	0	8239060	-2906905
13	Parbhani (MC)	5007000	-1913108	5007000	0	5018231	26247	272147	0	0	0	0	0	5316625	-2222733
14	Phulbani (MC)	3893000	1524884	2263566	0	2762775	31300	179556	0	0	0	351520	0	3325151	463299
15	Chianki (MC)	2825000	3319272	987000	0	2340356	31120	244221	0	0	0	1162367	0	3778064	528208
16	Rewa (MC)	5920000	-312470	5920000	0	7910779	41471	439357	0	0	0	0	0	8391607	-2784077
17	Solapur (MC)	7140000	-4135840	7140000	0	9545645	45340	360310	0	0	0	0	0	9951295	-6947135
18	Targhadia (MC)	7912000	-3273293	7912000	87342	6314285	99865	362506	0	0	0	0	0	6776656	-2050607
19	Varanasi (MC)	9616000	-6223947	9616000	0	9588377	96216	365909	0	0	0	0	0	10050502	-6658449
20	Agra (SC)	6120000	-413447	6120000	10634	5890240	12459	89980	0	0	0	0	0	5992679	-275492
21	Faizabad (SC)	5307000	-1539261	5307000	0	3764394	3185	117666	0	0	0	0	0	3885245	-117506
22	R.Dhiansar (SC)	3598000	205000	3598000	0	4776000	24000	171000	0	0	0	0	0	4971000	-1168000
23	Anantapur (ORP)	2105000	-595606	2105000	0	4113230	43462	197290	0	0	0	0	0	4353982	-2844588
24	Arjia (ORP)	3250000	-3082368	3250000	0	5476261	62986	202721	0	0	0	0	0	5741968	-5574336
25	B.Saunkhri (ORP)	3120000	-1156409	3120000	0	2903976	35018	228617	0	0	0	0	0	3167611	-1204020
26	Bangalore (ORP)	2630000	-1414615	2630000	0	1965299	26653	315875	0	0	0	0	0	2307827	-1092442
27	Hisar (ORP)	2670000	-3183700	2670000	0	3103452	20244	81898	0	0	0	0	0	3205594	-3719294
28	Indore (ORP)	3930000	-3437675	3930000	0	5053791	32194	96290	0	0	0	0	0	5182275	-4689950
29	Chianki (ORP)	34000	3455504	2000	0	0	0	28553	0	0	0	0	0	28553	3428951
30	Solapur (ORP)	3630000	-2248221	3630000	0	3816493	39196	147400	0	0	0	0	0	4003089	-2621310
31	PC Unit	1140000	0	1140000			140000	1000000	0	0				1140000	0
	Total	174500000	-53022814	171000566	97976	183252358	1680177	10067206	0	0	5403402	7648119	499122	208550384	-90474656

Acronyms

AESR	Agroecological Subregion
AEY	Anola Equivalent Yield
AICRPAM	All India Coordinated Research Project for Agrometeorology
AICRPDA	All India Coordinated Research Project for Dryland Agriculture
ANGRAU	Acharya NG Ranga Agricultural University
ARS	Agriculture Research Station
ATER	Area Time Equation Ratio
ATMA	Agricultural Technology Management Agency
AWC	Available Water Capacity
Bo	Boron
CAEY	Custard Apple Equivalent Yield
CAZRI	Central Arid Zone Research Institute
CCSHAU	Chaudhury Charan Singh Haryana Agricultural University
CCT	Continuous Contour Trenches
CD	Critical Difference
CEC	Cation Exchange Capacity
CEY	Castor Equivalent Yield
CGIAR	Consortium Groups on International Agricultural Research
CP	Country Plough
CR	Crop Residue
CRI	Crown Root Initiation
CRIDA	Central Research Institute for Dryland Agriculture
CSI	Chlorophyll Stability Index
CSIR	Council of Scientific and Industrial Research
CSWCR&TI	Central Soil and Water Conservation Research & Training Institute
CT	Conventional Tillage
CUM	Cubic Meter
DAP	Days After Planting
DAS	Days After Sowing
DBHR	Days Before Harvesting of Rice
DFRS	Dryland Farming Research Station
DH	Disc Harrow
DMR	Directorate of Maize Research
DOR	Directorate of Oilseeds Research
DRDO	Defence Research Development Organization
DRR	Directorate of Rice Research

