NATIONAL AGRICULTURAL TECHNOLOGY PROJECT

Rainfed Agro-Ecosystem

Technology Assessment and Refinement through Institute Village Linkage Programme

COMPLETION REPORT
1999-2004

Agro-Ecosystem Directorate (Rainfed)
Central Research Institute for Dryland Agriculture
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Preface

The Rainfed Agro-Ecosystem occupies a distinct place in Indian agriculture, as it constitutes nearly 67% of net sown area contributing 44% of food grain production and supporting 40% population. Despite concerted efforts made in the past to improve the productivity of these areas by transferring improved technologies, gains in terms of higher yield and income have not been spectacular due to associated risks like aberrant weather, land degradation and poor socio-economic base of the farmers. Small and marginal farmers in rainfed areas have little surplus income to invest in a new technology and inputs.

Usually, technology development stops with laboratory and or research stations. Many farm technologies have the signature of the scientist concerned but the requirements of farmers are rarely considered. Hence, the benefits of research are not always commensurate with the efforts put in. Farmers participation is key to successful adoption of improved agricultural technologies. Unlike the top down traditional approach, the farmer and the farm assume central place in the present form of technology transfer. Improving crop productivity with declining natural resource quality and increasing off-farm activities to generate additional income are real challenges in rainfed farming. This could be possible only if the scientists and farmers work together in the field sharing their knowledge and experiences.

Keeping this aspects in view, the Indian Council of Agricultural Research has launched a project on "Technology Assessment and Refinement through Institute Village Linkage Programme (TAR-IVLP)" under the National Agricultural Technology Project (NATP). The Rainfed Agro-Ecosystem Directorate of the NATP at CRIDA has implemented the programme at 24 centers across the country. The main objectives of this programme was to achieve stability and sustainability of production in rainfed areas. Key methodologies in this innovative programme include Participatory Rural Appraisal, focus group interactions, prioritization of the problems and development of action plans with involvement of the farmers and implementation of the technology modules pertaining to the assessment and refinement of technologies for wider adoption in rainfed areas.

The on-farm research programmes under TAR-IVLP are mainly based on farmers perspective and implemented with their active involvement. The analyses of the experiences at 24 TAR-IVLP centers across the country provide an insight in to the problems faced by the farmers and the ability of the farmers to draw plans to improve their livelihoods and to achieve the desired goals of improved productivity. I have no doubt that the experiences described in this report shall set a new trend in the participatory on-farm research in India.

This report contains a comprehensive account of the progress made by the TAR-IVLP project during 1999-2005. I compliment Dr.G.Subba Reddy, Fecilitator, TAR-IVLP programme, Dr.B.Venkateswarlu, PPSS, and Dr.A.K.Mishra, Senior Scientist (LPM) for their efforts in compilation and synthesis of this final report. Dr.I.A.Khan, Principal Scientist, Drs.Balloli, M.Srinivasa Rao and Ch.Srinivasa Rao Senior Scientists and Dr.M.Prabhakar, Scientist (Sr.Scale) have also contributed significantly in editing/correcting the report along with the core team members.

The TAR-IVLP was ably supported by Finance Officers Mr.P.V.Epachan, Mr.S.K.C.Bose, Mr.P.Bala Brahmaiah and Mr.G.Lakshminarayana, Assistant Administrative Officer. The Technical and Secretarial staff who contributed for the success of project include Dr.G.Ramesh, Research Associate, Ms. P.Lakshmi Narasamma, T-6, Ms. Hemlata Kapil, T-4, Ms.M.A.Rekha, Stenographer and Mr.K.R.Srinivas Rao, Assistant whose help is duly acknowledged.

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October, 2005

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Executive Summary

The Rainfed agro ecosystem in India is very diverse and unique. It represents nearly 67% of net sown area, contributes 44% food grain production and supports nearly 40% of human and 65% of livestock population, thus playing an important role in Indian Agriculture. Aberrant behavior of monsoon, low and degraded soils with multiple nutrient deficiencies, poor resource base of farmers are important constraints affecting productivity, profitability and sustainability. Despite concert efforts made in the past through research and technology transfer, the gains in terms of higher yield and income have not been spectacular due to associated risks. Small and marginal farmers who dominate in rainfed ecosystem have little surplus income to invest in a new technology and inputs.

Usually, new technologies did not move forward from laboratories and research stations to the clientele. The technologies developed at research station seldom considered the requirements of farmers. Hence, the benefits of the research were rarely commensurate with the efforts put in. Farmers' participation is key to the successful adoption of the improved agricultural technologies. Unlike the top - down approach traditionally, the farmer and the farm assume central place in the present concept of technology transfer. Improving crop productivity with declining natural resource quality and increasing off-farm activities to generate additional income are real challenges in rainfed agro ecosystem. This could be possible only if scientists and farmers work together to achieve the goals.

Keeping these aspects in view, the Indian Council of Agricultural Research (ICAR) launched a project on "Technology Assessment and Refinement through Institute Village Linkage Programme (TAR-IVLP)" in 1999 under the auspices of the National Agricultural Technology Project (NATP). The Directorate of Rainfed Agro Ecosystem at Central Research Institute for Dryland Agriculture (CRIDA) implemented TAR-IVLP through 24 ICAR/SAU centers in five production systems viz., rainfed rice (Ranchi, Raipur, Cuttack, Koraput, Hassan and Nagaon), oil seeds (Junagadh, Bhopal, Bharatpur, Indore and Jabalpur), cotton (Akola, Nagpur, Warangal and Ajmer), nutritious cereals (Hyderabad, Bangalore, Solapur, Vengurle, Dharwad, Jhansi, Udaipur and Nagpur) and pulses (Kanpur). The main objective of the programme was to assess the potentials of rainfed technologies through verification trials and refinement of technologies under different micro farming situations through on-farm trials with active involvement of farmers. A multi disciplinary team was constituted at each center to implement the programme. The programme started with the selection of target villages, agro eco system analysis, problem diagnosis, action plan for technology intervention, technology assessment and refinement through farmer's participation.

Under this directorate 3,029 technological interventions covering 25,323 ha with participation of 72,274 farmers covering 423 villages were implemented over a period of five years. The interventions covered the theme areas of natural resource management, crops and cropping systems, integrated nutrient management, integrated pest management and livestock management. Agroforestry and farming systems help to bring sustainability and profitability in rainfed areas. More than 126 technological interventions have created greater impact in terms of productivity, net returns, adoption and technology spread. Efforts were made to refine the technologies suitable for varied micro farming and social conditions of the farming community.

In the rainfed rice based production system, 841 technological modules were evaluated covering 8,943 ha with 29,088 farmers in 166 villages. The rice varieties

assessed best are IR-64 and *Poornima* in uplands (Raipur), Sali varieties of *Satya* and *Basundhara* (Nagaon), *Brown Gora* in upland *Tnar-II and Tnar-III (*Ranchi), KRH-2 (Hassan), *Pooja* and CR 260-77 in Jholla lands (Koraput), *Vandana, Kalinga-III* and *Annada* in uplands and *Gayatri, Uthkalaprabha* and *Sarla* in lowlands (Cuttack) and IR-64, *Satya* and *Vasundhara (*Raipur). All these improved varieties enhanced the grain yield and profitability upto 65% compared to the locals. Rice-cucurbits system became popular among 25% of the farming community at Ranchi, while rice+pigeonpea (4:1) was adopted on large scale by majority of farmers at Cuttack by replacing mixed cropping of rice and pigeonpea. Based on the results of the TAR-IVLP at Cuttack, the state Dept. of Agriculture included this system as a package of practice in their *kharif* programme. In medium lands, wheat with recommended dose of fertilizer (100:50:40 NPK /ha) was adopted by 70% of the farmers at Ranchi. Gliricidia mulch @ 5t/ha with bio-fertilizer (PSB and *Azospirillum*) enhanced the yields by 20% over farmer's practice of 50 kg N/ha. This technology was found simple and adopted by 60% of the farming community in the project villages of Koraput. At Raipur, use of green manure with *dhaincha* in rice reduced the cost of production by 29%. About 30% of rice area in the IVLP villages was covered with this technology. Bunding in upland rice fields, line sowing across the slope after opening a furrow at 5 m interval, line seeding behind the country plough with improved beaushening at Cuttack enhanced the productivity of rice by 15-45% over farmers' practice. Use of adjustable power-operated, multi-crop intercultivator, multi-crop thresher for paddy at Hassan, line sowing of rice by Bhormder seed drill at Raipur reduced the time of operation by 50 and 30%, respectively. Rice-fish culture with improved fish species of Rohu, Mrigal, Katla and Carps with 1:1:1:1 ratio at Nagaon and improved rice (IR-64) + fish (mixed carp) – wheat (PBW–443), fish-cum-pig and fish-cum-duck at Ranchi enhanced 100% net returns as compared to rice alone. At Ranchi, feeding of top feeds of pepal, jamun and pakar leaves with mineral mixture (Agrimine @ 30g/ animal) along with wheat bran for 30 days enhanced the milk yield of cow by 150% over farmers practice. Introduction of improved buck of *Beetal*, Black Bengal and crossbred (Tamworth x *desi*) breed increased the weight at maturity compared to the farmers' practice. At Koraput, *Vanaraja* poultry birds in backyard, upgradation of local goats using Serohi buck and oyster mushroom cultivation technologies were diffused to the neighboring districts of Rayagada, Nawarangpur and Malkangiri due to additional employment and income for the farm women.

In the oilseeds-based production system, 444 technology modules were implemented in 4,092 ha with 7,776 farmers in 83 villages. Improved varieties of soybean JS-90-41 and NRC-37 (Indore), pearl millet ICMH-356 (Bharatpur), soybean (NRC-37 and MAUS-47), potato (*Chip Sona, Kufri Sindhuri)* at Jabalpur recorded 30-50% of higher seed yields as compared to respective local varieties under rainfed environment. About 20% of farm families in the project villages adopted the variety JS 90-41 by replacing existing variety (JS-335) at Bhopal. Soybean + maize (4:1) and soybean + pigeon pea (4:2) at Bhopal, soybean + maize (4:2) at Indore were found profitable cropping systems (40-60%) over respective sole crops. Graded bunds and line sowing across the slope gave higher yield (11-15%) in soybean at Jabalpur. Recommended dose of fertilizer (50:50:30 kg NPK/ha) along with contour cultivation enhanced the productivity of rainfed wheat by 17% over recommended fertilizers alone. About 34% and 19% of farmers in the project and neighboring villages have adopted this technology to get stable yields.

At Junagadh, eco-friendly bio-pesticides (Azadirachitin) and bio-control agents such as *Trichoderma* reduced the incidence of major diseases of collar rot (65%) stem rot (54%) leaf spot (36%) in groundnut compared to farmers practice. At Bhopal, two sprays of Nimbecidin (0.05%) in chickpea reduced the pod borer incidence (15%) and increased the seed yield and net returns (20%) compared to the farmers' practice of one spray of Endosulphan. This technology was adopted by 34% and 20% of the farmers in project and neighboring villages, respectively. Drudgery of farm women was reduced (40-60%) by use of hand weeders, maize cob sheller, Naveen sickle and groundnut decorticator. The technology of agri horti system, soybean-cauliflower in guava gave highest net returns followed by soybean-chickpea and lemon grass at Bhopal. Feeding of treated wheat straw with 4% urea, 3% jagery and 1% of salt was beneficial and produced 41% higher milk yield in cows at Bhopal.

In the cotton-based production system, 444 technology modules were introduced in 4,484 ha with involvement of 11,806 farmers in 53 villages. The improved varieties of cotton i.e., PKV-*Rajat* in medium black soils (Akola), *Narasimha* (Warangal), *Bikaneri Nerma* (Ajmer), AKH-84635 and LRK-156 (Nagpur) recorded 40–50% higher yields compared to the local varieties. The PKV-*Rajat* variety was spread in 80% of the farmers' field area. Sowing across the slope and in alternate furrows (Akola), formation of ridges and furrows (Nagpur) in cotton were adopted by the farmers in 425 and 610 ha, respectively. The IPM modules in cotton were adopted in 60 ha representing 55 farmers at Nagpur. At Warangal agri- sheep farming @ 10 lambs per unit, maize + cowpea, sorghum (fodder)-cowpea gave additional income of Rs.9,258/ha/unit as compared to the arable crop of cotton alone (Rs.21,408/ha).

Under nutritious cereals-based production system, 1,179 technology modules were undertaken covering 6,628 ha of area with the involvement of 20,530 farmers in 113 villages. Improved varieties of sorghum (CSV-15), pigeonpea (*Asha*), castor (*Kranti* and *Jyothi*) in rainfed alfisols at Hyderabad; groundnut (*Konkan Gouri* and *Phule Pragathi*), horse gram (*Dapoli-1*) at Vengurle; sunflower (SS-56), sorghum (*Mouli*), onion (N-2-4-1) and tomato (*Dhanashree*) in vertisols of Solapur; littlemillet (TNAU-63), mungbean (*Sel*-4) and potato (*Kufri Pukhraj*) at Dharwad; groundnut (ICGS-44 and TAG-24), soybean (PK-1042), sorghum (CSV-15), tomato (PDVR-2 and *Kalyanpur* T-1), wheat (HD-2189, HD- 2284, WH-147) and maize composite (*Surya*) at Jhansi registered yield increment and profitability (30-70%) compared to the respective local varieties. Sorghum+pigeonpea (3:1) at Hyderabad, 60% area of finger millet and 40% area with pigeonpea/ dolichos, fingermillet + pigeonpea/dolichos and intercropping of coriander and french bean in banana at Bangalore, sunflower + pigeonpea (2:1) at Solapur, littlemillet+ pigeonpea (5:1) and relay cropping of horsegram with littlemillet at Dharwad were found efficient to get higher profits (30-60%) under different micro farming situations. At Hyderabad, about 60% of small and marginal farmers adopted simple soil conservation measures like additional interculture and conservation furrows for stability of production in rainfed crops. While medium and big farmers showed preference to adopt top dressing of nitrogen @ 10 kg/ha to mitigate the drought effects in sorghum and castor. CRIDA planter improved the plant stand by 20% as compared to the country plough in maize and pigeonpea system besides saving time of coverage by 300% and labour cost by Rs. 200/ha. A marginal farmer having an area of 0.4 ha of each under cotton (*Bunny*), and maize + pigeonpea system along with one milch animal could get net returns of Rs. 3,275/- with an investment of Rs.1,460/- on his

farm. At Bangalore, use of blast resistant variety of fingermillet (GPU-28) with improved nutrient and conservative technology recorded 3.8 t/ha towards food security of small and marginal farmers. As a result, the farmers in the project villages diverted 30-40% of area for cash earning crops like dual-purpose pigeonpea, dolichos bean, maize and drumstick. Use of *Trichoderma* for nematode control was spread to the farmers up to 25 km from the adapted village. About 60% area of traditional sorghum at Dharwad was shifted towards cultivation of soybean by the farmers in the project area for higher and stable yields.

In the pulse-based production system at Kanpur, 121 technology modules were implemented in 1,206 ha with involvement of 3,074 farmers in 8 villages. The major thrust was on the use of Rhizobium culture in chickpea and mixed cropping. About 20% of the chickpea growing farmers in the IVLP village used Rhizobium culture with 10 kg nitrogen + 20 kg P_2O_5/ ha. Intercropping of chickpea + linseed (6:2) has given 30% higher profit over farmers' practice. Similarly, lentil varieties DPL-62 followed by IPL-81 (rainfed Vertisols) have not only showed higher productivity over local varieties (35 %), but also were tolerant to root wilt. In mung bean–wheat crop rotation, 75% of area of wheat was covered with Lok-1 variety followed by Raj-1555. As a part of the seed village concept, area under improved seeds of pigeon pea, urdbean, mungbean, sesame, chickpea, lentil, fieldbean, wheat and mustard enhanced from 30 to 170, 25 to 265, 3 to 42, 8 to 36, 180 to 430, 60 to 157, 3 to 17, 190 to 280 and 10 to 95 ha, respectively over the period from 2000-2004.

Site Committee Meetings (26), Peer Review Team (4), Annual Workshops (11) and publication of Annual Progress Reports (120) and frequent visits of core team members of Directorate (RF) facilitated in finalizing the technical programme, budget utilization, procurement of equipments and implementation of technological module as per the mandate of the project.

The 24 centers have assessed and refined 126 technologies through 3,029 on-farm trials covering the area of 25,323 ha involving 423 villages. Besides, these centers documented 87 success stories covering rainfed rice (26), oilseeds (13), cotton (13), nutritious cereals (32) and pulses based production systems (3) in different theme areas. These success stories were published to bring more awareness on profitability of rainfed technologies.

Training programmes (1,185) were organized by the 24 IVLP centers covering (40,925) farmers during 1999-2005. The themes covered are crop production, cropping systems, integrated pest management, natural resource management, dryland horticulture, livestock, poultry, aquaculture, entrepreneurship and income generating activities for improvement of skills leading to better livelihoods. Besides imparting knowledge through training, dissemination of technology was made by releasing pamphlets, leaflets, folders, bulletins, radio talks and TV coverage in Telugu, Kannada, Oriya, Hindi, Marathi and English (191).

The TAR-IVLP has proved to be successful in making farmers as partners of research. It helped in generating appropriate technologies suiting the micro environment situation and socio economic conditions of farmers. It provided valuable experience in participatory research and created an impact on mind set of the scientists to conduct need based farmers participatory action research. This project made an excellent impact on adoption and diffusion of the technologies in IVLP and neighboring villages to improve productivity, profitability and sustainability in rainfed farming communities.

CHAPTER

1

Introduction

Rainfed agro eco-system in India occupies 66% of the net cultivated area, supports 40% population and contributes 44% to the food basket. This system also supports two-thirds of India's livestock population. The farming systems are complex, diverse and risk prone and instable in biological productivity. The agro ecosystem is dominated by small and marginal farmers with degraded lands and acute shortage of fodder for livestock. Farmers are resource poor with inadequate infrastructure and credit support and are unable to improve their livelihoods due to low and unstable income. Adoption rate of new technologies in rainfed areas is low due to poor investment capacity and inadequate extension support.

Unlike in irrigated agriculture, development in rainfed agriculture is based on resource capability and its management. It is, therefore, increasingly recognized that alignment of research objectives with local agricultural and resource management practices through participatory approach is the best method to develop appropriate farmer-oriented technologies. With unabated growth of human and livestock population, the productivity in this region has to be raised on a sustainable basis from 0.8 to 2 t/ha to meet the requirements of the people. Even though it is an uphill task, concrete efforts are needed in this direction by facilitating technology adoption by all categories of the farming community.

1.1 Concept of TAR - IVLP

Technology Assessment and Refinement (TAR) refers to the process or a set of activities needed to be taken up before the dissemination of any technology in a new production system. Since, the situation under which a given technology is developed differs from those operated by the users (farmers), research information is to be reviewed in terms of specific needs, opportunities and constraints faced by the farmers. It is often realized that the reasons for low acceptance of technologies are that they are neither economically viable, operationally feasible, stable nor match with the farmers' needs and are compatible with the overall farming system. This would, therefore, call for more scientist-farmer linkages for better understanding of the farming situation and adequate perception of farming community and their needs.

Keeping these aspects in view, the Indian Council of Agricultural Research (ICAR), in 1999, launched a project on "**Technology Assessment and Refinement through Institution Village Linkage Programme**" under National Agricultural Technology Project (NATP). The Rainfed Agro-Ecosystem component of this TAR-IVLP project covered 24 network centers and paid greater emphasis on the farmers' needs, resources and local environment. The farmer was treated as an active partner, both at decision making and implementation stages. The overall objective of the programme was to integrate appropriate technologies in which stability, sustainability and equitability concerns were addressed.

1.2 Extent and Scope

In order to critically analyze crop and area specific problems and potentials, the rainfed areas have been divided into five homogenous production systems: rainfed rice, nutritious (coarse) cereals, oilseeds, pulses and cotton. The activities of Technology Assessment and Refinement (TAR) project as assigned to specific production system centers (24), and were coordinated by Central Research Institute for Dryland Agriculture (CRIDA), Hyderabad.

Each center, depending on the appropriateness, focused on 8 major themes: natural resource management (NRM), varietal evaluation and cropping system (CS), Integrated Nutrient Management (INM),

Integrated Pest Management (IPM), Livestock Production System (LPS), Alternate Land Use System (ALU), Post Harvest Value Addition (PHVA) and Post Harvest Technology (PHT). The technologies generated in these theme areas were prioritized and upscaled to the extension system in the district including 24 pilot districts identified for implementation of innovative technology dissemination (ITD) project through Agricultural Technology Management Agency (ATMA).

1.3 Objectives

Two of the main objectives of NATP was to enhance the performance and effectiveness of research scientist in response to location specific needs of the farmers, and to support agro- eco region specific research by TAR-IVLP. Specific objectives of the latter were:

- To assess the farmers needs and identify potential of various technologies by understanding local agricultural and environmental conditions and knowledge on production systems
- To assess the impact of refined technologies in different production systems
- To identify extrapolation domains and outer limits for new technology modules and strengthen linkages with the extension system in the district, and
- To address gender specific issues.

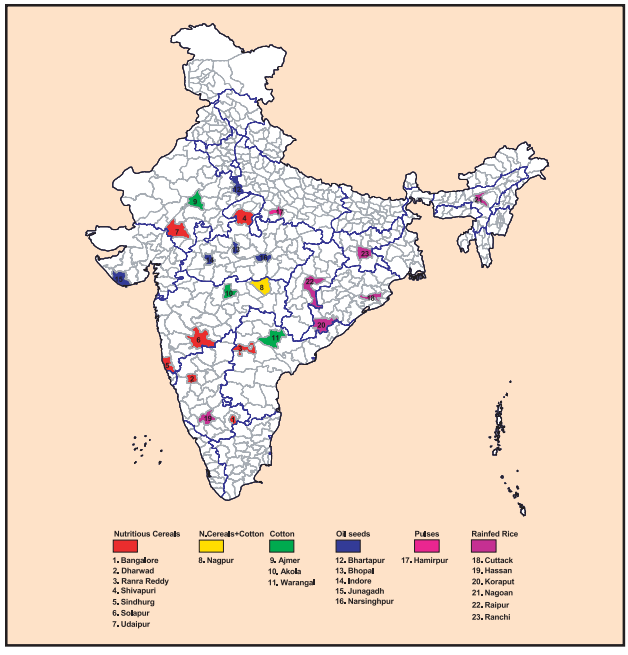


Fig 1. Location of TAR-IVLP centers

1.4 Methodology

Selection of Villages

A village was selected as a unit of operation at each center. The villages were chosen which best represented that particular eco-region for soil, rainfall, crops and production system, lack of urban influence, absentee land lordism, and community comprising of several religions, castes, socio-economic status, etc. and with little or no impact of modern agricultural techniques. Importance was given for selection of those villages which had cooperatives, schools and panchayat to forge better links. In addition, factors such as proximity to the implementing agency, willingness of farm families and options of political/social/class conflicts were also considered.

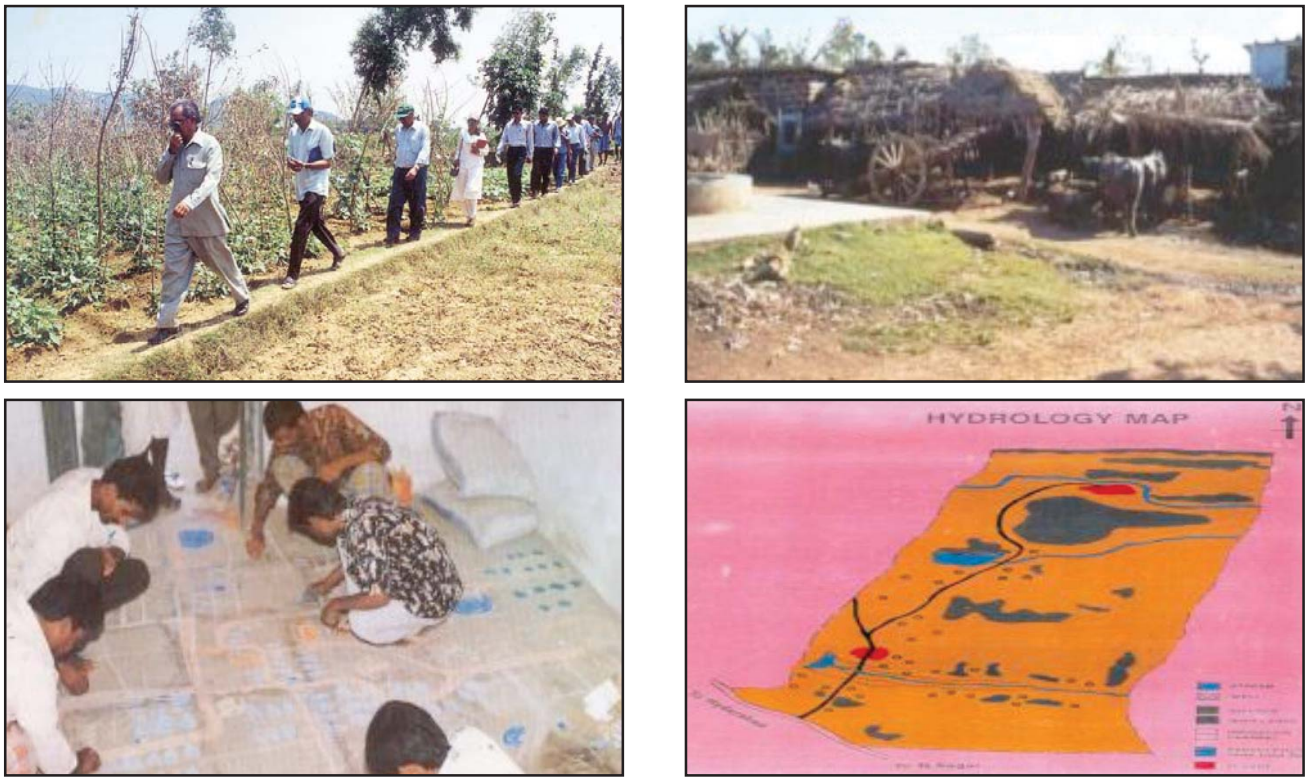
Constitution of Multidisciplinary Teams

The project was implemented at each center by several ICAR institutes and state agricultural universities (SAUs) through a 4-5 members multidisciplinary core team of scientists, led by a Principal Investigator. The TAR-IVLP at each center also envisaged an optional team of scientists drawn from other institutes to look into specific issues while implementing the programme.

Agro-eco System Analysis

This project was developed on the basis of participatory rural appraisal (PRA) and participatory learning and action (PLA). The key principles followed were participation, flexibility, teamwork, and optimal ignorance and appropriate imprecision. A complete picture of the local agro ecological conditions of each project area was evaluated to provide sufficient background information about the land and the people.

The information collected through PRA/PLA exercises for agro eco-system analysis helped in identification and prioritization of farmers' problems and their bio-physical and socio-economic causes. Based on this, appropriate technical interventions were decided in focus group discussions facilitated by scientists. These



Assessment of resources of farmers by agro-ecosystem analysis

interventions were broken down into specific action plans for on-farm and verification trials with appropriate treatments and local checks for assessment and refinement. The technologies generated under PSR and core programmes of NARS were evaluated not only for their technical and economic performance but also for compatibility with socio-economic and cultural circumstances and needs of farm families.

In order to understand the status of project villages, the teams conducted *spatial pattern* analysis and obtained information through direct observations, interviews, group discussions and diagramming techniques besides consulting secondary data from concerned developmental agencies operating near by. *The social and resource maps* of selected villages in each IVLP centre gave a fairly good idea about the settlement pattern of houses, infrastructure facilities, religious, social and educational institutions, services, co-operative societies, banks, hospital etc. These maps also indicated land utilization patterns and available irrigation sources.

The multi-disciplinary team in each IVLP centre carried out village transects with active participation of farmers to understand topography, soil type, crops grown, livestock reared and irrigation sources for assessment of the agricultural scenario of the area. *Time line analysis* was done to study the changes that occurred in the cultivation of crops, incidence of pests and disease, availability of labour, fodder and credit, rainfall pattern, productivity of various crops, institutional structure and infrastructure over a period /seasons in the project villages.

Information on inflow and outflow of resources was gathered from farmers to know the extent of their demand for seeds, fertilizers, pesticides, fuel wood, farm yard manure, cattle feed, etc within and outside. This revealed how much produce was sold and marketed in and outside the villages. A clear picture of the assets/ resources like tube wells/open wells/tanks, livestock and other subsidiary enterprises unfolded before the scientists. The analysis also indicated farm machinery and implements, transport facilities and household gadgets available in the village. *Mobility map* and *Venn diagram* were used to ascertain access of farmers to developmental

institutions like school, agriculture information centre, hospital, development offices, power distribution center, market and panchayat. Similarly, *livelihood analysis* was also done by each center for knowing the sources of income and expenditure pattern.

Decision analysis method was used at the stage of preparing action plans and during implementation to ascertain farmers' preferences in the selection of farm enterprises, crops and varieties, etc. Finally, appropriate matrices were developed by the scientists to make decisions.

Problem Diagnosis and Technological Interventions

Based on information generated from agro ecosystem analysis (AESA) and focus group discussions, the problems of various enterprises in terms of bio-physical and socio- economical causes were identified for each center. These were prioritized considering farmers needs and resources. A listing of technologies was made both already tested on farmers fields and on station research for assessment and refinement.

Action Plan

Based upon agro ecosystem analysis and prioritization of problems as perceived by farmers at each center, action plans were developed for different micro farming situations for assessment of potential technologies through verification trials and refinement of technologies through on farm trials. The core team in association with farmers, then decided upon the nature of interventions, based on identification of problems and available technologies under each production system.

Implementation of the Programme

Technological modules pertaining to arable cropping, agroforestry and livestock farming were implemented after identifying homogenous groups. The output was documented in terms of biophysical, economical and social parameters at each center from 1999-2005.

Site Committee Meetings

Action plans were discussed in the site committee meetings to improve the nature of interventions and for proper implementation including site selection and project report submission as per the guidelines of NATP.

Monitoring and Evaluation

Monitoring and evaluation exercises were initiated as per the NATP guidelines at the agro-ecosystem directorate. The technical programme of different IVLP centers under different production systems was discussed and finalized every year under the chairmanship of Deputy Director General, Extension (ICAR) and Director, AED (RF). The peer review teams visited TAR-IVLP centers to monitor the progress of the project and to make specific recommendations. Progress of the centers was also monitored through organizing workshops at agro-ecosystem directorate headed by Project Monitoring Unit of Division of Agriculture Extension, ICAR. Details of the TAR-IVLP centers under rainfed agro ecosystem are given in **Annexure I**.

Mode of Technological Interventions

The technological interventions programme at 24 centers under different production systems were implemented in terms of On Farm Trials (OFTs), area covered, number of farmers and villages is given in **Annexure II**. There were only 14 centers operating in 1999-2000 covering 14 districts. Subsequently, 10 new centers were added in Rainfed agro-ecosystem from 2000 onwards. The number of technological interventions implemented in the form of OFTs and VTs are replicated 72,274 farmers fields covering 25,323 ha in 423 villages. In Rice based production system 841 OFTs were implemented covering 8,913 ha with 29,088 farmers of 166 villages. TAR-IVLP centers under Oilseeds production system (5) implemented 444 OFTs in 4,092 ha with 7,776 farmers. The Cotton based production system implemented on-farm trials of 444 in 4,484 ha in 53 villages. The TAR-IVLP centers under Nutritious cereal based system conducted 1,179 on-farm trials in 6,628 ha with active participation of 20,530 farmers. The TAR-IVLP center at IIPR, Kanpur organized 121 on-farm trials with 3,074 farmers in 1,206 ha over a period of 5 years. Among the various interventions, maximum number of interventions were implemented in the theme area of NRM followed by IPM and livestock.

CHAPTER

2

Resource Characterization

The site characterization of all the 24 target centers based on agro-ecosystem analysis under different production systems is briefly described below.

1.Rice Based Production System

Under rainfed rice-based production system, the programme was implemented in 5 centres located in Ranchi (Jharkhand), Hassan (Karnataka), Koraput and Cuttack (Orissa), Raipur (Chhattisgarh) and Nagoan (Assam). These centers focused their attention on crops and varieties, cropping systems, rainwater management, integrated nutrient and pest management, rainfed horticulture and livestock production systems for assessment and refinement.

1.1 BAU, Ranchi

This center (AESR- 12.3), under the zone of Chota Nagpur plateau and Gujarat hills, has hot dry sub humid climate with moderately deep loamy to deep clay, red and lateritic soils. Annual rainfall ranges from 1200 to 1500 mm. The 5-year programme was implemented in 14 villages covering 935 families. The upland soils are light textured and lowland are heavy textured with poor drainage. The upland soils are acidic (pH, 5.5 to 5.9) while medium lands are yellowish and slightly acidic (6.5 to 7.0) and lowlands are grey and neutral, slightly alkaline. The villages' total land area was 5,679 acres with homestead (14.9%), cultivable land (69.9%), waste land (8.05%) and ponds (5.37%). Based on topography, the lands are divided into *Don* (lowlands) and *Tnar* (uplands). Rice, wheat, lentil, linseed, maize and fingermillet are predominant crops. The micro-farming situations identified are i) Upland (*Tnar*) with a slope of 10 to 15 % and dominated by wasteland and forest; ii) Lower upland (*Khujir* and *Tnar)*, with 5 to 10% slope, occupied by homestead faming, animal husbandry, field crops, fruit plants, vegetable farming and forests; iii) Medium (*Don*) with 1 to 2 % slope of sandy loam and loam soils, under field crops and vegetables; iv) Low land plains (*Gardon*) of loam clay soils covered mainly with rice. Broadcast seeding, weed infestation and improper variety in upland rice, imbalanced fertilizers in upland fingermillet, pigeonpea, groundnut, high incidence of wilt in rainfed tomato and powdery mildew in peas in irrigated uplands, incidence of rhizome rot in ginger and deficiency of boron and molybdenum in cauliflower in rainfed medium lands and improper land use are the main constraints causing low and unstable yields. Small body size and slow growth of pigs, poor quality of roughages for cattle and buffalos and low body weight in indigenous goats and poultry are main causes for low

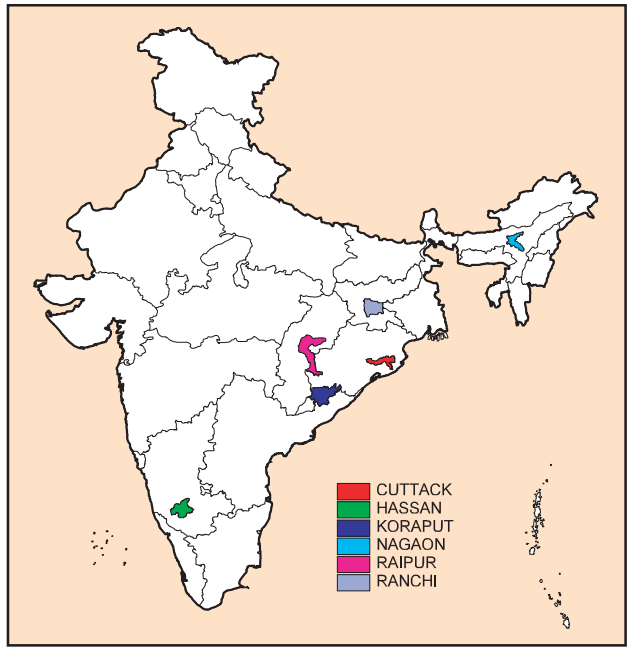


Fig 2. Rice based production centers

profitability in animal husbandry. Most of the technological interventions were assessed and refined in micro farming situations.

1.2 KVK, Hassan

This centre is characterized by hot semi-arid climate and is located in southern dry region of Karnataka. It receives an annual rainfall of 1030 mm, and has well drained sandy loam shallow soils with undulated topography. The project covered 865 families. Rice, fingermillet, maize, pigeonpea, horsegram, groundnut and sunflower are grown in both pure and mixed cropping systems. The prevalent micro-farming situations in the selected villages are i) Rainfed red sandy loam soils with undulated topography, eroded and poor in nutrients. In case of sufficient rainfall in May, ragi+castor, ragi+niger are taken up; ii) Rainfed red sandy shallow soils are under potato+castor, potato+redgram, maize, and coconut; iii) In rainfed red sandy soils with undulated topography, during rainy season fingermillet+castor, fingermillet+niger, fingermillet+avare and maize are grown; iv) Flat rainfed red sandy loam shallow soils are occupied mainly by fingermillet+niger, fingermillet+castor, fingermillet+avare and maize; v) In low lands, because of early rains of May-June, long duration rice varieties are grown which are irrigated by tank-stored rainwater. In case of late rains of July-August, only rice variety could be shown; vi) In deep clay loam soils of valleys with assured irrigation by tank, open wells and tubewells, dominant crops are paddy, vegetables, coconut, banana and areacanut. About 60% of population earns their livelihood from agriculture. Important problems identified are lack of appropriate varieties, imbalanced nutrition, labour shortage at peak period, soil degradation, poor milk yield in buffalos and cows, and poor health of the people due to imbalanced nutrition.

1.3 IGAU, Raipur

This center represents moderately to gently sloping Chhattisgarh basin which is hot moist/dry sub humid transitional zone (AESR 11). It has deep loamy to clay, red and yellow soils with medium AWC. Annual rainfall 1200-1600 mm and a LGP of 150-180 days. About 21% of the families are landless, and 47% are marginal and small farmers. Rice, wheat, soybean, chickpea, lentil and linseed are the main crops of the area. Erratic rainfall, delaying *biasi*, high weed infestation, imbalanced nutrient use in rice, poor fuel, fodder and timber production, lesser milk yield, and delayed sowing of lentil and chickpea are the important problems faced by the farming community.

1.4 CRRI, Cuttack

This region (AESR 12.1) is characterized by hot, moist sub-humid with deep loamy red (lowlands) and lateritic soils (uplands), low to medium AWC and a LGP of 182-210 days. The topography of the target villages is nearly flat with < 2% slope. Soils are acidic (pH 5.0-5.5) in the uplands. The depth of water table varies from 1 to 7.5 meters. The mean annual rainfall is around 1500 mm. Rice is the main food crop grown in the lowlands whereas groundnut, kulthi, mungbean, tomato, onion, chilies, garlic, bhendi and ridge gourd, banana and papaya are commonly grown in homesteads. Improper drainage, soil acidity, compaction and low availability of phosphorus, organic matter and calcium and high iron and aluminum and heavy weed infestation are main causes for low rice productivity. Termites and gundhi-bugs in uplands, stem borer and gall midge in low lands, diseases like blast and BLB in rice and blister beetle in pegionpea are yield limiting factors.

1.5 OUAT, Koraput

This centre is located in eastern ghat receiving annual rainfall of 1522 mm. It is a hot, moist sub humid eco sub region with deep loamy red and lateritic soils, low to medium AWC and a LGP of 180-210 days. A cluster of five villages located at eastern side of national highway were selected for the study. These villages are inhabitated by scheduled tribes and scheduled castes. The micro farming situations are, *Dangar*-I & II (Hill slope), *Dangar*-III (bunded uplands), Homestead, *Bada* (irrigated uplands), *Saria* (rainfed medium lands), and *Jholla* (rainfed low lands). Low yield of fingermillet, niger and smallmillets due to intermittent drought spells and severe weed infestation in hill slope areas; low yield of rice due to poor soil fertility and acidity, and wilting and imbalanced fertilizer use in kharif tomato; flat sowing and use of local varieties of ginger and turmeric in bunded uplands; lower weight gain in local breeds of goat and sheep; high disease incidence in homestead

poultry; improper pest management, soil acidity and imbalanced fertilizer use in vegetables under irrigated uplands; lower plant population and imbalanced fertilizer use in wheat in irrigated medium lands; lower yield of local rice cultivars, low fertilizer use efficiency and submergence are the main causes for low and unstable crop yield.

1.6 AAU, Assam

This centre is located in rainfed agro ecosystem of central Bramhaputra valley zone of Nagaon district, Assam. The project site comprises of six villages covering 577 families. Identified micro-farming situation are *Foringtoli* (upland, flat, loam to sandy loam); *Lahitoli* (medium flat land, loam); *Salitoli* (low flat land with gradient, clay loam); *Baotoli* (very low lying flat land, clay loam); *Baritoli* (undulated upland, loam to silty loam); and *pitoli* (low lying basin, clay). The area receives an annual rainfall of 1600 to 1800 mm, mostly during June to August. The soils are sandy loam to clay loam in texture with 0.77 to 2.06 % organic carbon, 241 to 288 kg/ha available N, 16.8 to 38.5 kg/ha P_2O_5 and 59.13 to 160.7 kg/ha of K_2O. Soils are acidic in nature. Rice is grown in *ahu*, *sali* and *seetkalin.* In uplands *ahu* rice/ jute-rapeseed/potato and vegetables/pulses are common. In mid lands *ahu* rice-*sali* rice-rapeseed/pulses, jute-*sali* rice systems are predominant. In low lands, *Bao*-rice-b*ao, Sali*+fish, *ahu*-*sali*-jute system are prevalent. Medicinal herbs are grown in kitchen gardens and mixed farming is a common practice. For some farmers fishery is an important commercial enterprise. Stem borer in s*ali* rice and rot in jute, late blight in potato, aphids in toria, fruit drop in pointed gourd, poor cattle health, low production of coconut/arecunut, high calf mortality in cattle, imbalanced ratio of fish species, and lower productivity of local breeds of duck and poultry are limiting factors for achieving higher productivity and income.

2. Oilseeds - Based Production System

The oilseeds based production system programme was implemented in Junagadh (Gujarat), Bhopal, Jabalpur and Indore (Madhya Pradesh), and Bharatpur (Rajasthan).

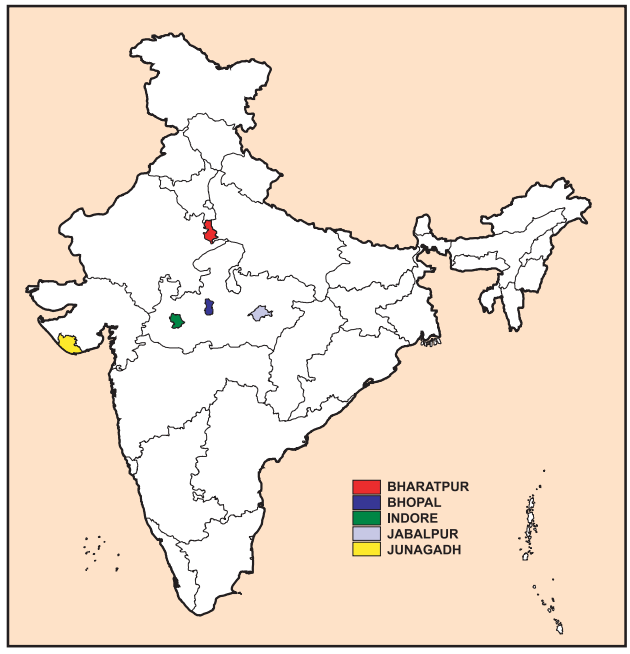


Fig 3. Oilseeds based production centers

2.1 NRCG, Junagadh

This center falls under central highlands (Malwa), Gujarat Plain and Kathiawar peninsula semi-arid eco region (AESR 5.1) and receives an annual rainfall of 500-600 mm. The soils are shallow, black and medium loamy to clayey with medium AWC. The LGP is 90-120 days. The major micro farming situations identified are rainfed upland with medium black soils. Sandy loam, shallow, partly irrigated lands and rainfed sandy loam soils are under groundnut - based cropping systems. The major crops are groundnut, castor, cotton (kharif) and wheat (rabi). Bottle and ridge gourd, brinjal, tomato and cauliflower are grown under irrigated conditions. Inefficient use of natural resources, heavy incidence of pests, intermittent drought spells, and shallow tillage are the main bottlenecks. Major livestock wealth is cows and buffaloes. Milk yield is meager because of scarcity of fodder and malnutrition.

2.2 CIAE, Bhopal

The center (AESR-10.1) is located in the hot sub humid climate zone(part of Vindhyan Plateau of MP). It has medium to deep black soils and medium to high AWC. Annual rainfall is 1000-1500 mm and LGP of 120-150 days. Most of the land is under cultivation (80-

85%). The average ground water depth is 150 m. Major crops grown are soybean, pigeonpea, groundnut, chickpea, wheat, lentil and vegetables. There are five micro-farming situations: medium *Vertisols* with and without irrigation, deep *Vertisols* with and without irrigation, shallow *Vertisols* with lime, kankar and stony lands rainfed medium *Vertisols*, rainfed deep *Vertisols* and rainfed shallow stony *Vertisols*. The technology gaps are heavy weed infestation, poor drainage, inadequate and imbalanced fertilization, lack of efficient sowing devices, poor productivity in cows, scarcity of green fodder during non rainy period and poor quality fodder for cows and buffaloes.

2.3 NRCRM, Bharatpur

The center is located in eastern plain zone of Rajasthan (AESR-4.1). Average annual rainfall is 645 mm and a LGP of 120-150 days. The target village with a total area of 1,305 ha with five hamlets covering 800 farm families has three micro farming situations: i) clay sandy loam, sandy loam, with upland and low land situations dominated with mustard, lentil, chickpea, wheat, berseem, sorghum and pearl millet. Flood water stagnation, sand deposition, termite and painted bugs are the important problems ii) sandy and sandy loam soils in which wheat, mustard, pearlmillet, sorghum and sesamum are grown with borewell/river irrigation. Sand deposition, termite, high weed infestation and salinity limit the productivity of crops iii) the upland areas which have sandy to sandy loam soils are covered with wheat, mustard, pearlmillet and sesamum and irrigated by borewells. Sand deposition, poor soils and weeds limit the productivity of these crops in uplands. Livestock comprises of desi cows, buffaloes, sheep, goats, pigs and poultry. Liver fluke and round worm, in sheep and goat and foot and mouth disease in cows and buffaloes; and poor nutrition are major constraints for livestock productivity.

2.4 NRCS, Indore

The center is situated in Malva plateau, of western Madhya Pradesh. It is characterized by hot moist semi-arid weather with medium and deep black clay soils with medium to high AWC. Annual rainfall is about 800-1000 mm and a LGP of 120-150 days. The target area is plain with poor drainage and limited irrigation facilities. It is dominated with soybean, pigeonpea, wheat, maize and chickpea. Lack of irrigation facility, inadequate income from agricultural produce, poor soil fertility, weeds, heavy incidence of beetle, severe moisture stress, non-availability stress tolerant varieties, rust problem of wheat, early and late blight diseases of potato, imbalanced feeding, non availability of green fodder during off season, and lack of good cattle management practices limit the productivity and profitability of various enterprises.

2.5 JNKVV, Jabalpur

The center belong to the central highlands hot sub-humid dry eco region has medium and deep clay black soils with medium to high AWC. The LGP is 150-180 days. Important crops grown are soybean, pigeonpea, chickpea, wheat and lentil. The micro-farming situations are: i) flat undulating fields with medium textured *Bhuata (*1.5-2.4 m) soils in rainfed situation. Predominant crops are sole soybean, pigeonpea, soybean+pigeonpea and soybean-chickpea; ii) flat undulating soils with medium texture (1.5-2.4m) where chickpea, wheat and lentil are predominant; iii) flat and bunded fields with medium to deep Vertisols (3-4.5 m). Soybean-chickpea/pea/mungbean/sugarcane are common systems here; iv) flat to gently sloppy, bunded lands having medium textured black soils. Water stagnates for about 80 to 105 days varying from 0.8 to 3.2 m. In this system chickpea, wheat and lentil are grown with conserved soil moisture only; v) in hareli system, water is used for protective irrigation to rice and for land preparation to subsequent crops. Rice, chickpea/wheat and lentil are predominant crops. Local varieties, high weed infestation, low soil fertility, moisture stress at maturity, incidence of blast and blight in rice, aphids, frost injury and rust in lentil, wilt and pod borer in chickpea, smut and termite in wheat are common problems. Rearing of local breed, worm infection and imbalanced feeding are the major bottlenecks for lower milk yield.

3. Rainfed Cotton - Based Production System

The technology assessment and refinement programme on cotton - based production system was carried out at Akola and Nagpur (Maharastra), Warangal (A.P.) and Ajmer (Rajasthan).

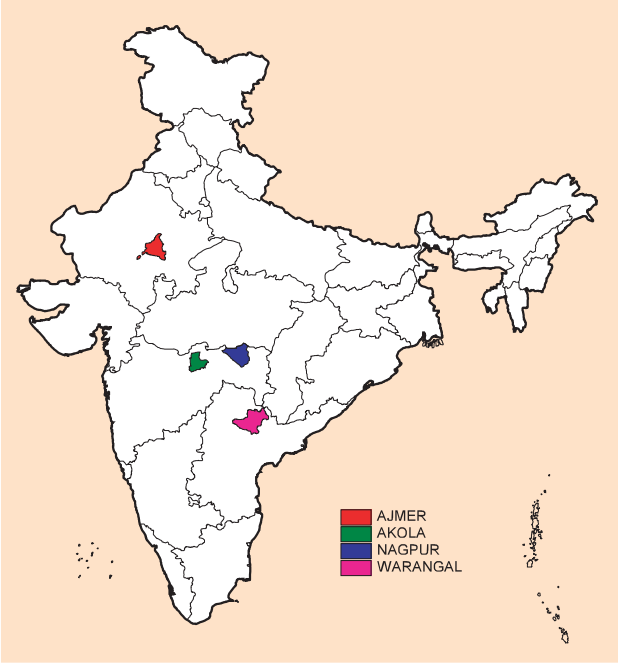


Fig 4. Rainfed cotton based production centers

3.1 PDKV, Akola

This center is located in hot semi-arid eco-region of Deccan Plateau (AESR 6.3). The soils are medium and deep black clay with medium to high AWC. Annual rainfall is about 750-950mm and the LGP is 120-150 days. Cotton, sorghum and pigeonpea are the predominant crops. In rabi, wheat, chickpea and safflower are taken up. Four micro-farming situations are identified: i) upland, rainfed, shallow black soils are under greengram, blackgram, sorghum and pigeonpea; ii) upland, protectively irrigated shallow, black soils are occupied with cotton, greengram, blackgram, pigeonpea and chickpea; iii) flat rainfed black soils with medium depth are under cotton, soybean, sorghum, pigeonpea and chickpea; and iv) flat, protectively irrigated black soils of medium depth, covered by cotton, soybean, sorghum, wheat, chickpea and horticultural components. The major constraints identified are non-availability of HYV, incidence of pests and diseases, fodder scarcity and deterioration of soil fertility.

3.2 ANGRAU, Warangal

The center is located in the Semi-arid, Sub-agro region of North Telangana Zone of AP (AESR 7.2). Red and black soils dominate the region with annual rainfall of 900 mm. The LGP is 120-180 days. The target villages have a net sown area of 1156 ha, occupied by 840 farm families. The soils are red sandy loams (60%) and black clay (40%). Soil alkalinity is a problem in low lying black soils where cotton is mono-cropped. There are four micro farming situations: i) Chalka soil with less than 30 cm depth. Cotton and maize are grown both under rainfed and irrigated conditions; ii) Black soils with more than 45 cm depth where cotton is grown; iii) Chalkas under limited irrigation with cotton, turmeric, maize and chillies; iv) Black soils (20-30 cm) where cotton, maize, turmeric, chillies and rice are grown under limited irrigation. The main problems here are sucking pests and boll worms in cotton, rhizome rot and leaf spot in turmeric and weeds in maize. White brown plant hopper and leaf folder are severe constraints in enhancing the productivity of rice in black soils. Rearing less productive cattle and poultry breeds limit the profitability from livestock.

3.3 KVK, Ajmer

This area falls under rainfed semi-arid eastern plateau zone of Rajasthan (AESR 2.3: black soils; annual rainfall 525mm; low AWC; LGP of 60-90 days). Cotton, mungbean, pearlmillet, clusterbean and wheat are the important crops. Most of the technological interventions were assessed and refined under micro-farming situations of rainfed, medium textured black soils.

3.4 CICR, Nagpur

The soils of the region are black with moderate depth (40-60 cm). The area receives 750 mm rainfall. Farming is diverse with cotton occupying maximum area followed by sorghum, soybean, pigeonpea and groundnut in kharif. Wheat and chickpea are cultivated during rabi. Citrus dominates the horticulture sector, occupying 88 ha. Brinjal, field bean, ladies finger and tomato are grown under irrigated conditions. Majority of the farmers keep livestock, especially bullocks, cows and goats as a major of source of income. The area has four micro farming situations: i) Deep plain *Vertisols* with 150-200 ft water table, growing mainly cotton, soybean, sorghum, wheat, pigeonpea, chilli, tomato, brinjal and orange; ii) Shallow *Alifisols* with steep slopes, mainly under soybean, sorghum and groundnut; iii) Vertic inceptisols with medium depth, plain topography, with

100-150 ft of water table growing cotton, pigeonpea, sorghum, soybean and groundnut; iv) *Alfisols* and vertic inceptisols, shallow to medium deep, sloppy in nature with water table ranging from 80-100 ft. Acacia, neem, mango, jamun, phalsa, cotton and vegetables are the main agricultural components. Drainage, moisture stress and pests and diseases in cotton, soybean and chillies in *Vertisols*., water logging, salinity/alkalinity and water deficits in *vertic inceptisols* and soil degradation, intermittent drought spells and poor soil fertility in *Alfisols* are limiting factors. Local breeds, foot and mouth disease, nutritional imbalance, high calf mortality and short lactation period in cattle and goat limit income from livestock sector.

4. Rainfed Nutritious Cereal Based Production System

The nutritious cereal - based production system covered five states: Andhra Pradesh (Rangareddy), Karnataka (Bangalore, Dharwad), Maharashtra (Vengurle, Solapur, Nagpur), Uttar Pradesh (Jhansi) and Rajasthan (Udaipur).

4.1 CRIDA, Hyderabad

This center is located in the hot semi-arid eco-region of southern telangana zone of A.P. (AESR 7.2). It is dominated by red soils of low to medium AWC and a LGP of 120-150 days. The normal annual rainfall is 750 mm. Sorghum + pigeonpea, castor, horsegram and greengram are grown in the *Alfisols*, while maize and cotton are grown in the *Vertisols* during Kharif. Chickpea and safflower are major crops during rabi. Rice and vegetables are grown under limited irrigation through tanks and wells in all seasons/soil types. Sheep and goat rearing is an important occupation for 10% of the families. The micro-farming situations prevalent are: Alfisols: i) Undulated topography (2 to 4% slope) where castor, sorghum + pigeonpea and cowpea are grown; ii) Rice and vegetables (tomato, brinjal and okra) under tankfed system; iii) Scrub jungle, dominated by *Acacia nilotica/auriculiformis;* iv) Rice and vegetable crops, fodder lucerne, tapioca and horticultural crops grown with limited well irrigation; v) Rocky, hardy stones dispensed in small patches i) Rainfed mild slopes mainly under coriander, castor, maize + pigeonpea during Kharif

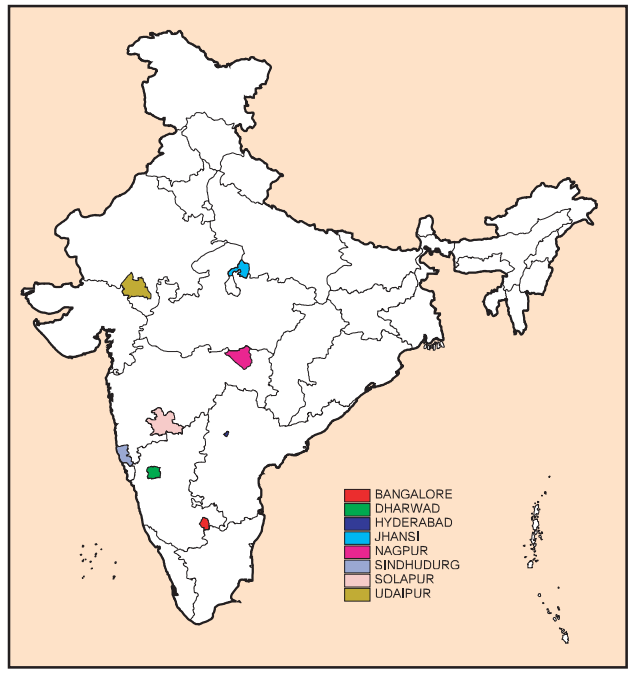


Fig 5. Nutritious cereal based production centers

and chickpea + safflower during rabi; ii) Mixed *Vertisols* and *Alfisols* have rainfed castor and vegetables, fodder crops and turmeric under well irrigation iii) Mixed *Alfisols* and *Vertisols* having 2 to 4% slope grows cotton under limited well irrigation during Kharif and vegetables in rabi. Semilooper and red hairy catter pillar in castor, shoot fly and grain mold in sorghum, pod borer in pigeonpea, boll worms and sucking pests in cotton causes major yield losses. Intermittent dry spells, inadequate/ imbalanced nutrition, low yielding cultivars, soil degradation, undependable rainfall, water logging in vertisols and labour shortage at peak period are important problems encounted.

4.2 IIHR, Bangalore

The center is situated in the eastern dry zone of Karnataka (AESR 8.2) and is characterized as hot, semi-arid eco-region, low in AWC and with a LGP of 120-150 days. The major soil type in the target area is red sandy loam. The area has an annual mean rainfall of 650-900 mm and is dominated by fingermillet, dolichos and fodder sorghum. Groundnut and pigeonpea are the other important rainfed crops. Tomato, cabbage, brinjal, frenchbean, banana, guava, potato and okra are grown under limited irrigation. Blast disease, poor nutrition in

fingermillet, pod borer damage in dolichos and pigeonpea, poor plant establishment, inadequate plant protection in rainfed tomato, delayed sowing, diamondback moth and imbalanced nutrition in summer cabbage are the main problems. Poor nutrition of milch cows, green fodder shortage in summer and prevalence of local breeds result in uneconomical milk yield. Sericulture is a livelihood for poor farmers. Improper rearing houses, poor quality leaves and misfit chawki variety limit the profitability from this enterprise. Improper pesticide and nutrient management, micro nutrient deficiencies and fungal diseases in banana, canker disease in guava, stem bleeding, spindle rot and nut diseases in arecanut cause severe yield losses.

4.3 RFRS, Vengurli

This center is located in the hot sub humid hilly terrain zone (AESR 19.2) and receives an annual rainfall of 3000-4000 mm. The length of growing period is 180 to 200 days. Rice, fingermillet, horsegram and blackgram are the important crops. The area under mango, cashewnut, cabbage, cauliflower, brinjal and chilies is increasing. The existing farming situations are i) Uplands with sandy soils covered with forest area; ii) Mid-lands where arable (rice, fingermillet, niger, groundnut and cucumber) and horticulture crops (cashew, mango, kokum and jackfruit) are grown; and iii) Lowlands of sandy loam where rice, groundnut, chillies, leafy vegetables, banana, areacanut and coconut are grown. Bullocks, buffaloes and cows, form an integral part of the traditional farming systems. Non-availability of water storage facilities, severe land degradation and pests and diseases on annual and perennial crops result in low and unstable income.

4.4 MPKV, Solapur

This center of the Deccan Plateau (hot semi-arid eco-region) represents scarcity zone of Maharastra receiving an annual rainfall of 500-600 mm (AESR 6.1). Soils are shallow and medium deep black with medium to high AWC. The LGP is 90-120 days. The target villages are characterized by shallow to deep *Vertisols.* On shallow soils, rainfed horsegram, mothbean, and pearlmillet are grown while medium deep soils are under strip cropping of sunflower and pigeonpea. Rainfed rice and groundnut are grown on shallow to medium deep soils. Onion, chilli and tomato are grown on medium deep soils under limited irrigation. Wheat and chickpea are grown as rabi crops. The micro farming situations identified are i) Slightly sloppy lands (1-2% slope) with medium deep loamy soils where rainfed pigeonpea+sunflower during kharif and fallow-rabi sorghum cropping are practiced; ii) Undulating topography (2.5-3.5 % slope) with shallow coarse loamy soils are generally under pigeonpea+sunflower, sole pigeonpea, horsegram+mothbean and pearlmillet+ mothbean; iii) Slightly undulated topography (1.5-2.5% slope) with shallow to medium deep soils are under pigeonpea+sunflower, sole pigeonpea, horsegram+ mothbean and pearlmillet+mothbean, groundnut and paddy; iv) Deep black clay loam soils (0.5 - 1.0% slope) where rainfed kharif and rabi crops are grown. Rabi sorghum, chickpea, wheat, summer groundnut, sugarcane, onion and chilies are cultivated under limited irrigation; v) Medium to deep soils (1.5 to 2% slope) suitable for raising well irrigated rabi sorghum, chickpea and vegetables and kharif crops are grown under rainfed environment. Incidence of hairy catter pillar, pod borer and sterility mosaic, intermittent drought spells for *kharif* crops, unfilled sunflower seed, frost and blight diseases in onion, leaf curl in chillies, fruit drop and moisture stress in ber and mango, sugary disease in rabi sorghum, imbalanced fertilizer use, untimely harvest of onion, inadequate green fodder, frequent sickness during lactation period in cows and buffaloes are main causes for low profitability.

4.5 UAS, Dharwad

Dharward, located in Deccan Plateau and falling under the hot semi-arid transitional zone of Karnataka (AESR 6.4) has shallow medium black soils and receives an annual rainfall of 750 mm. It has medium to high AWC and a LGP of 150-180 days. The target villages have undulated topography and black, red and mixed soils. Sorghum, pigeonpea, minor millets, paddy, potato, groundnut, chickpea, wheat and cotton are predominant crops. The prevailing cropping systems are: i) rainfed lowlands having pure and mixed soils are under drill sown paddy; ii) rainfed upland having shallow soils and are covered with littlemillet and horsegram; iii) rainfed flat lands having black soils of medium depth are under sorghum, chickpea, soybean, greengram and wheat; iv)

rainfed flat midlands having red and shallow to medium mixed soils and support groundnut, potato and maize; v) rainfed midland having medium deep black and mixed soils are covered by hybrid cotton; vi) flat midlands having black, mixed grow green chillies, vegetables and sugarcane under protective irrigation. One of the major problems in these villages is depletion of ground water. Constraints for lower agricultural productivity are use of local varieties, inadequate nutrient supply, incidence of BPH and blast in rice, occurrence of leaf eating caterpillar, leaf spot and intermittent drought spells in groundnut and soybean. Poor nutrition and animal health care in milch animals, rearing of local breeds of sheep and goat having poor growth potential and lower mutton yield and poor quality poultry birds are the bottlenecks for livestock management.

4.6 IGFRI, Jhansi

The project area comes under hot semi-arid eco sub-region (AESR 4.4) having deep, loamy - clay and mixed red and black soils. It receives an annual rainfall of 640 mm, has medium to high AWC and a LGP of 120-150 days. The target villages have undulated topography (1 to 5% slope) with few hillocks in some patches. Predominant crops are sorghum, wheat, chickpea and lentil. Cows, buffaloes, sheep and goat are important livestock species. The prevailing micro-farming situations are: i) mildly sloppy areas with red soil under groundnut, maize, soybean, wheat, chick pea and mustard; ii) uncultivated lands with 3 to 5% slope under fallow but covered predominantly with neem and korindi; and iii) hillocks with 5 to 10 % sloppy uplands under *mahua, babool, lantana* and *korindi*. The important problems identified are land degradation, low milk yield in cattle, low productivity of groundnut, soybean and wheat, drudgery faced by women and water scarcity.

4.7 MPAUT, Udaipur

This center is located in the northern plain, under the hot semi-arid eco-region covering south plains and Aravelli zone (AESR 4.2). It is characterized by *Aridisols* with 600 mm annual rainfall, medium AWC and a LGP of 90-120 days. About 60% of the farmers earn their income through agriculture and 30% from livestock. The topography of the villages is flat to mild sloppy and undulating. Four distinct micro farming situations were identified. The soils are mostly sandy loam, yellowish sandy loam and gravelly clay loam. Guava, urd bean, sorghum and chickpea are grown under rainfed environments. In yellowish sandy loam and clay loam soils, topography is flat with sparse vegetation of neem, *babul*, mango and *peepal*. The main crops grown are maize, sorghum, guava, groundnut, wheat, barley, mustard and vegetables under rainfed and irrigated conditions. The stony patches having undulating topography are dominated by neem and babul. The problems identified by the farming community are: i) decrease of water table and poor recharge of wells; ii) poor and irregular supply of electricity; iii) low yield of maize, groundnut and sorghum, wheat, mustard, sugarcane and barley; iv) low milk production in buffaloes and cows; v) high mortality rate in sheep and goat; vi) lack of veterinary health facilities; vii) salinity problem, viii) soil erosion; ix) transportation and marketing of agricultural produce; x) drudgery of farmwomen, and xi) storage losses in food grains.

4.8 NBSS&LUP, Nagpur

This center located in the hot, sub-humid Eastern Maharastra plateau (AESR 10) has shallow to deep, loamy to clay, black and red soils and gets an annual rainfall of 1150 mm. It has medium to high AWC and a LGP of 150 - 180 days. The target villages are characterized with shallow to deep well drained, gravelly clay loam / sandy clay loam soils and are under sorghum, cotton, oilseeds, wheat, fruits and vegetables. Sweet - orange, wheat and vegetables are grown under irrigation where as sorghum, cotton, pigeonpea, soybean, groundnut, greengram, chickpea, cowpea and chilies are rainfed. There are five micro farming situations: i) Rainfed, medium to deep vertic undulating terrain, covered with jowar and cotton; ii) Rainfed, shallow to medium deep Vertisols, *under* jowar, cotton, soybean, groundnut and pigeonpea; iii) Rainfed and irrigated, medium to deep Vertisols dominated by jowar, cotton, soybean, cotton+pigeonpea, wheat, gram and mardarin orchards; iv) Rainfed Vertisols with bushes, shrubs, shallow rooting trees on escarpment having shallow soils and rock out crops; v) Rainfed entisols, stony and rolling,

cultivated with jowar, cotton + pigeonpea and soybean. Delayed onset of monsoon and intermittent dry spells, shoot fly and earhead bug in sorghum, non availability of good quality seeds and pesticides, bollworm, red leaf incidence, terminal stress and unbalanced nutrition in cotton, termites, low nutrient status of soils under groundnut, pod borer in pigeonpea etc., are problems faced by the farmers. Fodder scarcity, poor genetic potential of native animal breeds, malnutrition and incidence of diseases result in lower milk yield in milch animals, and poor productivity of goats.

5. Pulses Based Production System

The programme under pulse-based production system was implemented at Kanpur. The centre is located in Doab of Ganga - Yamuna, Bundelkhand and Awadh plains (AESR 4.3). It is characterized by hot, moist semi-arid climate. The center has deep, loamy alluvium derived soils and gets an annual rainfall of 750-1100mm. It has medium to high AWC and a LGP of 120-150 days. Rice, sorghum, urdbean, mungbean, pigeonpea, sesamum, soybean, wheat, chickpea, lentil, linseed and mustard are other important crops.

5.1 IIPR, Kanpur

The target villages covered an area of 817 ha, occupied by 528 farm families. The soils are clay loam and black, low in organic matter, nitrogen and phosphorus. The annual rainfall is about 1100 mm. Chickpea, lentil, pigeonpea, sorghum, mustard, mungbean and linseed are important crops. Two micro-farming situation were identified: i) Mildly sloppy lands with clay and clay loam soils support lentil, chickpea, linseed, wheat, mungbean, mustard and sorghum; ii)

Fig 6. Pulses based production center

Gentle to rolling topographic areas having clay and clay loam soils are under rainfed monocropping (70%), irrigated mono-cropping (25%) and double-cropping (5%). Chickpea+mustard, lentil+linseed and wheat are grown during rabi season. Incidence of wilt, root rot and pod borer in chickpea and pigeonpea, root rot, wilt, aphids and pod borer infestation in lentil, lower fertilizer use, incidence of smut, late sowing in wheat, yellow mosaic virus, high weed infestation in mungbean, incidence of rust and bud fly, non-availability of good quality seed, scarcity of green fodder, lack of improved livestock breeds and incidence of foot and mouth disease are the main problems.

CHAPTER

3

Rice Based Production System

3.1 Crops and Varieties

Improved varieties of rice, IR-64 and Poornima in the uplands of Raipur, Satya and Basundhara at Nagaon, Brown Gora, Tnar-2 and Tnar-3 at Ranchi, Vandana and Kalinga (uplands), Ranjit and Gayatri (low lands) and, hybrid rice PHB-71 (summer) at Cuttack, IET-7191 and IR-64 at Hassan and Pooja and CR-26077 at Koraput were found suitable, productive and remunerative. About 55% of the farmers are adopting Brown Gora and KRH-2 at Ranchi and Hassan, respectively. Cultivar Satya (sali rice) was adopted by 60 farmers in 9 ha at IVLP site at Nagaon. Improved varieties GPU-28 and MR-1 (fingermillet) and NAC-6004 of maize at Hasan, HYV Bhirabi (fingermillet) and Gaint Double African Yellow (marigold), BT-12 and BT-10 (tomato) at Koraput, Birsa Arhar-1 (pigeonpea), Suwan-1 (maize) and Lemon Drop (marigold) at Ranchi, JG-74 and JG-322 of chickpea and GW-173 and DL-788-2 of wheat at Raipur, on an average, enhanced the yield and profitability by 25-30%, compared to their respective local varieties. At Raipur, improved rice variety IR-64 recorded higher productivity (24%) and profitability (60%) over the local variety, while at Nagaon, the sali rice varieties Satya and Basundhara gave 35 and 25 % higher yield over farmers variety, respectively (Table 1).

These varieties facilitated timely sowing of succeeding *rabi* crops. About 60% of the farmers adopted these varieties at the IVLP site. HYV Pooja, in Jholla lands of Orissa, increased its coverage from 193 to 480 ha over a period of 4 years. HYV marigold cultivar of Giant Double African Yellow, which has more productivity (180% over local) and gives higher income (Rs.3400/ha) became more popular among farmers at IVLP and neighboring villages. In wheat, improved varieties GW-173 and DL 788-2 enhanced yield by 30 and 29%, respectively over local variety at Raipur. At Hassan, rice variety IET-7191 was found suitable for tankfed areas. About 40 farmers covering 10 ha area are adopting this variety from the inception of the project. At the same center, fingermillet varieties (GPU-28 and MR-1) out yielded the locals. At Nagaon, medium duration rice varieties Satya and Basundhara, on an average recorded yield of 4,190 and 4030 kg/ha and net returns of Rs.15,288/ha and 13,873/ha, respectively.

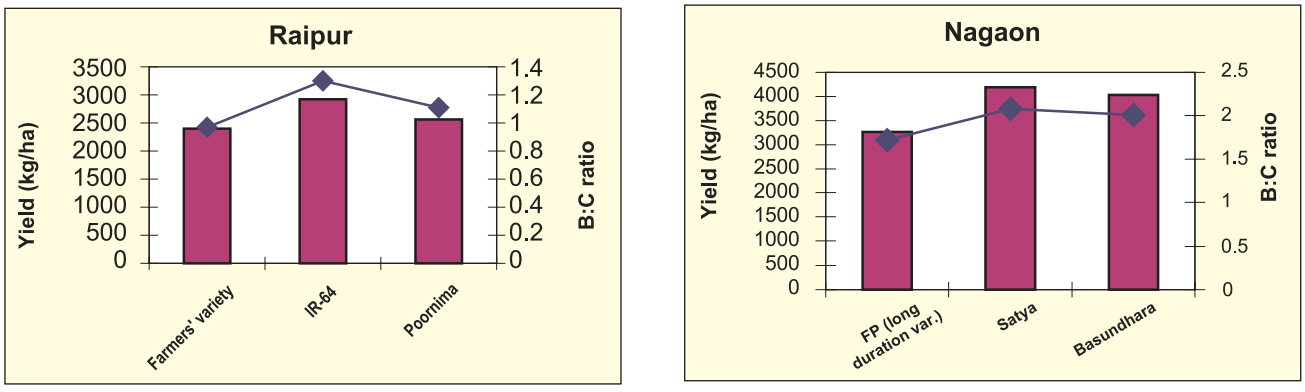


Fig 7. Performance of different varieties of rice at Raipur and Nagaon (1995-05)

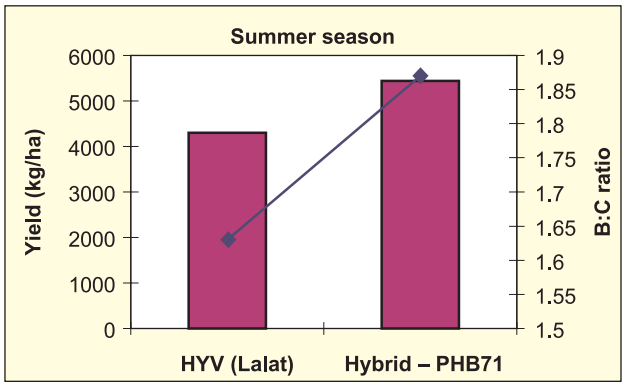
Table 1: Performance of crops and varieties at Hassan and Koraput

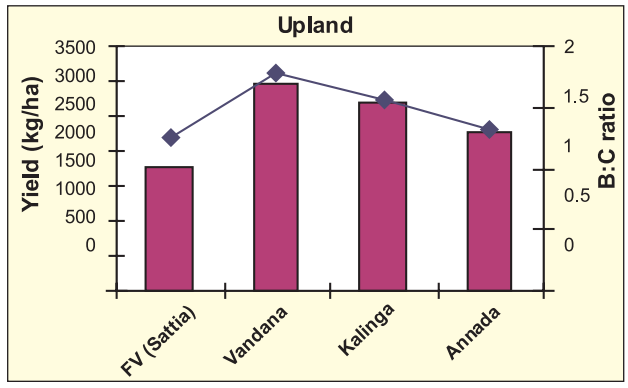
Center	Crop	Cultivars	Yield (kg/ha)	Net income (Rs/ha)	B:C ratio
Hassan	Rice (1999-01)	Local varieties	1780	215	1.02
		IR 64	2090	1640	1.16
		IET 7191	2930	5715	1.54
	Finger millet (1999-01)	Local (PR-202)	1080	650	1.10
		MR-1	1500	2500	1.38
		GPU-28	1720	3400	1.50
		GPU-26	1020	200	1.03
	Maize (1999-00)	Local (Deccan -101)	2050	4627	1.72
		Composite variety-NAC-6004	2450	6824	2.10
Hassan	Rice (1999-01)	Local varieties	1780	215	1.02
		IR 64	2090	1640	1.16
		IET 7191	2930	5715	1.54
	Finger millet (1999-01)	Local (PR-202)	1080	650	1.10
		MR-1	1500	2500	1.38
		GPU-28	1720	3400	1.50
		GPU-26	1020	200	1.03
	Maize (1999-00)	Local (Deccan -101)	2050	4627	1.79
		Composite variety-NAC-6004	2450	6824	2.10
Koraput	Rice (*Zholla* lands) (2002-03)	Local (Kerandi)	1900	2870	1.31
		Durga	2800	7370	1.73
		Sarala	3200	9610	1.95
		Puja	3400	10850	2.08
	Ragi (2002-03)	Koraput Local	7200	1270	1.51
		HYV- Bhairabi	8800	1980	1.76
	Tomato (2002-03)	Local (Pusa Ruby)	15000	63000	5.20
		BT-2	21500	92250	7.00
		BT-3	23600	102750	7.70
		BT-10	24000	104750	7.80
		BT-12	24200	105750	7.90
		BT-18	25100	110250	8.20
	Cabbage (2002-03)	Local (Golden Acre)	17300	48550	5.00
		Hybrid - Konark	28200	82900	6.24
	Marigold (2002-03)	Local variety	5300	11500	1.76
		Giant Double African Yellow	15100	45500	2.51

At Cuttack, high yielding medium duration upland rice variety Vandana gave higher yield (65%) and profitability (244%) compared to local Sattia (1,786 kg/ha). Under lowlands, HYVs Ranjit and Gayatri recorded 4,740 and 4,000 kg/ha with B:C a ratio of 2.43 and 2.07, respectively as against farmers variety Gangakuli which gave 2,700 kg/ha with a B:C ratio of 1.59. Hybrid rice PHB-17 in coastal Orissa, during dry season, recorded higher grain yield (5,383 kg/ha) as compared to the HYV Lalat (4153 kg/ha).

3.2 Cropping Systems

At Cuttack, intercropping of short duration rice cultivar (Vandana) with long duration pigeonpea (UPAS-220) with 4:1 ratio, recorded higher rice equivalent yield





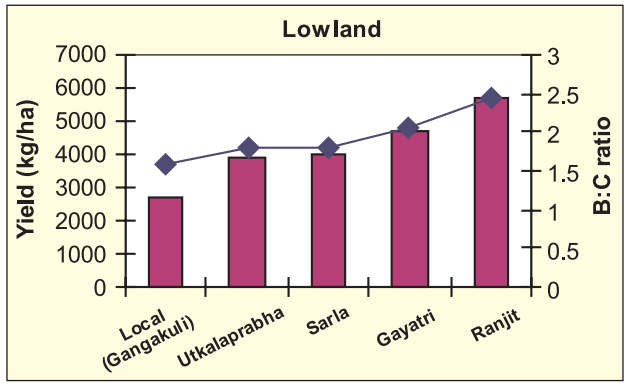


Fig 8. Performance of rice varieties at Cuttack

(5400 kg/ha) and net returns (Rs.20,650/ha) over sole crop. This system was adopted in 50 and 80 ha at IVLP and surrounding villages, respectively. In rice fallows, tomato during *rabi* gave higher net returns (Rs.18,500/ha) followed by horsegram (Rs.4,540/ha). Rice-horse gram system exhibits higher B:C ratio (2.82) followed by rice - tomato (2.26) (Table 2).

These double cropping systems were adopted in 40 and 70 ha in IVLP and nearby villages, respectively. Under limited irrigation, rice-maize system recorded higher net returns (Rs36,250/ha) followed by vegetables (Rs.28,750/ha). These systems were adopted in 15 and 30 ha area in IVLP and nearby villages, respectively. Rice-cucurbit, rice-lentil/toria cropping and rice-fodder (oat) at Ranchi, maize+pigeonpea (6:1) and fingermillet and Dolichos (4:1) at Hassan, rice+pigeonpea (4:1) at Cuttack, rice-chickpea, rice-coriander at Raipur were found profitable. Rice-cucurbit system became popular among 25% of farming community at Ranchi. Maize cultivar (Suwan)+ pigeonpea cultivar (Birasa Arahr-1) (1:1) contributed 40% higher productivity and profitability compared to their respective soles. This technology was adopted in 60% of the farmers at IVLP site. Intercropping of wheat cultivar (PBW-443) and chickpea cultivar (Pant-114) enhanced productivity by 50% compared to soles. This technology was adopted by 45% of farming community in the target villages. Para cropping of lentil cultivar (T-397), pea cultivar (Swarnarekha) and bottle gourd in rice fallows increased

Rice varieties *Vandana* in rainfed uplands and *Gayatri* rainfed lowlands at Cuttack

Table 2: Productivity and profitability of rice fallows in rabi at Cuttack(2002-04)

Treatments	Yield (kg/ha)	Net income (Rs/ha)	B:C ratio
Upland			
Rice-horsegram	880	4540	2.82
Rice-tomato	9500	18500	2.36
Irrigated medium lands			
Rice-rice	8500	22500	1.75
Rice-maize	4100	36250	3.43
Rice-vegetables	20000	28750	2.15
Low land			
Rice-greengram	850	7550	3.16
Rice-watermelon	9700	17112	3.51

Coriander in rice fallows at Raipur

Rice + pigeonpea 4:1 at Cuttack

Tomato in rice fallows at Cuttack

cropping intensity from 100 to 200%. These systems were adopted by 75% of the rice growers in rainfed low lands of Ranchi.

At Raipur, coriander and okra after rice recorded additional net returns (Rs.7,274/ha) compared to *kharif* rice alone (Rs.2,253/ha). At Hassan, while fingermillet + pigeonpea was adopted by 20 farmers in 5 ha in IVLP villages, maize+soybean (4:2) was adopted in 12 and 3 ha by 32 and 7 farmers in IVLP and neighboring villages, respectively. Horsegram after potato gave higher net returns (Rs.17,565/ha) than fingermillet (Rs1,125/ha) (Table 3).

3.3 Rainwater Management

At Cuttack, bunding of round upland rice field (50 cm width and 25 cm height) increased grain yield (1,000 kg/ha) and net returns (Rs.4,402/ha), compared to non-bunding (Rs.4,496/ha). Optimum dyke heights for light, medium and heavy soils were determined as 15, 17.5 and 20 cm, respectively for major rice growing areas of Bhubaneswar. Under average rainfall conditions, these technologies were adopted in 10 and 20 ha in IVLP and nearby villages, respectively with average benefit ranging from Rs.4,000 to 6,000 /ha. Line sowing of major crops across the slope in furrows at 5 m spacing on sloppy lands gave 25% higher yield over farmers practice of broadcasting. At Hassan, ridges and the

Rainwater harvesting through bunding in rainfed uplands at Cuttack

Table 3: Performance of cropping systems

Centre	Systems	Yield (kg/ha) Crop-I	Yield (kg/ha) Crop-II	Net returns (Rs/ha)	B:C ratio
Hassan	Fingermillet+jowar (FP)	1050	150	3500	1.05
	Fingermillet+pigeonpea (8:1)	1200	280	6950	2.56
	Fingermillet+fieldbean (8:1)	1205	250	6575	2.40
	Fingermillet+hybrid castor (8:1)	980	300	6270	2.24
	Maize+ castor (8:1) (FP)	1420	242	1875	0.19
	Maize + pigeonpea (6:1)	2580	337	3144	0.86
	Maize+ castor (8:1) (FP)	1310	175	2390	0.34
	Maize+soybean (4:2)	2580	200	8980	1.50
	Maize+soybean (2:2)	2225	202	7499	1.90
	Potato+ local castor (8:1) (FP)	5800	280	4999	1.25
	Potato+ hybrid castor (6:1)	8320	480	9781	1.48
	Potato+ pigeonpea (6:1)	9800	338	14265	1.71
Koraput	Fingermillet	685	-	1117	1.46
	Fingermillet + pigeonpea (5:2)	715	165	3291	2.24
Cuttack	Sole rice	2652	-	6155	1.63
	Rice+pigeonpea (4:1)	4548	-	15336	2.36
Hassan	Fingermillet (FP)	-	850	1200	1.24
	Pea (Bonville)-fingermillet	900	850	4600	1.51
Raipur	Rice-lathyrus (FP)	1981	316	5642	0.59
	Rice-chickpea	2850	473	11920	0.81
	Rice-coriander	2680	143	11891	1.42

* Green Pods

furrows across the slope enhanced productivity by 18 to 20% of fingermillet, maize and pigeonpea. At Koraput, cultivation of ginger HYV, Suprava on raised beds with mulching reduced rhizome rot and recorded higher yield (14,800 kg/ha) and net returns (Rs.2,16,000/ha) compared to the flat beds without mulching which gave yield of 9,400 kg/ha and net returns of 1,18,000/ha (Table 4).

3.4 Integrated Nutrient Management

At Cuttack, Integrated Nutrient Management (INM) in rainfed upland rice with 30:15:15 kg NPK along with 2 t of FYM/ha gave 78% increased yield and net returns (Rs.5,688/ha) compared to the farmers practice of applying 10 - 20 kg N/ha (139 kg/ha). In summer rice, use of HYV (CR-749-20-2), row planting

Table 4: Influence of rainwater management practices

Centre	Crop	Treatments	Yield (kg/ha)	Net returns (Rs/ha)	B:C ratio
Cuttack	Upland rice (2002-05)	Farmers practice (No bunding)	2093	4497	1.53
		Improved practice (50 cm wide & 25 cm high bund surrounding the field)	3053	8898	1.83
	Upland rice (1999-05)	Farmers practice (Broadcast seeding)	1926	2499	1.23
		Row seeding across the slope	2572	6466	1.70
Koraput	Ginger	FP local variety on flat bed	6700	79000	2.43
		HYV Suprava on flat bed without mulching	9400	118000	2.68
		HYV Suprava on raised bed with mulching	14800	216000	3.70

at 15 x 15 cm, and balance use of nutrients (80:40:40 NPK/ha) increased grain yield from 30 to 70% over the farmers practice. At Nagaon, green manuring with *dhaincha* in *sali* rice with 50% recommended dose of NPK gave higher B:C ratio (1.66) and net returns (Rs.11,690/ha). Due to increased profitability of 74%, this practice was adopted on 8 ha at IVLP villages.