DSI	Drought Susceptibility Index
DSR	Directorate of Sorghum Research
DTE	Drought Tolerance Efficiency
DTPA	Diphenyl Triamine Penta acetic Acid
EC	Electrical Conductivity
ER	Effective Rainfall
FB	Flat Bed
Fig.	Figure
FL	Family Labour
FLD	Front Line Demonstration
FP	Farmers' Practice
FYM	Farmyard Manure
GEY	Groundnut Equivalent Yield
GEY	Ginger Equivalent Yield
GIS	Geological Information System
GLM	Greenleaf Manure
GMR	Gross Monetary Returns
GRD	General Recommended Dose
HC	Hydraulic Conductivity
HL	Hired Labour
HP	Horse Power
HW	Hand Weeding
HYV	High Yielding Variety
ICAR	Indian Council of Agricultural Research
ICRISAT	International Crops Research Institute for Semi-Arid Tropics
IF	Inorganic Fertilizer
IFS	Integrated Farming System
IGAU	Indira Gandhi Agricultural University
IGFRI	Indian Grassland and Fodder Research Institute
IIVR	Indian Institute of Veterinary Research
IMD	Indian Meteorological Department
INM	Integrated Nutrient Management
IP	Improved Practice
ITK	Indigenous Technical Knowledge
IVT	Initial Varietal Trial
JAU	Junagadh Agricultural University
JNKVV	Jawaharlal Nehru Krishi Vishwa Vidyalaya
KVK	Krishi Vigyan Kendra
LAI	Leaf Area Index

LDV	Long Duration Variety
LER	Land Equivalent Ratio
LPA	Long Period Average
LR	Lime Requirement
LT	Low Tillage
MAI	Monetary Advantage Index
MANAGE	National Institute of Agricultural Extension Management
MAU	Marathwada Agricultural University
MCEY	Main Crop Equivalent Yield
MEY	Maize Equivalent Yield
MJ	Mega Joule
MLT	Multi Location Trial
MoR	Ministry of Rural Development
MoWR	Ministry of Water Resources
MPKV	Mahatma Phule Krishi Vidyapeeth
MPUA&T	Maha Rana Pratap University of Agriculture & Technology
MSL	Mean Sea Level
MUSLE	Modified Universal Soil Loss Equation
NAARM	National Academy of Agricultural Research Management
NAIP	National Agricultural Innovation Project
NAU	Navsari Agricultural University
NB	Nala Bund
NDUAT	Narendra Dev University of Agriculture & Technology
NHM	National Horticulture Mission
NICRA	National Innovation on Climate Resilient Agriculture
NMR	Net Monetary Return
NRCG	National Research Centre on Groundnut
NRM	Natural Resource Management
OC	Organic Carbon
ORP	Operational Research Project
OT	Off-Season Tillage
OUAT	Orissa University of Agriculture & Technology
OW	Open Well
PAU	Punjab Agricultural University
PC	Project Coordinator
PDKV	Dr. Panjabrao Deshmukh Krishi Vidypeeth
PET	Potential Evapotranspiration
PEY	Pigeonpea Equivalent Yield
PMT	Permanent Manurial Trial

POP	Package of Practices
PR	Paired Row
PRI	Productivity Ration Index
PSB	Phosphate Solubilizing Bacteria
QRT	Quinquennial Review Team
RDF	Recommended Dose of Fertilizer
RDN	Recommended Dose of Nitrogen
REY	Rice Equivalent Yield
RF	Rainfall
RI	Residue Incorporation
Rs.	Rupees
RSR	Recommended Seed Rate
RT	Reduced Tillage
RWP	Rainwater Productivity
RWUE	Rainwater Water Use Efficiency
SAU	State Agricultural University
SCMR	SPAD Chlorophyll Meter Reading
SD	Standard Deviation
SDV	Short Duration Variety
SEY	Sesamum Equivalent Yield
SHGs	Self Help Groups
SK Nagar	Sardarkrushi Nagar
SKDAU	Sardar Krushinagar Dantiwada Agricultural University
SKUAS&T	Sher-e-Kashmir University of Agricultural Science & Technology
SMW	Standard Meteorological Week
SOC	Soil Organic Carbon
SSNM	Site Specific Nutrient Management
STBF	Soil Test Based Fertilizer
SW	South-West
SWC	Soil Water Conservation
SYI	Sustainable Yield Index
TNAU	Tamil Nadu Agricultural University
TSP	Tribal Sub-Plan
UAS	University of Agricultural Sciences
VC	Vermicompost
WCE	Weed Control Efficiency
WEY	Wheat Equivalent Yield
WHH	Wheel Hand Hoe
WI	Weed Index
Zn	Zinc
ZT	Zero Tillage

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