In Ranchi medium lands, transplanting Birsa Dhan-202 with moderate dose of nutrients (50:25:12 NPK kg/ha) increased the productivity by 40% compared to the farmers' practice of 25 kg N. At Koraput, *Azosprillum* and PSB each @ 5 kg/ha along

Green manure crop *dhaincha* in Sali rice at Nagaon

Table 5: Performance of INM practices at Koraput and Hassan centers

Centre	Crop	Treatments	Yield (kg/ha)	Net returns (Rs/ha)	B:C ratio
Hassan	Rice (2004)	FP (imbalance fertilizers)	1815	715	1.01
		RDF + biofertilizers	2870	4765	1.43
		RDF + *in situ* green manuring with sunnhemp	3500	7515	1.60
	Maize (2003-05)	FP	1583	1450	1.2
		Compost@ 5 t/ha+ 50% RDF	2527	5811	1.8
		Compost@ 5 t/ha+ RDF +$ZnSO_4$ @ 20 kg/ha	3033	7820	2.0
	Potato (2003-05)	FP (more N and less P_2O_5 and K_2O)	6183	1640	1.08
		Biofertilizers + compost@ 5 ha+ soil test-based fertilizer application	11083	17040	1.78
		Soil test-based fertilizer application alone	9317	11259	1.53
	Finger millet (2000-05)	Farmers management			
		Local variety (PR-202)	1080	650	1.1
		MR-1	1500	2500	1.38
		GPU-28	1720	3400	1.50
		GPU-26	1020	200	1.03
		RDF (50:40:25 N:P:K/ha)			
		MR-1	1810	3500	1.47
		GPU-28	1950	4050	1.55
		GPU-26	1150	0.00	1.00
Koraput	Potato (2001-04)	FP (NPK 40:20:20/ha)	9300	36800	2.90
		RDF (120:60:60/ha)	14200	64200	4.00
		FP + soil application of *Azospirillum* and PSB (each 5 kg/ha)	10800	45100	3.20
	Cabbage (2001-04)	FP (no boron)	24200	57600	4.80
		Soil application of B @1.5 kg/ha	38500	98600	6.80
		Foliar application of B @0.3% twice at 30 and 40 DAT	34400	87740	6.60

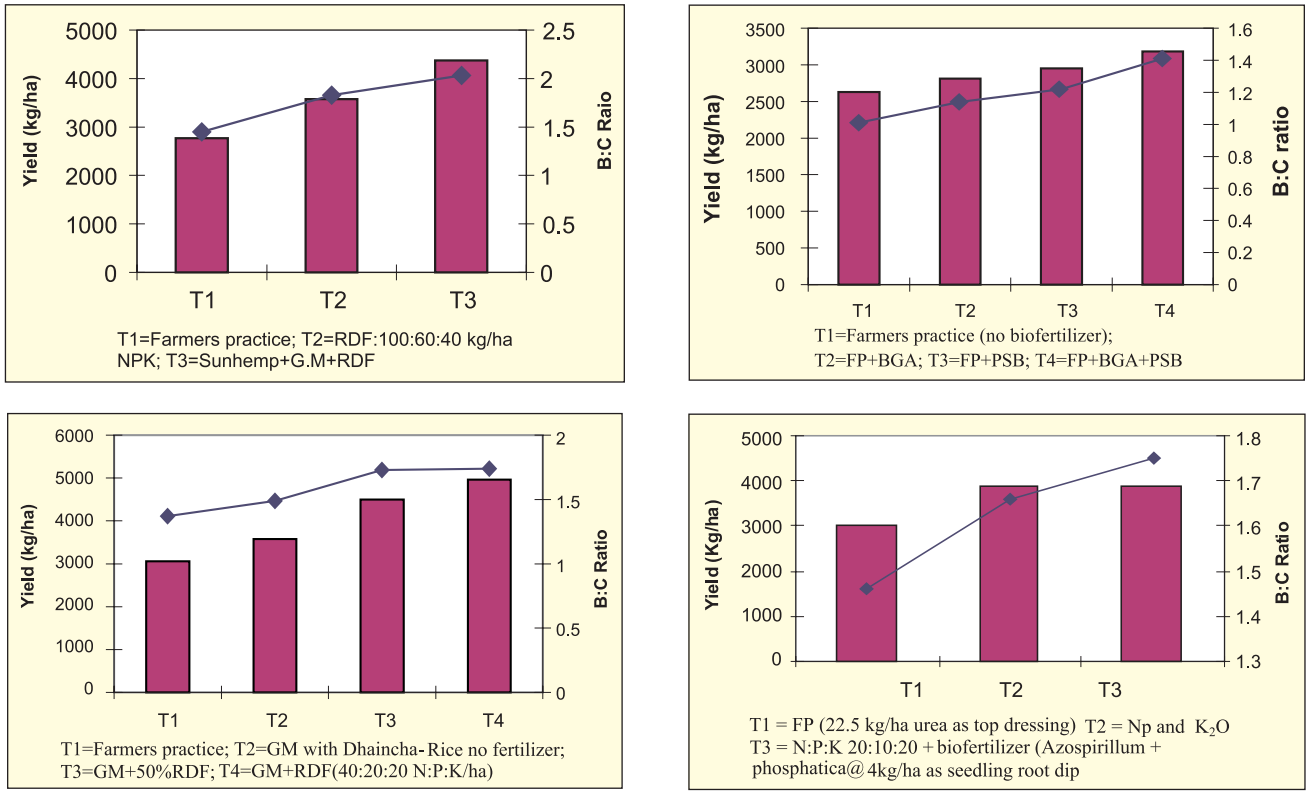


Fig 9. Influence of INM practices in sali rice at Nagaon

with 40:20:20 kg NPK/ha enhanced the productivity of *kharif* potato (16%) compared to the farmers practice. Application of 40:20:20 NPK and boron (1.5 kg/ha) in cabbage increased the yield (59%) and net returns (Rs.41,000/ha) as compared to the control (24,200 kg/ha). This practice was adopted by 52 and 30% farmers in IVLP and non-IVLP villages, respectivelyBoron application for cabbage was adopted in 30 ha at IVLP site. At Hassan, in-*situ* green manuring along with RDF in rice, enhanced the productivity (630 kg/ha) and profitability (Rs.2,750/ha) compared to the RDF and bio-fertilizers (2,870 kg/ha) (Table 5). This technology was adopted in 10 ha area covering 25 farmers in non-IVLP villages. Use of compost @ 5 t/ha with RDF along with Zinc Sulphate @ 20 kg/ha in maize gave higher yield (508 kg/ha) and net returns (Rs.2,009/ha) compared to the compost @5 t/ha along with 50% of recommended dose of fertilizer (2,527 kg/ha). This technology was adopted by 46 and 52 farmers in the targeted and neighboring villages, respectively. In potato, soil test-based fertilizers with compost @5 t/ha and bio-fertilizers, enhanced tuber yield (1,780 kg/ha) and net returns (Rs.5781/ha) over the soil test-based fertilizer recommendation alone (9.32 t/ha). At Raipur, green manuring with sunhemp along with 80:50:30 NPK kg/ha in rice gave higher productivity (36%) compared to the recommended dose of 80:50:30 NPK kg/ha (3,464 kg/ha). Gliricidia @ 5 t/ha with bio-fertilizers (PSB *and Azosprillum*) enhanced yield by 20% over the farmers practice. This technology was found simple and thus adopted by 60% of the farming community in project villages. Farmers opined that gliricidia could be planted on field boundaries, reducing the cost of production by 20%.

3.5 Integrated Crop Management

At Cuttack, use of HYV Vandana, line seeding behind country plough, FYM @ 2 t/ha, mechanical weeding and need-based plant protection measures, enhanced productivity by 108 to 152% over farmers variety and method of cultivation (1450 kg/ha).

Improved beaushening (gap filling) and nitrogen

Rice cultivar Vandana in rainfed uplands at Cuttack

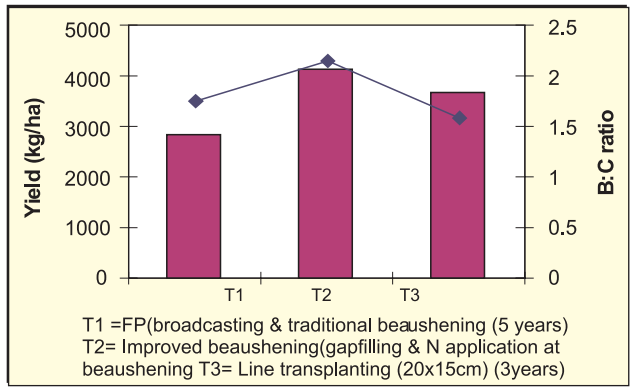


Fig 10. Influence of improved beaushening in rainfed low land rice at Cuttack

application @ 20kg N with HYV Gayatri improved plant stand, yield (5,350 kg/ha) and net returns (Rs.5,997/ ha) compared to broadcasting and traditional beaushening (2,152 kg/ha). At Nagaon, in polyhouses measuring 50 m^2 farmers could produce early vegetable seedlings for sale at higher price and could earn Rs.2,735/ polyhouse. This technology is suitable for high rainfall areas. At Raipur, line sowing of rice recorded 24% higher

Table 6: Effect of IPM practices on productivity and profitability at Raipur, Assam and Cuttack

Centre	Crop	Treatments	Grain Yield (kg/ha)	Net returns (Rs/ha)	B:C ratio
Raipur	Rice (1999-05)	Farmers practice	1939	3585	0.40
		Monocrotophos @ 1 L/ha (2 sprays)	2552	7118	0.77
		Neem-based insecticide @ 750 mL/ha + monocrotophos @ 500 mL/ha (2 sprays)	2887	9002	1.04
	Chickpea (1999-05)	Farmers practice	416	1644	0.46
		Endosulphan spray @ 1 L/ha	596	2436	0.81
		Monocrotophos	639	2818	0.71
		Recommended practice	663	3329	1.02
Assam	Potato (1999-00) (2002-03)	Farmers practice	11150	8946	1.25
		T-2: Ridomil @ 2g/L & Mancozeb 2.5g/L (alternate application of 6 sprays at an interval of 12 days starting from mid December)	14100	18064	1.46
		T-3: Malathion 5% dust @40 kg/ha + MOC @150 kg/ha at the time of earthing up	12700	13360	1.36
		T2+T3	15900	23880	1.59
	Banana (2003-05)	Farmers practice (no control)	11760	19905	1.68
		Cloth bagging for 15-20 days during emergence of bunches	15100	39179	2.43
Cuttack	Rainfed low land rice (2002-04)	Farmers practice (no control measure)	3250	6400	1.48
		Insect pest control by using IPM technology	5100	14325	1.86
	Dalua/ summer rice (2002-03)	Farmers practice (no pest control)	2800	3575	1.26
		Control of stem borer by IPM (resistant variety Lalat, seedling root dip, Chloripyriphos 1 mL/L, Pheromone traps @ 20/ha)	4500	10120	1.61

yield over broadcasting and gave additional net returns of Rs.5,440/ha. Line sowing was found more economical compared to transplanting, particularly when operations were delayed due to prolonged dry spells. At Ranchi, line sowing (20 cm) with improved variety of rice (Birsadhan 106), and moderate dose of nutrient, enhanced productivity by 50% compared to the broadcast upland rice. This technology was adopted by 50% of the farming community in IVLP villages. Application of vermicompost and biopesticides in vegetables gave higher productivity (30%) over the use of conventional chemical fertilizers and pesticides. Line sowing of rice by Bhoramdeo seed drill and application of anilophos @ 0.40 kg a.i./ha gave higher yield (964kg/ha) and net returns (Rs.4,551/ha) compared to the farmers practice of beaushening and no weedicides (3,070 kg/ha).

3.6 Integrated Pest Management

At Cuttack, IPM package (resistant rice variety Swarna, pheromone traps for stem borer @ 20/ha, *Trichogramma, japonicum,* egg parasitoids @ 1,00,000/ha, monocrotophos 35EC @ 500g ai/ha for case worm, leaf folder, WBPH, thrips and whorl maggot, spot application of phorate 10g/ha for mealy bug) enhanced the grain yield (57%) and net returns (Rs.7,925/ha) compared to the farmers practice of no control measures (3,250 kg/ha) (Table 6). This package was adopted in 10 ha. in target villages over a period of 5 years. At Ranchi, intercropping mustard with every 4 lines of cauliflower, and soil application of borax @ 10 kg/ha recorded 27% increased yield and 10% additional profit as compared to farmers practice (1,190 kg/ha).

At Nagaon, two sprays of carbendazim 50WP (@ 1g/L at 25 and 45 DAS (to jute for controlling

Table 7: Effect of IPM practices on productivity and profitability at Hassan

Crop	Treatments	Yield (kg/ha)	Net returns (Rs/ha)	B:C ratio
Rice (3 years)	FP (improper control of stem borer and blast)	1790	65	1.01
	Seed treatment with carbendazim @ 4g/kg seed	2877	5670	1.55
	Foliar spray of monocrotophos and carbendazim at 25 and 75 DAP	3677	8448	1.72
	Seed treatment with carbendazim @ 4g/kg seed + foliar spray of monocrotophos and carbendazim at 25 and 75 DAP	3917	9528	1.80
Maize	FP (improper plant protection measures)	1500	1865	1.29
	Seed treatment with Ridomil@ 1g/kg + two sprays of Mancozeb @2.5g/L	2500	5388	1.72
	Seed treatment with Ridomil@ 1g/kg +one spray of Ridomil @ 1g/L	2950	6859	1.82
Potato	FP - No seed treatment and improper dosage of pesticides	6683	2965	1.15
	Seed treatment with Mancozeb+ soil application of bleaching powder @25 kg/ha + Dicofol@ 2.5 mL/L	9983	13404	1.62
Cabbage	FP - no seed treatment and non acceptance of recommended practice	2100	24400	4.40
	Seed treatment with Streptomycin sulphate + 2 sprays of COC @ 2.5g/L	3000	40500	5.50
Peas	FP -improper plant protection measures	530	2110	1.49
	Spraying of wettable S @ 3g/L and monocrotophos @ 1.5 mL/L	920	5540	2.00
Cowpea	FP- spraying of Methyl Parathion@ 2 mL/L at the time of pod formation	480	1520	1.54
	Spraying Dimethoate @ 1.7 mL/L at 50% flowering	720	2980	1.85

anthracnose, root rot), and stem rot and spraying endosulphan 35%EC(@ 2mL/L at 15 day interval (against hairy caterpillar) increased yield (41%) and net returns (Rs.3,690 /ha) compared to the farmers practice (1.67 t/ha). At Hassan, foliar spray of monochrotophos and carbendazim (50% WP) to rice gave higher grain yield (800 kg/ha) and net returns (Rs.2,778 /ha) compared to the untreated control. This technology was adopted in 25 and 30 ha in IVLP and non-IVLP villages. For pea, wettable sulphur @ 3 g/L (to control powdery mildew) and mono chrotophos 1.5mL/L (to control aphids) gave an additional yield of 390 kg/ha and increased net returns of Rs.3,430/ha compared to the farmers practice (530 kg/ha). More than 75% of the farmers adopted this technology in target and non target villages (Table 7).

At Raipur, IPM module for chickpea (neem based insecticide+endosulphan+NPV 250 LE+mono-crotophos) gave 40% higher seed yield compared to NPV 250 LE+endosulphan (950 kg/ha).This technology enhanced net returns (Rs.6,046) as compared to the farmers practice (Rs.6,822).

3.7 Rainfed Horticulture

At Hassan, *in-situ* green manuring with sunhemp along with 100 g nitrogen, 90g phosphorus and 120 g potassium per plant enhanced the yield in arecanut (237 kg/ha) and net returns (Rs.28,777 /ha) compared to balanced dose of fertilizer alone (941 kg/ha). About 105 arecanut farmers are adopting *in-situ* green manuring of sunhemp + along with RDF. Use of pre emergence (Gramoxone) and one post emergence weedicide (Glyphosate) gave additional 200 kg dry nuts and net returns of Rs.63,837/ha compared to control (500 kg/ha). At Nagaon, application of 1.5 kg urea, 2.5 kg SSP, 1.75 kg MOP and 25 g of borax in 2 equal splits in April and October by ring method gave higher coconut yield (2,350 kg/ha) and net returns (Rs.37/tree), compared to no fertilizer application (3,250 kg/ha). At Vengurli, coppice grafted cashew trees (HYV V-7) increased the net yield by 208% as compared to the seedlings of cashew trees (1.25 kg/tree).

3.8 Livestock

At Ranchi, feeding of top feed; peepal, jamun and pakar leaves with mineral mixture @ 30 g/animal along with wheat bran for 30 days enhanced the milk yield of cows by 150% over farmers practice. Cross breeding of Black Bengal goats with Beetal buck gave return of Rs. 3.76/rupee investment. This technology was adopted by almost all goat rearing farmers of IVLP center (Table-8).

Oral administration of fazole bolus/calf, suffering from endoparasites, along with 50 g powdered neem leaves/kg body weight at an interval of one week for six months reduced mortality rate to the extent of 15%.

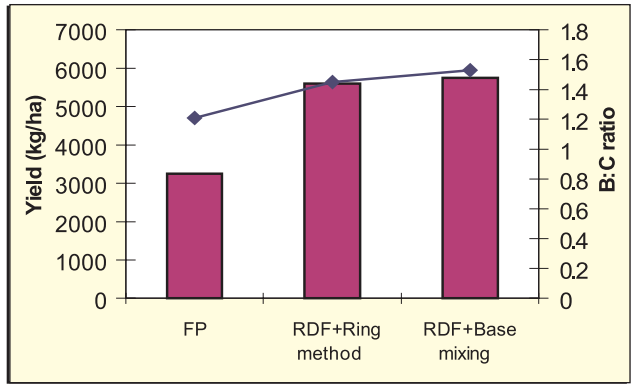


Fig 11. Effect of fertilizer management practices in coconut at Nagaon

Table 8: Performance of improved crossbreds at Ranchi. (2000-2002)

Breed	Average birth weight (kg)	Adult body weight (kg)	Net returns (Rs.)	B:C ratio
Farmers practice (Desi goat crossed with desi buck)	2	6.50	2750	2.05
Desi goat crossed with improved buck (Beetal)	3	9.75	6250	8.01

Almost all the farmers in IVLP villages are adopting this technology. Concentrate feed prepared from locally available ingredients like rice bran+mahua cake+niger cake+urad chunni+ragi flour+ salt became popular in 60% of the livestock farmers. Cross breeding of indigenous birds with Divyayan red cocks was adopted by all the farmers of the target and neighboring villages. Feeding of urea-treated paddy straw (2% urea) for 3 months enhanced productivity (27%) and net income by Rs.213/animal compared to untreated straw (Table 9).

Supplementation of mineral mixture to cattle enhanced the productivity (56%) and profitability (Rs.230/animal) compared to control (Table 10).

Rearing of Crossbred (Tamworth x Desi) pig under farmers management increased the productivity and net returns by Rs.11,875/unit as compared to desi breed of pigs reared in free range system (Table 11).

At Hassan, use of Pestoban and Panacure to control endo and ecoparasites in lactating animals gave additional milk yield (25%), compared to control (1,010 L/305 days). Feeding of enriched dry fodder (4% urea, 3% jaggery and 1% salt) increased milk yield of dairy animals (250 L/year) compared to feeding of untreated fodder alone (700 L/year). Poultry breed Girirani laid higher eggs per annum(175), meat (1-1.5 kg) and net returns (Rs.1,800) as compared to the local breeds under backyard (50 eggs/year with net returns of Rs.1,185/ year) (Table-12).

Backyard poultry with improved strains (*Kalinga Brown)* at Koraput

At Koraput Italian honeybee keeping was found a profitable enterprise for landless farming community. It

Table 9: Effect of enrichment of paddy straw in dairy animals at Ranchi

Treatment	Yield (kg/day)	Increase in productivity (%)	Net returns (Rs.)	B:C ratio
Traditional feeding practice (untreated paddy straw)	3.29	-	789.60	1.57
Feeding urea treated paddy straw	4.18	27.05	1003.20	1.82

Table 10: Effect of mineral mixture on milk productivity in cattle at Ranchi

Treatment	Yield (L/cow/day)	Net returns (Rs)	B:C ratio
FP (without supplement)	2.48	345	1.46
Supplementation with mineral and vitamin (Calvin Forte)	3.53	575	2.25

Table 11: Effect of rearing crossbreed piglets on productivity and income at Ranchi

Treatment	Average liter size	Net returns (Rs.)	B:C ratio
FP (desi pig in free range system)	5.5	8,525	2.13
Cross breed pig (TxD) under farmers management condition	9.0	20,400	5.10

A. Utilization of existing fish ponds through composite fish culture at Nagaon

B. Italian bee keeping and oyster mushroom production

Income generation activities for tribals farmers in Koraput district

gave annual gross income of Rs. 5,500/box as compared to Rs. 1,500/ box from Indian honey bee. Yield of honey from Italian bee was higher (32 kg/box/year) as compared to the Indian bee (8 kg/box/year). Mushroom cultivation with niger sticks as substrate was found suitable off-farm activity for small, marginal and landless farmers and provided an income of Rs. 2,200/ family in 4 months. Rearing Vanaraja poultry birds in the backyard resulted in an increase of net income of Rs. 419/bird/year due to higher egg production (160 eggs/year) and higher body

Table 12: Performance of improved breeds in backyard poultry at Hassan

Treatments	Eggs/ annum	Meat (kg)	Cost of production (Rs)	Gross returns (Rs)	Net returns (Rs)	B:C ratio
FP (local birds)	50	1.5-2.0	120	1305	1185	-
Giriraja	150	3.0-4.0	300	3270	2970	9.87
Girirani	175	2.5-3.5	320	3305	2985	10.00

Table 13: Influence of Vanaraja poultry bird on production and gross income at Koraput (2000-2003)

Treatments	Body weight at 6 months (kg/bird)	Egg production (Nos/annum)	Cost of production (Rs/bird)	Gross income (Rs/bird)
Desi bird	1.12	60	16	269
Vanaraja poultry bird	2.60	160	26	688

weight gain (2.6 kg in 6 months) in comparison to local birds (60 eggs/year and 1.12 kg body weight). This technology has spread to 4,200 households in all the 14 blocks of the districts (Table 13).

The DRDA at Koraput produced 50,000 chicks during the last 4 years. Different organizations like ATMA, DRDA, ITDA and NGOs have included this technology as a component in their poverty alleviation programmes.

Upgradation of local goats with superior bucks (Sirohi) reduced kid mortality from 40 to 15% and increased the slaughter weight by 42.5%. Net income from sale of goats increased from Rs. 565 to 849. This technology has spread widely in three villages of IVLP. Honeybee keeping with Italian honeybees has been accepted by more than 35 families of neighboring villages, besides 25 in IVLP villages (Table-14).

Improved poultry bird (Kalinga Brown) enhanced survival rate (97%) and egg laying capacity(150-160% eggs) over local bird at Cuttack (Table 15).

Use of Barbari buck for upgradation of local goat resulted in higher birth weight and growth rates of offsprings (Table 16).

At Nagaon, use of antihelminthic drugs to improve the health of cattle resulted in 67% higher milk yield and additional returns of Rs.114/cow. Similarly the body weight of goat after medication enhanced by 34.38% with additional net returns of Rs.128.

3.9 Farming Systems

At Ranchi, a module consisting of improved rice cultivar (IR-64)+fish (mixed carp) + wheat cultivar (PBW -443) enhanced net returns (Rs.58,557/ha) as compared to the farmers practice (Rs.2,770/ha). This system, besides wheat and rice, realized additional gain of 911 kg of fish. An other module, integrated system through fish cum pig (2:3) along with the improved management in rice farming system increased net returns of Rs.53,100/ ha with B:C ratio of 4.12 as compared to the farmers practice of rearing fish alone (Rs.12,125/ha; B:C ratio 2.49). Similarly, fish cum duck culture in rice farming system enhanced net returns by Rs.7,108/ha over farmers practice of rearing fish alone. The refined technology of fish-cum-duck rearing under composite fish culture in rice-based ecosystem was accepted by 80% of the farmers at target sites.

Table 14: Effect of cross breeding in goats at Koraput

Treatment	Body weight at 9 months (kg/goat)	Mortality (%)	Cost of production (Rs/goat)	Gross income (Rs/goat)
Breeding with desi buck	10.0	40	135	700
Breeding with improved buck (Sirohi)	14.2	15	145	994

Table 15: Influence of improved poultry breed on survival rate and body weight gain at Cuttack

Treatment	Survival (%)	Initiation of egg laying (days)	Egg laying capacity/year	Weight of egg (g)	Weight of hen (kg)
FP (local bird)	85	180	60-70	50	1.60
Improved strain (Kalinga Brown) with scheduled vaccination	97	175	150-160	51	2.75

Table 16: Performance of improved goat breeds at Cuttack (1999-2002)

Treatment	Body weight (kg)			
	at birth	at 2 months	at 4 months	at 6 months
FP(local buck for breeding)	1.47	3.87	6.16	8.06
Breeding by superior buck (Barbari)	2.06	5.23	8.03	10.10

Integrated farming system Pig-cum-duck-cum-fish-cum-wheat at Ranchi

At Cuttack, from the community pond situated in the village, scientific fish rearing (catla; Rohu; Mrigal and fresh water prawn in 20:30:25:35 ratio) not only increased the fish yield by 150%, but also increased the net income from Rs.1,250/- to Rs.26,500/- (Table 17).

At Nagaon, stocking of Rohu, Mrigal and Katla @ 7000 fingerlings/ha at 1:1:1 ratio with supplemental fish feed during lean period was found to fetch higher fish yield (61.5%) compared to farmers practice. This technology was adopted by 9 and 18 farmers in IVLP and non-IVLP village, respectively (Table 18).

At Raipur, Catla, Rohu, Mrigal and Carp fish in 2:2:1:1 and 2:1:1:1 in empty and nutrient rich ponds, respectively and liming @ 250kg/ha/year 10 days before

Table 17: Influence of composite fish culture on meat yield and net returns at Cuttack

Treatment	Yield (kg/pond)	Net returns (Rs./pond)	B:C ratio
FP (improper stocking ratio)	717	2500	1.17
Scientific fish farming/ Catla:Rohu:Mrigal:Common carp (20:30:25:25)	1500	22000	1.96

Table 18: Influence of management practices on fish yield and income at Nagaon

Treatment	Yield (kg/ha)	Net returns (Rs/ha)	B:C ratio
FP	1855	36887	3.35
Appropriate population, ratio and fish species	3000	95471	6.64

seed stocking with rice bran polish, oil cake of groundnut/mustard, generated an amount of Rs.77,000 with a net profit of 46,800 in 1.6 ha tank.

3.10 Farm Implements

At Nagaon, bullock drawn rice puddler recorded higher yield by 12% and net returns of Rs.3,037/ha compared to the traditional puddling. The farmers in target villages opined that the weight of puddler should be increased to match with draft capability. Bullock drawn MB plough gave 14% higher yield in rice and increased net returns of Rs.2,450/ha compared to the desi plough (3,420 kg/ha). Bullock drawn MB plough was better than desi plough in terms of tilth and field capacity. By using MB plough, the cost of production was reduced along with consequent increase in net return by 51%. Use of improved paddy weeder in Sali rice gave 10% increase in yield and net returns of Rs.3,145/ha as compared to manual weeding. This improved tool reduced labour requirement by 50% as compared to the farmers practice(Table 19).

At Hassan, power operated refined tube cob sheller shelled about 1,500-2,000 kg/day with increased efficiency of 3-4 folds, while refined maize cob sheller which has shelling capacity of 2,800 kg/h, could shell with 94% efficiency (Table 20).

Use of serrated sickle reduced the cost of operation (Rs.1200/ha) and number of man-days (12/ha) for harvesting paddy, fingermillet and maize compared to the traditional sickle (Table 21).

Adjustable power multicrop intercultivator used for weeding, pulverization, earthing up and spraying pesticides recorded fuel efficiency of 2.75/acre with operational cost of Rs.192/day in SRI method of cultivation. As a result, the yield of rice increased by 20-30% with 50-75% reduction in cost for intercultivation.

Table 19: Assessment of improved paddy weeder at Nagaon (2004-05)

Intervention	Treatments	Yield (kg/ha)	Net returns (Rs/ha)	B:C ratio
Transplanted	Farmers Practice (manual weeding)	3480	6608	1.48
Sali rice	Improved paddy weeder	3821	9753	1.77
Bullock drawn	Farmers practice (Desi plough)	3420	6727	1.50
MB plough	Bullock drawn MB plough	3909	10147	1.80
Puddler	Traditional puddling	-	6761	1.52
	Bullock drawn puddler	3815	9798	1.78

Table 20: Evaluation of threshing tools in maize at Hassan

Treatments	Shelling capacity(kg/h)	Efficiency of operation(%)	Cost /quintal (Rs)
Cob shelling by using Vandri	8	0.3	83
Hand operated tubular maize cob sheller	20	0.7	31
Power operated tubular cob sheller	150	5.0	12
Tractor mounted maize cob sheller	2800	94.0	7

Table 21: Performance of interculture equipments in rice at Hassan

Treatments	Field efficiency (ac/day)	Tillage depth (cm)	Operation cost (Rs/day)	Cost required (Rs/ac)
FP - Kurpi	0.03	3-4	50	400
Bullock drawn blade harrow	1.00	5-7	270	170
Adjustable power multicrop intercultivator	2.75	8-10	192	76.8

More than 150 units were purchased by farmers in the state during the last two years.

Multicrop thresher for paddy, maize and fingermillet has 1,100kg/h capacity with 74% efficiency. Cost for processing 1 tonne of grain is Rs.185. Use of power operated chaff cutter reduced the number of man days to 7/ha and saved Rs.350/t compared to the farmers practice (Table 22).

Mini dal mill with improved preconditioning oil treatment, water spraying and drying gave higher dal recovery (16.3%) and reduced grain damage (5.5 %) compared to the farmers practice of traditional preconditioning (soaking in water, coating with red soil and drying) which recorded dal recovery of (58.5%) and broken grains of (12.2%) (Table 23).

Table 22: Assessment of mulitcrop thresher for rice, maize and fingermillet at Hassan

	Treatments	Threshing capacity (kg/h)	Efficiency of operation (%)	Cost/ton (Rs)
Multicrop & thresher	FP - Hand beating (for paddy)	20	1.2	322
	FP with bullocks - animal treading with stone roller (for paddy and ragi)	300	18.5	238
	Multicrop thresher for paddy, maize and ragi	1100	74.1	185

Table 23: Assessment of power operated dal mill on pigeonpea at Hassan

Treatment	Dal recovery (%)	Broken (%)	Milling capacity (kg/h)	Cost/q (Rs)
FP with traditional preconditioning (soaked in water + coated with red soil + drying)	58.50	12.20	8	78.00
Using mini dal mill + improved preconditioning (oil treatment + water spraying + drying)	74.80	6.40	85	36.00
Using refined dal mill + improved preconditioning (oil treatment + water spraying + drying)	75.65	6.10	180	20.69

CHAPTER

4

Oilseeds Based Production System

4.1 Crops and Varieties

Improved varieties of soybean (JS-90-41, NRC-37 and MAUS-1) and wheat (LOK-1 and HI-1418) at Indore, pearlmillet (ICMH-356) and mustard (RH-189) at Bharathpur, soybean (NRC-37 and MAUS-47), potato (Chipsona and Kufri Sinduri) and pigeonpea (ICPL-87119), rice (Faram Nungi, Anjan and Chatri), chickpea (JG-322) and lentil (JL-1, JL-3 and JL-21) at Jabalpur, soybean (JS-9041), wheat (HD-2004 and JW-17), tomato (Rashmi and Nidhi), brinjal (MUH-18) and cauliflower (Madhuri) at Bhopal, recorded 30 to 50% higher yield as compared to respective local varieties.

Soybean cultivars JS-335 and MAUS 47 at Indore

The improved soybean cultivar JS-90-41 was adopted in 120 ha. Malavi Shakthi, a variety of wheat, was taken up by 195 farmers in about 435 ha. Rainfed wheat variety Sujatha was replaced by cultivars JW-71 and HW-2004 and were adopted in 234 ha by 155 farmers. Similarly, cultivar JL-21 (lentil) completely replaced cultivar T-36 (Table 1).

4.2 Cropping Systems

At Junagadh, groundnut+sesamum (2:1) intercropping increased gross monetary returns by 21% compared to the sole groundnut (2,078 kg/ha). Cotton+groundnut (1:2) system recorded higher gross monetary returns (Rs.75,188/ha) compared to the farmers practice (Rs. 41,212/ha). At Bhopal intercropping of soybean and maize (4:2) enhanced the profitability by Rs. 5,900 and 12,100/ha compared to sole maize (Rs. 12,600) and soybean (Rs. 6,400), respectively. Similarly soybean+pigeonpea (4:2) system recorded higher monetary returns of Rs. 4,060 and 12,860 compared to sole pigeonpea (Rs.16,200) and soybean (Rs.7,400). This system was adopted in 140 ha area at IVLP site. Alternate crops like pigeonpea, maize and marigold were found profitable, compared to soybean, in rainfed, medium and deep Vertisols under delayed sowing conditions. The highest net returns were obtained through marigold (Rs.20,430/ha) as compared to soybean. As a result marigold was adopted by 71 farmers in 50 ha area at the target site. At Indore, soybean+maize (6:3) recorded the soybean equivalent yield of 1,700 kg/ha as against the local practice of mixed seed (Table 2).

4.3 Rain Water Management

At Bhopal, contour cultivation of improved wheat variety (JW-17) together with RDF (50:30:30 kg/

Table 1: Performance of improved varieties

Centre	Crop	Cultivars	Yield (kg/ha)	Net returns (Rs/ha)	B:C ratio
Bhopal	Soybean	Local JS-335	1030	9300	1.00
	(2000- 2004)	JS-335	1380	12000	1.29
		JS-90-41	1550	13500	1.45
		NRC-12	1490	12900	1.39
		NRC-37	1380	11800	1.27
		PK-1029	1290	10900	1.17
	Tomato	Local (Pusa Ruby)	20090	39445	1.00
	(2000-2004)	Pusa Gourav	27100	44200	1.46
		Hybrid - Rashmi	42250	54500	1.77
		Hybrid - Nidhi	41900	72800	1.92
		Pusa Hybrid-2	36800	48660	1.58
	Brinjal	Local-PPR	22800	40100	1.00
	(2000-2004)	Pusa Hybrid 6	37650	55300	1.49
		MBH-80	43220	76137	1.89
		MBH-2	35520	51100	1.37
		Pusa Champion	38700	67400	1.82
	Cauliflower	Local (PSBK-1)	15650	60125	1.00
	(2000-2004)	Madhuri	29500	102375	1.65
	Cabbage	Local - (GA)	16700	32850	-
	(2000-2004)	Bahar	33500	75000	-
	Chickpea	Ujjain-21	840	11840	1.00
	(2000-2004)	JG-74	1500	21600	1.80
		JG-218	1250	17600	1.49
		JG-322	1290	18240	1.54
		JG-315	1360	19360	1.63
		BG-372	1460	20960	1.77
	Lentil	T-36	600	8320	1.00
	(2000-2004)	JLS-1	940	13015	1.56
		K-75	810	11065	1.33
Indore	Soybean	Local(Samrat)	1416	-	-
	(2001- 2003)	MAUS-47	3113	19219	10.15
		NRC-37	1864	4369	2.08
		NRC-2	1162	985	1.49
		JS-335	1744	1619	1.77
		JS-93-05	1907	4808	3.69
	Potato	Local (Kufri Jyoti)	11420	-	-
	(2000-2003)	Kufri Lauvkar	17820	10795	1.66
		Chipsona-1	15100	10616	1.74
	Wheat	Local (Lok-1)	2158	-	-
	(2000-2003)	Naveen Chandosi	3111	15650	3.08
	Garlic	Local (Omleta)	8130	-	-
	(2000-2003)	G-241	9740	34150	5.86

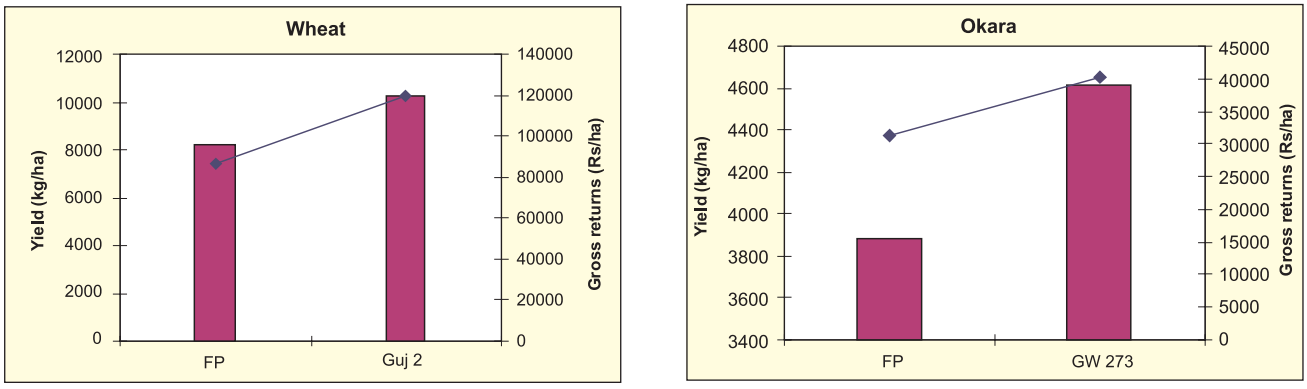


Fig 12. Performances of improved wheat and okra varieties at Junagadh (2002-04)

Table 2: Performance of different cropping systems

Centre	Crop	System	Grain equivalent yield (kg/ha)	Net returns (Rs/ha)	B:C ratio
Bhopal	Soybean	Sole soybean (FP)	1200	6400	1.00
	(2000- 2004)	Soybean + maize (mixed seed) (FP)	2147	14275	1.79
		Soybean + maize (4:2) 2600	18500	2.16	
		Sole maize	1860	12600	1.55
	Soybean	Sole soybean	1340	7400	1.00
	(2000- 2004)	Soybean + pigeonpea (4:2)	2870	20260	2.14
		Sole pigeonpea	2320	16200	1.76
	Soybean	Soybean (JS335)	1030	-	1.00
	(2000- 2004)	Pigeonpea (ICPL-87-119)	1420	-	2.30
		Maize (JL-8/NLD)	3620	-	2.04
		Marigold (Pusa Basanti/ Sierra Orange)	8150	-	3.52
Junagadh	Groundnut	Sole groundnut	2078	49640	2.94
	(2000- 2003)	Groundnut+sesamum (2:1)	1817+886	59913	4.02
	Groundnut	Sole Cotton	1857	41212	2.41
	(2001- 2003)	Cotton+groundnut (1:2)	1576+2316	75188	4.01
Indore	Soybean (2001- 2004)	Mixed crop of soybean and maize	1671	-	-
		Soybean + maize	1948	3255	5.03

NPK/ha) enhanced the productivity (34%) and net returns (Rs.3,370/ha) compared to the farmers practice of 50 kg N/ha (1,440 kg/ha). This technology was adopted in 157 ha with the involvement of 102 farmers in IVLP villages. Formation of drainage lines at 30 m interval with the help of ridger (tractor/bullock) in soybean increased the productivity (30%) and additional net returns (Rs.1,600/ha) compared to the farmers practice of no drainage line (690 kg/ha). Drainage line formed at 30 m interval with ditcher enhanced the productivity (41%) and additional returns (Rs.2,040/ ha) over the farmers practice. At Indore, graded bunds and line sowing of soybean across the slope gave 11 to 15% yield advantage. At Jabalpur, broad bed and furrow

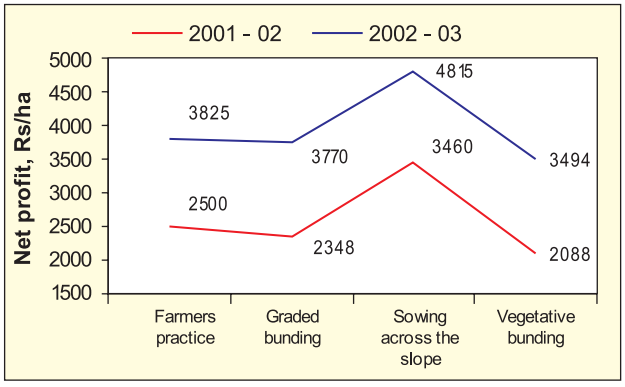


Fig 13. Economics of different land management practices in soybean FSN 1 (Narsinghpur)

Broad bed and furrow method of *insitu* moisture conservation at Indore

Ridge and furrow method of moisture conservation at Indore

at 180 cm width and 20 cm height separated by 50 cm wide furrows to 20 cm of depth formed across the contour at 0.6% slope recorded 20% increase in soybean yield as compared to the farmers practice.

Deep tillage in groundnut increased pod yield (28%) over shallow tillage and resulted in higher gross monetary returns of Rs. 39,121/ha at Junagadh. This practice was adopted by 70 and 28% area in IVLP and non-IVLP villages, respectively. At Jabalpur, cultivation of soybean across the slope in undulating, unbounded fields enhanced productivity by 10 to 13%, compared to the control. This practice created multitude of barriers across water flow and increased time for infiltration of rain water into the soil profile, thereby reducing erosive potential (Table 3).

4.4 Integrated Nutrient Management

At Bhopal, use of 50% organic manure (5 t/ha), along with 50% recommended dose of *Rhizobium* and PSB in soybean and *Azotobacter* in wheat enhanced the total yield (470 kg/ha) and net returns (Rs.2,950/ha) in soybean-wheat system compared to the farmers practice. This efficient system was adopted in 296 ha involving 253 farmers. In groundnut, 50% RDF + FYM 5 t/ha+*Rhizobium*+PSB enhanced the productivity (63%) and profitability (Rs.5,550/ha) over the farmers practice of FYM (2 t/ha+50 kg DAP/ha (1,140 kg/ha). This technology was adopted in 104 ha by 68 farmers at the IVLP site. At Junagadh, recommended dose of NPK (12.5:25:20 kg NPK/ha) with Rhizobium increased the gross monetary returns by 22% compared to the farmers practice of using 150 kg DAP/ha in groundnut and pigeonpea intercropping system. Use of (20:26.2:16.6:20:6) NPKS Zn kg/ha along with *Rhizobium* and FYM (5 t/ha) gave 82% higher yield in soybean as compared to the farmers practice of 30:22:8.5 kg NPK (873 kg/ha) at Indore. This system gave additional net returns (Rs.9,321/ha) over the farmers' practice. At Jabalpur, use of early maturing, drought and blast tolerant rice variety (JR-201) in combination with moderate dose of 40:20:10 NPK kg/ha+butachlor @ 2 kg/ha as pre-emergence and one hand weeding at 30-35 DAS produced 58% higher grain over the farmers practice. In soybean-chickpea sequence, 20:40:20:20:20 NPKS Zn kg/ha in *Bhatua* soils was found optimum for higher and profitable yield in soybean, while in chickpea, 20:40:20 NPK was found profitable (Table 4).

At Bharathpur, short duration clusterbean as a green manure in mustard along with 60:30 NP kg/ha increased yield (30%) and profitability (Rs.2,938/ha)

Table 3: Evaluation of soil management practices

Centre	Crop	Treatments	Yield (kg/ha)	Net returns (Rs/ha)	B:C ratio
Bhopal	Soybean (2002-2004)	FP - No drainage	690	6900	1.00
		Drainage at 30 m interval with Ditcher	970	8940	1.29
		Drainage at 30m interval with Ridger	900	8500	1.23
Indore	Soybean (2001-2004)	FP- Flat method	1292	-	-
		Broad bed fertilizer method	1735	5874	4.43
Jabalpur	Soybean (2001-2003)	FP (no land treatment)	875	3825	0.94
		Graded bunding	980	3770	0.74
		Sowing across the slope	985	4815	1.18
		Vegetative bunding by lemon grass/rosa grass	916	3494	0.73

Table 4: Impact of INM practices in different crops

Centre	Crop	Treatments	Grain Yield (kg/ha)	Net returns (Rs/ha)	B:C ratio
Bhopal	Groundnut (2002-04)	FP- FYM 2t/ha + 50 kg DAP/ha	-	5400	1.00
		RDF - 20:50:30:20:10 NPKS&Zn/ha	2540	7800	1.25
		RDF 50% +FYM 5t/ha + Biofertilizers (R&PSB culture)	6230	10950	1.62
Indore	Soybean (2001-2005)	FP (30:22:8.5 N:P:K)	1332	-	-
		20:26.2:16.6:20:6 N:P:K:S:Zn + *Rhizobium* +PSB	1841	5088	3.81
		FYM 5 t/ha + balance through fertilzer to make RDF	1933	6673	3.87
	Wheat (2002-2003)	FP - 100 kg of IFFCO (12:32:16)	2540	9945	1.71
		RDF (80:40:20)	4173	14385	3.38
Jabalpur	Soybean (2002-2003)	FP	805	3195	-
		FP+Rhizobium+PSB	900	3860	4.26
		RDF (20:40:20:20:20)NPKSZn	1055	4345	8.63
		RDF + Rhizobium+PSB	1075	4290	7.25
	Rice (2003-2005)	FP	1515	1923	1.37
		Improved variety (JR-21)+improved weed management	2108	3336	1.53
		Improved variety (JR-21)+improved weed management+moderate dose of fertilizers	2448	4410	1.63
	Chickpea (2003-2004)	FP (N-10, P-20 kg/ha)	750	3750	-
		FP+Rhizobium+PSB	855	4780	1.01
		RDF (20:40:20 NPK/ha)	950	5400	15.30
		RDF+Rhizobium+PSB	975	5350	13.83

Table 5: Performance of integrated pest management practices

Centre	Crop	Treatments	Yield (kg/ha)	Net returns (Rs/ha)	B:C ratio
Bhopal	Groundnut	Drying pods to 10% moisture	885	6325	1.00
	(2002-04)	Summer deep ploughing + neem cake + summer tillage with *Trichoderm a viridae* + pod drying upto 8-10% moisture	1475	12820	2.03
	Pigeonpea (2002-04)	FP- 1-2 sprays of endosulphan	1060	8400	1.00
		Polytrin 40% @ 0.002 % +chloropyriphos 0.05 % sprays at flowering and pod formation IPM Module	1310	11150	1.33
			1540	15050	1.79
	Chickpea (2002-04)	FP (1-2 sprays of endosulphan/ any other pesticide)	830	5450	1.00
		Triozophos one at early stage + methomel 1 kg/ha at flowering and pod formation stages	1110	7650	1.40
		IPM- SDP +ST with *Trichoderm a* viridae + polytrin 40% @ 0.002% + chloropyriphos 2 sprays at flowering and pod formation	1220	9800	1.80
		Nimbicidin 1 L/ha+*Trichogramma* cards 8/ha + pheromone trap @10/ha	1130	9950	1.82
		SDP+ST with TV + nimbicidin @ 0.45% + Ha-NPV 250 LE/ha + pheromone traps @ 10/ha +bird perches	1320	11700	2.15
	Chickpea + mustard (2000-04)	FP - Sole chickpea (2 sprays of endosulphan)	1080	11780	1.0
		Chickpea +mustard (4:2) (Control)	1680	20384	1.73
		Chickpea +mustard (4:2) +2 sprays of endosulphan @ 0.05 %	1880	23032	1.95
		Chickpea+mustard (4:2)+nimbicidin +NPV +PT	2240	28360	2.41
	Wheat (smut) (2000-02)	FP (no seed treatment)	3340	14845	1.00
		Lok-1 +ST with Raxil	3780	17805	1.20
		Malav Shakti+ST with Raxil (Pebuconazole 2% DS)	4140	20555	1.38
Indore	Soybean	FP (Quinolphos/Cypermethrin)	17	-	-
		IPM practice (Phorate 10G @10kgha, 0.08 % Trizophos @ 0.08 . BT @ 1 g/L, Trichoderma @ 3g/kg seed, pheromone traps @ 5-6/ha)	20	5624	5.05
	Potato (2000-03)	FP (Control)	115	-	-
		Captan@ 2g/kg seed	147	13400	3.79
	Potato (2000-02)	FP (Control)	127	-	-
		Dithane M-45 @2 kg/ha (2 sprays)	157	7850	2.19

compared to local mustard with 60:40 NP kg/ha (1,302 kg/ha).

4.5 Integrated Pest Management

At Jabalpur, quinolphos @ 1.5 L/ha, 20 and 45 DAS, effectively controlled semilooper and stemfly in soybean and increased seed yield (19%) and profitability (Rs.1,058/ha) over control. Use of bird perches and one spray of quinolphos @ 1.5 L/ha at 50% flowering in chickpea kept the pod borer population below ETL and gave 17% higher seed yield.

At Junagadh, IPM module (seed treatment with carbendiazim @ 2g/kg, foliar spray of 2% crude neem oil, pheromone traps @ 10/ha, and castor as trap crop) in groundnut+castor (2:1) reduced incidence of major pests and diseases and enhanced monetary returns (35%) over farmers practice (Rs.40,134/ha). In sole groundnut, IPM package (soil application of castor cake @ 500kg/ha, foliar spray of 2% crude neem oil at 35, 50 and 60 DAS and use of pheromone traps @10/ha) reduced the incidence collar rot (65%), stem rot (54%), late leaf spot (35%), rust (37%), PBND (28%), thrips (40%), aphids (30%) and defoliators (57%) over farmers practice (no control measures). This technology increased the pod yield of groundnut (23%) and net returns (Rs.49,588/ha). At Bharathpur, plucking and destruction of affected brinjal shoots followed by spraying of endosulphan @ 0.05% enhanced productivity (225%) and net returns (Rs.36,000/ha) compared to the farmers practice (Rs.4,000/ha). This technology was adopted in 434 ha. At Bhopal, IPM module (summer deep ploughing, soil treatment with phorate @ 10 kg/ha, two sprays of neem oil (0.3 %) and one spray of methomil @ 1 kg/ha at flowering, 10 pheromone traps/ha and bird perches) reduced the incidence of girdle beetle, green semilopper and stem fly by 25 to 20% in soybean and enhanced the grain yield (23%) and net returns (Rs.1,850) over recommended practice (1,370 /ha). This technology was adopted in 283 ha by 180 farmers in both IVLP and non-IVLP villages. IPM technologies in pigeonpea (SDP+ST with *Trichoderma viride*+Nimbicidin @ 0.45%+HaNPV 250 LE/ha+Pheromone traps @ 10/ha+bird perches) and chickpea (Summer Deep Ploughing+ST with *Trichoderma viride*+Nimibicidin @ 0.45%+HaNPV 250 LE/ha+ Pheromone traps @ 10/ha+bird perches) enhanced the yield by 49 and 59%, respectively, compared to the farmers practice. The economical gains were increased to the extent of Rs.4,000/ha in both the crops over the recommended practices of pesticides alone. These IPM modules were adopted in 49 and 139 ha in target and non-target villages. In chickpea+mustard intercropping, pod borer in chickpea was effectively controlled by two sprays of Nimibicidin 0.45% and NPV 250 LE at flowering and pod formation stages. This schedule increased the yield (108%) and net returns (Rs.16,580/ha) compared to the sole chickpea with two sprays of endosulphan (1,080 kg/ha). This technology was adopted by 48 farmers covering 52 ha in both IVLP and non-IVLP sites. Improved variety of wheat (Malav Shakti) along with seed treatment by raxil (*Tebucibazole*) @ 1g/kg, improved the yield by 24% and completely eliminated smut. This IPM technology along with improved variety gave higher yield (710 kg/ha) compared to no seed treatment (510 kg/ha).

At Indore, IPM practice (Phorate 10-G @ 10 kg/ha, Trizophos @ 0.8 L/ha, Bt @ 1 L/ha, *Trichoderma* @ 3 g/kg seed and pheromone traps @ 5-6/ha) enhanced the yield (25%) and net returns (Rs.5,624) in soybean compared to the farmers practice of pesticides alone (2,034/ha). Captan @2 mg/kg seed of potato effectively controlled seed rotting and enhanced the yield (28%) and net returns (Rs.13,400) compared to the farmers practice of no control (11,500 kg/ha) (Table 5).

Two sprays of Dithane M-45 @ 2 kg/ha controlled blight in potato and enhanced the yield (25%) and net returns (Rs.7,850) compared to the untreated or FP (12,700 kg/ha) (Table 6).

4.6 Farm Implements

At Bhopal seed cum fertilizer drill recorded 18% improvement in yield of soybean compared to the local drill (1,180 kg/ha), while strip till drill recorded plant population of 5 lakhs/ha and gave higher yield (23%) with a saving of Rs.1,575/ha compared to the local drill. The inclined plate planter reduced seed requirement of groundnut and pigeonpea up to 54 and 15 kg/ha, respectively as compared to farmers' practice. This tool helped to increase productivity by 21 and 48%, respectively and generated income ranging from Rs.4,000 to 8,000/ha (Table 7).

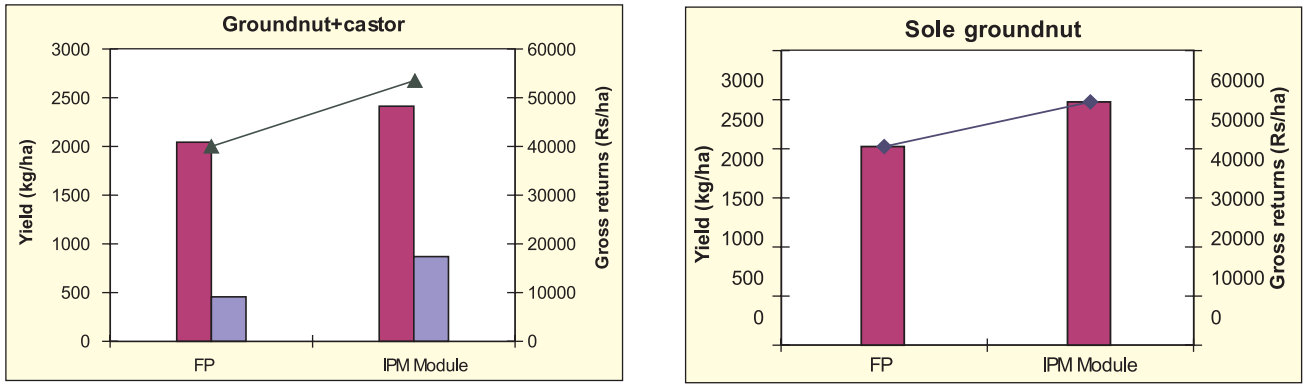


Fig 14. Effect of IPM modules in groundnut and castor in sole and intercropping system at Junagadh

Table 6:Evaluation of wilt management practices at Bhopal

Crop	Treatments	Grain yield (kg/ha)
Pigeonpea	FP- no seed treatment	860
	Seed treatment with Thyrum @1.5g + Bavistin @1.5g/kg	1010
	Seed treatment with *Trichoderma viridae* @ 4g/kg	1140
	Wilt resistant variety +ST	1360
	IPM- resistant variety + ST+ soil treatment with *Trichoderma viridae* @ 4-5 kg/ha	1560
Chickpea	FP- no seed treatment	1060
	Seed treatment with Thyrum @1.5g + Bavistin @1.5g/kg	1140
	Seed treatment with *Trichoderma viridae* @ 4g/kg	1360
	Wilt resistant variety +summer tillage	1540
	IPM- resistant variety + ST+soil treatment with *Trichoderma viridae* 4-5 kg/ha	1640
Lentil	FP- no seed treatment	510
	Seed treatment with Thyrum @1.5g + Bavistin @1.5g/kg	630
	Seed treatment with *Trichoderma viridae* @ 4g/kg	780
	Wilt resistant variety +ST	1020
	IPM- resistant variety + ST+soil treatment with *Trichoderma viridae* @4-5 kg/ha	1220

Table 7: Evaluation of seeding devices on different crops at Bhopal

Crop	Treatments	Yield (kg/ha)	Net returns (Rs/ha)	B:C ratio
Soybean (2000-04)	FP- Local seed drill	1180	4770	1.00
	Ferti-seed drill	1390	7805	1.37
	Strip till drill	1450	9045	1.85
Groundnut (2000-04)	Local seed drill	937	6125	1.00
	Inclined plate planter	1138	10890	1.50
Pigeonpea (2000-04)	Local seed drill	1030	10121	1.00
	Ferti-seed drill	1230	14470	1.29
	Inclined plate planter	1530	19040	1.59

Improved seed cum fertilizer and strip drill were used by 53 and 12 farmers, respectively. The reduction of drudgery of women in agricultural operations was achieved by the use of hand weeders, maize cob sheller, Navin sickle, groundnut decorticator and grain cleaner. Improved hand weeder and power weeding tools improved the profitability by 45 to 60% than weeding by *khurpi.* Manual wheel hoe reduced time requirement by 63% and increased net returns by Rs.900/ha. The serrated Navin sickle saved cost of operation compared the local sickle, besides increasing efficiency of operation by 8-12%. Hand held maize sheller reduced the cost of shelling to Rs.76/q compared to shelling by hand (Rs.119/q of grain). Groundnut decorticator reduced the man hours by 40 and saved the cost of Rs.308, compared to the decortication by hand (Table 8).

The cleaner/grader for value addition which has a cleaning efficiency of 99 % and capacity of 5-6 q/ha, saved Rs.15/q of grain. This tool was used by 135 farmers at IVLP site. The CIAE multicrop thresher (5 and 20HP) recorded higher working efficiency (4-5%) reduced seed damage (11 to 3%) and fetched higher market price of Rs.20/q compared to the local power thresher (Table 9).

Use of combine harvester in soybean on custom hiring basis reduced the cost of operation by Rs. 546/-,

Table 8: Performance of various post harvest farm machinery at Bhopal (2000-03)

Crop	Treatments	Capacity (kg/h)	Man hours (h/q)	Operation cost (Rs/ha)	Saving in cost (Rs/q)	Shelling efficiency (%)	Grain damage (%)
Maize	FP - Shelling by hand	6.00	17.0	119	-	100	1.3
	Shelling by manual maize sheller	15.0	6.3	43	76	100	2.6
Groundnut	FP - Decortication by hand	2.10	47.0	329	-	98.6	1.5
	Decortication by hand operated decorticator	33	3.0	21	308	99.3	3.0
Cleaning & grading	FP- Winnowing and cleaning by hand	100	2.0	18	-	78.5	-
	Hand operated cleaner	112	0.9	8	10.0	90.5	-
	Power operated cleaner/grader	500	0.2	2.6	15.4	97.5	-

Table 9: Performance of CIAE multicrop thresher on chickpea and soybean at Bhopal

Treatment	Capacity (kg/ha)	Cleaning efficiency (%)	Seed damage (%)	Germination (%)	Cost of operation (Rs/q)	Difference in price of produce (Rs/q)
FP - Local power thresher operation	194	88.8	9.7	65	28	0
CIAE multicrop thresher (5 HP)	204	92.4	3.2	76	27	20
FP Local power thresher (20 HP)	500	91.0	4.3	70	45	0
Multicrop thresher (20 HP)	700	92.0	2.2	78	43	20
FP - Local power thresher	190	90.4	9.0	68	26.3	0
CIAE Multicrop thresher (5 HP)	220	93.0	3.0	79	23.0	23
FP Local power thresher (20 HP)	850	94.0	5.0	71	35.0	0
Multicrop thresher (20 HP)	1000	99.5	1.3	78	30.0	19

Table 10: Performance of harvesting devices in soybean at Bhopal

Treatments	Man hours (h/ha)	Cost of operation (Rs/ha)	Shattering losses (kg/ha)	Saving in cost (Rs/ha)
FP (Sickle + power thresher)	216	1840	31.5	-
Self propelled VCR + Power thresher	51	1405	48.5	435
Combine Harvester	4	1294	20.0	546

man hours by 212 h/ha and shattering losses by 36% compared to the farmers practice of using sickle and power thresher. At Indore, use of reversible plough in soybean increased the yield (32.5%) and net returns (Rs.5146 /ha) compared to the conventional plough (1382 kg/ha) (Table 10).

4.7 Horticulture

At Junagadh, cultivation of rainfed groundnut in mango orchard resulted in increased pod (2,071 kg/ha) and fodder yield (2,790 kg/ha). This practice led to generate an additional monetary return of Rs.36,483/ ha. At Bhopal, hybrid varieties of tomato (Rashmi and Nidhi) produced 108 and 118% higher yield over local variety, Pusa Rubi (20 t/ha). In brinjal, hybrid NBH-80 produced 90% additional yield and net returns (Rs.36,037/ha) compared to the local variety, Pusa Purpul (22.8 t/ha). Cauliflower (hybrid Maduri) gave 90% higher yield and profitability (Rs.42,300/ha), compared to farmers variety, PSBK-1 (15.6 t/ha). The agri-horti system with soybean-cauliflower in guava gave highest net returns (Rs.47,350/ha) followed by soybean-chickpea in lemon grass. This technology was adopted in 5 and 28 ha in IVLP and non-IVLP villages. Turmeric, colocasia and soybean+wheat in mango orchards received the additional returns of Rs. 47,262; 42,162 and 19,087/ ha, respectively compared to sole mango. (Table 11).

On an average, farmers adopted these intercrops under mango in 29 ha at the target site. Introduction of papaya in diversified farming system improved income

Table 11: Performance of agri-horti systems and management practices at Bhopal

Treatment	Yield (kg/ha) Fruit	Intercropping	Net returns (Rs/ha)	B:C Ratio
Soybean-wheat	-	1300 -3600	24622	1.00
Guava-soybean-gram	8750	725-625	34587	1.46
Guava-soybean-cauliflower	8750	920-10100	47350	2.18
Amla-soybean-gram	3250	875-700	25900	1.19
Lemon-soybean-gram	5750	825-635	47045	2.17
Mango alone	21550	-	171363	1.00
Mango+turmeric	20000	9000	218625	1.27
Mango+colocacia	20000	6800	213525	1.24
Mango+soybean+ chickpea	21250	820,1075	190450	1.11
Guava (No treatment)	13000	-	69000	-
Rejuvenation of old fruit tree	15800	-	82950	-
Lemon (No treatment)	9500	-	132900	-
Treatment	11000	-	152150	-
Ber (No treatment)	12200		53450	
Ber (Treatment)	15100		65750	

by Rs.37,000/ha over soybean+wheat (Rs.26,400). Rejuvenation of old fruit orchards was done by pruning with improved tree pruner and application of recommended manure, fertilizer and pesticide doses. Treated Guava, lemon and ber generated net returns of Rs.13,950, 19,250 and 12,300/ha over no treatment, respectively.

The IPM module for management of shoot and fruit borer in brinjal gave 33% higher yield and net returns of Rs.18,640/ha compared to the farmers practice of 2 sprays of monocrotophos along with trap crop of marigold (30,200 kg/ha). This technology was adopted in 26 and 55 ha in IVLP and surrounding villages, respectively. The IPM module in tomato to control leaf curl virus enhanced the yield by 23% and net income by Rs.8,000/ha over farmers practice. This module was adopted by 73 farmers in 38 ha area in IVLP villages and 15 ha of 28 farmers in nearby villages.

4.8 Crop Management

At Bhopal, improved rainfed wheat variety (JW-17) with RDF enhanced yield (30%) and profit (Rs.2,040/ha), compared to the farmers practice of 50 kg N/ha (1,440 kg/ha). Adoption of contour cultivation, seed treatment and RDF recorded higher returns of 19% compared to the RDF alone (Rs.9,060/ha) (Table 12).

This technology was adopted in 157 ha area with 102 farmers in IVLP villages. In irrigated wheat, use of isoproturan@ 1/kg/ha as pre-emergence spray increased the yield (14.5%) and additional profit (18%) compared to no weeding (3,860 kg/ha).

At Indore, post emergent herbicide enhanced yield (31%) and net returns Rs.5,509 compared to the farmers practice of two hoeing and two weeding in soybean (1,264). From the experiments conducted at farmers fields, it was demonstrated that the seed production plot in soybean should be 1/10 of the total area sown to meet the requirement of seed by the farmer.

4.9 Livestock

At Bhopal, FMD vaccination before the onset of monsoon reduced the abortions in animals (25%) and enhanced milk yield in cows (71%) and buffaloes (39%), compared with the local treatment with turmeric powder. FMD vaccination was done in 750 animals in IVLP and 320 animals in nearby villages.

Table 12: Performance of crop management practices in wheat and soybean

Center	Crop	Treatments	Yield (kg/ha)	Net returns (Rs/ha)	B:C ratio
Bhopal	Rainfed wheat (2000-05)	FP - use of 50 kg N/ha	1440	7020	1.00
		RDF - 50:30:30 NPK/ha +improved variety+ seed treatment	1870	9060	1.29
		Contour cultivation+ improved variety (JW-17)+ST (Vitavax)+RDF-50:30:30 NPK/ha	2080	10390	1.48
	Irrigated wheat (2004-05)	FP - No weeding	3860	18590	1.00
		Chemical weeding by Isoproturan @ 1 kg/ha as pre-emergence spray or 2,4-D , ether extracts @ 1kg/ha as post emergent spray	4420	21940	1.18
Indore	Soybean (2000-04)	Farmers practice	1313	-	-
		Seed production technology (cultivar NRC-37)	1905	8414	3.92
	Soybean (2001-04)	FP (2 hoeing+2 weeding)	1264	-	-
		Pre-emergence herbicide (Alachlor @ 4 L/ha / pendimethalin @1kg/ha)	1573	2501	3.55
		Post-emergence herbicide (Imazethapyr @ 100g/ha)	1929	2469	2.98

Table 13: Performance of deworming and supplemental feeding in animals at Bhopal

Animal	Treatment	Infestation (%)	Milk yield (L/day)	Net returns (Rs/day)	B:C ratio
Cows	Treatment with neem leaf extract/turmeric powder; no feeding of mineral vitamin mixture.	91	1.80	15	1.00
	Helminthic medicines albendazole @ 20mL/100 kg body wt. and Butox @ 2mL/l water once in 3 months + mineral + vitamin mixture @ 50 g/day	1	2.60	19	1.27
Buffaloes	Treatment with neem leaf extract/turmeric powder; no feeding of mineral vitamin mixture.	91	3.50	21	1.00
	Helminthic medicines like albendazole @ 20mL/100kg body wt. and Butox @ 2mL/l water once in 3 months + mineral + vitamin mixture @ 50 g/day for 3 months	1	4.80	41	1.28

Use of helminthic medicines (Albandozole @ 20 mL/ 100 kg body weight and butox @ 2 mL/litre in water once in three months, mineral+vitamin mixture @ 50 g/day enhanced milk yield in cows (30-40%) and buffaloes (20%), and profitability by Rs 25 to 28/- compared to neem leaf extract and turmeric powder treatment. This technology was adopted on 820 and 420 animals in IVLP and other villages, respectively (Table 13).

To resolve the problem of fodder scarcity, cultivation of fodder crops such as sudan grass, maize+cowpea and sole maize was taken up. These crops produced 36.80, 41.30 and 2.27 t/ha over three years during *kharif* season.. Among the systems, maize and cowpea-berseem and mustard gave highest net returns (Rs.23,650), followed by sudan grass-berseem+ mustrad, (Rs.21,400). These systems were adopted on 32 and 38 ha in IVLP and adjoining villages, respectively (Table 14).

Table 14: Evaluation of green fodders and its economics at Bhopal

Treatment	Yield (kg/ha)	Cost of production (Rs/ha)	Net returns (Rs/ha)	B:C ratio
Natural green grass+berseem	35200	7000	10600	1.00
Sudan grass+berseem+mustard	61800	9500	21400	2.02
Maize+cowpea berseem+mustard	66300	9500	23650	2.23
Maize-berseem+mustard	52700	9500	16850	1.59

Table 15: Performance of enriched fodder on dairy animals at Bhopal.

Treatment	Protein content of straw (%)	Cost of treatment (Rs/day)	Milk yield (L/day)	Net returns (Rs/day)	B:C ratio
FP - Feeding of dry wheat straw without any treatment	1.90	-	3.70	34.40	1.00
Feeding wheat straw with 4 % urea + 3% jaggery + 1 % salt treatment	9.40	5	5.20	47.40	1.38

Feeding of wheat straw enriched with 4% urea, 3% jaggary and 1% salt increased milk yield (41%) and net returns (Rs.13/day), compared to feeding of dry wheat straw alone (3.7 L/day) to buffaloes. The cost of treatment was Rs.5/day, but it resulted in increased income of 38% (Table 15).

At Junagadh, feeding of sorghum silage+mineral mixture to milch buffaloes increased milk yield(15.27%) and gross monetary returns by 17% over farmers practice of feeding dry groundnut haulms. At Jabalpur, deworming improved the body weight of milch animals by 11% and milk yield by 8% compared to the control. An expenditure of Rs.35/animal/year on this, gave an additional net profit of Rs.440/animal/year. Milch animals fed on soybean straw+mineral mixture improved milk yield by 12%. At Indore, FMD vaccination in cow and buffaloes resulted in the net gain of Rs.731 and 1,429, respectively. Feeding mineral mixture and vitamins to buffaloes resulted in net gain of Rs.1,160 as compared to the control over a period of 4 months.

CHAPTER

5

Cotton Based Production System

5.1 Crops and Varieties

At Nagpur, transgenic Bt cotton which yields 25% higher, gave 17% additional net returns over conventional hybrid Ankur-651. Bt cotton brought down consumption of pesticides by 60%. The area under Bt cotton increased by 15% in IVLP villages. The PKV-4 GMS - based cotton hybrid performed better in terms of yield (10 to 15%) and profitability (8%) than CVS Ajit-11 and H-10. *Arboreum* cv AK-1 gave 11% more yield than cv LRA-516. Improved cotton cv Bikenari Nirma enhanced the productivity (25%) and profitability (Rs.3850/ha) compared to the local (1279 kg/ha). At Ajmer, Improved maize cv Mahi Kanchan recorded 21% increase in green cob yield, net returns of Rs.2,220/ha and showed a benefit cost ratio 1.65 in comparison with farmers' own Sathi (1,832 kg/ha). Improved clusterbean cv RGC-1003 enhanced grain yield (27%) and additional returns (Rs.1,785) and exhibited a benefit cost ratio of 1.30 over the standards due to early maturity. A similar beneficial trend was observed with improved variety of wheat and barley. At Akola, the improved cotton cv PKV - Rajat gave 24% higher yield than the local (643 kg/ha). About 440 farmers of IVLP and adjoining villages are adopting this variety covering over 800 ha. Another improved cultivar, AKA-7 increased yield by 30% and gave additional net returns of Rs.1700/ha compared to cv AKA-5. Presently, cv AKA-7 has been adopted by 240 farmers of IVLP and surrounding villages. Similarly, cv Narasimha's performance is quite encouraging (Table 1).

Cotton on PKV Rajat at Akola

Early maturing sorghum hybrid CSH-14 and chickpea cv SAKI-9218 have done exceedingly well in Akola. The sorghum hybrid now occupies an area of 425 ha in IVLP and surrounding villages.

5.2 Cropping Systems

At Nagpur, cotton + soybean (1:2) increased the profitability by about 20% over sole cotton and soybean, thereby providing 10 to 25% additional income. Groundnut and cotton intercropping system is the next alternative ensuring 17 and 19 % monetary returns. Currently, more than 50% cotton growers in the project area and adjoining villages are adopting cotton + soybean intercropping. In Akola, greengram and blackgram intercropped with cotton gave higher cotton equivalent yield by 30 and 26% over sole cotton and greengram, respectively. This remunerative system was well accepted by almost all the farmers in IVLP and 20 nearby villages. Intercropping of cotton+sorghum+pigeonpea increased the cotton equivalent yield (27%) and net returns (Rs.150/ha) over sole cotton (500 kg/ha). This system has also become popular in the target and adjoining villages. Benefits of intercropping soybean with pigeonpea (4:2) coupled with *Rhizobium* and RDF (30:75:0 NPK/ha) was also demonstrated. At Warangal, cotton followed by maize+fieldbean (2:1) provided an additional income of Rs.5,657/ha than monocropping of cotton (Rs.32,062 /ha). One hundred and forty IVLP

Table 1: Comparative performance of cultivars under Cotton based production system

Centre	Crop	Cultivars	Yield (kg/ha)	Net returns (Rs/ha)	B:C Ratio
Nagpur	Bt cotton (2002-05)	Ankur-651	762	8990	0.98
		MECH-184	943	14614	1.25
		Non Bt Refuge	833		-
	Hybrid cottons (2002-04)	Ajit -11	875	9806	1.00
		PKV-4	992	12235	1.22
		Mahabeej - 2	1090	11800	1.18
		H-10	883	12562	1.32
	Desi cottons (2002-04)	LRA-516	715	7691	1.05
		AKA-7	833	9200	1.23
	Marigold	FP (Local Variety)	4410	7458	1.63
		African Variety (Golden Sierra)	5230	9351	1.92
Ajmer	Maize	Farmers' own seed (Sathi)	1832	-	-
		Mahi Kanchan	2235	2220	1.65
	Cluster bean	Farmers' own seed	901	-	-
		RGC-1003	1088	1785	1.30
	Wheat	Farmers' own seed	4120	-	-
		Raj-3765	4680	39.20	1.45
	Barley	Farmers' own seed	3950	-	-
		RD-2052	4470	3120	1.24
Warangal	Cotton (2000-04)	Hybrid Brahma	1337	-	1.46
		Narasimha	1556	-	2.09
Akola	Cotton (1999-03)	Local Variety	643	7120	1.25
		PKV Rajat	800	9762	1.62
	Sorghum (1999-02)	CSH 9	1119	-	-
		CSH-14	1620	-	-
		SPH 388	1130	6125	1.53

farmers in 218 ha have adopted this practice over a period of four years (Table 2).

5.3 Rain Water Management

At Nagapur, the productivity and profitability of cotton was increased by 18 and 26%, respectively by adopting *in-situ* moisture conservation practices (ridges and furrows) over farmers practice of planting on flat bed. This practice was compatible with farmers need for the availability of moisture during flowering and boll development stages. At present, more than 90 % farmers in the target area and 30 % in adjoining villages are adopting this technology. Sowing across the major slope with opening of alternative furrows at 50 to 60 days after sowing, gave 29 % higher yield and a profit of Rs. 2,590, compared to farmers' practice of no conservation (Rs. 573 kg/ha) at Akola. This practice has been widely accepted in IVLP and surrounding villages.

5.4 Integrated Nutrient Management

At Akola, soybean seed treatment with 2% *Rhizobium* and urea spray at flowering and pod development gave 34% higher grain yield over control (937 kg/ha). Seed treatment was adopted by 42 IVLP farmers in 48 ha and by 100 farmers in 150 ha in nearby 6 villages. Use of 4 tonnes compost alongwith 50:25:25

Table 2: Performance of Cotton based cropping systems

Centre	Crop	System	Yield (kg/ha)	Net returns (Rs/ha)	B:C ratio
Nagpur	-	Sole cotton	799	8745	0.95
Akola	Cotton+ Greengram (2002-05)	Sole cotton	4900	4467	0.84
		Cotton+greengram	6480	6633	1.05
		Sole soybean	1031	8150	1.39
		Cotton + soybean	584+548	11842	1.47
	Cotton + Sorghum+ pigeon pea (2002-04)	Sole cotton	500	5000	1.00
		Cotton + sorghum + pigeonpea (6:2:2)	637	6500	1.14
Warangal	Cotton (2000-04)	Monocropping of cotton	1489	32062	1.45
		Cotton- maize+ fieldbean	2764+5290	37719	3.34
	Cotton (2000-04)	FP (Cotton only)	1615	-	2.73
		Cotton - sesame	1480+700		3.54

Alternate furrowing for stabilizing cotton yield at Akola

kg NPK/ha in cotton increased the seed yield 46% and net returns (Rs.4,053/ha) compared to the farmers practice of compost @ 2 t/ha. This technology was adopted by a large majority in IVLP and in near by 8 villages. At Nagapur, 45:45:45 NPK kg/ha + *Azotobacter* + PSB produced higher cotton yield (16%) and net returns (26%) over the farmers practice of 80:22:12 NPK/ha (798 kg/ha). Foliar spray of 2% urea at flowering stage and 2% DAP at boll formation resulted in higher cotton yield (13-15%) and profitability (10%) over the farmers practice. Spraying 1% $MgSO_4$ at 45 and 75 DAS, and 0.1% to 0.15% of boron at 60 and 80 DAS, raised the productivity and profitability of cotton by 12 and 14%, respectively over no spray (1,249 kg/ha). Seed treatment of *Rhizobium*+PSB+FYM+ (18:46:0:20)+ NPKS kg/ha increased yield and profitability by 20 and 23% compared to the farmers practice. These practices are being adopted on a large scale by the farmers of IVLP and adjoining villages (Table 3).

5.5 Integrated Pest Management:

At Akola, one spray of NSE @ 5% and HaNPV @ 250 L.E./ha economically managed boll worm infestation and increased cotton yield by 20% over farmers practice of 2 sprays of endosulphan. Two sprays of NSE 5% followed by two sprays of HaNPV @ 250 L.E./ha recorded 18% higher yield and net returns in cotton, compared to the farmers practice of controlling pests by chemicals alone. The IPM modul of PDKV based on ETL, enhanced cotton yield by 20% and net returns by Rs.2,850/ha over the farmers practice (Rs 510 kg/ha). These IPM practices have spread over a large area in IVLP and neighboring villages. At Nagapur, the IPM package (deep ploughing using resistant hybrid, early sowing, introduction of trap crop (marigold/ amaranthus), spraying 0.07% endosulphon when the pest is at 1 egg/plant, use of *Trichogramma,* spray of HaNPV 250 LE ha and need based application of pyrethroids increased cotton yield (16%) and profitability (12%) compared to the farmers practice of 7 chemical sprays. This practice has been adopted in 20 ha at IVLP site and has reduced pesticides consumption

Table 3: Comparative performance of integrated nutrient management practices

Centre	Crop	Treatments	Yield (kg/ha)	Net returns (Rs/ha)	B:C ratio
Nagpur	Cotton (2001-05)	Farmers Practice - 80:22:12 (NPK)	797	8466	0.87
		10 t FYM /compost+ 45:45:45 N:P:K/ha + *Azotobacter* + PSB	918	10703	1.04
	Cotton (2002-05)	No foliar spray	957	13594	1.42
		2% urea at flowering and 2% DAP at boll development stage	1052	15645	1.51
	Cotton (2003-04)	No foliar spray	1249	20242	1.84
		Spraying of 1% Mg SO_4 twice at 45&75DAS + spraying of 0.1 - 0.15% boron twice at 60&80DAS	1404	23100	1.92
	Soybean (2001-05)	No seed treatment	866	5781	1.25
		Seed treatment with *Rhizobum japonicum*+PSB +FYM +18:46:0:20 N:P:K:S/ha	1035	7911	1.49
Ajmer	Pearlmille (2004-05)	Farmers practice - top dressing with 30kg N/ha	1560	-	-
		Seed treatment with *Azotobacter* + PSB and top dressing with 30kg N/ha	1850	1450	3.21
		Suggested dose of fertilizer i.e. 60kg N + 30 kg P_2O_5	2000	2200	3.49
Akola	Soybean (2001-05)	Control	937	5732	1.74
		Rhizobium + PSB seed treatment + 2% urea foliar spray at flowering and pod development stage	1071	6930	2.05
			1145	9840	2.64
	Cotton (1999-02)	Compost 2 ton /ha	604	6093	0.99
		Compost 4 ton /ha + NPK (50: 25:25)	882	10146	1.37
Warangal	Turmeric + maize (2000-04)	Farmers Practice: Basal application of 60 kg N+120 kg P/ha + topdressing of 90 kgN/ha each at knee high and tasseling stage	1838 + 2470 (T)	- -	1.74 -
		Turmeric + maize (2:1) and application of 80:120:120 NPK + 50 kg $ZnSO_4$/ha as basal and top dressing 90 kg N/ha at knee high and tasseling stage + top dressing of 60 N/ha to turmeric after harvest of maize	2280 + 3186(T)	-	2.13 -

by 22%. The insecticide resistance management (IRM) comprising of cotton seed treatment with imidacloprid, one spray of NSKE + neem oil at 50 DAS, installation of pheromone traps, use of tricho-cards, spray of HaNPV250 LE/ha, spray of 0.07% endosulphon, spray of 0.05% pyrethorids increased productivity and profitability by 16 and 24%, respectively over farmers practice. This strategy reduced 30% insecticide consumption at IVLP site and was adopted in 15 and 20 ha area in IVLP and adjoining villages, respectively.

Table 4: Performance of integrated pest management practices

Centre	Crop	Treatments	Yield (kg/ha)	Net returns (Rs/ha)	B:C ratio
Nagpur	Cotton (2001-05)	Seven sprays of various pesticides (FP)	795	8967	0.95
		IPM- Deep ploughing +sucking pest resistance hybrid + early sowing+ introduction of trap crop (marigold, amaranthus) + 0.07% endosulphan + use of trichogramma + spray of Ha NPV 250 LE/ha + 0.05% pyrethroids	919	11148	1.11
	Cotton (2002-05)	Farmers Practice	814	10585	1.20
		Seed treatment with imidacloprid, one spray of NSKE + neem oil at 50DAS, installation of pheromone trap, use of tricho cards, spray of Ha NPV 250LE/ha, spray of 0.07% endosulphan, spray of 0.05% pyrethroids	932	12810	1.37
	Cotton (2001-04)	Farmers Practice	784	7784	0.70
		PAT - nozzle held 30-40 cm above the canopy sprayer facing down, and spraying done by maintaining 40 PSI at 5 km/hr walking speed	784	8434	0.80
	Pigeonpea (2001-05)	Farmers Practice- local variety, no seed treatment	606	5459	1.58
		Wilt resistance variety (ICPL-87119) + seed treatment with *Trichoderma viridi*	722	6909	1.90
Ajmer	Cotton	Farmers practice (6-7 sprays insecticides)	1270	-	-
		Growing bajra as guard crop, installation of bird perches, yellow sticky traps @ 20-24/ha, spray of azadirachtin @ 2 L/ha, spray with dipel @ 625 mL/ha + endosulfan @ 625 m/ha, spray of quinalphos or monocrotophos @ 1 L/ha	1616	6747	6.68
Akola	Cotton (2003-05)	Three sprays of Endosulphan	452	2340	1.28
		Two sprays of NSKE 5% followed by two sprays of HaNPV 250 LE/ha	537	4450	1.63
		Based on AESA Decision (no plant protection measures in the year)	605	6475	1.92
	Cotton (2003-05)	Three sprays of Endosulphan	510	4200	1.70
		Two sprays of NSKE 5% followed by two sprays of HaNPV 250 LE/ha	530	4350	1.71
		PDKV module	612	7200	1.88
	Sorghum	Farmers practice	1200	2450	1.74
		Phorate @ 10 Kg/ha	1337	2975	1.84
		PDKV IPM module	1725	4725	1.25

At Ajmer, a successful IPM module (pearlmillet as guard crop, bird perches, yellow sticky traps @ 20-24 L/ha, spray of azadirachtin @ 2 L/ha, spray with dipel @ 625 mL/ha, spray of quinolphos or monocrotophos @ 1 L/ha increased cotton yield (27%), reduced the boll damage (1.6%) and enhanced additional net returns (Rs.6747) over farmers practice of 6-7 chemical sprays (Table 4).

5.6 Horticulture

At Nagpur, *citrus* in combination with marigold enhanced profitability by 22% compared to the *mandarin* + pure cotton system, while chillies in *orange* orchards increased the profitability by 28 % compared to cotton + mandarin. About 52 orchard owners have adopted this technology in 35 ha of the project area. 50 kg FYM and 7.5 kg neem cake along with 600 g N, 200 g P and 100 g of K/tree after pruning increased the yield by 39% over farmers practice (414 q/ha). This technology was also widely adopted since it fetched an additional profit of Rs 50,000/ha. Sprays of 0.05% monocrotophos in April, 0.07% phosphomidon in July and 0.05% phosalone in December, effectively controlled black and white flies in citrus and enhanced 25% fruit yield over the farmers practice (476 q/ha). About 20 and 30 orchard owners adopted this technology in IVLP and adjoining villages, respectively, and gained additional net returns of Rs 213/tree over the farmers practice. At Ajmer, application of 100 kg N, 50 kg P_2O_5 and 80 kg sulphur/ha in onion, increased the productivity (27%) and additional returns of Rs. 7,200/ha over farmers' own practice of 40 kg N and 30 kg of P_2O_5/ha (135 q/ha). Farmers opined that balanced application of NPK and sulphur increased bulb color appeal, luster, keeping quality and reduced pest and diseases. Covering nursery with optimal nylon mesh and four times application of Nimibecidin @ 2 L/ha and monocrotophos @ 625 mL/ha effectively controlled leaf curl virus in chilies. This practice increased the yield (39%) and net returns (Rs.8,932/ha) compared to the farmers practice of 3-4 sprayings of insecticides. At Akola, budded ber tree gave 33% higher net returns compared to the unbudded ber tree. At Ajmer, application of FYM @ 2.5 t/ha with 52.5 kg N, 36 kg P_2O_5, 37.5 K_2O/ha and PSB increased with yield by 33% and net returns of Rs.7600 /ha over the farmers practice (Table 5).

Table 5: Performance of cropping systems and integrated nutrient and pest management in horticulture crops

Centre	Crop	Treatments	Yield (kg/ha)	Net returns (Rs/ha)	B:C ratio
Nagpur	Citrus (2001-05)	Mandarin+cotton		3829	0.96
		Mandarin+soybean		4150	1.31
		Mandarin+marigold		5300	2.93
		Mandarin+soybean		6249	1.56
		Mandarin+marigold		6895	1.74
		Mandarin+chilli		7730	1.98
	Mandarin (2001-05)	FP 10 kg FYM +(400; 150; 50g NPK/tree)	414	235	2.11
		50 kg FYM + 7.5 kg neem cake +600g N; 200 g P; 100 g K/tree	571	343	2.59
	Mandarins (2003-05)	FP	382	213	2.02
		Ambia (April) Monocrotopohos (0.05 %)	476	276	2.30
		Murg (July) phosphomidon (0.07%)			
		Hasta (Dec) Phosalone (0.05%)			
Ajmer	Tomato	Farmers practice - 40 kg N and 30kg P_2O_5/ha	198	-	-
		Suggested dose of fertilizer - 120 kg N, 80kg P_2O_5 and 60 kg K/ha	260	12400	6.91
	Onion (2004-05)	Farmers practice - 40 kg N and 30kg P_2O_5/ha	135	-	-
		Suggested dose of fertilizer - 100 kg N, 50kg P_2O_5 and 80 kg sulphur/ha	171	7200	5.27

Centre	Crop	Treatments	Yield (kg/ha)	Net returns (Rs/ha)	B:C ratio
Ajmer	Chilli	Farmers practice - application of FYM @ 250 q/ha (once in three years) + 40 kg N and 30kg P_2O_5/ha	56	-	-
		Suggested dose of fertilizer - application of FYM @ 250 q/ha (once in three years) + 52.5 kg N, 36kg P_2O_5/ha , 37.5 kg K/ha and PSB	75	7600	14.13
	Tomato	Farmers practice - No bulb treatment and 2 sprays of Rogor @ 625ml/ha (after visual pest attack) without Sandoviot	131	-	-
		Bulb treatment with oils/Bavistin, 2 sprays of 0.1% methyl demeton at 20 and 40 days after sowing and application of dithane 0.2% M-45 with Sandovit	165	6900	3.09
	Tomato (2004-05)	Farmers practice - 2-3 sprays of non-specific insecticide after visual insect infestation, with out Sandovit	184	-	-
		Covering the nursery with 40 mesh white nylon net, seed treatment with trichoderma @ 4g/kg and 2 sprays of azadirachtin 0.15%	233	12250	9.77
	Onion	Farmers practice - 40 kg N and 30kg P_2O_5/ha	152	-	-
		100 kg N, 50 kg P_2O_5 and 100 kg K/ha	182	13434	8.58
		Suggested dose of fertilizer - 100 kg N, 50kg P_2O_5 , 100 kg K and 80 kg sulphur/ha	195	19944	11.04
	Tomato (2004-05)	Farmers practice - 2-3 sprays of non-specific fungicide without Sandovit	193	-	-
		Suggested practice of 3 sprays of blitox @ 3kg/ha at 30, 45 and 60 DAT with sticker	218	6250	8.22
	Cauliflower (2004-05)	Farmers practice - 4-5 sprays of non-specific insecticides without sticker	151	-	-
		Two sprays of endosulfan or quinalphos @ 1.25 l/ha at ET level and 2 sprays of dipel or biobit @ 750 ml/ha with sticker	187	14400	6.13
	Cumin (2004-05)	Farmers practice - 4-5 sprays of non-specific insecticides or fungicides without Sandovit.	6.4	-	-
		Suggested practice - seed treatment with trichoderma @ 4 g/kg, 2 sprays of dithane M-45 @ 2.5 kg/ha at 30 and 45 days after slowing with sandovit and 2 sprays of wettable sulphur @ 2 kg/ha at 75 and 95 days after sowing along with 2 sprays of monocrotopohos or methyl demotion @ 1 l/ha at 45 and 60 days after sowing.	7.7	9100	9.66

5.7 Farm Implements

At Nagpur, sowing of cotton with bullock drawn planter saved 25% energy and 33 % cost, resulted in 11% increment in yield compared to local seed drill (626 kg/ha). At Akola, use of bullock drawn seed ferti-drill enhanced the yield (12-19%) and net returns (Rs.1,500 /ha) over control. More than 125 farmers from IVLP and 290 from and non-IVLP villages have adopted this technology.

5.8 Livestock

At Nagapur, supplementary feeding of lucerne increased the milk yield by 13% and profitability by 27% in dairy animals over feeding of conventional maize/ sorghum (6.39 L/cattle/day). Fifteen farmers of IVLP villages and 20 from adjoining villages have taken up cultivation of lucerne due to an additional income of over Rs.24,200/ha in 90 days. Use of antihelminthics (Morantal citrate @ 2 bolus/100 kg body weight) in dairy animals increased the milk yield and profitability by 18 and 21%, respectively over the farmers practice of no deworming (6.2 L/cattle/day). Open grazing along with supplementation of concentrate mixture @ 2 to 2.5 kg/ day + mineral mixture @ 25 g/animal/day and vitablend AB_3 @ 25 g/100 kg feed in dairy animals led to higher milk production and net returns by 18 and 20%, respectively over farmers practice of grazing + concentrate @ 2-3 kg/day (Table 6).

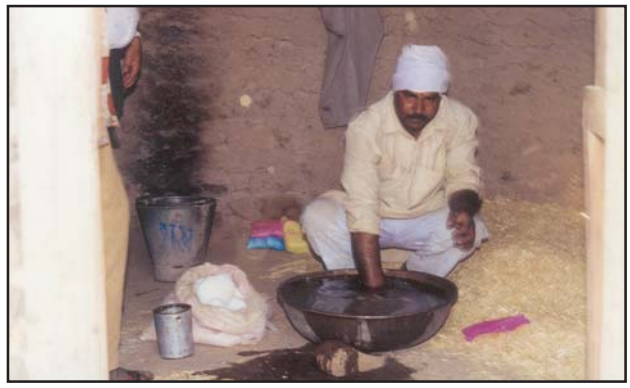
At Akola, feeding of 5% urea treated cereal straw to cattle could save Rs. 3,600/animal/year. Majority of farmers in IVLP and adjoining villages are going for

Table 6: Evaluation of livestock based interventions

Centre	Interventions	Treatments	Milk yield L/day/animal	Net returns (Rs/animal)	B:C ratio
Nagpur	Leguminous fodder (2003-05)	FP - Maize/jowar	6.45	3851	1.97
		Fodder (Lucerne cv T-9)	7.09	4327	2.11
	Deworming in cattle (2001-05)	FP - no deworming	6.38	3721	1.92
		Fenbendazole (panacure) 2 bolus/animal	7.28	4409	2.07
		Morantal citrate (banminth) 2 bolus/100kg body wt.	7.65	4741	2.72
	Mineral mixture in dairy cattle (2001-05)	FP - Grazing +conc. feed 2-3 kg/day	6.63	3815	1.81
		Grazing +conc. feed 2-2.5 kg/day + mineral mixture @ 25g/animal/day	7.37	4321	1.94
		FP + mineral mixture + vitablend AD3 @ 25 g/100 kg feed	7.72	4635	2.03
	Balanced nutrition in milch cows (2001-05)	FP - Grazing + cotton seed (2-3 kg/day)	6.65	3863	2.04
		Grazing + conc. feed @ 5kg + vitablend AD3@ 25 g/day	7.78	4723	2.12
Warangal	Agri-sheep farming (2001-03)	FP -growing cotton only	-	30666*	0.77
		Agri-sheep farming (Maize + cowpea and jowar + cowpea)	-	21408*	1.23
	Improved poultry breeds in backyards (1999-2004)	FP - rearing local birds	-	678	2.73
		Rearing improved breed (Giriraja)	-	2300	3.83

* Gross return

Backyard poultry at Akola



Preparation of urea enriched straw at Akola

enrichment of straw. Mineral deficiency (Pica Syndrome) in cattle and buffaloes can be effectively controlled by supplementary feeding of mineral bricks. At Ajmer, supplementation of mineral mixture @ 40-50 g/animal/day increased milk yield (200-250 mL/animal/day) and reduced dry period from 24 to 14 months. At Warrangal, poultry birds of Giriraja, an improved breed, attained live weight of 3.5 to 4 kg/bird in 6-7 months with an average gain of 700 g/bird /month. This breed is more productive (20 eggs/bird/month) than the local (15 eggs). Farmers realized net benefit of Rs.1,623/unit of 10 birds by rearing this breed in the backyard, compared to the local birds. About 70 farmers in IVLP villages established these units during the project period.

At Warangal, agri-sheep farming @ 10 lambs along with maize + sorghum and sorghum + cowpea realized 43% higher gross returns than cotton cultivation alone (Rs.21,408/ha). The farmers could harvest green cobs of maize worth of Rs.9,500/ha besides getting valuable fodder. Due to balanced feeding, 1.3 to 1.5 kg/month live weight gain in sheep was recorded. The integration of sheep in maize + sorghum and sorghum + cowpea system, exhibits a BC ratio of 1.23, compared to cotton alone (Table 7). The agri-sheep system has become more popular in the area and most of the farmers in surrounding villages are adopting this.

CHAPTER

6

Nutritious Cereals based Production System

6.1 Crops and Varieties

A number of improved varieties of nutritious cereal, pulse and oilseed crops that are part of the cropping system have been evaluated on farmers fields: sorghum (CSV-15), castor (*Kranti* and *Jyothi*) sunflower (MSFH-8) in rainfed A*lfisols* and chickpea (ICCV-2 and KAK-2) in vertisols at Hyderabad; sorghum (Yashoda and Mouli), onion (N-2-1), tomato (Dhanasree) in vertisols of Solapur, maize (PEMH-2), sorghum (CSV-15), wheat (Raj-4037), groundnut (DH-86 and TAG-24) mustard (Vasundhara and Lakshmi,), chickpea (ICCV-88202) onion (Nasik Red) in vertisols at Udaipur; groundnut (ICGS-44), soybean (PK-1042), wheat (HD-2189 and HD-2244), maize (Composite Surya), tomato (DVR-2), chickpea (BG-256) at Jhansi; groundnut (Konkank Gowri and Phule Pragathi), horsegram (Dapoli-1), rice (Palgar-1 and Rathnagiri-3 and 24), chilli (Pusa Jwala and Phule Jyothi) okra (Arka Anamika) at Vengurli; soyabean (JS-335) littlemillet (TNAU-63/Sukshema), mungbean (Sel-4), potato (Kufri Pukhraj) and *rabi* sorghum (DSV-4/SPV-1359) at Dharwad. These cultivars recorded 30-70% higher yield compared to the respective locals (Table 1).

The area under improved *rabi* sorghum varieties: DSV-4 and SPV-1359 increased by 12 and 29 ha after 5 years of project implementation at Dharwad. Improved variety of littlemillet (Sukshema) was adopted by 110 farmers in neighboring villages of IVLP. Twenty-two per cent higher productivity and profitability was obtained due to adoption of hybrid varieties. Improved varieties DMH-2 (maize), JSS-335 (soybean), GPBD-4 (groundnut), DWR-2006 (wheat), DHH-11 (hybrid cotton) were adopted in 3, 138, 5, 2 and 35 ha, respectively in adjoining villages of IVLP over a 5-year period.

At Hyderabad, improved varieties of sorghum (CSV-15, SPV-462/475), pigeonpea (Maruthi, PRG-100 and Lakshmi) in sorghum+pigeonpea intercropping system, maize (DHM-105/107) with pigeonpea (PRG-100, Maruthi), castor (Kranti, Jyothi, Haritha), sunflower (KBSH-1, MSFH-8 and Modran), mungbean (ML-267, WGG-77), horsegram (Palem-1 and 2), soybean (MACS-58, JS- 335), cotton (NSH-44, Bt MECH-12), fodder sorghum (Pusa Chari) fodder maize (African Tall) and rice under limited irrigation (BPT-5204, MTU-7028) enhanced the productivity and profitability by 25 to 38% as compared to the respective traditional varieties. Informal seed production of castor (Kranti and Jyothi) and pigeonpea was taken up during 2002-2003 by 60 farmers in three villages. Five tones of improved seeds of castor and 3 tones of pigeonpea was produced over a period of three years. These improved seeds met 90% seed requirement of all IVLP and near by villages.

In Bangalore, the fingermillet blast resistant variety (GPU-28) was adopted on 56 and 112 ha area at IVLP and neighboring villages, respectively due to increase in productivity and profitability. The drumstick (PKM-1) recorded a net returns of Rs 48,301/ha of in rainfed *Alfisols*. At Vengurli, improved varieties of rice were adopted by 350 farmers in IVLP and nearby villages. Groundnut cv Konkank, Gourav and TG-26 recorded higher productivity of 31 and 61%, respectively. High yielding variety of cashewnut (V-7 and V-4) obtained through coppice grafting helped the farmers to realise yield of 3.85 kg/tree against 1.20 kg from the local seedling plants within 3 years.

At Nagapur, introduction of improved cultivars of sorghum (CSH-9) and pearlmillet (BJH-117) recorded 30 and 20% higher yield over respective locals in

Table 1: Performance of improved varieties

Center	Crop	Treatment	Yield (kg/ha)	Net returns (Rs./ha)	B:C ratio
Solapur	Onion (2000-03)	Local -Harna	14835	33904	2.16
		N-2-4-1	20554	55191	2.75
		Phule Safed	18568	44935	2.30
	Sorghum (1999-03)	Local- Own seed of M	855	12159	2.53
		35-1	1106	14901	2.97
		M-35-1 Yasoda	1286	15978	3.15
Hyderabad	Castor (1999-2005)	Aruna	416	1330	1.34
		Kranti	604	3447	1.75
		Jyothi	392	1339	1.46
		Kiran	630	4060	2.16
		Haritha	707	4506	3.09
		GCH - 4	797	5521	2.01
		DCH -32	520	2659	1.73
		DCH -177	383	2120	1.50
	Sunflower (1998-05)	Morden	645	3720	1.82
		MSFH -8	753	7621	2.27
	Chickpea (2003-04)	Local	447	3217	1.60
		JG-II	532	5140	1.93
		ICCV-2	763	7687	2.36
		KAK-2	780	8884	2.50
	Rice (2000-02)	Tellahamsa	3781	10093	2.11
		Swarna/Vikas	4931	14355	3.12
Udaipur	Maize (2001-03)	Local Sathi	1542	1973	1.27
		Hybrid variety PEHM-2	2044	2976	1.35
	Sorghum (2003-04)	Local	120	387	0.91
		CSV-15	578	618	1.14
	Fodder crops (2003-04)	Local fodder sorghum	12200	6175	2.00
		Bajra Chari	28500	22160	4.50
	Durum wheat (2003-04)	FP - own seed	3620	16415	2.84
		HI-8498	3870	18165	3.04
	Groundnut (2003-05)	Local seed (GG-2)	642	5315	1.70
		DH-86	1160	14115	2.60
		TAG-24	1086	12635	2.40
	Mustard (2002-05)	FP- local variety	1650	23100	
		Bio 902	2040	28560	
		Vasundhara	2270	31780	
		Lakshmi	2180	30520	
		Swarna Jyothi	1930	26820	
	Blackgram (2003-04)	Local	460	2590	1.50
		Improved var RBU-38	690	6430	2.10
		Rec var - T9	620	6224	2.10

Center	Crop	Treatment	Yield (kg/ha)	Net returns (Rs./ha)	B:C ratio
	Onion	FP Local variety	9400	3970	1.15
	(2000-02)	Improved var Nasik Red	12800	15360	1.47
	Chilli	Deshi var	785	16475	2.25
	(2003-05)	Pusa Sadabahar	965	29375	3.55
Jhansi	Groundnut	ICGS-44	1465	13509	1.67
	(2001-03)	TAG-24	1451	13302	1.64
		Local	964	6119	0.75
	Soybean	JS-335	2350	15300	1.86
	(2001-03)	JS 90-41	1250	4300	0.52
		PK-1042	2065	13383	1.61
		Local	1230	4615	0.56
	Cluster bean	Bundel Guar-1	410	7389	1.73
	(2001-03)	Local	330	4194	0.98
	Sorghum	CVS-15	1880	3547	0.72
	(2001-03)	Local	825	1201	0.24
	Wheat	Local	2125	-871	-0.06
	(2001-03)	WH-147	3300	5886	0.44
		HD-2189	3800	8760	0.67
		HD-2285	3450	6754	0.51
	Chickpea	Local	1050	6925	0.78
	(2001-02)	Avarodhi	2000	18324	1.62
		BG-256	2250	21610	1.85
		KWR-108	1900	17350	1.61
	Barley	Local	1800	2000	0.29
	(2002-03)	Jagruti	3400	10160	1.45
		Jyoti	3250	9425	1.35
		Lakhan	2300	4650	0.67
		K-560	3750	11975	1.71
	Mustard	Local	1000	9548	1.13
	(2002-03)	Pusa Bold	1200	12981	1.50
		Pusa Barani	1100	11181	1.29
		Vaibhav	1350	15680	1.82
	Tomato	Kalyanpur Type-1	22200	9680	0.77
	(2001-03)	DVR-2	29240	11960	0.95
		Local	14460	4800	0.38
	Fodder crops	Berseem (Wadan)	90000	27796	1.06
	(2001-03)	Berseem (Local)	59000	7937	0.34
		Hybrid napier (No.6)	45480	7368	0.47
		Guinea grass (Gutton)	27750	368	0.09
		Maize (Vijai)	32500	8225	0.39
		Maize (Local)	22630	-30	-0.003

Improved dual purpose sorghum varieties SPV-462 (left) Hyderabad and rabi sorghum Phule yeshoda (right) at Solapur

Vertisols. The area under CSH-9 and BJH-117 in IVLP villages increased from 80 to 86% in the fourth year, even after withdrawal of interventions.

6.2 Cropping Systems

Sorghum+pigeonpea (3:1) at Hyderabad, Fingermillet+pigeonpea(3:2), pigeonpea+dolichos (3:1), and intercropping of coriander and frenchbean in banana at Banglore, sunflower+pigeonpea (2:1) at Solapur, little millet+ pigeonpea (5:1) and relay cropping of horsegram with little millet at Dharwad were found efficient in getting higher profits (30-60%) under different micro farming situations (Table 2).

Intercropping of sorghum (SPV-462) and pigeonpea (PRG-100) (5:1 and 3:1) recorded an additional sorghum grain equivalent yield of 665 and 700kg/ha and net returns of Rs 4,096/ha and Rs. 4,960/ha, respectively over traditional varieties in rainfed Alfisols at Hyderabad. Farmers preferred improved varieties to meet the fodder demand. Sixty percent farmers in IVLP villages are now adopting these improved varieties of sorghum and pigeonpea. In Vertisols, intercropping maize (Ganga-2, Sri Tulasi, Kargil, DHM-105) and pigeonpea (PRG-100, Durga, Maruthi) (5:1) gave higher net returns over the years.

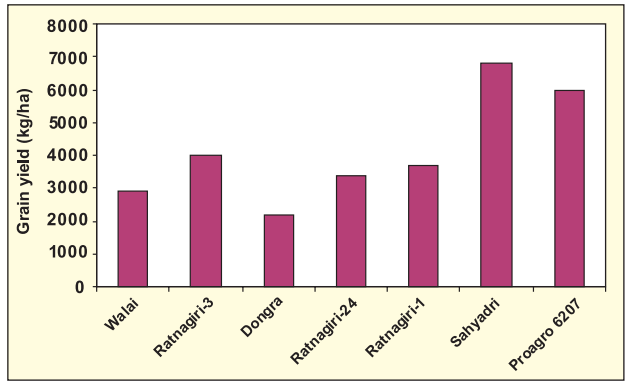


Fig 15. Performance of improved rice varieties at Vengurli (1996-98)

Relay cropping of littlemillet-horsegram

Little millet + pigeonpea (5:1)

Table 2: Performance of cropping systems

Center	Crop	Treatments	Yield (kg/ha) Crop I+II	Net returns (Rs/ha)	B:C ratio
Solapur	*Kharif* Pearlmillet+ mothbean (2:1) (1999-05)	Farmers practice (Mixed cropping of Pearlmillet and mothbean)	228+70	3361	1.03
		Pearlmillet+mothbean (2:1)	351+157	5435	1.51
	Pigeonpea+ sunflower (1999-05)	FP: Pigeonpea+sunflower (2:2 and 3:3)	183+89	4270	1.44
		Sunflower+piegeonpea (2:1)	269+144	6544	1.93
		Sunflower+piegeonpea (1:1)	1249+103	6545	2.06
	Pigeonpea +sunflower (2003-05)	FP - Sunflower+Pigeonpea (2:2)(No fertilizer)	730+516	20610	2.93
		Piegeonpea+clusterbean (1:2) with BF+NP (12.5:25 kg/ha)	1337+1770	37762	3.91
Dharwad	Littlemillet (2001-03)	Sole littlemillet	911	3978	2.66
		Littlemillet+horsegram	109	4731	2.63
		Littlemillet+redgram (5:1)	1144	5206	2.86
		Littlemillet+redgram(5:1)-horsegram	1386	5972	2.93
	Fingermillet +pigeonpea (1999-02)	Fingermillet alone	2986	6148	1.46
		Fingermillet+pigeonpea (3:2)	2041+1300	22634	3.23
		Fingermillet+dolichos	1918+870	10815	2.04
Hyderabad	Sorghum +pigeonpea (1998-05)	Sorghum(L)+pigeonpea(L)* (5:1)	1494	2996	1.93
		Sorghum(Ll)+pigeonpea(L) (3:1)	1572	3478	2.04
		Sorghum(SPV-475/462/ CSV-15)+ pigeonpea (Asha/PRG-100) (5:1)	2115	6751	2.93
		Sorghum(SPV-475/462/ CSV-15)+ pigeonpea (Asha/PRG-100) (3:1)	2215	7508	3.10
	Maize+ pigeonpea (3:1) (2003-05)	Maize(Bioseed)+pigeonpea (L)	10563+480	33262	3.12
		Maize(Ganga-II)+Pigeonpea (L)	7288+647	29915	3.02
		Maize(SriTulasi)+pigeonpea (L)	14625+688	51626	4.28
		Maize(Kargil)+pigeonpea (L)	11781+593	39938	3.53
		Maize(DHM-105)+Pigeonpea (L)	9988+716	39540	3.60
	Pigeonpea + maize (1:3) (2003-05)	Maize (Ganga-II) + pigeonpea (L)	7288+666	29414	2.90
		Maize (Ganga-II)+pigeonpea (PRG-100)	7804+619	30431	2.95
		Maize (Ganga-II)+pigeonpea (*Maruthi*)	12125+638	55626	3.77
		Maize(Ganga-II)+pigeonpea (*Maruthi*)	8144+659	37553	3.37
		Maize(Ganga-II)+pigeonpea (ICPL-85063)	3350+518	14244	1.85
	Castor (1998-05)	Castor	385	1841	1.68
		Sunflower (Morden)	490	4213	2.41
		Mungbean (Ml-267)	462	3631	2.62
		Fingermillet	420	2200	2.10

Center	Crop	Treatments	Yield (kg/ha) Crop I+II	Net returns (Rs/ha)	B:C ratio
		Horsegram	488	2880	2.44
		Horsegram (Palem-1)	372	1000	1.50
		Horsegram (Palem-2)	372	1450	1.70
		Cowpea (C-152)	377	1080	1.50
		Soybean (MACS-58)	789	4970	2.10
		Soybean (JS-335)	677	3620	1.80
Solapur	Cereal-pulse system (1999-05)	Fallow - sorghum	884+1956	11293	2.01
		Cowpea - sorghum	54+493	10839	1.61
		Blackgram	485+1283	23151	3.00
		Soyabean - sorghum	1571+5819	39766	3.12

* Sorghum grain equivalent

Most of the IVLP farmers are preferring maize cultivar BHM-105.

At Dharwad littlemillet+pigeonpea (5:1)-horsegram recorded higher millet equivalent yield (1,386 kg/ha) and net income (Rs 5,972/ha) followed by littlemillet +pigeonpea (5:1) in rainfed Vertisols. The income obtained in relay-intercropping system was higher by Rs.766 and 1,241/ha, respectively compared to littlemillet+pigeonpea and littlemillet-horsegram system (Rs.4731/ha). Hybrid cotton+pea (1:2) and hybrid cotton+mungbean (1:2) gave higher profitability of 15.4 and 11.7% respectively as compared to the sole hybrid cotton (1,980 kg/ha). The cotton+pea and littlemillet+pigeonpea systems were adopted in 63 and 48 ha at IVLP site and 43 and 41 ha in neighboring villages. Among the systems cotton+pigeonpea gave higher returns Rs (5,500/ha) compared to littlemillet+pigeonpea). At Solapur *kharif* blackgram-*rabi* sorghum on Vertisols recorded 25% higher net returns over farmers practice of *kharif* fallow-*rabi* sorghum. Sunflower+pigeonpea and pigeonpea+clusterbean in Inceptisols with improved varieties, IPM and RDF enhanced the returns by 94 and 83% over farmers sole cropping of sunflower and pigeonpea, respectively. Pearlmillet+mothbean (2:1) gave 62% of higher returns compared to farmers practice of mixed cropping of pearlmillet, mothbean and pigeonpea in Alfisols. Soyabean-sorghum system enhanced net returns by 252% compared to farmers practice of *kharif* fallow-*rabi* sorghum (Rs 11,293/ha).

At Bangalore, crop diversification in drylands with 60% of fingermillet and drumstick, enhanced the productivity and profitability by 30 to 40% as compared to farmers practice of sole fingermillet. Crop-diversification was adopted in 10 ha with the involvement of 26 farmers at the IVLP site. While 60% area under fingermillet with 40% of vegetable pigeonpea increased the productivity by 20% and profitability by 5% compared to sole fingermillet. This practice was adopted in 22 ha area at IVLP villages and also by 50 farmers in non-IVLP villages over a period of time.

At Udaipur, maize+blackgram system recorded higher maize equivalent yield (2230 kg/ha) which was 59% higher compared to maize alone (1,430 kg/ha). About 30% of farmers of IVLP villages adopted this technology (Table 2).

6.3 Integrated Nutrient Management

Application of 10:30:0 kg NPK/ha recorded an additional grain equivalent yield of sorghum (470 kg/ha) and net returns (Rs.1164/ha) with improved varieties as compared to local varieties in sorghum and pigeonpea system (3:1) in Alfisols (1897 kg/ha) at Hyderabad. In sorghum and pigeonpea system (3:1), use of 20:30:0 kg NPK/ha during low/skewed rainfall years and 30:30:0 kg NPK/ha during good rainfall years was found optimum. Technology of 10:30:0 kg NPK/ha was adopted in 200 and 150 ha area in IVLP and surrounding villages, respectively. About 10% of the farmers are adopting 30:30:0 kg NPK/ha on 60 ha area for higher

productivity of the system in IVLP villages. In castor, use of 10:30:0 kg NPK/ha was found economically optimum even under uneven rainfall years like 2000, 2001 and 2002. Moderate dosage of nutrients (10:30:0 kg NPK/ha) as basal along with 20 kg N as top dressing was found beneficial to bring stability in yield and income during good rainfall years. About 30% farmers in IVLP villages are now applying 20 kg N as top dressing along with basal application of 10:30:0 kg NPK in castor. In Vertisols, use of 20 kg N/ha as top dressing at flowering enhanced the profitability by 63% in rainfed maize+pigeonpea system. But the use of 40 kg K_2O/ha along with 10 kg N at knee height stage gave additional profitability (Rs.14,272/ha), compared to farmers practice (Rs.30,212/ha). Use of potassium improved the yield of pigeonpea and maize in the intercropping system.

At Nagpur, recommended dose of NPK (80:40:40 kg/ha), timely sowing and optimum plant population improved grain yield of sorghum (CSH-9) by 30% over farmers practice of late sowing with local variety and application of 60:80:10 kg NPK/ha. In hybrid cotton, use of 100:50:50 kg NPK/ha+*Azotobacter* along with 0.5 L/plant dung slurry (at flowering to early boll development stage) recorded 41% higher yield than farmers practice. Improved variety of LRK-516, application of 50:25:0 kg NPK/ha with 60x60/90x45 cm spacing+*Azotobacter*+0.5 L cow dung slurry recorded 39% higher yield compared to farmers practice. Response to RDF was highest in deep soils (21%), whereas, application of RDF+*Azotobacter* +cow dung slurry showed optimum response in shallow soils (37-44%). In soybean, application of RDF (25:75kg NP/ha) with R*hizobium* inoculation improved grain yields by 28%, and 75% RDF +*Rhizobium* and PSB by 37% in medium deep Vertisols. Seed inoculation with liquid *Rhizobium* (broth) improved soybean yield by 15% over carrier-based inoculant. The response to liquid *Rhizobium* was more in deep (1,800 kg/ha) than in medium deep (1,350) and shallow soils (970) in soybean. Area under recommended dose of fertilizers in cotton increased from 7 to 25% at the IVLP site, while that under seed treatment with *Azotobacter* increased from 6 to 30%.

At Dharwad, application of RDF to improved and local soybean varieties resulted in additional grain yield of 87 and 46 kg/ha, respectively as compared to the farmers practice. Spilt application of nitrogen to green chilies enhanced productivity (15,370 kg/ha) and additional returns (33.33%) compared to control in Vertisols (11,530 kg/ha). The INM practice in soybean was adopted in 35 and 15 ha area at IVLP and neighboring villages, while that in green chillies was adopted in 18 and 4 ha. At Jhansi, use of 20:60:30 kg NPK/ha along with vermicompost @ 1.5 t/ha in soybean gave higher productivity (19%) and profitability (Rs.2,500/ha) as compared to RDF (20:60:30) NPK alone (1,310 kg/ha). Similarly, use of vermicompost enhanced the productivity of rainfed sorghum to the extent of 255 kg/ha. In wheat, vermicompost application @ 2.5 t/ha with 60:40:20 NPK/ha enhanced the net income by 32% over vermicompost alone (Rs.9,555/ha). In chickpea, use of 60 kg P_2O_5/ha gave higher yields by 16% over 40 kg P_2O_5/ha (2,020 kg/ha). In mustard application of $ZnSO_4$ sulphate @ 10 kg/ha gave higher yield (221 kg/ha) and net income (Rs.2,963/ha) compared to control in Zn deficient soils of Buldelkhand. INM practice in soybean, sorghum, wheat, chickpea, barley and mustard was adopted by 9, 2, 54, 18, 21 and 17% of the farmers at the IVLP site.

At Udaipur, use of zinc sulphate @ 25 kg/ha along with RDF increased maize yield (7%) over the farmers practice (1,782 kg/ha). Use of vermi compost (3 t/ha) and FYM (10 t/ha) gave higher productivity by 16 and 20%, respectively in maize compared to the no manure application (1,225 kg/ha). Application of gypsum @ 250 kg/ha along with RDF (basal) increased groundnut pod yield by 18% and higher gross returns of Rs.3,500/ha over farmers practice. Application of 20 kg N+60 kg P_2O_5/ha through SSP+gypsum @ 250 kg/ha enhanced the pod yield in groundnut (77 to 80%) over farmers practice 10 kg N and 25 kg P_2O_5/ha (642 kg/ha). At Solapur, use of FYM (3t/ha)+biological fertilizer (BF)+vermicompost (4t/ha) + P:K at 50:50 kg/ha, *Trichoderm* +, two sprays each of blitox 2 kg/ha and monocrotophos 750 mL/ha enhanced onion yield (156%) and net returns (144%) compared to farmers practice with local variety, FYM 3 t/ha + NPK 25:25:25 kg/ha along with one or two sprays of insecticides (4,760 kg/ha) (Table 3).

Table 3: Influence of integrated nutrient management practices

Center	Crop	Treatment	Yield (kg/ha)	Net returns (Rs./ha)	B:C ratio
Hyderabad	Sorghum +pigeonpea (1998-00)	Sorghum+pigeonpea(L)- Basal- 10:30:0 NPK/ha	1897	3790	2.20
		Sorghum+pigeonpea(L) - 40:30:0 NPK/ha	2188	4954	2.51
		Sorghum (SPV-475/CSV- 15)+ pigeonpea (LRG-30/Maruthi) - Basal - 10:30:0 NPK/ha	2367	4771	2.30
		Sorghum(SPV-475/ CSV-15) + pigeonpea (LRG-30/ Maruthi) (3:1) 40:30:0	3001	6959	2.76
	Castor (1998-03)	FP (FYM @ 2t/ha)	343	1257	1.56
		FP + basal (10:30:0 kg NPK/ha)	441	1961	1.64
		10:13:0 + 20 kg N as top dressing	508	274	1.90
		RDF 50:30:0 kg NPK/ha	597	3585	2.07
Hyderabad	Sunflower (1998-01)	No fertilizer	276	1096	1.38
		Basal - 10:13:0 Kg NPK/ha	375	1978	1.56
		Basal + 20 kg N as TD	474	3274	1.87
		RDF 50:13:0 kg NPK/ha	531	3946	2.00
	Rice (2000-02)	FP- 120:60:-0 kg NP/ha	2745	11567	2.98
		120 - 60- 40 kg NPK/ha	3988	13937	3.13
	Rice (2000-02)	No zinc application	2393	3854	1.61
		Soil application Zn @ 50 kg/ha	3267	6455	1.99
		Foliar application Zn @ 0.2%	2939	5305	1.83
	Maize + pigeonpea (2003-05)	FP- NPK 40:50:40 kg/ha	5596+338	15998	2.23
		FP+10 kg N/ha at knee high stage	7568+ 463	25752	2.89
		FP +20 kg N/ha at Tasseling stage	8377 +553	35977	3.57
		RDF:NPK 90:50:40 kg/ha	9565 +620	34607	3.19
Udaipur	Summer groundnut (2003-05)	FP	1080	12850	2.5
		FP+ Gypsum @ 250 kg/ha	1270	16350	2.8
	Groundnut (2001-03)	FP (10kg N+25P_2O_5/ha)	644	1760	1.25
		20 kg N + 60 kg P_2O_5/ha through SSP +urea	1057	4883	1.53
		20 kg N + 60 kg P_2O_5/ha gypsum @ 250 kg/ha	1021	4931	1.56
Jhansi	Soybean (2003-04)	FP	900	3900	1.35
		NPK (20:60:30)	1310	8400	1.63
		NPK + vermi compost	1570	10900	1.75
	Sorghum (2003-04)	FP	1300	5409	1.63
		NPK (60:30:20)	1460	5367	1.78
		NPK + vermicompost (10q/ha)	1715	6242	1.75
	Mustard (2003-04)	FP	1150	5431	1.29
		Vermicompost	1270	9370	1.44
		Vermicompost +NPK (60:40:20)	1420	9280	1.45
	Mustard (2003-05)	FP	1000	5200	1.27
		$ZnSO_4$ @ 10 kg/ha	1221	8163	1.38
	Mustard (2003-05)	FP	2050	98.5	1.01
		Vermicompost	2750	3438.2	1.22
		Vermicompost +NPK (60:40:20)	3070	4918.4	1.30

Center	Crop	Treatment	Yield (kg/ha)	Net returns (Rs./ha)	B:C ratio
Solapur	Pearlmillet	FP(Local variety + 20:0:0 NPK/ha)	800	5945	1.10
		Shradha + 50:25:25 NPK/ha	1707	12742	1.76
	Maize	FP - Local variety (only N 20kg/ha)	1255	12009	1.83
		MPQ-13 variety (NPK 100:30:0 kg/ha)	1729	16709	2.19
	Maize	FP - N 25 kg/ha	1677	11117	1.64
		BF + NP 50:15 kg/ha	2551	16153	1.83
		NP 75:30 kg/ha	2381	15093	1.90
		NP 100:30 kg/ha	1957	15492	2.12
	Rabi sorghum	FP- N;20 kg /ha	718	8534	2.10
		BF + NP 25;'12.5 kg/ha	907	11769	2.49
		BF + NP 30;25 kg	1088	13407	2.62

FP= Farmers practice; BF: biological fertilizer

Conservation furrows and application of additional N dose as drought management strategy in Alfisols at Hyderabad

6.4 Rain Water Management

At Solapur, summer harrowing and compartmental bunding before the onset of monsoon along with bio-fertilizer and NPK 12.5:25:0 kg/ha with two hoeings enhanced the productivity of sunflower (54%) and pigeonpea (71%) and recorded higher net returns (64%) as compared to farmers practice of summer harrowing with two hoeings in Inceptisols during *kharif* season (Rs.19,856 /ha) in sunflower+pigeonpea intercropping system. The technology was adopted in 65 and 110 ha in IVLP and non-IVLP villages. Compartmental bunds before sowing of *rabi* sorghum with BF+N @ 25 kg/ha

Protected irrgation for drumstick and groundwater recharge technologies at Bangalore

along with three hoeings enhanced the yield (35%) and net returns (37%) compared to the farmers practice of no fertilizer and two hoeings (Rs.5,817/ha). In Vertisols, two harrowings before sowing *rabi* sorghum and ridges and furrows, and compartmental bunding with three hoeings along with 50:25 NP kg/ha gave 34% and 37% increase in yield and net returns compared to the farmers practice of 25:25 NP/ha along and two hoeings and three harrowings (1,007 kg/ha). This technology was adopted in 15 and 75 ha, respectively in IVLP and non-IVLP villages at Sholapur.

At Hyderabad, formation of conservation furrows at 1.2 m interval gave additional sorghum grain equivalent yield (318 kg/ha) and net returns (Rs.890/ha) in sorghum+pigeonpea cropping system compared to no conservation furrows (1,830 kg/ha) with local varieties. Conservation furrows with improved varieties contributed to additional productivity (486 kg/ha) and profitability (Rs.1,526/ha) over no conservation furrows (2,476 kg/ha and Rs.6,328/ha). In castor, soil conservation practices like conservation furrows, additional interculture during dry spells and additional application of N @ 20 kg/ha after dry spells were evaluated against farmers practice. Among the components, additional N application after the dry spell and formation of conservation furrows increased productivity by 29 and 16%, respectively compared to farmers practice (361 kg/ha). About 90% of the marginal and small farmers adopted the conservation furrows and additional interculture since these were simple and easy to adopt. About 30% of the farmers are applying additional N to mitigate the stress effects in castor at IVLP villages. Mungbean, sunflower, fingermillet and horsegram can be sown profitably under delayed sowing as alternative to castor. For sunflower cultivars Moden and hybrid MSFH-8, conservation furrows recorded additional yield of 17 and 89%, respectively over no conservation furrows (292 and 456 kg/ha) and higher net returns of Rs.436 and 1,213/ha.

Ridges and furrows prior to sowing enhanced the lint yield (50 kg/ha) and net returns (Rs.2,903/ha) in cotton compared to farmers practice of flat sowing. Ridges and furrows along with additional 20 kg N/ha after the relief of each dry spell enhanced the profitability (Rs.2,366/ha) compared to ridges and furrows alone (Rs.19,996/ha). Farmers perceived that ridges and furrows were beneficial for getting increased yield and income and this practice is simple to adopt with local plough. At Nagpur, opening of broadbed furrow improved the grain yield of sorghum by 16 and 25% in CSH-9 and BJH-117, respectively over flat bed method of sowing . The increase in net return due to this rain water management technology was higher in shallow soils. This technology was adopted by 58, 37 and 25% of farmers in shallow, deep and medium deep soils, respectively. Opening of broad bed furrow at 30 DAS after every 8 lines was the best rainwater conservation technology for rainfed sorghum in v*ertisols*. For cotton, opening of ridges and furrows gave higher net returns and B:C ratio in shallow soils (87%) than medium and deep soils. At BangAlore, application of tank silt and deep ploughing in fingermillet significantly enhanced the productivity (2,305 kg/ha) over farmers practice (1,518 kg/ha) (Table 4).

6.5 Integrated Pest Management

At Hyderabad, two sprays of neem-based formulation @ 5 mL/L along with shaking of plants increased the yield (42%) in sorghum and net returns

Adoption of IPM technologies in arecanut, mustard and cabbage in farmers fields at Bangalore

Table 4: Effect of rainwater management

Center	Crop	Treatment	Yield (kg/ha)	Net returns (Rs./ha)	B:C ratio
Hyderabad	Sorghum + pigeonpea (1998-05)	Sorghum(L)+pigeonpea (3:1) - No conservation furrows	1720	3005	1.95
		Local S +pigeonpea (3:1) - CF S (SPV - 475 /CSV - 15)	2025	3779	2.06
		Pigeonpea (Maruthi/PRG-100) (3:1) - no CF	2327	5845	2.44
		S(SPV - 475 /CSV - 15) + pigeonpea (Maruthi/PRG-100) (3:1) - CF	2778	7282	2.57
	Pigeonpea+ mungbean (1998-02)	Local pigeonpea+mungbean (1:3) - No conservation furrow	839	4330	2.61
		Improved pigeonpea (Maruthi) + mungbean (ML- 267) (1:3) - No CF	1503	9680	4.07
		Local pigeonpea + mungbean (1:3) - CF	1102	6553	3.34
		Improved pigeonpea (Maruthi) +mungbean (ML -267) (1:3) - CF	1770	12109	4.77
	Castor (1997-05)	Farmers practice	436	2367	1.76
		CF in between crop rows	558	3587	2.05
		Additional interculture during dryspells	511	3114	2.04
		Additional 20 kg N/ha after relief of dry spell	615	4425	2.16
	Sunflower (1999-02)	FP - Morden with no CF	292	1066	1.31
		Hybrid (MSFH -8) with no conservation furrow	456	3168	1.75
		Morden with CF	340	1502	1.37
		Hybrid (MSFH -8) with CF	554	4381	1.98
	Cotton (2003-05)	Farmers Practice	1519	10197	1.46
		Ridges and furrows prior to sowing	1694	13998	1.60
		Ridges and furrows prior to sowing + Addl. N 20 kg/ha	1819	16106	1.66
Bangalore	Fingermillet (1999-02)	Farmers practice	3520	9300	1.67
		Tank silt 30 t/ha	3875	10587	1.72
Solapur	Pigeonpea+ sunflower (2004-05)	FP : Summer harrowing+ 2 hoeings	677+523	19856	2.92
		SH+ compartmental bunding before onset of monsoon + biofertiliser + NPK (12.5:25:0) + 2 hoeings	1157+806	32572	4.38
		FP - 4-5 harrowings during off season	565	6404	1.60
		2 harrowings, CB + one harrowing	785	8244	1.89
		Two harrowings+ridges and furrows + one harrowing	675	7271	1.57
	Rabi - Sorghum (1999-03)	FP-4-5 harrowings during off season	625	6996	1.73
		Harrowings (2) + CB + one harrowing	870	8645	1.96
		Harrowings (2)+ridges and furrows +one harrowing	770	8527	1.83

FP= Farmers practice; CB= Compartmental bunding; CF=Conservation furrow

(132%) compared to chemical control alone (2 sprays of Quinalphos 0.05%). About 40% farmers of the project area, particularly small and marginal are now adopting this technology due to its simplicity and profitability. The IPM module in castor with sequential application of NSKE and *Annonol* with bird perches increased yield (30%) and additional net returns (Rs.1151/ha) as compared to the use of chemical pesticides alone (583 kg/ha). About 30% of the farmers are adopting this technology because of availability of botanical pesticides at the village level. In cotton, IPM components such as seed treatment, pest monitoring using pheromone traps, cultivation of border crops (maize/sorghum in 4 rows), trap crops (castor/marigold), nipping shoot tips between 80-100 days, use of bio pesticides like NSKE, HaNPV, Trichogramma egg parasitoids and need-based application of chemical insecticides gave higher B:C ratio of 5.24 as compared to 1.52 of farmers practice (Table 5).

Table 5: Performance of integrated pest management practices

Center	Crop	Treatment	Yield (kg/ha)	Net returns (Rs/ha)	B:C ratio
Hyderabad	Sorghum +pigeonpea (2001-03)	Farmers practice	1534	970	1.20
		Chemical control (quinalphos @ 2.0 mL/L of water) 2 sprays	1879	1955	1.40
		Neem based formulation @ 5.0 mL/L of water - 2 sprays	2318	3982	1.80
		Neem +custard apple formulation @ 5.0 mL/L of water 2 sprays/cultural method (shaking of plants)	2467	4553	1.90
	Castor (2001-04)	Untreated check	349	557	1.14
		Neem seed kernel extract 5%	518	1368	1.45
		Annonol 0.125%	446	1260	1.39
		Endosulfan 0.075%	583	2941	1.84
		IPM I	687	4092	2.04
		IPM II	618	3361	1.82
	Tomato (2001-03)	Farmers practice (flat bed nursery)	4400	10200	4.40
		Raised nursery bed with seed treatment	4800	11300	4.65
Udaipur	Blackgram (2003-05)	No seed treatment	420	2478	1.50
		Bavistin 2g/kg seed + rhizobium	500	3840	1.70
		Bavistin 2g/kg seed + rhizobium + trichoderma 6g/kg	530	4080	1.80
	Chickpea (2003-05)	Farmers practice	1400	10117	0.89
		NPV + mechanical, agronomic practices	2120	19637	1.70
	Mustard (2002-05)	Farmers practice	1050	5554	0.38
		Line sowing	1200	6679	0.48
		Early line sowing in lost week of September with spacing of 40x10cm, cypermethrin @ 500 ml/ha	1400	7999	0.57
	Groundnut (2002-04)	No seed treatment	1120	13215	
		Treatment (Bavistin+thirum 1:1 @ 2g/kg kernel)	1260	15735	
			1240	15375	
		Bavistin+ thirum 1:1 + chlorpyriphos 4.5 mL/kg kernel Trichoderma @ 5 g/kg kernel	1230	15178	

At Nagpur, application of neem seed extract recorded 16% higher seed yield of cotton and net returns Rs.20,000/ha as compared to the farmers practice (1,230 kg/ha). At Solapur, the IPM practice (pheromone trap, NSE 5%, HaNPV and endosulphon) in pigeonpea enhanced grain yield (51%) and net returns (58%), compared to farmers practice (mixing sorghum seed with and one dusting with methyl parathion). In sole pigeonpea, IPM module (seed treatment of Trichoderma 5g/ kg seed, mixing of sorghum seed @ 50 g/kg (ITK) and fixing pheromone trap @ 5 no/ha, NSKE 5% spray, HaNPV @250mL/ha and Endosulphon) in *Vertisols* enhanced the productivity and profitability (55 to 57%) compared to farmers practice of one spray of insecticide (1,085 kg/ha). This technology was implemented on 112 ha of the target village covering 171 farmers. In safflower+chickpea strip cropping (3:6) IPM module (low cost inputs like timely planting, use of resistant variety, mixing sorghum seed, seed treatment with Trichoderma, interculturing, pheromone traps, bird perches, two NSE 5% sprays, two dustings of methyl parathion and dimethoate (0.03%)) recorded lowest aphid and jassid population ((12.55 and 0.9), reduced larval and pod borer infestation (1.3 and 4.61%), enhanced the seed yield of safflower and chickpea (398 and 821 kg/ha) and gave additional net returns of Rs.10632/ha over other modules.

At Bangalore, one spray of s*ypramethan* at flower initiative and incorporation of neem cake @ 250 kg/ha to soil at flowering stage in pigeonpea recorded higher seed yield (1,220 kg/ha) and net returns of (Rs.15,000/ ha) compared to farmers practice. This technology was adopted in 54 ha involving 59 farmers.

At Dharwad, groundnut seed treatment with *Trichoderma viride* @ 4 g/kg increased yield by 16% with B:C ratio of 7.7 as compared to farmers practice. In potato, tuber treatment with *Trichoderma viride* @ 10 g/ kg reduced sclerotium rot (81%) and increased tuber yield by 15% compared to farmers practice. At Jhansi , use of NPV @ 625 mL/ha along with mechanical/ agronomic practices enhanced the productivity (51%) and net returns (94%) over farmers practice (1,400 kg/ ha) due to better control of pod borer in chickpea. The IPM technologies were adopted in 21% chickpea and 14% mustard growing farmers, respectively. In Udaipur, seed treatment with bavistin+thiram (1:1) @ 2g/kg kernel in groundnut effectively controlled crown rot disease (26to29%) and increased the pod yield (12%) and net returns (Rs.2,520/ha) over no seed treatment. Carbandezim (0.75g)+1g of thiram+ chloropiriphos @ 8 mL/kg seed along with spray of either endosulphon or 10% neem leaf extract increased chickpea yield by 15-19% over control (800 kg/ha). This IPM module effectively controlled wilt, termite and pod borer in chickpea. In blackgram, seed treatment with bavistin (2 g/kg)+*Rhizobium* and *Trichoderma* (6 g/kg seed) gave higher seed yield (110 kg/ha) and net returns (Rs.1,602/ha) compared to no seed treatment (420 kg/ ha) (Table 6).

6.6 Horticulture

At Hyderabad, mulching with grass and microsite improvement with FYM+ tank-silt+native soil (1:1:1) gave 93 to 100% of survival of tamarind rainfed Alfisols. During the dry months of January-May, supplemental

In-situ mango grafting with pitcher irrigation at Dharwad

Improved pitcher system for tamarind at Hyderabad

Table 6: Performance of integrated pest management technologies

Center	Crop	Treatment	Yield (kg/ha)	Net returns (Rs/ha)	B:C ratio
Solapur	Pigeonpea+ sunflower (2003-05)	FP: No fertilizer, 1 spray of endosulphan	535+ 390	15275	2.18
		BF+NP (50:25 kg/ha), trichoderma, pheromone traps, NSE 5% spray, HA NPV @ 250 mL/ha, endosulphan 0.07%	1160+610	29579	3.32
	Pigeonpea (1999-04)	FP - mixing sorghum seed, one dusting of Parathion (ITK)	403	6213	1.53
		IPM Tech. (Pheromone trap, NSE 5%, Ha NPV, Endosulfan 0.07%)	607	9825	2.37
		Endosulfan 0.07% +Fenvalarate 0.02%	470	7470	2.09
	Pigeonpea (2004-05)	FP: only one dusting or spraying of insectides	1085	18883	3.22
		IPM : seed treatment with Trichoderma @ 5 g/kg seed Mixing of sorghum seed @ 50 g/kg (ITK), fixing of pheromone traps @ 5 nos/ha, NSKE 5% spray, HaNPV @ 250 ml/ha, Endosulphan 0.07%	1682	29653	4.03
	Rabi sorghum (2003-05)	FP- No control	1190	14509	3.21
		Spray of dimethoate 0.03%	1387	16510	3.46
		Dusting Methylparathion 2% @ 20 kg/ha	1415	14705	3.13
Hyderabad	Cotton (2003-04)	NHH-44 (FV)+ No IPM	1929	11670	1.36
		NHH-44 (FV)+IPM	2636	33312	2.27
		Bt-Cotton (MECH-162)+IPM	2736	41851	2.87

irrigation through pitcher (15 L/week/plant) not only improved the survival percentage but also saved the water up to 60%. In agri-horti system, pigeonpea alone recorded highest pigeonpea equivalent yield (560kg/ha) followed by pigeonpea+mungbean system (533 kg/ha). The intercrops of pigeonpea, pigeonpea + mungbean and mungbean recorded net income of Rs.3,920, 3,372 and 2,446/ha, respectively. *Cenchrus* in between tamarind rows recorded net returns of Rs.2,800/ha over the years. The productivity of the existing custard apple in the system can be improved by using FYM @ 5 kg+500g DAP/plant. At Vengurli, application of Paclobutarzon to mango tree recorded 155 % higher fruit yield compared to control (1,590 kg/ha). About 40% of mango plantations were sprayed with this chemical in the IVLP area. Application of 5 sprays, one each of syperbetrin, endosulphon, phosalom and monocrotophos to mango gave higher fruit yield (52%) and net returns (Rs.15895) compared to farmers practice with two sprays of syperbetrin (1,903 kg/ha). Coppice grafted cashew nut HYVV-7 increased yield by 2.6 kg/tree compared to seedling cashew trees (1.25 kg/tree) during fourth year of grafting. Application of one KCL+250 g of P_2O_5 + 250 g K_2O and 40 kg compost to cashewnut tree produced additional yield (656 kg/ha) and net returns (Rs.12,889/ha) compared to farmers practice (513 kg/ha). Intercropping ridgegourd (Konkan Haritha) in cashewnut gave Rs.40582/ha compared to the natural grass which yielded 2.18 t/ha. Application of 2.5 kg urea+3 kg SSP+1.6 kg MOP to coconut produced an additional nut yield (62%) compared to farmers practice (7,440 nuts/ha). Introduction of Parbhani kranthi in vokra gave 18% additional yield compared to local (6404 kg/ha). Balanced nutrition in guava (2 kg N, 8.5 kg P and 1 kg K_2O every year, zinc sulphate 250 g once in three to four years, 50 kg FYM / plant) resulted in increased yield of 11 t/ha. Application of neem and pongamia cake @ 250 kg/ha at the time of brinjal planting and also at 30-40 days interval, reduced the incidence of ash weevil and fruit borer. At Jhansi,


Vermicompost a livelihood option for farm women at Hyderabad

budding technique in ber helped the farmers to generate income of Rs. 5,000 to 15,000/ha. At Nagpur, planting of amla at 4x5m spacing with crescebt shaped trenches resulted in 60% survival in the first year. Application of 5 kg vermicompost and 25 kg FYM/plant during basin preparation increased the number of fruits, fruit weight and fruit yield by 13, 12 and 23 %, respectively over four seasons (Table 7).

Table 7: Effect of management practices in horticulture crops

Center	Crop	Treatment	Yield (kg/ha)	Net returns (Rs/ha)	B:C ratio
Hyderabad	Tamarind	Sole tamarind	-	-	-
	(2000-03)	Tamarind+pigeonpea+ mungbean	533	2446	1.62
		Tamarind+pigeonpea	560	3920	2.40
		Tamarind+mungbean	281	3372	1.69
		Tamarind+castor + cowpea	370	235	1.06
		Tamarind+castor	342	344	1.12
		Tamarind+cowpea	150	-1225	0.56
		Tamarind+cenchurus	225	2800	4.50
		Tamarind+stylo	230	90	1.20
Jhansi	Tomato	Farmers practice	12250	9460	0.46
	(2001-04)	Vermicompost (5 t/ha)	25625	48660	1.98
		Vermicompost (5 t/ha)+NPK	29250	51350	2.06
Hyderabad	Tomato	Farmers practice (flat bed nursery)	4400	10200	4.40
	(2001-03)	Raised nursery bed with seed treatment	4800	11300	4.65
	Custard	Farmers practice	42	150	
	apple	FYM @ 5 kg/plant	130	250	
	(2001-03)	FYM @ 5 kg/plant + 500 g DAP/plant	207	404	
Solapur	Alternate cropping system (2004-05)	FP : Fallow/mixed cropping of minor pulses	400	5050	1.00
		Custard apple+stylo @10 kg/ha	0 +10000	10658	1.46
	Onion	FP - FYM 6-8 cartloads/ha, NPK 25:25:25 kg/ha	9954	25733	1.93
	(2000-03)	BF+NPK (100:50:50 kg/ha)	11940	31883	1.92
		BF+ Vermicompost 4 t/ha + PK (50:50 kg/ha)	14447	40395	1.43
		BF + normal compost @ 16 t/ha	11330	31275	1.63

Center	Crop	Treatment	Yield (kg/ha)	Net returns (Rs/ha)	B:C ratio
Dapoli	Cashewnut + ridge gourd (1996-98)	Farmers practice (No inter crop only grass)	218	-65	
		Intercrop ridgegourd (Konkan Haritha)	915	40582	
Bangalore	Arecanut (1999-03)	Farmers practice no fertilizer	1450	152103	7.94
		Use of (100:40) 140 /plant /year	1829	193183	8.30
	Banana (1999-03)	Farmers practice	56316	165389	2.42
		Banana + coriander	55882 +17499*	178472	2.51
		Banana + palak	55449 +16666	175373	2.48
		Banana + French bean	56316 +850	191839	2.61
	Banana (1999-03)	Farmers practice (no ratoon)	56316	165389	2.42
		Ist ratoon	62814	229676	3.72
		2nd ratoon	60648	220442	3.66
		3rd ratoon	68770	262313	4.21
	Cabbage (1999-03)	Farmers practice NSKE 7.5% at	6835.6	65009	3.87
		20:30:40 and 50 DAP	7088.8	84347	3.62
		Pongamia soap 1% 20:30:40 and 50 DAP	6950.0	78404	3.20
		Neem soap 1% 20:30:40 and 50 DAP			
	Brinjal (1999-03)	Farmers practice NSKE 7.5% at	6835.6	30888	1.90
		20:30:40 and 50 DAP	7088.8	90043	4.77
		Pongamia soap 1% 20:30:40 and 50 DAP	6950.0	83540	4.50
		Neem soap 1% 20:30:40 and 50 DAP			
	Guava (1999-03)	Farmers practice (mulching with fallen leaves)	1065	13088	1.99
		NPK 150:200:200 g/plants	1195	26925	2.99
	Drumstick (1999-03)	Farmers practice (only finger millet)	2986	6148	1.46
		Fingermillet + drumstick (60:40)	2041+55466	20834	2.21

6.7 Farm Implements

At Hyderabad, CRIDA planter improved the plant stand by 20%, coverage by 300% and reduced the labour cost by Rs.200/ha as compared to country plough (Rs.500/ha). The tractor mounted maize cob sheller could shell upto 300 q/day with fuel cost of Rs.700 and a labour cost of Rs.600/day. By this, farmers realized a net profit of Rs.3,200/day. At Jhansi, groundnut planter saved 8.1 man days or Rs.355/ha as compared to the farmers practice of using desi plough, which required 10 man/days/ha with an average wage cost of Rs.450/ ha. Use of groundnut digger required only 15 man-days as against 40 man-days for farmers practice. The digger could be save 25 man days/ha (Rs.1150/ha) compared to farmers practice. Hanging type double-screened seed cleaner in wheat saved 1 hour and also Rs.10 as wages for cleaning 1 quintal seed. At Solapur, by using bhindi plucker one person could harvest 50 kg fruits as against 25 kg by hand plucking. These tools increased efficiency and minimized the drudgery for women.

6.8 Gender Issues

Women in rainfed agriculture perform difficult tasks like sowing, weeding, harvesting and other post-harvest operations, which involves lot of drudgery. In this context, various technological interventions were evaluated to reduce the drudgery of farmers and farm women, in particular, at different centers.

At Hyderbad, use of dryland weeder required 33.30 hr/ha with a coverage of 1.50 ha/day, whereas three pointed hand hoe covered about 0.62 ha/day and required 80 hr/ha. The local sickle covered 0.58 ha in a day to perform weeding with 88 hrs in ha. Farmers were

Groundnut decorticator to reduce the drudgery of farm women at Udaipur

Nutritional improvement through minor millets

convinced about the efficient performance of different interculture equipments owing to reduced drudgery. Thus, inter row weed control by dryland weeder reduced the time requirement by 33% as compared to the local sickle. On the whole, 63% of farm women had a preference to three pointed hand hoe due to lesser time taken for weeding and ease of operation (Table 8).

Application of vermicompost @ 1.5 t/ha in napier grass enhanced the productivity and profitability by 20% as compared to the use of chemical fertilizer alone under limited irrigation at Hyderabad.

Use of serrated sickle saved the labour cost by Rs 350/ha over traditional sickle at Udaipur. Farmers perceived that serrated sickle is lighter in weight, easy in handling and caused lesser fatigue. For post-harvest storage, the use of modified bins reduced the loss of grains by 3.5 to 4%, compared to the traditional mud/stone/ bamboo bins. The tubular maize sheller saved 75% time required as compared to beating cobs with wooden sticks. Farm women preferred this device due to its lighter weight, convenient operation, and its ability to reduced drudgery. Groundnut Decorticator significantly reduced the drudgery and time compared to manual shelling. Grinding of food grains (maize and wheat) with *chakki* having ball bearings saved 110-130% time as compared to the traditional stone made hand mill without ball bearing. Improved churner with ball bearing churned 5-30 kg of curd than a churner without ball bearing. This was preferred by small and marginal farmers in the project area to save time and reduce the drudgery. Refined *Chulhas* saved fuel up to 40% and fetched net saving of Rs 148/m compared to traditional *Chulha.*

Eighty per cent of small and marginal farmers at Dharwad reared improved poultry birds (Girirani) in the backyard. The adult male and female Girirani birds attained a body weight of 4.2 and 3.4 kg, respectively as against 1.9 and 1.5 of local birds. The average egg production of this breed was 160 while local birds laid only 68 eggs.

Incorporation of soybean in processed product for diet, improved nutrition of farm women as compared to the use of traditional diet. The sorghum-based health

Table 8: Performance of farm implements for drudgery reduction

Treatment required for	No. of h/ha (8 h)/ha weeding	Man days coverage/	Area by women day/ha	Preference (%)
Local sickle	88.0	11	0.6	6.5
Khurpi	80.0	10	0.6	23.9
3 pointed hand hoe	80.0	10	0.6	63.0
Dry land weeder	33.3	4	1.5	10.9

Improved chulha (left) and mushroom (right) (Udaipur)

mix helped to reduce anemia and tiredness in adolescent women.

At Jhansi, hand operated peg type dryland weeder saved 20 man/days and Rs.70/ha in weeding of dryland crops compared to manual weeder.

The groundnut decorticator saved 6.5 man/days and Rs.247/q compared to manual decortication. Harvesting of crops by serrated sickle resulted in saving of two man/days or Rs.120/ha along with reduction in health hazards and increased efficiency in harvesting. Value addition in tomato through sauce resulted in net saving of Rs.480/q compared to farmers practice of direct selling of the fresh produce. About 50 % of farmers of IVLP and adjoining villages have adopted this technology.

At Solapur maize cob sheller could shell 150 kg maize cobs/day/person with no physical exhaustion as against 75 kg/day/labour by hand shelling. Bhendi

Backyard poultry as a source of income generation for farm women at Nagpur

Establishment of stylo(left), vegetative barrier (middle) and water harvesting structure in watershed villages at Nagpur

plucker increased work efficiency and minimized physical exertion and allowed 50 kg fruit harvest by one person in a day as against 25 kg fruit by hand plucking. About 50% of the farmers have adopted this tool in IVLP villages. Groundnut sheller shelled 50 kg pods/hour/two persons as against a manual of 10 kg. The adoption of groundnut sheller has gone up to 60%. Mini dal mill produced an additional value of Rs.300/q by processing pigeonpea grains into dal.

At Dapoli, Rhode Island poultry birds attained body weight of 2.48 kg (male) and 2.16 kg (female), and laid 87 eggs compared to local birds, which attained 2.0 kg (male) and 1.4 kg (female) with an egg production of 45. At Nagpur, vermicomposting was found most economical venture for landless and marginal farmers and provided employment, particularly to women folk. Farm women harvested thrice the yield of 1-2 kg honey per harvest by improved honeybee hives. This activity became the main source of income for the farm women at IVLP village.

6.9 Watershed Management

A micro watershed of 10 ha area was developed, in April 2000, with the involvement and active participation of 12 tribal farm families in Nallavelli village in Yacharam mandal of Ranga Reddy district, Hyderabad. The hydrology, soil and land use maps were prepared through PRA. Four water ways with a cross section of 0.45 m^2 and a length 300 meter, diversion channels of 200 m length, 4 drop structures and graded bunds for 2000 m length were developed with active participation of the farmers. Sorghum and pigeonpea intercropping system with local varieties yielded 400 kg of sorghum and 150 kg of pigeonpea/ha. The farmers realized that the application of urea after dry spell at vegetative stage is useful for obtaining higher productivity of sorghum (200 kg/ha) than their traditional management. The improved varieties of castor Aruna and *Kranthi* gave 300 to 400 kg/ha yield even in ill distributed rainfall year (2001). About 50% of the area under castor was top dressed with 10 kg N, resulting in an additional yield of 100 kg/ha compared to the basal application alone. Gliricidia cuttings, planted on both sides of the waterways and on the periphery of the bunds, showed 40% revival compared to previous years. Stylo established on field bunds during first year produced 0.5 t biomass/ha. Subsequently, 1.50 and 2.50 t of biomass was harvested during second and third year of the establishment. Supplementation of water through pitcher system helped in 90% of survival during second year of establishment of custard apple and henna. Seedlings of custard apple and tamarind were planted on field boundaries during August with micro site improvement.

At Nagpur, land use planning for conservation of natural resources and sustainability of cropping system was implemented adopting watershed approach. Maize cv African Tall produced 70-80% higher yield than sorghum cv Pusa Charry. Establishment of improved pasture with legumes (Signal and Stylo) on degraded lands produced 3.5 t/ha of good quality green fodder compared to local pasture (0.8 t/ha). Fodder trees planted on field boundaries and degraded lands helped to meet the fodder shortage by 10-15%. Establishment of vegetative barriers with Gliricidia, Leucaene and Napier hybrid conserved moisture, besides improving soil fertility and providing fodder. Treatment of vegetative bunding, plugging of gully land, construction of 20 check dams and gabion structures, and desilting tanks resulted in the increased levels of water in wells from 3-8 m, and percolation tanks (6-10 m). The adoption of these improved measures increased the duration of water availability in the wells from the past 3-4 months to the present, 8 months. Before these interventions, wells used to get dry after 1.5 hours of pumping and recuperated in 24-36 hrs. Now, the wells recuperate in 18-20 hrs only. The impact of percolation tanks was seen in the

Upgradation of local breed of goats with Osmanabadi bucks at Nagpur

increased area by *rabi* season and enhancement of the irrigated area by 41%, which ultimately led for crop diversification.

6.10 Livestock

In order to mitigate the problem of fodder scarcity, improved cultivars of fodder maize (cv African Tall), sorghum (cv Pusa chary), oat and lucerne were tested at farmers fields. Influence of various feed supplements on milk production was also studied at Hyderabad center. Introduction of (cv African Tall) maize increased yield by 91% and an additional net returns of Rs.5,850/ha over local sorghum. Similarly Pusa chary recorded 63% higher yield with net returns of Rs. 4,000/ha. The increase in milk yield from 1 to 3 L/day/animal and net returns of Rs. 20 to 30/day/animal was recorded as a result of feeding green fodder. Treatment of rice straw with 4% urea increased milk yield by 0.47-1.20 L/day with an average increase of 0.80 L/cow/day. About 1.15 kg increase in paddy straw consumption was also recorded in crossbred cows. Feeding of urea treated straw enhanced the net return by Rs.381/animal as compared to control. Supplementation of UMMB blocks resulted in increased yield of milk by 25-35%. Introduction of UMMB blocks increased farmers' income by Rs.4/day/animal and was found very useful in maintaining the overall health and productivity of animals, particularly when fodder scarcity was acute.

Supplementation of mineral mixture along with concentrate to milch animals considerably increased milk yield and net returns compared to the farmers practice of grazing alone (Table 9). Mineral supplements not only helped in increasing the appetite but also in maintaining higher reproductive and productive efficiency of the animals.

Feeding of balanced concentrate formulated with locally available ingredients (rice bran 40 parts, cakes 37, grain 20, common salt 1 and mineral mixture 2 parts) enhanced the milk yield by 0.90 and 0.70 L/day in cows and buffaloes, respectively and increased the income of farmers by Rs.8-9/day/animal. The supplementation of rice bran @1.5% of the body weight significantly improved the growth rate of lambs (121 vs 72 g/h/d) and kids (93 vs 65 g/h/d) reared on common grazing lands.

At Solapur, feeding of salt licks for 8 months duration were found beneficial in minimizing mineral deficiencies and increasing milk yield and its fat content. Control of round worm and foot and mouth disease in cattle increased the feed intake of animals by 50% and milk yield in cows by 200-250 mL/cows/day and in buffaloes by 200-275 mL/day. The upgradation of local goat through Osmanabadi buck, increased the weight of kids (200-300 g/kid) and decreased the mortality (25%) as compared to the locals. Upgradation of local goats was adopted by 45% of the families in IVLP villages. At Vengurli, inroduction of Osmanabadi breed of goat enhanced the weight of kids (150-200 g/kid) over locals. Supplementation of "Uromol" to dairy animals improved milk yield by 8%. At Jhansi, feeding of complete feed block made of wheat straw and concentrate (60:40) to buffaloes enhanced milk yield by one L/day and profitability by 14.32% compared to the farmers practice (5.5 L/d). In buffaloes, control of ecto-and endoparasites enhanced milk yield by 130

Maize + pigeonpea with milch animal: a promising farming system for marginal farmers at Hyderabad

Table 9: Influence of feed supplements

Interventions	Treatment	Milk yield/ (L/day)	Total*milk yield (L)	increase in milk yield (%)	Net Return (Rs)	B:C ratio
Mineral supplementation (1999-2001)*	Grazing alone	1.80	216	-	2156	-
	Grazing+conc. @ 1.5 kg/day/animal	3.36	403	86.5	3159	1.38
	Grazing+MM @50g/animal/day	2.84	341	57.9	2972	4.13
	Grazing + conc @ 1.5 kg/day /animal + MM@50g animal/day	4.42	530	145.4	4202	2.10
Urea treated straw (2000-03)**	Control	4.04	242	-	2420	1.00
	Urea treated rice straw	4.83	290	20.5	2900	4.18
Urea Molasses Mineral Block (UMMB)	Cows:					
	Farmers practice	4.61	277	-	2770	1.00
	Farmers practice + UMMB *ad lib*	5.75	345	24.6	3285	3.12
(2001-02)**	Buffaloes:					
	Farmers practice	4.00	240	-	2880	1.00
	Farmers practice + UMMB *ad lib*	5.00	300	25.0	3418	2.96

* Supplementation for 90 days MM-Mineral mixture ** 60 days

and 300 liters with the net gain of Rs.1,517 and Rs.3,783, respectively over the control. Supplementary feeding of mineral mixture @30-50 g/day reduced the dry period by 8 months and age of first calving by 2 months than no mineral supplementation. Use of Albendazone @ 20ml/100 kg live weight in young calves reduced the infestation from 90% to 1%, mortality from 50% to 1% and increased milk yield by 11.40% as compared to the farmer practice of no deworming. At Nagpur, upgradation of local goats through Osamanabadi buck increased birth weight and kidding percentage over locals.

Crop diversification with finger millet (60%) and pigeonpea (40%), area allocation for higher profits at Bangalore

6.11 Farming Systems

At Hyderabad, farming system modules in combination with arable crops and livestock for small and marginal farmers were studied in rainfed Alfisols and Vertisols. Maize-coriander-chickpea and maize+pigeonpea-coriander-chickpea gave higher profitability in marginal and small farmers, respectively in Vertisols. In A*lfisols*, maize+pigeonpea, coriander-maize+pigeonpea yielded higher net returns for marginal and small farmers, respectively. Cotton+two dairy animals for both small and marginal farmers exhibited higher profitability for rainfed Vertisols. In Alfisols, integration of two dairy animals in castor and sorghum+pigeonpea, cotton-maize+pigeonpea gave highest profitability for marginal and small farmers, respectively. Animal component with arable crops

contributed to the net income to the extent of Rs.1,500 along with 1,000 kg of FYM as a by-product.

At Dharwad, the farming system module for medium farmers comprising of 32.19% of oil seed crop (intercrop in mango), 26.82% of food grains, 8.81% of commercial crops, 5.36% of vegetable/pulse crops and 5.36% crops of fodder of was found optimum to get stable productivity and profitability. The over all net income increased from Rs.17,358 to Rs.23,074 and the benefit cost ratio, from 2.72 to 3.00. The farming system module for small farmers comprising of 30.36% of commercial crops, 26.18% of food grain crops, 17.80% of horticulture, and oil seed crops as intercrops in mango improved the intensity of cropping by 21%. Along with these, animal husbandry components (backyard poultry and rearing milch animals) further helped to increase the net farm income from Rs.7,329 to Rs.10,107. This farm plan module raised the benefit cost ratio from 2.32 to 3.58.

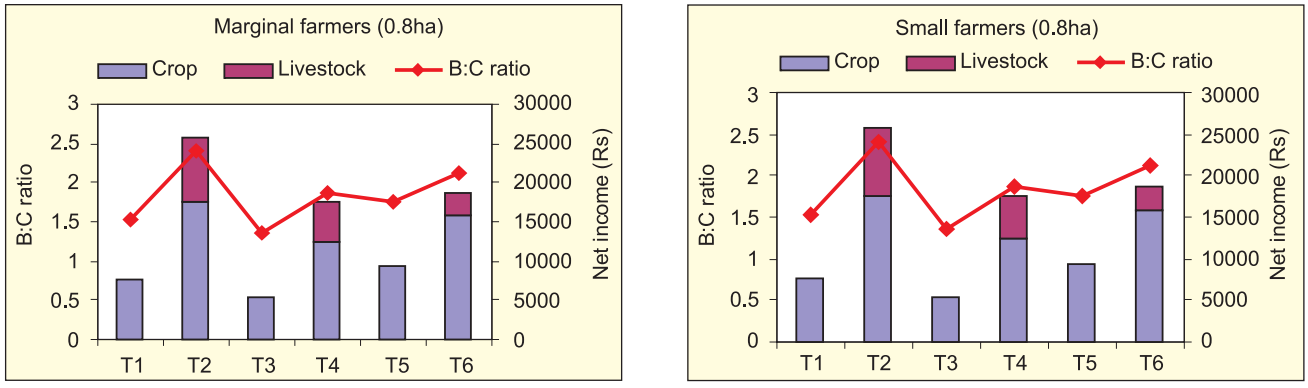


Fig 16. Influence of farming system modules on productivity and profitability in marginal small farmers
T1:Cotton; T2: Cotton + 2 buffaloes; T3: Maize + pigeonpea-cotton; T4: Maize + pigeonpea-cotton + 2 buffaloes; T5: Maize + pigeonpea; T6: Maize+pigeonpea+2 buffaloes

CHAPTER

7

Pulses Based Production System

The TAR-IVLP programme under pulse based production system was implemented in Vidokhar village of Hamirpur district in Uttar Pradesh. In order to generate appropriate, profitable, environmentally sound and sustainable technologies to improve the livelihood of rainfed farmers, 20 technological interventions were identified as usable technologies for different categories of farmers.

7.1 Crops and Varieties

Improved varieties of urdbean (IPU 94-1), pigeonpea (Narendra Arhar 1), chickpea (JG 315 and DCP 92-3), lentil (DPL 62 and JL-1), wheat (Lok-1), sesamum (TKG-22), mustard (Vaibhav) and oat (JHO-822) enhanced the productivity by 74, 29, 47, 42, 38, 23, 19 and 26%, respectively as compared to respective local varieties. Informal seed production and distribution system was initiated during *rabi* 2001-2002 in which 30 farmers took keen interest. Presently, 60 farm families (18 medium, 32 small and 10 marginal) are actively engaged in seed production of improved varieties of pulse, cereal and oilseed crops. During 2003-2004, 37.5 t seed of chickpea, 17.8 t of pigeonpea, 16.8 t of lentil and 45.0 t of wheat were produced by the farmers.

The farmers in target village adopted chickpea cultivar JG 315 (99 ha), lentil cultivar DPL 62 (108 ha), urdbean cultivar IPU 94-1 (34 ha), pigeonpea cultivar Narendra Arhar-1 (37 ha) and wheat cultivar Lok-1 (192 ha) during rainy and post rainy season of 2004-2005. Farmers of neighbouring villages within the district and nearby districts like Jalaun, Banda, Mahoba

Pigeonpea (Narendra Arhar-1)

Fieldpea (HUDP-15)

Chickpea

and Chitrakoot purchased 0.9 t seed of pigeonpea, 12.2 t of chickpea, 9.0 t of lentil and 12.8 quintal seed of wheat during *kharif* and *rabi* seasons (2004-2005) from the farmers engaged in seed production in the IVLP village. Thus the farmers of IVLP village have not only become self sufficient for seeds of pulse crops, but also gained an additional gain of Rs. 5000/t there by bringing in improvement in the status of the families (Table 1).

7.2 Cropping Systems

Adoption of intercropping of chickpea cultivars JG-315/DCP 92-3+linseed cultivar Shikha (6:2) recorded additional chickpea equivalent yield (270 kg/ha) and net income (Rs. 17,820/ha) compared to farmers practice (Rs.14,467/ha). Intercropping of lentil cultivar (DPL 62) and linseed cultivar (Shikha) (6:2) exhibited an additional lentil equivalent yield of 180 kg/ha with B:C ratio of 4.25, compared to farmers practice (mixed cropping).

In mustard, thinning once after 25 and 45 DAS enhanced the productivity by 56 and 65% compared to the farmers practice of no thinning under mono and double cropping, respectively. But the practice of thinning after 25 DAS was found economically optimum under irrigated mono and double cropping situations. This practice was preferred by small and marginal farmers in 22 and 14 ha in IVLP and nearby non-IVLP villages (Table 2).

Table 1: Performance of Improved varieties at Kanpur

Crop	Varieties	Yield (kg/ha)	Cost of production (Rs/ha)	Gross returns (Rs/ha)	Net returns (Rs/ha)	B:C ratio
Rainfed mungbean	Local variety	220	3000	4400	1400	1.47
	Samarat	770	3312	15400	12087	4.65
	PDM 54	510	3312	10200	6887	3.08
	NM-1	507	3312	10140	6827	3.06
Rainfed sesamum	Local variety	420	3125	10500	7375	3.36
	TKG 22	730	3237	18250	15012	5.64
	Type 78	650	3237	16250	13012	5.02
	Type 13	410	3237	10250	7012	3.17
	Type 4	380	3237	9500	6262	2.93
Rainfed pigeonpea	Local variety	723	4380	11568	7188	2.64
	Amar	927	4830	14832	10002	3.07
	Narendra Arhar-1	929	4830	14864	10034	3.08
Irrigated pigeonpea	Local variety	918	5652	14688	9035	2.60
	Amar	1323	6102	21168	15065	3.47
	Narendra Arhar-1	1329	6102	21264	15161	3.48
Urdbean in uplands	Local variety	420	3000	6300	3300	2.10
	IPU 94-1	1013	3312	12156	8843	3.67
	Azad Urd -1	450	3312	5400	2087	1.63
	Shekhar Urd -1	470	3312	5640	2327	1.70
Rainfed chickpea	Local variety	904	7105	13560	6455	1.91
	KWR 108	928	8305	13920	5615	1.68
	JG 315	1209	8305	18135	9830	2.18
	JG 322	1135	8305	17025	8720	2.05
	JG 74	1000	8305	15000	6695	1.81
	DCP 92 -3	1110	8305	16650	8345	2.00

Crop	Varieties	Yield (kg/ha)	Cost of production (Rs/ha)	Gross returns (Rs/ha)	Net returns (Rs/ha)	B:C ratio
Iirrigated	Local variety	1330	8535	19950	11415	2.34
chickpea	KWR 108	1570	9735	23550	13815	2.42
	JG 315	1803	9735	27045	17310	2.78
	JG 322	1715	9735	25725	15990	2.64
	JG 74	1563	9735	23445	13710	2.41
Chickpea	Local variety	1157	9150	17355	8205	1.90
under irrigated	KWR 108	1285	10350	19275	8925	1.86
double cropping	JG 315	1570	10350	23550	13200	2.28
	JG 322	1673	10350	25095	14745	2.42
	DCP 92 -3	1500	10350	22500	12150	2.17
Lentil	Local Variety	1025	5240	16400	11160	3.13
	DPL 62	1398	6040	22368	16328	3.70
	IPL 81	1256	6040	20096	14056	3.33
	Jl 1	1099	6040	17584	11544	2.91
	JL 3	1250	6040	20000	13960	3.31
Fieldpea	Local variety	1880	7824	18800	10976	2.40
(rrigated	HFP 4	2560	12162	25600	13438	2.10
monocropping)	HUDP-15	3250	12162	32500	20338	2.67
Fieldpea	Local variety	1202	7824	12020	4195	1.54
(irrigated	HFP 4	2580	12162	25800	13637	2.12
double cropping)	HUDP-15	2960	12162	29600	17437	2.43
Irrigated wheat	Local variety	3488	129690	20928	7959	1.61
(clay soils)	Lok 1	4050	13731	25312	11581	1.84
	Raj 1555	3358	13731	20148	6418	1.47
	PBW 343	2750	13731	16500	2769	1.20
	UP 2338	4120	13731	24720	10989	1.80
	Maghar	3358	13731	20148	6417	1.47
Irrigated wheat	Local variety	3716	14219	22296	8077	1.57
(loamy soils)	Lok 1	4339	14981	27119	12157	1.81
	Raj 1555	3603	14981	21618	6637	1.44
	PBW 343	2878	14981	17268	2269	1.15
	UP 2338	4290	14981	25740	10759	1.75
	Maghar	3050	14981	18300	3319	1.22
Monocrop	Local variety	1783	7262	28528	21265	3.93
mustard (partial	Varuna	1900	7322	30400	23077	4.15
irrigation)	Vaibhav	1833	7322	29328	22005	4.01
Mustard	Local variety	1215	8450	19440	10990	2.30
(kharif fallows)	Varuna	1323	8575	21168	12593	2.47
	Vaibhav	1268	8575	20288	11713	2.37

Table 2: Influence of crop management practices in mustard

Crop and micro farming situation	Treatments	Grain yield (kg/ha)	Cost of production (Rs/ha)	Gross returns (Rs/ha)	Net returns (Rs/ha)	B:C ratio
Mustard (monocropping)	FP:No thinning	1040	7322	16640	9317	2.27
	Thinning 25 DAS	1570	8042	25120	17077	3.12
	Thinning 25 and 45 DAS	1620	8762	25920	17157	2.96
Mustard under (double cropping)	FP:No thinning	810	7322.50	12960	5637	1.77
	Thinning 25 DAS	1250	8042.50	20000	11957	2.49
	Thinning 25 and 45 DAS	1340	8762.50	21440	12677	2.45

Lentil (DPL-62)

Mustard (Varuna)

Wheat (Lok-1)

Sesamum (TKG-22)

7.3 Integrated Nutrient Management

In chickpea, use of 50% RDF, NPS along with *Rhizobium* recorded higher B:C ratio in both rainfed and irrigated monocropping systems in clay and clay loam soils. In partially irrigated conditions, yield of chickpea under double cropping due to 50% NPS+*Rhizobium* and 100% NPS gave 1,364 and 1,377 kg/ha, respectively. As a result, about 65 farmers have started application of 9 kg N + 23 kg P_2O_5 in IVLP villages and more than 20% of chickpea and lentil growing farmers use *Rhizobium*. The INM practices in

chickpea/ lentil and pigeonpea were adopted in 95, 17 and 5 ha in IVLP and 14, 16 and 2 ha in neighboring villages, respectively. In wheat, use of 75% RDF (NPK) along with FYM and improved variety gave higher yield (3,936 and 4,268 kg/ha) in clay loam and loamy soils, respectively under irrigated double cropping (Table 3).

7.4 Integrated Pest Management

Use of one spray of NSKE 5% and monocrotophos 0.04% in chickpea gave on par seed yield of pigeonpea with two sprays of monocrotophos in rainfed upland

Table 3: Effect of integrated nutrient management of chickpea and wheat under different micro farming situations

Crop and system	Treatments	Yield (q/ha)	Cost of production (Rs/ha)	Gross returns (Rs/ha)	Net returns (Rs/ha)	B:C ratio
Chickpea under irrigated double cropping	Farmers Practice	1222	9150	18330	9180	2.00
	100% NPS	1377	9667	20655	10987	2.14
	50 % NPS + RC	1364	9299	20460	11160	2.20
Chickpea under rainfed mono cropping	Farmers Practice	890	7690	13350	5660	1.74
	100% NPS	1083	8207	16245	8037	1.98
	50 % NPS + RC	1195	7839	17925	10085	2.29
Chickpea under irrigated mono cropping	Farmers Practice	1228	9120	18420	9300	2.02
	100% NPS	1506	9495	22590	13095	2.38
	50 % NPS + RC	1422	9037	21330	12293	2.36
Lentil under rainfed mono cropping	Farmers Practice	1281	6352	20,496	14143	3.00
	100% NPS	1519	7182	24304	17121	3.38
	50 % NPS + RC	1491	6807	23856	17048	3.50
Pigeonpea under rainfed mono cropping	Farmers Practice	804	4830	12864	8034	2.66
	100% NPS	1092	6127	17472	11344	2.85
	50 % NPS + RC	1033	5830	16528	10698	2.83
Pigeonpea under partially irrigated mono cropping	Farmers Practice	1118	5345	17888	12543	3.35
	100% NPS	1475	7127	23600	16472	3.31
	50 % NPS + RC	1358	6642	21728	15085	3.27
Wheat in clay loam soil under irrigated double cropping	Farmers Practice + Local variety (LV)	3601	12969	21606	8637	1.67
	50% R.D of NPK (60:30:20+FYM)+ Improved Variety (IV)	3598	13902	22487	8585	1.62
	75% R.D. of NPK (90:45:40 + FYM) +IV	3938	14491	24612	10122	1.70
Wheat in loam soil under irrigated double cropping	Farmers Practice + Local variety (LV)	3695	14219	22170	7951	1.56
	50% R.D of NPK (60:30:20 + FYM) + Improved Variety (IV)	3843	15152	24019	8866	1.52
	75% R.D. of NPK (90:45:40 + FYM) +IV	4268	15740	26675	10934	1.69

RC: Rhizobium culture

Chickpea+linseed (6:2)

and partially irrigated conditions under clay loam and loam soils. This practice was adopted in 16 and 13 ha in IVLP and adjoining villages, respectively. Application of NSKE was found effective in controlling pod borer in chickpea. This practice became successful among the farmers due to high net returns of Rs.13,272 to 15,860 from one spray alone. Two sprays of monocrotophos were found effective in management of pod borer and pod fly in pigeonpea. This practice resulted in higher profitability of Rs. 3,208 and Rs.7,744/ha in rainfed upland and partially irrigated uplands, respectively. But majority of the farmers in IVLP village preferred use one spray of NSKE 5% and monocrotophos for control

Active involvement of farm family in preparation of NSKE

Use of Pheromone trap in chickpea

Table 4: Influence of integrated pest management practices in chickpea and pigeonpea

Crop and system	Treatments	Yield (kg/ha)	Cost of production (Rs/ha)	Gross returns (Rs/ha)	Net returns (Rs/ha)	B:C ratio
Chickpea under partial irrigated double cropping	Control	1205	7607	18075	10467	2.38
	Two sprays of Endosulphan (0.7%)	1628	9087	24420	15332	2.69
	One spray of NSKE (5%) + one spray of Endosulphan (0.7%)	1687	8837	25305	16468	2.86
Pigeonpea under rainfed upland mono cropping	Local Practice (no spray)	792	4830	12672	7842	2.62
	Two sprays of Monocrotophos (0.04%)	1075	6150	17200	11050	2.80
	One spray of NSKE 5%+ Monocrotophos	986	6110	15776	9666	2.58

Crop and system	Treatments	Yield (kg/ha)	Cost of production (Rs/ha)	Gross returns (Rs/ha)	Net returns (Rs/ha)	B:C ratio
Pigeonpea	Local Practice (no spray)	1100	6102	17600	11497	2.88
under	Two sprays of	1584	7422	25344	17921	3.41
partially	Monocrotophos (0.04%)					
irrigated	One spray of NSKE	1436	7382	22976	15593	3.11
mono cropping	5% + Monocrotophos					

of pod borer in pigeonpea. This practice was adopted in 32 ha in IVLP village. Two sprays of home made neem-based solution NSKE (5%) and one spray of chemical insecticide proved equally effective against control of pod borer in chickpea and pigeonpea (Table 4).

7.5 Livestock

To mitigate green fodder scarcity, efforts were made to popularize berseem, lucerne and oat under limited irrigation during *rabi*. Improved varieties of oat (JHO-822, 851) gave more than 15 t/ha green fodder yield at the first cutting. Farmers took three cuttings of oat by giving two irrigations. Feeding of oat fodder resulted in increased feed intake by 24.2 and 32.4% at 30 days, and 48.3% and 61.8% at 60 days in cattle and buffaloes, respectively. The milk yield was also increased by 21.0 and 24.5% at 30 days and 33.3 and 40% at 60 days (Table 5).

Feeding of wheat straw along with 2 kg concentrate (oil cake + pulses and cereal) enhanced productivity of buffaloes from 2.6 to 3.10 L/day. Presently 20 farmers are cultivating oat as a fodder crop in IVLP village under partial irrigation. More than 7,000 milch and draft animals were vaccinated against Haemmorhegic Septicaemia and Foot and Mouth disease in Vidokhar and Ingohta villages during the project period.

Table 5: Response of feeding green fodder (oat) on feed intake and milk yield in cows and buffaloes

Animal	Cow			Buffalo		
	Before	After 30 Days	After 60 Days	Before	After 30 Days	After 60 Days
Feed intake (kg/day)	3.80	4.50	5.40	4.60	6.00	7.30
Per cent increase	—	24.20	48.40	—	32.40	61.50
Milk yield (L/day)	1.50	1.90	2.00	3.00	3.80	4.40
Per cent increase	—	21.00	31.30	—	24.50	41.60

CHAPTER

8

Impact of the TAR-IVLP programmes

The TAR-IVLP centers under Rainfed Agro Eco System conducted survey before and after the implementation of project activities to asses the impact of the programme.

The core team of the TAR-IVLP at different centers had an opportunity to develop a close contacts with the farmers from the very inception of the project. The problems of the farmers were identified and prioritized with active involvement of people which resulted in knowledge sharing between researchers and farmers. This rapport became source of encouragement and raised the team sprit. Collective efforts of core team and farming community brought about a visible change in the local agricultural practices and allied services. Since IVLP is a multi-disciplinary program, linkages were developed with different organizations for successful implementation of the project. The salient features of adoption and diffusion of various technological modules are discussed here:

8.1 Rice based Production System

At Ranchi, interventions implemented in rainfed rice and livestock components contributed to increased productivity (20-50%), cropping intensity (150-200%), family income (25-40%), B:C ratio (1.25 to 6%) and employment generation (200 man days/family/year) as compared to the levels at projects inception. Integrated duck-fishculture increased fish production (111%) and net returns (150%) compared to the farmers practice. The drudgery of farm women was reduced up to 50% by using improved farm implements like grubber, dutch hoe and Naveen sickle, which on an average increased the efficiency from 60 to 66%. Income of the farm women enhanced from Rs.1,985 to 3,500/year by adopting mushroom production, bee keeping, value addition of vegetables and preparation of vermicompost.

At Koraput, popularity of rice cv P*ooja* in *Jholla* lands spread to the neighboring Malkangiri, Nawarangapur and Rayagada districts. As a result, the Orrisa State Seed Corporation included this variety in their seed multiplication programme. Variety Bhairabi of fingermillet evaluated in IVLP programme spread in 8,250 ha of Koraput district. The Orrisa State Seed Corporation sold 165 tonnes of certified seeds of this variety as a part of the seed chain during 2004. Tomato cv Bt-10 and Bt-18 were taken up on a large scale by ATMA and ITDA, Koraput. ATMA also organized seed villages through FIG members and collectively produced 50 to 75 kg tomato seeds/year. Horticulture Department and ITDA, Koraput included hybrid cabbage variety Konark in mini kit programmes as a part of tribal development. The State Horticultural Department, Integrated Horticulture Development Programme and Watershed Programme together produced 10 lakh marigold cv Giant Double African Yellow seedlings of marigold/year during the last three years to meet the growing demand of planting materials. The technology of raised bed and mulching with HYV *Suparva* of ginger was spread to other blocks of the district (Pottangi, Nandapur, Koraput, and Lampataput) in 400 ha. About 1.5 t seeds of HYV Suparva were lifted from Koraput by NGOs to Maharastra, Andhra Pradesh and Chhattisgarh. The Koraput district was declared as organic zone. Vanaraja breed of poultry was spread in backyard to 4200 households in Koraput and 1500 households of neighboring districts. The DRDA, Koraput supplied chicks to different SHGs by producing 50,000 chicks during the last 4 years. Different organizations like ATMA, DRDA, ITDA, NGOs and Watershed Projects have included this technology as a component in their poverty alleviation programmes. Mushroom cultivation for income generation spread to 650 and 250 farm families in Koraput and other districts of Orrisa. The

DRDA funded a spawn production unit in KVK which sold 2,950 bottles. Italian honeybee keeping became very popular among the marginal farmers and landless labourers of the district as an income generating activity and self-employment enterprise for rural youth.

At Cuttack, while rice variety Vandana covered more than two-thirds area of rainfed uplands, other varieties like Ranjit, Moti, Pooja, Sarala and Gayatri occupied 66% area of lowlands. Line seeding, intercropping system of short duration rice (Vandana) with long duration pigeonpea (UPAS 120) in 4:1 ratio, improved beaushening in lowlands, sequence cropping of rice (short duration variety Vandana) followed by horsegram with moderate dose of 25 kg/ha of P_2O_5, rain water harvesting through bunding (50 cm width and 25 cm height) surrounding the field, and introduction of Kalinga Brown in backyard poultry system became quite popular among majority of the farmers in IVLP and surrounding villages.

At Nagaon, green manuring before *Sali* rice has been accepted by 25% farmers as it reduced fertilizer dose and increased income by Rs.6,000/ha as against their traditional practice (fallow-*Sali* rice sequence). Introduction of medium duration *Sali* rice varieties, Satya and Basundhara facilitated timely sowing of *rabi* crops. Thus area under *rabi* crops increased by 28 ha which helped the farmers to get an additional net return of Rs.3,000-5,000/ha. Adoption of scientific methods of fish production increased the net income of farmers and was adopted by 70% of farmers.

At Raipur, INM with blue green algae and PSB in rice improved variety of rice IR-64 line sowing of rice using Bhoramdev seed drill soil test-based Zn application were adopted in 175, 100, 42 and 52 ha, respectively in IVLP villages.

At Hassan, use of rice hybrid (KRH-2) and (IR-64) variety and Giriraja birds for backyard poultry were adopted by 60% of farm families.

8.2 Oilseed based Production System

At Bhopal, the area under soybean, pigeonpea, groundnut, maize, fodder crops, vegetables and marigold increased by 176, 20, 77, -3, 29, 26 and 80 ha during 2004 as against the base year of 1999 during *kharif* season. Similarly, the area under wheat(irrigated), mustard, berseem, cabbage, cauliflower and capsicum increased by 5, 15, 7, 5, 10 and 5 ha, respectively. However, area under wheat (rainfed), chickpea, lentil and tomato reduced by 41, 95, 20 and 4 ha, respectively during the same period. The area under fruit: mango, guava, lemon, papaya and amla increased during 2004 as compared to 1999. The productivity of soybean, pigeonpea, groundnut and maize enhanced by 400, 700, 650 and 1,200 kg/ha, respectively during the implementation of the programme. The productivity of brinjal/tomato enhanced by 223% due to implementation of improved modules. During *rabi,* productivity of wheat (rainfed/irrigated), chickpea, lentil, mustard, berseem, tomato, brinjal, cabbage, cauliflower and capsicum enhanced by 450, 1,100, 460, 400, 500, 19,000, 15,000, 22,000, 7,000, 15,000 and 1,300 kg/ha, respectively due to implementation of the programme over the years. The yield of mango (46,000 kg/ha), guava (5,000), lemon (3,600), papaya (20,000) and amla (3,000) increased during 2004 as against 1999 (Table 1).

8.2.1 Diffusion of Technologies

Improved varieties of soybean spread in 3000 ha because of additional productivity (7%) and profitability (5%). The INM practices in soybean was adopted in 86 ha covering 65 farmers of neighboring villages. The technological module on moisture conservation was adopted in 56 and 25 ha in soybean and wheat, respectively. The IPM modules in soybean, wheat, chickpea, lentil and pigeonpea was adopted in 102, 20, 50, 48 and 20 ha, respectively in neighboring villages too. Improved vegetable varieties tomato, brinjal and cauliflower increased their spread in 65, 20 and 25 ha, respectively in neighboring villages.

In IVLP villages, the number of milch cattle and buffaloes increased by 68 and 81%, respectively. Bullock and goat population decreased by 81 and 31%, respectively. Feeding of animals through dry fodder decreased from 10 to 4.5 kg/day, while green fodder increased from 5 to 20 kg/day. Use of concentrates enhanced by 2.5 kg/day/animal during 2004 as against 1 kg in 1999. Feeding of concentrates to poultry increased by 50 g/bird/day by the end of 2004. The milk

Table 1: Area, production and productivity of different crops in IVLP villages

Crop	Area (ha)		Production (t)		Productivity (kg/ha)	
	1999*	2004*	1999	2004	1999	2004
***Kharif* (Rainfed)**						
Soybean	1924	2100	1539	2520	800	1200
Pigeonpea	44	62	26	81	600	1300
Groundnut	93	170	79	255	850	1500
Maize	83	80	191	280	2300	3500
Fodder crops						
Maize & Sudan grass	13	42	17	907	13300	216000
Vegetable crops						(Maize+chickpea)
Tomato/ Brinjal	20	46	124	920	6200	20000
Marigold	-	80	-	480	-	6000
Rabi (Rainfed/ Irrigated)						
Wheat (Rainfed)	161	120	249	240	1550	2000
Wheat (Irrigated)	1645	1650	3948	5775	2400	3500
Chickpea	645	550				
574	742	890	13			
Lentil	105	85	65	87	620	10
Mustard	10	25	10	37	1000	1500
Berseem	36	42	450	1323	12500	31500
Vegetables						
Tomato	16	12	60	300	10000	25000
Brinjal	15	15	40	450	8000	30000
Cabbage	8	13	64	195	8000	15000
Cauliflower	7	17	70	425	10000	25000
Capsicum	5	10	35	200	7000	20000
Horticulture						
Mango	4	8	16	40	4000	50000
Guava	7	15	24	127	3500	8500
Lemon	3	11	5	60	1900	5500
Papaya	-	6.6	-	132	-	20000
Amla	-	5	-	15	-	3000

* Before implementation ** After implementation

yield of cows and buffaloes increased by 2 and 4 L/milk/day during 2004 compared to 1999. Similarly, the mutton production gave up from 18 to 23 kg/goat during the same period. However, consumption of milk reduced by 40 to 10 L of milk/family/week at IVLP site during the project period. Marketability of animal-based products increased by 20% in 2004 as against 1999 (Table 2).

8.2.2 Input and Out Flow Analysis

In IVLP villages there was decrease in the amount of improved soybean seed purchase from 100 to 200-300 kg/farmer/year. The farmers adopting application of split dose of nitrogen to wheat during 2004 as against basal application only during1999, the bio-fertilization consumption in IVLP villages increased by 20% due to the intervention of the INM practices (Table 3).

Table 2: Impact on population, productivity and consumption pattern of livestock product

A. Population (Nos)

Animals	Dry		Pregnant		Milch		Total	
	1999	2004	1999	2004	1999	2004	1999	2004
a. Cattle								
1. Cows	204	285	51	97	229	435	484	817 (68%)
2. Oxen	195	121					195	121 (-) (38%)
3. Buffaloes (milch)	192	288	210	400	415	790	817	1478(81%)
4. Goat	194	48	58	68	106	130	358	246 (-) 31%
b. Poultry birds	-						425	12,000 (6 poultry farm)

B. Production and marketing of livestock products

Animal	Production		Consumption		Market	
	1999	2004	1999	2004	1999	2004
a. Cows (L of milk/day)	2-3	4-5	60	20	40	80
b. Buffaloes (L of milk/day)	3-4	6-8	30	20	70	80
d. Goat (Mutton (kg/animal)	18	23	-	-	-	100
e. Poultry Eggs/ year	70-80	135-150	100	40	-	60
Chicken kg/bird	0.8	1.5-2.0	100	10	-	90

At Indore, improved varieties of soybean (NRC 37, MAUS-47, MAUS-81, JS-93-05), soyabean+maize (4:2), use of Dora for control of weeds, seed village of soybean, participatory watershed development, supplemental irrigation to wheat with rainwater, and IPM technology to control Girdle Beetle in soybean became most popular and widely adopted by the farmers in IVLP and surrounding villages.

At Junagadh, area under cotton, pigeonpea and castor increased by 134, 22 and 22 ha, respectively in

Table 3. Input/outflow analysis in Bhopal

Particulars	Pre project period (1999)	Post-project period (2004)
Improved variety of soybean (JS-335) (kg/farmer/year)	100	200- 300 kg/ farmer/ year
Fertilizer consumption (kg/ha/year)	100	200 kg DAP + 100 kg MOP + 50 kg $ZnSO_4$ + 100 kg Gypsum or SSP
Use of organic manure (t/ha)	2.0	5.0
Time of application of fertilizer (wheat)	At basal	Basal+spilt doses of N
Fertilizer dose in wheat (N-P-K kg/ha)	50:30:0	100:60:30
Fertilizer dose in soybean (N-P-K-Zn kg/ha)	18:46:0:0	20:60:30:20
Fertilizer dose in chickpea and pigeonpea (N-P-K-Zn kg/ha)	18:46:0:0	20:60:30:20
Biofertilizer (g/ha)	-	500 g/ha
Bio-pesticide consumption	-	Nimbicidin, Trichoderma viridi, NPV, Pheromone trap, etc.

Particulars	Pre project period (1999)	Post-project period (2004)
Improved farm implements		
Seed cum fertidrill	-	5-10% farmers.
Strip till drill	-	1% farmers on custom hiring basis
Inclined plate planter	-	1% farmers on custom hire basis
Hand weeder	-	20% of the farmers
Improved sickle (Naveen:serrated sickle)	-	20% of the farmers
Groundnut decorticator	-	Used by 20-25% farmers.
Maize cob sheller (Land held)	-	30% farmers
Grain cleaner-cum - grader	-	5-10% of the farmers
Livelihood activities		
Dairy units - Big	-	12
Medium	66	119
Small	239	245
Poultry units	-	6 with 2000 birds each
Agro processing unit	10	16
Agro process center for soybean	-	1
Motor winding units	-	12
Tractor repairing units	-	5
Tailoring and art shops	10	26
Implement repairing center	8	15
Black smith & carpentry	6	20
Biogas plants	4	26

2004 as against the base 1999. Productivity of pigeonpea, castor and wheat enhanced by 278, 115 and 500 kg/ha from 1999 to 2004 in Vadhavi village. In Zanjarda village, the productivity of pigeonpea and castor was higher by 273 and 100 kg/ha in 2004 as against 1999.

Use of improved groundnut variety GG-7, adoption of INM and IPM practices in groundnut, diffused by 10, 16 and 15% in other villages during 1999 to 2004. The livestock population of buffaloes increased by 189, 82 and 20 in Vadhavi, Zanjarda and Nandarkahi villages, respectively. The productivity of cows and buffaloes raised upto 6 and 12 L/day/animal. At the inception of the project activities, farmers were applying 150 kg DAP /ha to cereals, oilseed and pulses during 1999. At present, the farmers are adopting 120:60:0 NPK/ha in wheat and 12.5:25:20 NPK/ha in groundnut, castor and groundnut+ pigeonpea intercropping systems.

At Jabalpur, introduction of high yielding varieties of chickpea and lentil, control of pod borer in chickpea, weed management in irrigated wheat and wilt management in pigeonpea and chickpea were extensively adopted by the farmers. Seed replacement of soybean and chickpea crops was less profitable in gentle slopy bunded medium textured rainfed black soils compared to flat bunded medium to deep black soils in village adopted in Narsinghpur district of M.P. (Table 4).

In Jabalpur district, farmers continued the adopted technologies in 69, 274 and 371 ha in rice, chickpea, lentil and irrigated wheat crops during 2003-2005. The details of technologies adopted by different group of farmers are given in (Table 5).

Table 4: Adoption of technological interventions in different years at Narsinghpur, M.P

S No	Technology	Category of farmer	First year		Second year		Third year	
			No. of Farmers	Area (ha)	No. of Farmers	Area (ha)	No. of Farmers	Area (ha)
1	Introduction of new varieties of gram and lentil	Adopted	70	28	70	71	70	115
		Non-adopted	-	-	46	57	92	98
2	Seed treatment in soybean, lentil and gram	Adopted	35	14	35	33	35	45
		Non-adopted	32	13	51	30	66	56
3	Nutrient management in soybean, gram and wheat	Adopted	47	19	46	32	47	72
		Non-adopted	36	17	85	40	114	94
4	Weed management in soybean and wheat	Adopted	30	12	21	24	25	50
		Non-adopted	11	5	32	19	42	36
5	Plant protection in soybean, gram and arhar	Adopted	55	22	48	74	50	93
		Non-adopted	71	26	122	130	141	155
6	Wilt management in arhar and gram	Adopted	45	18	56	64	45	87
		Non-adopted	24	11	47	54	70	85
7	Line sowing of soybean a cross the slope	Adopted	3	1	3	3	3	7
		Non-adopted	20	8	35	14	52	28
8	Improved management practices in soybean	Adopted	10	4	10	8	10	16
		Non-adopted	5	3	12	7	18	15

Table 5: Adoption of different technologies at Jabalpur (2003-2005)

S No	Technology	Category of farmer	First year		Second year		Third year	
			No. of Farmers	Area (ha)	No. of Farmers	Area (ha)	No. of Farmers	Area (ha)
1	Introduction of HYV of early duration drought tolerant variety of rice	Adopted	14	5.6	91	40	91	63
		Non-adopted	-	-	22	8	42	28
2	Introduction of HYV of medium duration variety of rice	Adopted	16	6.4	99	55	99	68
		Non-adopted	-	-	25	10	45	35
3	Introduction of HYV of scented rice	Adopted	-	-	82	32.8	82	45
		Non-adopted	-	-	20	7	35	15
4	Introduction of HYV of lentil & gram	Adopted	12	4.8	12	32	12	48
		Non-adopted	-	-	15	6	28	16
5	Integrated nutrient management	Adopted	20	8.8	44	25	38	28
		Non-adopted	-	-	6	2	12	6
6	Integrated blast management in rice	Adopted	13	5.2	76	20	65	25
		Non-adopted	-	-	2	1	8	4

S No	Technology	Category of farmer	First year No. of Farmers	First year Area (ha)	Second year No. of Farmers	Second year Area (ha)	Third year No. of Farmers	Third year Area (ha)
7	Integrated blight management in rice	Adopted	12	4.8	22	15	18	17
		Non-adopted	-	-	3	1	6	2
8	Integrated weed management	Adopted	24	11.5&2	91	28	88	42
		Non-adopted	-	-	22	10	42	20
9	Integrated plant protection in gram, lentil & wheat	Adopted	55	22	55	26	55	35
		Non-adopted	-	-	19	10	36	20

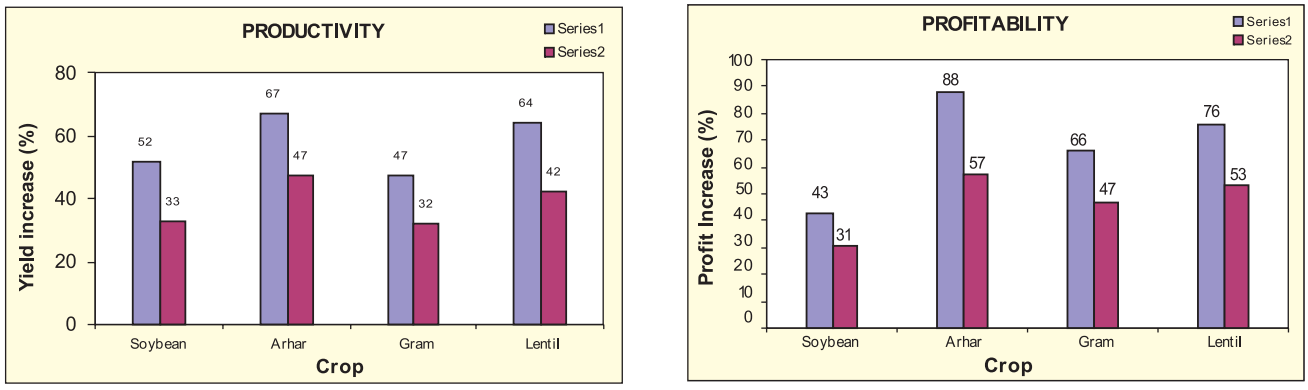


Fig 17. Changes in productivity and profitability of different crops under rainfed situation in adopted and non-adopted villages in Narsinghpur district of Madhya Pradesh (2000-2003)

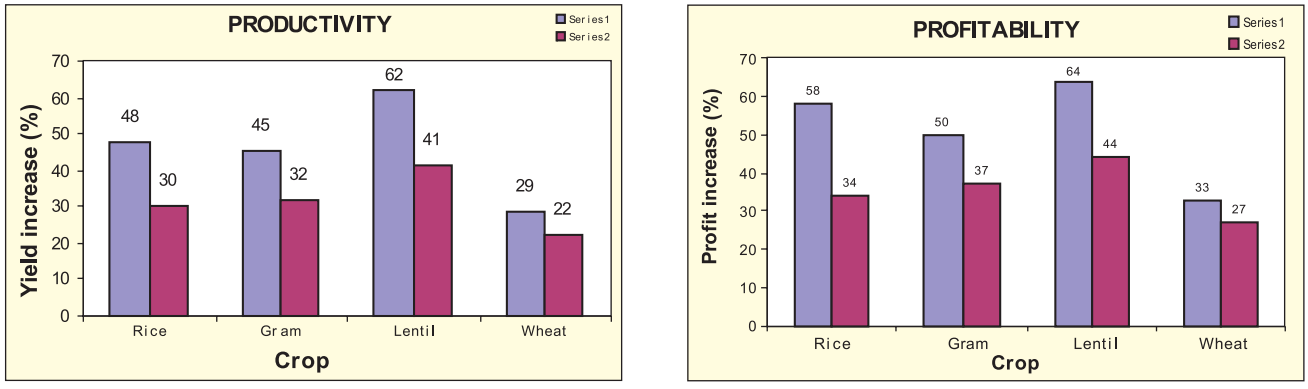


Fig 18. Changes in productivity and profitability under rainfed situation in adopted villages in Jabalpur district of Madhya Pradesh (2002-2004)

Adopted farmers could achieve increased productivity of rainfed rice, chickpea, lentil and wheat by 48, 45, 62, and 29 %, respectively in 2005 as against 2003. The net profit in rainfed rice, chickpea lentil and wheat increased by 58, 50, 64 and 33%, respectively in 2005 compared to the base 2003. The productivity increase among the non-adopted farmers in rainfed rice, gram, lentil and wheat was 30, 32, 41 and 22 %, and the profitability 34, 37, 44 and 27%, respectively.

8.3 Cotton based Production System

At Nagpur, the introduction of transgenic *Bt.*cotton reduced pesticide consumption up to 60% in IVLP villages, while arboreum varieties brought down

pesticide consumption by 25%. The i*n-situ* moisture conservation technique of opening ridges and furrows after two rows of cotton was adopted by 90 and 30% farmers in project and adjoining villages, respectively. Currently, more than 50% cotton growers in the project and adjoining villages are adopting cotton and soybean intercropping. INM technologies in cotton was adopted in 28 and 40 ha in IVLP and adjoining villages, respectively. Up to 10% reduction in nitrogenous fertilizer was noticed due to increased units of vermicomposting in project and adjoining villages. Technology of 2% DAP to mitigate the drought in arable crops was adopted by 56 farmers in 22 ha in project villages.

At Akola, marginal, medium and big farmers enhanced their income by 60, 71 and 66% due to implementation of technological interventions from 1998-2004 (Table 6).

Farmers in IVLP villages created additional assets like dug well (12), motor pumps (12), pipe line (13,000 ft), percolation tanks (3), farm ponds (3), loose bolder structures (20), thereby increasing cropping intensity from 106 to120% during 1999-2004. Area under irrigation during the project period increased from 25 to 60 ha in *rabi* and from 0 to 15 ha during *kharif* (Table 7).

The area under improved arboreum cotton (AKA-7) increased by 32 and 120 ha in IVLP and neighboring villages since it produced 30 % additional yield over AKA-5. Sowing of cotton across the slope and opening of alternative furrow was adopted in 80 to 90% of farmers. Intercropping cotton+mungbean (1:1) and cotton+sorghum +pigeonpea (6:1:1) was adopted by almost all the cotton-growing farmers in both IVLP and non-IVLP villages. *Rhizobium* treatment along with 2% urea spray at flowering and pod development stages in soybean was adopted in 48 and 150 ha by 42 and 100 farmers in IVLP and nearby villages, respectively. The IPM module with two sprays of NSE 5% followed by HaNPV 250 LE/ha was adopted in 200 and 410 ha in project and non-project villages, respectively. Use of bullock drawn seed-ferti drill for proper placement of seed and fertilizer was adopted by 125 and 290 farmers at project site and nearby villages, respectively.

Table 6: Income generation by farmers at Akola **(Rupees)**

Particulars	Before Project (1998)	After Project (2004)	Per cent increase
Marginal farmers (< 2 ha)	20,000	32,000	60
Medium farmers (2-10 ha)	1,25,000	2,14,000	71
Big farmers (> 10 ha)	2,40,000	3,98,000	66

Table 7: Impact of TAR-IVLP on crops and livestock at Akola

Particulars	Before project (1999)	After project (2005)
Area under irrigation (ha.)		
Rabi	25	60
Summer	NIL	15
Cropping intensity (%)	106	120
Fruit orchards (Nos.)	0.8	2.4
Thresher (Nos.)	3	4
Bullocks pairs (Nos.)	95	120
Cows - Desi (Nos.)	135	115
- Crossbred (Nos.)	4	18
Goats (Nos.)	90	300
Buffaloes (Nos.)	15	32
Poultry birds (Nos.)	15	1120

At Warangal, short duration cotton variety Narasimha was adopted in 120 ha in neighboring villages of IVLP. Crop rotation of cotton-maize+field bean became popular in 218 ha. Agri-sheep farming (maize+cowpea and sorghum+cowpea) with 10 lambs enhanced the profitability (Rs. 9,258/ha). This practice adopted by 44 farmers over a period of 3 years. Rearing of Vanaraja breed of poultry under backyard was adopted by 70 families to improve their livelihood options.

At Ajmeer, while area under pearlmillet and groundnut increased during the project period, that under vegetables and cotton decreased up to 50%. The average family income from main occupation increased from Rs. 20,250 to 33,600/year, whereas income from subsidiary occupation increased by Rs. 6,000 to 12,000 by the end of the project period. Basal application of phosphatic fertilizers in pearlmillet, optimum seed rate in groundnut, use of improved variety of cotton (Bikaneri Narma), IPM technologies in cotton, and scientific nursery raising in tomato were adopted by 46, 53, 68, 48 and 30%, respectively in IVLP villages from 1999 to 2004.

8.4 Nutritious Cereals based Production System

At Bangalore, the impact studies conducted in IVLP village of Kestur during 2003 over the base year 1998 showed that the average fingermillet yield increased from 1.6 to 3.3 t/ha. About 134 farmers adopted dual purpose vegetable pigeonpea variety (Hy-3c) as against only 3 farmers in the base year. The yield of banana increased from 30 to 40 kg/plant. The expenditure on pest management in cabbage was reduced from Rs.12,000 to 6,000/ha due to adoption of IPM packages. About 80% area of wasteland was brought under agroforestry with neem, teak, bamboo and silver oak in adopted village at Bangalore. At the inception of the project, farm families was purchasing vegetable pigeonpea, during 2003, now they are selling on an average of 1000 kg in the market. Milk production also increased from 660 to 1200 L/day (Table 8).

At Vengurili, area of *kharif* rice under local varieties reduced from 25 to 8%; while that under the HYVs, enhanced from 17 to 40%. The area under *rabi* rice was taken over by fingermillet (131%), groundnut (40%)

Table 8: Input-output flow analysis at Bangalore **(kgs)**

Particulars	1997-98	2002-03
Organic products		
a) Pongamia cake	110 kg	200
b) Neem cake	Not used	500
c) Neem soap	Not used	100
d) Pongamia soap	Not used	150
e) Trichoderma harzianum	Not used	150
Natural Resources		
a) Neem seeds	Not used	450
b)Tank Silt	5 t/year	300 t/year
Fingermillet	Every family under rainfed farming purchased 4-5 q/year	Every family under rainfed farming is selling 2-3 q/year
Pigeonpea	Every family purchased 30 kg pigeonpea/year from nearby town	Full need of the villager is met within the village
Fertilizer application in banana	50% through the soil	50% through the soil and 50% through foliar application

and chili during 1999-2000. Area under coconut, mango and cashew increased by 26, 25 and 19%, respectively during 2000 as against base year 1996 (Table 9).

High yielding varieties like Sahyadri, Ratnagiri-24, Ratnagiri-2, Ratanagiri-3, Palghar-1 and Jaya covered 60% of the total area in project villages. The average yield of paddy and cashewnut increased from 3,079 to 4,520 kg/ha and 824 to 992 kg/ha, respectively during 1999-2001.

The population of cows and buffalos increased by 417 and 816%, respectively in 2001 compared to 1996. The income of landless, medium and big farmers increased by Rs.3,500, 25,000 and 35,000/family, respectively over a period of 5 years. Due to the implementation of the project, the landless and lower income group categories reduced by 1.3 and 4.9%, respectively in 2000 as against 1995.

At Solapur, the area under mothbean, maize, pigeonpea and sunflower increased by 24, 7, 215, and 178 ha in 2005 as compared to 1999 in Darphal village. During the same period, the productivity of pearlmillet, mothbean, maize, pigeonpea and *rabi* sorghum enhanced by 600, 500, 1500, 1700 and 450 kg/ha. In Wadala village, the area under rainfed maize, pigeonpea and sunflower increased by 19, 142 and 115 ha. The area under improved varieties of *rabi* sorghum *(Mauli, Phule Yashoda and M35-1)* increased by 40, 72 and 300 ha from 1999-2005. The improved varieties of pigeonpea (VDN-2) and sunflower (SS-56) increased their area by 60 and 33 ha due to implementation of the modules during 1999 to 2005. The milk yield of local and cross bred cows enhanced up to 3 and 10 litres due to implementation of livestock modules at project site. Fertilizer dose for cereals, oilseeds and pulses increased from 10:15:0 to 50:25:0, 25:15:0 to 50:25:0, 10:25:0 to 25:50:0 NPK/ha, respectively from pre-to-post project period at IVLP site. The consumption of bio-fertilizers and vermicompost increased from 25-100 kg, 10-15 t in IVLP villages (Table 10 & 11).

At Dharwad, though the area and production under *kharif* sorghum reduced from 53 to 32 % in 2004 as against 1999, the productivity increased by 500 kg/ha compared to that of 1999 (1850 kg/ha). The area under littlemillet, maize, soybean and fodder sorghum increased by 31, 30, 55 and 5 ha in 2005 as against 1999. The area and production of groundnut reduced by 36 and 17%, respectively at IVLP site over the past 6

Table 9: Impact of technological modules Veguruli (1995-2001)

Sl. No	Crop	No. of farmers			Area in hectares		
		1995-96	2000-01	Change	1995-96	2000-01	Change
1.	*Kharif* rice						
	a. Local	372 (74.85)	156 (26.68)	-216	89.29 (25.32)	35.52 (7.79)	-60.22
	b. HYVs	123 (24.75)	473 (74.85)	+350	59.52 (16.88)	179.30 (39.34)	+201.24
2.	*Rabi* rice	153 (30.78)	-	-	27.90 (7.91)	-	-
3.	Ragi	31 (6.24)	56 (8.86)	+25	4.10 (1.16)	8.60 (1.89)	+109.76
4.	*Kharif* Groundnut	16 (3.22)	68 (10.76)	+52	2.35 (0.67)	5.45 (1.20)	+131.91
5.	*Rabi* Groundnut	185 (37.22)	45 (7.12)	-140	19.51 (5.53)	27.25 (5.98)	+39.67
6.	Mango	305 (61.37)	428 (67.72)	+123	76.20 (21.60)	97.60 (21.41)	+28.08
7.	Cashewnut	245 (49.30)	379 (59.97)	+134	34.62 (9.82)	48.25 (10.59)	+39.37
8.	Coconut	99 (19.92)	142 (22.47)	+43	36.15 (10.25)	46.50 (10.20)	+28.63
9.	Vegetables	50 (10.06)	128 (20.25)	+78	3.04 (0.86)	7.35 (1.61)	+141.78
	Total:	**497** (100.00)	**632** (100.00)	**135**	**352.68** (100.00)	**455.82** (100.00)	**+29.24**

* Figures in parenthesis indicate per cent

Table 10: Improvement in area/production and productivity at Solapur

Village	Crop	Area (ha)		Production (t)		Productivity (kg/ha)	
		1999	2005	1999	2005	1999	2005
Darphal	Mothbean	-	24	-	1.2	-	500
	Maize	-	17	-	2.55	-	1500
	Pigeonpea	25.16	240	1.95	4.08	775	1700
	Sunflower	24.55	200	1.84	1.90	750	950
	Groundnut	-	17	-	8.9	-	525
	Sorghum	1030	585	10.30	11.67	1000	2000
	Chickpea	0.5	5	0.2	3.5	400	700
	Sunflower	13	53	1.65	4.50	550	850
Wadala	Pearlmillet	0.2	8	0.12	9.6	600	1200
	Maize	0.5	20	0.4	30	800	1500
	Pigeonpea	164	306	12.71	52.06	775	1700
	Sunflower	15	130	1.13	12.35	750	950
	Sorghum	1101	870	180	174	1000	2000
	Chickpea	560	9	2.24	6.3	400	700
	Sunflower	10	15	5.5	12.75	550	850

Table 11: Adoption and diffusion of technologies in IVLP villages

Technology Crop/variety	Adoption in IVLP villages				Diffusion in neighboring villages			
	Area (ha)		No. of farmers		Area (ha)		No. of farmers	
	1999	2005	1999	2005	1999	2005	1999	2005
Rabi sorghum								
Mauli	0	20	0	40	0	25	0	20
Selection-3	4	0	20	0	0	0	0	0
Phule Yashoda (Inc)	3	75	15	60	5	125	10	80
M.35-1	30	120	45	150	60	90	150	200
Phule Yashoda	3.6	80	18	105	10	120	15	175
M.35-1 (Ve)	50	350	60	225	200	390	150	425
Sunflower								
SS-56	42	75	30	45	50	100	45	153
Pigeonpea								
BDN-2	90	150	80	225	50	140	125	110
Pearl millet								
Shradha	0	60	0	75	0	25	0	47
Saburi+mothbean	25	42	35	70	20	57	32	92
Groundnut								
TG-26	0	7	0	20	0	5	0	20
TAG-24	0	5	0	17	0	7	0	32

Technology Crop/variety	Adoption in IVLP villages				Diffusion in neighboring villages			
	Area (ha)		No. of farmers		Area (ha)		No. of farmers	
	1999	2005	1999	2005	1999	2005	1999	2005
Onion								
Baswant-780	10	18	35	40	15	22	32	44
Maize								
MPQ-13	12	16	30	35	20	25	40	45
Blackgram								
TAU-1	8	15	20	35	10	22	17	53
Chili								
Phule Jyothi	2	5	7	12	1	6	4	20

years. The productivity of littlemillet, maize and soybean increased by 340, 570 and 955 kg/ha from 1999 to 2004.

The area under improved varieties DSV-2 (*kharif* sorghum), DSV-4 and SPV-1359 (*rabi* sorghum), Sukshema (littlemillet), DMH-2 (maize), JSS-335 (soybean), GPBD-4 (groundnut), Selection-4 (greengram), SSV-74 (fodder sorghum), DWR-2006 (wheat), DHH-11 and DHB-105 (Hybrid cotton) increased to 10, 4, 15, 49, 3, 126, 5, 10, 3, 2, 35, and 5 ha, respectively in the neighboring villages.

Under dryland horticulture, Alphonso (mango), DHS-2 (sapota), DTS-1 (tamarind) and Dhanraj (drumstick) was adopted in 20, 5, 2 and 11 ha and by 10, 2, 1 and 8 farmers due to implementation of the programme. Split application of RDF in green chili was adopted in 21 and 8 ha at IVLP and neighboring villages, respectively. *In-situ* soil moisture conservation techniques were adopted for better survival of seedlings in 8 ha, involving 28 farmers. This technology diffused in 13 ha of neighboring villages. Pitcher irrigation for establishment of horticulture plants during summer was adopted in 8 ha of IVLP villages. The INM practices in soybean, groundnut and chili spread to 31 ha by the involvement of 40 farmers of neighboring villages, besides its adoption in 74 ha at IVLP site. The IPM technologies in cotton and use of *Trichoderma* as seed treatment in field crops was adopted in 299 ha during the project. Integrated farming system module was adopted in 32 and 10 ha in IVLP and neighboring villages, respectively. This reduced the risk in crop production for small and medium farmers in the rainfed environment.

The productivity of local and crossbed cows and buffalos increased by 0.5, 2.5, and 1 L milk/day due to adoption of improved technological modules. Poultry production increased from 60 to 155 eggs, and weight of broiler from 2.5 to 4.0 kg/year due to the rearing of Girirani breed of poultry under backyard.

The input-outflow analysis at IVLP site over the project period indicated that yield of improved crops varieties raised from 2.5 t. to 10.5 t. The fertilizer application to cereals, oilseeds and pulses increased from 32-13-0 to 42-23-5, 7-11-0 to 15-30-11 and 15-23-0 to 20-35-15 from 1999 to 2004, respectively. The use of bio-fertilizers enhanced upto 600 kg/ha. The use of pesticides reduced to 50 % that of of bio-fertilizers like Nimbicidin/NPV increased from 0 to 320 litres for the same period. Use of improved implements like adjustable seed-cum-fertilizer drill, groundnut decorticator, gyplicator and fodder cutter increased up to 285, 231, 5 and 25, respectively by 2005. About 60 dairy and 77 poultry units were established by the farming community for improvement of livelihoods. The self-help groups increased from 5 to 14 during 1999 to 2004 (Table 12,13 & 14).

At Nagpur, about 12% of the wasteland and 34% of current fallows were brought under cultivation through fodder production, afforestation and agroforestry. There was a 5% increase in net sown area of cotton during project implementation and cotton hybrids were now grown in deep and shallow soils. Area under sorghum, pigeonpea, groundnut and orange reduced by 18, 16, 72 and 14%, respectively between 1999 to 2004. Area under soybean (39%), cotton (17%),

Table 12: Area, production and productivity of different enterprises in IVLP Villages

Crop	Area (ha)		Production (t)		Productivity (kg/ha)	
	1999	2004	1999	2004	1999	2004
***Kharif* (Rainfed) crops**						
Sorghum	163	110	383	259	1850	2350
Littlemillet	43	74	26	70	600	940
Maize	98	128	196	329	2000	2570
Soybean	95	150	114	338	1200	2255
Groundnut	85	58	81	67	950	1150
Fodder sorghum (green)	-	5	-	175	-	35000
***Rabi* (Rainfed) crops**						
Sorghum	116	89	93	91	800	1025
Bengalgram	58	68	32	44	550	650
Wheat	73	57	37	43	500	750
Bi-seasonal crops						
Hybrid cotton	182	215	182	409	1000	1900
Green chilli	63	51	945	857	15000	16800

Table13: Impact of interventions on livestock population at IVLP villages in Dharwad

Animals (No.)	Dry		Pregnant		Milch		Total	
	1999	2004	1999	2004	1999	2004	1999	2004
Cattle								
a. Local	51	46	68	77	97	178	216	201
b. Crossbred	40	28	55	36	43	62	138	126
Milch Buffaloes	119	106	198	176	147	193	464	475
Goat	40	65	45	80	65	75	150	220

Table 14: Livestock feeding systems at IVLP villages in Dharwad

Details of nutrition	Dairy		Draught		Goat Poultry		Backyard	
	1999	2004	1999	2004	1999	2004	1999	2004
Open grazing (%)	80	70	0.0	0.0	100	100	100	100
Dry fodder (kg/day/ animal)	8.0	6.5	10.0	10.0	-	-	-	-
Green fodder (kg/ day/animal)	5.0	20.0	-	-	-	-	-	-
Concentrates* (kg/ day/animal or bird)	1.0	2.0	0.5	0.5	-	0.2*	0.1*	0.2*

*mixed grains

wheat (35%), chickpea (76%), fodder maize (100%) and vegetable (67%) increased in Kokarda and Kaniyadol villages (Table 15).

The yield of dryland as well as irrigated crops increased from 14 to 48% for grain and 400% for fodder crops. (Table 16).

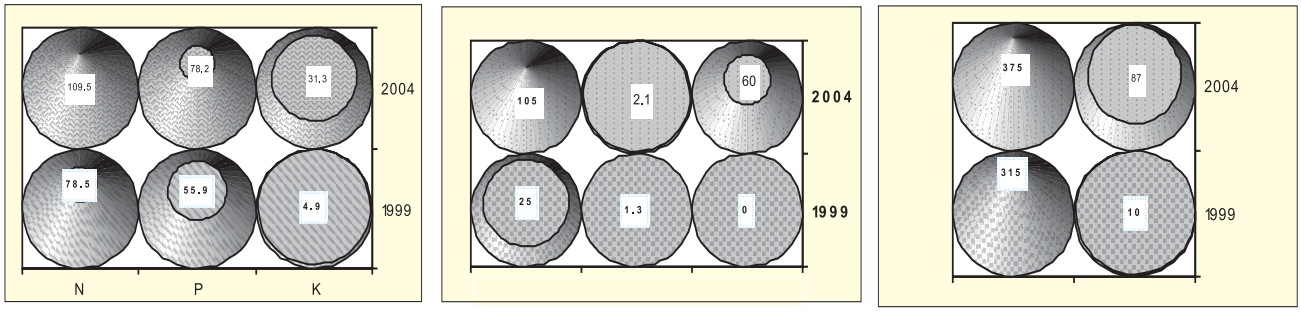


Fig 19. Input and output analysis of IVLP farmers at Dharwad

Crop diversification index increased by 5.5 and 41 % in rainfed and irrigation conditions in 2004 as against base year of 2000. Similarly, the index of crop productivity increased from 0.69 to 0.78, registering an increase of 13%. A considerable increase in milch animals (cows from 921 to 960 and buffaloes from 25 to 37) also took place which led to increased milk production (250 to 400 L/day).

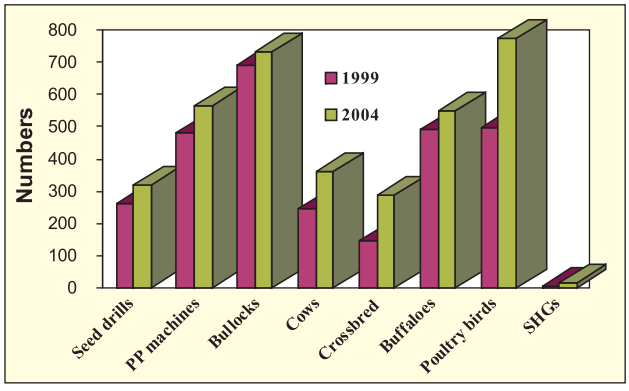


Fig 20. Socio economic attributes before and after implementation of TAR-IVLP

Introduction of improved dual purpose sorghum, fodder maize and sorghum, napier bajra hybrids and *Stylosanthes hamata* increased fodder productivity.

People contributed 25, 15, 30, 50, 50, 10 and 50% for rejuvenation of percolation tanks, desilting of cement structures, construction of modified gabion structures (nala bunding), desilting of gabion structures, planting of tree saplings in community lands, agave plantation and its maintenance, respectively as part of participatory

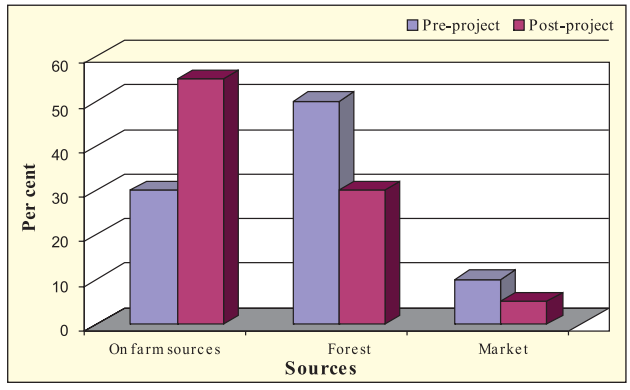


Fig 21. Fodder dependency in IVLP Villages

Table 15: Cropping pattern in the villages

Crops	Area before initiation of project (ha)			Area at the end of project (ha)		
	Kokarda	Kaniyadol	Total	Kokarda	Kaniyadol	Total
Sorghum	54	86	140	45	70	115
Soybean	24	71	95	40	92	132
Cotton	20	78	98	32	83	115
Pigeonpea	26	28	54	20	25	45
Groundnut	6	16	22	1	5	6
Wheat	15	30	45	26	35	61
Gram	7	10	17	10	20	30
Orange	13	57	70	10	50	60
Fodder crops	-	-	-	4	10	14
Vegetables	18	12	30	25	25	50

Table 16: Average crops yield in IVLP villages at Nagpur

Crops (%)	Average yield (kg/ha) Pre-project	Post-project	Increase
Rainfed			
Sorghum	1540	2170	40.9
Cotton:Variety			
: Hybrid	500	700	40.0
	810	1080	33.3
Soybean	1020	1340	31.4
Pigeonpea	600	750	25.0
Groundnut	925	1150	24.3
Local fodder sorghum	2500	10000	400
Irrigated			
Wheat	1500	1730	15.3
Gram	650	965	48.5
Brinjal	14000	16000	14.3
Orange	21500	26500	23.2

watershed development.

The gender parity indicators revealed that male to female ratio was more or less equal to that of population. The literacy and wage rates were higher for male than the female. Sharing of income was not observed, but increased decision-making power of women was noticed.

Maximum increment in income was observed from agriculture (121%) followed by animal husbandry (78%)

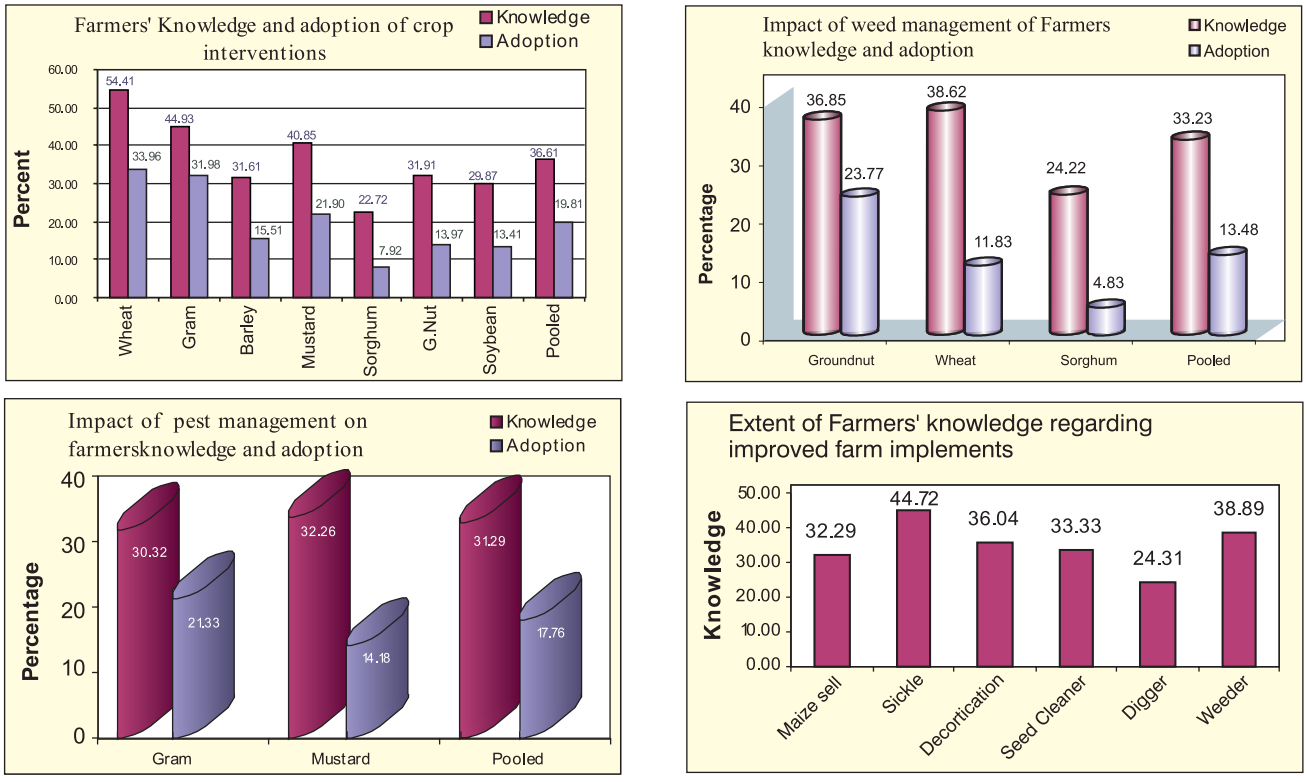


Fig 22. Adoption of different technological modules at Jhansi

among the farming communities in IVLP villages. Animal husbandry became the main source of income for small and landless people to improve their livelihoods. The labour contribution was reduced for small farmers due to increased opportunities of enterprises like dairy, vermicomposting, backyard poultry and goat farming.

Most of the infrastructure facilities like pucca roads, drinking water bore wells, community hall and school building were developed with the efforts of project implementing agency and NGOs. Transformation in occupation was observed after launching of IVLP by the service providers. More than three fourths of the population in the project area derived their livelihood from agriculture. Increase in farm production created marketable surplus for generating income. As a result few farmers shifted from agriculture to business. Stakeholders also went for other options of income generation like honeybee keeping, mushroom cultivation, dairy and goat farming.

At Jhansi, farmers adopted improved varieties, weed management practices, pod borer and aphid control measures in chickpea, improved package of practices in wheat and chickpea.

The parameters for selection of different varieties for adoption as perceived by farmers were yield (63.27%), bold seed (63.26%), higher price of produce (44.90%), tolerance to pests and diseases (32.65%), good taste (31.04%), lesser lodging (28.57%) and short duration (16.40%). Improved varieties of chickpea (Udai and BG-256), wheat (HD-2189,GW273), mustard (Vaibhav and Pusa Barani) were adopted by 59, 53 and 49% farmers, respectively at IVLP site (Table17).

Table 17: Farmers' reaction or reasons for adoption of improved varieties of crops

Practices	Wheat	Gram	Barley	Mustard	Sorghum	G.nut	Soybean	Total
Adopted varieties	HD-2189,	Udai, Pusa	Jagrati	Vaibhav, Pusa 256	CSV-15	TAG-24 Barani	PK-1042, JS335	GW-273
No lodging	57.14	28.57	28.57	42.87	14.28	14.28	14.28	28.57
Bold seed	100	85.71	57.14	100	28.57	57.14	14.28	63.26
Good taste	0.00	57.14	28.57	14.28	17.28	57.14	42.87	31.04
Higher yield	85.71	85.71	57.14	100	42.87	57.17	14.28	63.27
Higher price	71.40	57.14	42.87	57.14	28.57	14.28	42.87	44.90
Short duration	14.82	42.87	14.28	0.00	14.28	0.00	28.57	16.40
Tolerance to diseases and pests	42.87	57.14	14.28	28.57	28.57	42.87	14.28	32.65

Table 18: Adoption of animal production technologies in IVLP villages at Jhansi

Technologies	Full adoption	Partial adoption	No adoption
Treatment of sub-fertile animals	27 (42.89)	27 (42.89)	9 (14.29)
Control of ectoparasites	30 (47.67)	24 (38.10)	9 (14.29)
Control of endoparasites	24 (38.10)	27 (42.89)	4 (19.05)
Mineral mixture supplementation in lactating cows/buffaloes	21 (33.33)	30 (47.62)	4 (19.05)
Vaccination programme	33 (52.38)	30 (47.62)	0 (0.00)
Enrichment of low grade roughages	0 (0.00)	0 (0.00)	63 (0.00)
Over all	(35.73)	(36.52)	(27.78)

* Values in paranthesis indicate percent adoption. No. of farmers surveyed=63

Animal-based technologies, such as control of ecto-and-endo parasites, supplementation of mineral mixture, and enrichment of low grade roughages were adopted in total by 35.73% of the farming community in both IVLP and surrounding non-IVLP villages (Table 18).

8.5 Pulses based Production System

At Kanpur, area under improved cultivars of pigeonpea, urdbean, mungbean, sesame, chickpea, lentil, fieldbean, wheat and mustard increased from 30 to 170, 25 to 265, 3 to 42, 8 to 36, 180 to 430, 60 to 157, 3 to 17, 190 to 280, 10 to 95 ha, respectively over 2000 to 2004. More than 50% production from improved varieties was utilized as seed within a village, also in neighboring villages of Mahoba, Banda, Jalaun, and Chitrakut (Table 19).

After adopting new technologies, farmers are gaining 50-60% higher yields as well as saving the environment and ecology from the hazardous and harmful insecticides by adopting successful IPM practices in pulses. Spray of NPV 250 LE/ha and one spray of Endosulphan (0.07%) in chickpea was adopted in 17 and 25 ha area with involvement of 29 and 39 farmers during 2nd and 3rd year after the implementation of programme. This technology was diffused in 16 ha in non-IVLP villages. The area under improved varieties was increased maximum by mungbean (95.2%) followed by mustard (89.5%) and fieldpea (88.2%). In mungbean and urdbean, the productivity has increased 133 and 125% respectively at the end of the project activities. Employment of agricultural laborers had also increased in both kharif and rabi seasons (Table 20).

Table 19: Project impact at IVLP, Kanpur

Crop	Area in ha (2000)			Area in ha (2003-04)			Increase
	Desi	Improved	Total	Desi	Improved	Total	in area (%)
Pigeonpea	135	30	165	88	82	170	48.2
Urdbean	285	25	310	155	110	265	41.5
Mungbean	2	3	5	2	40	42	95.2
Sesame	17	8	25	14	22	36	61.1
Chickpea	155	180	335	140	290	430	67.4
Lentil	130	60	190	42	115	157	73.2
Fieldpea	2	3	5	2	15	17	88.2
Wheat	175	190	365	60	220	280	78.6
Mustard	90	10	90	10	85	95	89.5

Table 20: Improvement in productivity, income and employment in IVLP village at Kanpur (in per cent)

Crops	Productivity	Income	Employment
Chickpea	55.56	43.030	16.40
Lentil	50.00	42.10	14.00
Fieldpea	52.50	38.50	22.00
Pigeonpea	30.00	18.75	29.50
Urdbean	125.00	42.60	20.00
Mungbean	133.00	62.50	22.50
Wheat	42.85	22.00	13.00
Mustard	100.00	48.00	32.00
Linseed	80.00	34.00	16.00

CHAPTER

9

Refinement of Technologies

Rainfed agro-ecosystem has a distinct place in Indian Agriculture. The farming systems in rainfed areas are quite diverse having variety of soils, crops, animals, cropping and production systems with varying energy and nutrients linkages. The rate of adoption of rainfed technologies in smallholder production systems worldwide is generally low. Several efforts were made in the past to transfer the rainfed technologies among the farming communities, but the uptake of such technologies are not up to the desirable extent due to the lack of appropriateness in technologies in terms of economic viability and other variables. In order to solve this problem, approaches that guarantee effective linkages among researchers, extension workers, decision-makers and farmers are needed. Since members of farming community have access to most of the vital information, the local circumstances, culture and real goals of farming, they appear to be better equipped than outsiders to optimally design their farming systems. This implies that any technological interventions in smallholder production system should be properly tested and gradually introduced, focusing on economic and social acceptability. Therefore, there is need to refine the existing technologies under on farm conditions with active participation of farmers to suit their micro-farming situations. The TAR-IVLP project, covering 24 centers in different rainfed environments, made efforts to refine the recommended technologies for wider adoption of the farming community. This project has refined 126 technologies out of 349, in different production systems (viz. rainfed rice, oilseeds, cotton, nutritive cereals and pulses) from 1999-2005. The details are as under:

Rice based Production System

Recommended technology	Refined technology	Impact
Ranchi		
Traditional rice varieties in *Kharif* and fallow in *rabi*	Rice cv Birsa Dhan 202 with moderate dose of nutrients (40:20:20 kg NPK/ha); and cv T-397 as para crop	Twenty five per cent increase in overall productivity of system
Improved fine quality rice seed (Sugandha/Birsamati) and balanced dose of nutrients (80:40:20 kg NPK/ha) in lowlands	Improved cv Birsamati, green manuring by cowpea and moderate dose of nutrients (50:25:15 kg NPK/ha)	Increase in productivity and profitability by 45 and 25%, respectively. Forty percent of the TAR-IVLP farmers adopted this technology
RDF 100:50:25 kg NPK/ha in wheat (medium and low land) and use of wheat cv Rajshree in medium land (Don II & III)	Application of 25:12.5:6 kg NPK/ha for resource poor, and 50:25:12.5 kg NPK/ha for relatively better off farmers	Increased productivity and profitability by 50 and 80%, respectivelY
Improved variety of IR-36 with balanced dose of nutrients (80:40:20 kg NPK/ha)	Use of improved variety IR 36 and moderate dose of nutrients (50:30:15 kg NPK/ha)	The refined technology was adopted by 60% farmers

Recommended technology	Refined technology	Impact
Improved mustard cv BR 23 and application of balance dose of nutrients (25:25:25 kg NPK/ha)	Balanced moderate dose of nutrients (20:15:10 kg NPK/ha)	Increase in productivity by 20% and adoption by 50% of farmers
Improved fingermillet variety A404 and balanced nutrients (80:40:20 kg NPK/ha) in uplands	Improved variety A404 and application of moderate balanced dose of nutrients (50:30:15 kg NPK/ha)	Higher productivity by 35%. About 60% fingermillet growers adopted this technology
Improved horsegram seed cvs Madhu/Birsa Kulthi -1) and balanced dose of nutrients (30:40:20 kg NPK/ha) in uplands	Improved seed cvs Madhu/Birsa Kulthi-1) and balanced dose of nutrients (20:30:50 kg NPK/ha)	Increase in productivity by 30% and adoption by 50%
Para cropping of linseed variety T397/ sequence cropping of pea variety Swarn Rekha/ cultivation of oat variety Kent/ maize variety Birsa Maize-1/ bottlegourd followed by rice (variety IR 36/Birsa Dhan 202) in lowlands	Para cropping of improved variety of linseed in rice/ rice - pegionpea/ bottlegourdsystems	Increase in cropping intensity from 150 to 200%. About 75% of farmers adopted this technology
Diamond backmoth control through cauliflower + mustard (4:1) and two spray of ripcord 10% @ 600 mL/ha. Two sprays of borax @ 0.2%. Soil application of borax @ 10kg/ha in medium and up lands under limited irrigation	Biological control of diamond backmoth through cauliflower and mustard (4:1) and soil application of borax @ 10kg/ha	Increase in productivity by 50% and profitability by 75%. All cauliflower growers in the area adopted this technology
Improved bins and plant additives to store paddy seed sinduar/neem @ 100 g/q of grain	Improved bins and application of plant additives like leaves of this technology	Cent per cent safe storage. Fifty percent of farm families adopted
Wilt resistant varieties Arka Alok and Arka Abha for endemic areas of tomato	Cv Arka Abha is more tolerant than Arka Alok	Wilt susceptible variety Punjab Kesari was replaced by 30%. Mortality of seedlings reduced by 40%
Local varieties of marigold for Tanr 2 and Tanr 3	Improved cvs Lemon Drop and Orange Drop	Productivity and profitability increased by 35%
Indigenous bucks for breeding	Improved buck (Beetle) for breeding	Higher productivity and profitability of 25%
Albendazole 1/2 bolus/animal at early age and 1/2 bolus after 2 months and till one year and oral administration of indigenous dewormer (Neem leaves/seeds @ 50 g powder/kg body weight)	Oral administration of bolus/calf at early age along with 50g powdered Neem leaves/ kg body weight at an interval of one week for six months	Reduced the mortality rate by 15%. All farmers adopted this practice
Oral administration of piperazine solution (10mL/litre of drinking water, for 3 days) to reduce mortality in poultry birds	Seeds of *palas* (2 crushed seeds/ bird/day for 3 days)	This ITK was found to be effective and was at par with scientific recommendations

Recommended technology	Refined technology	Impact
Integrated fish-cum-duck-cum-pig systemin rice-based production system	Fish-cum-duck rearing under composite fish culture	About 80% of the fish farmers adopted this technolgoy
Hassan		
Transplanting fingermillet at 23 cm spacing with 3 or 4 seedlings/hill.	Transplanting fingermillet at 30 cm with 3-4 seedlings/hill	Increase in productivity by 44%
Improved fingermillet varieties MR-1, GPU-28 and GPU-26 for higher yields	Long duration cv MR-1 for early sowing (June 15-July 7); medium duration (GPK-28) for July, and GPU-26 for July 5 to Aug 7	These blast tolerant varieties increased productivity by 20% and are adopted by 36 farmers of IVLP villages
Maize+soybean (4:2) or (2:2) maize+pigeonpea (4:1) or (6:1) or (4:2)	Maize+soybean (4:2) Maize+pigeonpea (6:1)	System enhanced profitability by 30% than sole maize or maize + castor (8:1)
Rice cvs IR-64 and IET-7191 for rainfed sandy loam soils under tank bed conditions	cv IET-7191 for early and cv IR-64 for late sowing	Increased productivity of 72% by cv IET-7191 over local. 33% increased grain yield for cv IR-64 under delayed sowing. Adopted by 40 farmers covering 4 ha
Balance dose of fertilizers (100:90:120 g NPK) for Arecuna in loamy soils	*In-situ* sunhemp+RDF (100:90:20:g NPK) +green manuring	Higher profitability of Rs.26,000/ha. Adopted in 7.5 ha of 18 farmers in IVLP villages and 3.5 ha of 4 farmers in near by non-IVLP villages
Giriraja and Girirani breeds for backyard	Girirani for backyard	Higher productivity of 25 eggs per annum over Giriraja. Adopted by 40 and 60 farmers in IVLP and non-IVLP villages, respectively
Tubular maize cob sheller with 5 cm dia vedges with 5 cm, shelling only 5 cm diameter cobs	Tubular cob sheller with different sizes (5, 6 and 8 cm dia)	Saving of Rs.750-1000/ha; reduced drudgery
Raipur		
Short duration improved varieties IR-64 and Poornima for Kharif bunded rice fields	Early duration cv IR-64 for uplands	Productivity increased by 18%, Sixty six farmers occupying 40 ha are using this variety
Use of biofertilisers (BGA and PSB) in bunded lowland Vertisols	BGA @ 10kg/ha at beaueshening and transplanting at 6-10 days. PSB inoculation @ 5-10 g	This technology saved fertilizer cost by 20%. Sixty six farmers (30ha) are adopting this practice
Soil application of $ZnSO_4$ @ 25 kg/ha or 2 foliar sprays to rice crop @ 5 kg zinc sulphate/ha after 30 days	Soil application of zinc sulphate @ 50kg/ha before last puddling	Improved seed yield and net returns by 27 and 55%, respectively over no Z_nSO_4 application (2486 kg/ha)
Use of synthetic insecticides like Monocrotophos @ 1 L/ha (2 sprays) for lowland rainfed rice	Neem-based insecticides @ 750 mL/ha+Monocrotophos @ 500 mL/ha (2 sprays)	Higher seed yield by 76% and reduced pesticide by 17%. About 105 farmers are using this module

Recommended technology	Refined technology	Impact
Cultivation of lathyrus, chickpea and coriander in rice fallows	Rice - coriander system	Enhanced net returns of Rs. 725 and Rs.1910 compared to chickpea and lathyrus, respectively
Cuttack		
Line transplanting of rice (20-50 cm) in shallow rainfed lowlands	Improved beaushening with proper gap filling and 20kg N/ha after beaushening	Increased productivity by 50%
HYV Vandana, Kalinga III and Annada for rainfed uplands	Vandana followed by Kalinga III	56% higher yield over farmers variety Satya. 60% of IVLP village farmers adopted this technology
HYV Utkal Prabha, Sarala and Gayatri for rainfed lowlands	Gayatri followed by Sarala	Increase in yield by 35-52% over farmers variety (Gangakuli). Adopted by 30% farmers
Rice+pigeonpea (4:1) intercropping with Vandana, Sneha, and Kalinga in uplands	Rice+pigeonpea (4:1) with rice cv Vandana	Increased profitability of Rs. 5,000 to 8,000/ha. Adopted in 50 and 60 ha in IVLP and neighbouring villages, respectively
Kharif rice-tomato/green gram/ safflower/chickpea and horsegram system in uplands	Rice-horsegram in uplands	Higher profitability of Rs. 15000 to 21,000 /ha. Adopted in 10 and 30 ha area in IVLP and non-IVLP villages
Use of balanced fertilizers with FYM (5t/ha) and NPK 40:20:20 kg/ha in rainfed uplands and lowlands for summer rice	Rainfed uplands- 40:30:30 kg NPK+2 t FYM/ha Rainfed lowland-40:20:20 kg NPK/ha Summer rice-80:40:40 kg NPK/ha	Increase in productivity by 70, 45 and 36% in rainfed uplands and lowlands (10 kg N/ha) and summer rice, respectively
Koraput		
Rice HYVs of Pooja, Sarala and Tulasi for *jholla* lands	Cvs Pooja and Sarala	Increase in productivity by 20 25% over local cv Kerned. About 94 ha area was covered with this variety at IVLP site, giving a benefit of Rs. 3,000/ha
Bt varieties of tomato of like Bt-2, Bt-3, Bt-10, Bt-12, Bt-18 for wilt tolerance	Bt-10 and Bt-18 for higher tolerance of wilt	Increase in productivity of 38 61% over local Pusa Ruby. 75% farmers at IVLP site adopted these in 55 ha. 60% farmers of neighbouring villages are growing these varieties in an additional 300 ha
Recommended dose of 120-60-60 kg NPK/ha with full P and K as basal and N in two equal splits	Farmers practice 40-20-20 kg NPK/ha + Azosporillum and PSB @5kg each/ha (soil application) in *Kharif* potato	Higher production and profitability of 16% compared to farmers practice. Adopted by 54 and 25% farmers in IVLP and neighbouring villages covering 25 and 67 ha, respectively

Recommended technology	Refined technology	Impact
Use of paddy straw as bedding material for mushrooms	Niger stick as substrate	Increase in yield by 47% and additional net returns of Rs. 47/ bed over paddy straw. Adopted farmers in IVLP and non-IVLP by 80 and 50% of villages
Basal application of boron @ 1.5 kg/ha for cabbage in irrigated uplands	Two foliar application of boron @ 0.3% (30 days after planting and then 10 days later)	Improved yield (20%) and compactness of the head over non-boron application (228 q/ ha). This technology was adopted by 52 and 30% of IVLP farmers in 30 and 120 ha, respectively
Nagaon		
NPK @ 40:20:20 kg/ha for semi dwarf rice and 20:10:10 kg/ha NPK for tall rice varieties in mid to lowlands	Green manuring with Dhaincha before *Sali* rice followed by 50% of recommended fertilizer	Increase in productivity by 50% and profitability by 70% over farmers practice (3058 kg/ha). Adopted in 8 ha by 57 farmers in IVLP villages
NPK 40:20:20 kg/ha for Ahu rice	20:10:20 kg NPK/ha and bio-fertilizer Azotobatcer+ Phospatica seed treatment @200 g/kg seed	Higher yield by 20% over the farmers practice (2249 kg/ha). Increase in profitability by 27 and 22% in IVLP and near by non-IVLP villages, respectively
Spraying 0.1% malathion on banana bunches immediately after emergence	Bagging emerging bunches for 15-20 days with cloth bags	Enhance productivity (32%) over the and 10 farmers practice. Adopted by 26 farmers in IVLP and non-IVLP village
Sali rice varieties for mid to lowlands	Satya (125 days) and Basundhara (130 days)	Higher yield of 2.5-3 tons/ha compared to the farmers varieties
Oilseeds based Production System		
Junagadh		
Indiscriminate use of systemic pesticides (> 10-12 times) for groundnut in rainfed medium black soils	IPM module like seed treatment with Carbendazim @ 2 g/kg seed, soil application of castor cake @ 500 kg/ha, foliar spray of 2%, crude neem oil, castor as a trap/ inter crop and pheromone trap @10/ha	Enhanced productivity by 90%, controlled major insect pests by 24-46% and diseases by 28-48%. Adoption rate was 67% in project villages and 10% and 10% in neighboring villages
Bharatpur		
Improved rainfed mustard varieties RH-819 and RN-393 for eastern plain zone of Rajasthan	cv RH-819 is most suitable for rainfed conditions	Increase in productivity by 25% compared over local variety. About 30% of the farmers retain the seed of RH-819 for the next season

Recommended technology	Refined technology	Impact
Use of 60:40:0 kg NPK/ha for mustard in fallow- mustard cropping system in upland loamy sandy soils	Clusterbean with 75% of RDF for mustard	Increased the yield and saved the cost of fertilizer by 25%
Mixed sowing of lentil and mustard in upland loamy and sandy soils system	Mustard + lentil (1:6)	Produced 20% additional yield. 30% of the farmers in this area adopted this
Bhopal		
Maize and pigeonpea as alternate crops under delayed sowing of soybean in rainfed medium to deep Vertisols	Replacement of soybean with maize and marigold	Higher profitability of 130, 104 and 252% by pigeonpea, maize and marigold over sole soybean, respectively. Adoption was maximum for marigold (50 ha by 70 farmers in IVLP village)
Surface drainage with drains (0.75 to 1 m width & 30-50 cm deep at a spacing of 20 to 30 m through use of tractor drawn ditcher in soybean)	Surface drains (0.3 to 0.5 m width and 0.2 m depth and 20-30 length depending upon land sloop using ridger drawn by tractor)	Increased productivity (30-40%) and profitability (23-29%) over recommended practice. Adopted in 272 ha by 122 farmers in project villages
20:60:30:20:20 kg NPKS Zn/ha for soybean and 100:50:30 kg NPK/ha for wheat in soybean wheat system	INM with use of organic manure 5 t/ha + bio-fertilizer, Rhizobium and PSB culture in soybean, and azetobacter in wheat with 50% RDF in both crops	Higher yield (11%) and profitability (45%) over recommended practice. Adopted in 295 ha with 183 farmers since cost reduction was 25% in IVLP villages
Timely sowing+summer tillage +Methomil (1kh/ha) + Trizophos (1 L/ha) on ETL for soybean	IPM with summer deep ploughing, soil application of Phorate granules (10kg/ha), seed treatment with Trichoderma (4g/kg), Methomil (1kg/ha) at flowering stage, 10 pheromone traps along with bird percher for soybean	Improved productivity (23%) and profitability (5%) over recommended practice. Adopted by 180 farmers in 286 ha area in IVLP villages. Reduced cost of production by 20-30%
Recommended fertilizer 20:50:30:20:10 kg/ha NPKSZn in rainfed medium deep Vertisols for groundnut	IPNS - FYM (5 t/ha+ 10:50:20:20:10 kg/ha NPKSZn + Bio-fertilizer) with Rhizobium + PSB culture	Improved productivity (37%), profitability (40%) and reduced cost by 70%. This technology was adopted in 104 ha involving 68 farmers
Sole soybean	Soybean+maize (4:2) with 45 cm row spacing for soybean, and soybean+maize (7:2) at 30 cm row spacing	Maize+soybean (7:2) gave higher profitability (189%) over sole crop. Pest incidence reduced from 29 to 8%. Adopted by 90 farmers in 148 ha
Sole soybean	Soybean+pigeonpea (4:2) with 45 cm row spacing for soybean or soybean+ pigeonpea (5:2) with 37.5 cm row spacing	Improved productivity and profitability by 115 and 24% over sole pigeonpea. Pest incidence and cost of production reduced by 20%

Recommended technology	Refined technology	Impact
Chickpea varieties JG-219, JG-332 and JG-74 in rainfed Vertisols to control wilt disease	JG-74 + seed treatment with *Trichoderma viridi*	Increased seed yield by 41% due to reduced disease incidence (22%). Adopted by 24 and 7% of the chickpea-growing farmers in project and non-project areas, respectively
Lentil varieties K-75 and JLS-1 to control seed borne diseases in rainfed Vertisols	Cvs K-75, Mallika and JLS-1+ seed treatment with *Trichoderma viridi*	Productivity increased by 48% over the local variety. Adopted by 31 and 17% of farmers in project area and nearby villages, respectively
Chickpea varieties Ujjaian, JG-4, JG-218, JG-315, BG-372 for wilt tolerance	Cvs BG-372, JG-4, and JG-315+ seed+soil treatment with *Trichoderma viridi* @ 4-5kg/ha	Productivity increased by 15-20% leading to additional profitability of Rs. 1000/ha Wilt incidence reduced to 20-22%. Adopted in 75 ha in IVLP villages and in 110 ha in nearby IVLP villages
Trizophos 1 L/ha in early stages and 2 sprays of Methodic at flowering and pod forming stages in chickpea and pigeonpea	Summer deep ploughing, seed treatment before sowing, application of Nimbicidin @ 1 L/ha at 15-20 days after sowing and 30-40 days after sowing or spraying with any other systemic insecticide like Endosulphan @ 0.7 L/ha, application of Ha - NPV @ 250 LE/ha at 50 to 60 DAS and installation of pheromone trap @ 10/ha and bird perches at 5 m interval	Enhance the productivity of pigeonpea by 45% and chickpea by 59% over farmers practice. Economic gain increases Rs.4000/- with both crops over recommended practice with only Rs.550/- additional cost. Adopted in 19 ha (pigeonpea) 35 ha (chickpea) in IVLP villages and in 20 ha area with 25 farmers (pigeonpea) and 21 ha area with 48 farmers in (chickpea) nearby villages
Recommended fertilizer (50:30:30 kg NPK/ha) + improved variety (JW-7) and treatment of seed with Vitavax in wheat	Contour cultivation in slightly sloping lands+ improved variety JW-17/HD-2004 along with seed treatment with Vitavax + RDF (50:30:30: kg NPK/ha)	Increase in productivity (15%) and profitability (19%) over recommended practices. Adopted by 42 farmers in Khajuri and Ratatal villages in 77 ha
Chemical control of pests by Cypermethrine (2 sprays)+ Quinolphos (1 spray) for brinjal	Clean cultivation+trap crop of marigold (16:1) + NPV @ 250 LE/ha. (2 to 3 sprays)+pheromone traps (10/ha)+chloropyriphos (1.5 L/ha) at flowering	This IPM practice reduced pest incidence (37 to 10%) and enhanced productivity (11%) over recommended practice. This technology was adopted by 76 farmers in 102 ha
Indore		
Mixed cropping of soybean and maize in rainfed Vertisols	Soybean+ maize (4:2)	Enhanced the yield and profitability by 37%

Recommended technology	Refined technology	Impact
Use of improved soybean varieties JS-335, NRC-37, MAUS-47 in rainfed Vertisols	Cvs MAUS-47 and NRC-37	Increased productivity by 50 to 61%
Wheat cvs Vidisha, Amar, Malavashakti for rainfed Vertisols	Wheat cultivars under limited irrigation	Increased net income of Rs.1275/ha with an incremental CB ratio of 9.18 over local variety (Lok-1)
Seed treatment with trichoderma @3g/kg seed, soil application of phorate 10G @ 10 kg/ha at the time of sowing, spray of Bt-based bio insecticide @ 1.0 L/ ha at the flowering stage, followed by need-based spray of mono-crortophos @ 0.8 L/ha in soybean	Monocrotophos was replace d by trizophos 40 EC @ 0. 8 L/ha which is known to have good ovicidal action	It was found that the farmers are able to get average yield of 28 q/ha with the B:C ratio of 5.98
RDF 20:26.2:16.6:20:6 kg NPKSZn+PSB Rhizobium for soybean	FYM as per (farmers practice + balance requirement through fertilizer to make RDF	The refined technology produced 20 q/ha with a B:C ratio of 3.97
Broad-bed and furrow method (broad-beds 180 cm wide and 20 cm high, separated by 50 cm wide furrows at a depth of 20 cm and a grade of 0.6% slope)	Broad-bed and furrow method (135 cm wide and 20 cm high beds, separated by 50 cm wide furrows at a depth of 20 cm and graded across the contour to a 0.6% slope)	Higher productivity by 20% due to efficient conservation of moisture and drainage of excess water
Cultivation of soybean with maize in 4:2 ratio	Soybean and maize (7:2)	Improvement in productivity (117%) and profitability (189%) over farmers practice. Reduced pest incidence (29 to 8%) and cost (25%)
20:60:30:20 kg NPKS for soybean and 100:50:30 kg NPK /ha in soybean-wheat system	Use of organic manure (5 t/ha)+ biofertilizer (R and PSB) for soybean, Azotobacter in wheat, and reduction of recommended fertilizer dose by 50% for both crops	Higher yield (11%) and profitability (45%) over RDF. Adopted by 180 farmers in 295 ha
Spraying chickpea with Trizophos @ 0.8 l/ha to control Helisthis	IPM module (seed treatment with *Trichoderma* l NPV spray and bird perches)	Increased the yield of chickpea by 30%
Chemical control through polytrin (0.002%) + chloropyriphos (0.2%) at flowering and pod formation to control pests in pigeonpea	Summer deep ploughing + seed treatment with *Trichoderma viridae* + nimbicidin (2 sprays) @ 0.45% + Ha-NPV 250 LE/ha + Pheromone traps (10/ha) + bird perches	Higher productivity (45%) and profitability (35%); cost reduction upto 20-25%; adopted by 70 farmers in 50 ha
Recommended fertilizer dose (20:50:30:20:10 kg NPKSZn/ ha) for groundnut in Vertisols	50% of RDF + 5 t FYM and biofertilizers (rhizobium and PSB)	Improved productivity by 37% and profitability by 40% with cost reduction of 70%. Adopted in 104 ha by 68 farmers

Recommended technology	Refined technology	Impact
Jabalpur		
Use of 20-40-20 kg NPK/ha in soybean and 120-60-40 kg NPK/ha for irrigated wheat	50% recommended dose of N through FYM + balance by chemical fertilizers	Enhanced the yield of soybean (30%) and wheat (35%) over RDF. Adopted by 30% of the farming community
Two sprays of Quinolphos (at 50% flowering and 20 days after pod formation) in chickpea to control Helisthis	Bird perches at 5 m^2 +one spray of Quinolphos @ 800 mL/ha (1.5 mL/L of water)	Increased seed yield by 15 -17% over farmers' practice. Adoption is 20% by the farming community
Use of 40:20:10:20 kg NPKZn/ ha for upland rice	1/3 RDF through vermicompost/ FYM+2/3 N through fertilizer+ bio-fertilizer BGA, Azosprillum, PSB	Higher productivity by 76% as compared to recommended dose of fertilizer
Use of Methyl demeton @ 500 mL/ha to control Aphids	Use of neem oil @2mL/L of water and one spray of Methyl demeton @ 500 mL/ha at flowering stage	Higher yield by 29% compared to the chemical pesticides
Cotton based Production System		
Akola		
Traditional varieties of cotton in rainfed Vertisols	Improved Hirsutum cv PKV-Rajat	Higher productivity by 25%; adopted in 400 ha in IVLP villages
Arboreum cottons AKA-4 and AKA-7 in Vertisols	Cv AKA-7	Improved productivity by 30% and adopted in 120 ha
Four to five simple hoeings, sowing direction along length, in Vertisols of undulating topography	Alternate furrows at the end of two hoeing and sowing across the slope	Increased yield by 28% with additional profitability of Rs.26/ ha over farmers practice. Adopted by 670 farmers in 1035 ha in the project village
Use of sorghum hybrid seed-CSH-5 in rainfed medium Vertisols	Use of new sorghum hybrids CSH-14 and SPH-388	390 farmers have sown sorghum hybrids in 975 ha
Seed treatment with Rhizobium in soybean in Vertisols	Seed treatment with Rhizobium+ 2% urea spray at flowering stage	Increased productivity (15%) and net returns (Rs.405/ha). Farmers adopted this technology in 48 and 115 ha in IVLP and surrounding villages
Three sprays of Endosulphan to control pests in cotton	Based on ETL, HaNPV 250 LE/ha+ dose of Endosulphan NSE 5% followed by HaNPV 250 LE/ha+ ½ dose of Endosulphan	Higher productivity (18.8%) and profitability (Rs.300/ha) over chemical control. Adopted in 200 ha each in IVLP and surrounding villages
Sole cotton	Cotton+sorghum+pigeonpea+ sorghum (6:1:2:1)	Higher productivity (27%) and additional profitability (Rs.1500/ ha) over sole cotton. Adopted in 44 and 290 ha in IVLP and adjoining villages

Recommended technology	Refined technology	Impact
Local variety of wheat with lower chemical fertilizer dosage under late sowing	Cv AKW-1071 with NPK@ 80:40:40 kg/ha	107 farmers adopted this 184 ha of the project villages
Warangal		
Monocropping of cotton hybrids on red sandy loams	Cotton - maize+ field bean	Higher net returns; BC ratio of 3.34; practiced by 140 farmers in 218 ha of nearby IVLP villages
Sole cotton	Cotton - Sesamum/greengram	Enhanced gross returns by Rs.6532/ha. over sole cotton. Adopted in 680 ha of IVLP villages
Sole crops of maize and turmeric in rainfed Alfisols under limited irrigation with basal application of 60 kg N, 120 kg P+top dressing of 90 kg N/ ha at knee high and tasseling stage	Maize and turmeric (1:2) and application of 120:80 kg NPK + 50 kg $ZnSO_4$/ha as basal and top dressing of 90 kg N/ha each at knee high and tasseling of maize +top dressing of 60 kg N+60kg K/ha to turmeric after harvest of maize	Additional gross returns of Rs.18654/ha. Adopted in 21 ha and 14 ha of non-IVLP and IVLP villages
Sole cotton	Agri-sheep farming (maize + cowpea and sorghum + cowpea)	Increased the gross returns (43.2%) over sole cotton (2408). Adopted by 44 farmers of nearby IVLP village
Indiscriminate use of pesticide (10-12 sprays) on cotton	IPM practice (seed treatment, spot application, inter crops, guard crops, trap crops, pheromone traps, neem products and selective insecticides)	Additional benefit of Rs.470/ha. Adopted by 42 farmers
Ajmer		
Use of 60 Kg N and 32 kg P_2O_5 in cotton 50 kg of groundnut kernels/ha + 15 kg N, 60 kg P_2O_5 and 250 kg of gypsum/ha	Seed treatment with azeto bacter+ PSB and top dressing with 30 kg N/ha 75 kg of groundnut kernels/ ha+15 kg N, 60 kg of P_2O_5 250 kg gypsum/ha	Use of bio-fertilizer reduced fertilizer cost by 25-40 % without yield reduction Higher productivity (24.6%) and additional returns (Rs.3780/ha).
Use of 100 kg N, 50 kg P_2O_5 and 100 kg K under irrigation for onion	100 kg N, 50 kg P_2O_5, 100 kg K and 80 kg sulpar/ha	Increased yield (8%) and additional returns (Rs. 6.10 /ha)
Covering nursery with 40 mesh nylon and 3-4 sprays of neem-based insecticide @ 2 L/ha and Monocrotophos @ 625 mL at 15-30-45 and 60 DAT with sandovit	3-4 sprays of neem-based insecticide @ 2 L/ha and Mono-crotophos @625 mL/ha at 15-30-45 and 60 DAT with sandovit	Higher productivity (24%) and additional net returns (Rs.5600/ ha) over farmers practice

Recommended technology	Refined technology	Impact
Nagpur		
Cvs Ajit-11, PKV-4 and Mahabeej-2 (hybrid cottons) in Vertisols	Cvs PKV-4, Mahabeej-2	Higher yield by 10-15 % over other varieties. Adopted by 10% in IVLP villages
Flat bed cultivation of cotton in Vertisols	Opening of ridges and furrows after two rows and intercultivation after sowing with *dawara*	Higher productivity and profitability of 18 and 26%, respectively. Adopted by more than 90 and 30% of farmers in IVLP and adjoining villages
Cotton +soybean (1:1) cotton + groundnut (1:2), cotton+ pigeon-pea (8:2) and cotton+greengram (1:1) in vertisols	Cotton+soybean (1:1) followed by groundnut + cotton (1:2)	Increased profitability by 18-23% over sole cotton. Adopted by more than 50% farmers in IVLP and non IVLP villages
Chemical control of pests (seven sprays of insecticides) in cotton	IPM module: deep ploughing, sucking pest resistant hybrid, early sowing, introduction of trap crop (marigold, amaranthus) 0.07% Endosulphan at 1 egg/plant stage, use of Trichogramma spray of HNPV 250 LE/ha, 0.05% Pyrethrocides	Increased productivity and profitability by 16 and 21%, respectively. Adopted by 57 farmers in 20 ha. Consumption of pesticides reduced by 22%
Indiscriminate pesticide use in cotton	Seed treatment with imidacloprid, one spray of NSKE+neem oil at 50 DAS, installation of pheromone traps, use of Tricho-cards, spray of HNPV 250 LE/ha, spray of 0.07% Endosulphan, spray of 0.05% pyrethorids	Higher productivity and profitability by 16 and 24%, respectively. Adopted in 15 and 20 ha in IVLP and non-IVLP villages, respectively
Sole mandarin	Mandarin+cotton, mandarin+ soybean, mandarin+cotton + marigold	Higher profitability of 10-20% over sole crop. Adopted by 52 orchard owners in 35 ha in the project area
Use of 10 kg FYM + 400:150 + 50 g NPK/tree in mandarin	50 kg FYM+7.5 kg neem cake+ 600 g N, 200 g of P and 100 g K/tree after pruning	Increased productivity and profitability by 28 and 33%. Fifty orange orchard owners have adopted this technology
Grazing+concentrate feeding (@ 2 to 3 kg/day/animal)	Grazing+concentrate feeding (@ 2 to 3 kg/day)+mineral mixture (50 g/animal/day+vita blend AD3 @ 25 g/100 kg feed	Higher yield of milk by 18% and profitability by 22%. Adopted by 30 farmers in IVLP villages
Seed treatment with *Rhizobium*, *Raponicum*+PSB+30 kg N and 75 kg P/ha in soybean	Seed treatment with *Rhizobium, Raponium*+PSB+23 N and 75 kg P/ha	Increased productivity and profitability by 20 and 23% over farmers practice. Adopted by by 105 and 45 farmers in project and nearby villages, respectively

Recommended technology	Refined technology	Impact
Nutritious Cereal based Production System		
Hyderabad		
Sorghum cv CHS-6+pigeonpea cv HY2 (2:1) rainfed alfisols with undulated topography	Sorghum (cvs CSV-15, SPV-462)+ pigeonpea (cv maruthi) in 3:1	Improved the productivity 15-20% and additional net returns (Rs. 2500-3500/ha). 50% of farmers adopted these improved varieties
Sorghum+pigeonpea (2:1) with frequent interculture to mitigate the drought (rainfed Alfisols with undulated topography)	Sorghum+pigeonpea with conservation furrows; additional nitrogen @ 10 kg/ha to reduce early and mid season droughts	Enhanced productivity by 15-20% compared to control. About 45% of farmers are using these techniques for stabilizing productivity
Two Endosulphan sprays @ 600 mL/ha to control pod borer in pigeonpea	Early sowing, collection of larvae by mechanical shaking, one spray of systemic insecticide	The refined technology equals profitability with that of recommended pest control practice. 80% of small and marginal farmers adopted early sowing and mechanical shaking
Castor cv Aruna and hybrid Gauch - 4 for drought tolerance and higher yield	Cvs Kranti and Jyothi for quick revival after drought and cv 48-1 for tolerance against greymold	Farmers preferred cv Kranti due to its better drought tolerance. About 80% of farmers in this area are using Kranti and Jyothi
Recommended dose of 50 kg N and 30 kg P_2O_5 in castor under rainfed Alfisols	Basal application of 10:13:0 kg NPK /ha and 20 kg N as top dressing	Small and marginal farmers preferred to adopt the refined technology for higher area coverage and for risk minimization
Delayed sowing of castor	Mungbean (cv ML-267) and sunflower (cv Morden) proved more efficient than castor under delayed sowing	Medium and big farmers (30%) switched over to mungbean and sunflower under delayed sowing of castor
Maize (cv Kargil+pigeonpea (cv local) (5:1) at 30 cm spacing in Vertisols	Maize+pigeonpea (5:1) at 45 cm for better weed control	This system yielded 7 t of maize and 0.5 t/ha of pigeonpea. About 30% of the farmers are adopting this practice
Basal fertilizers for maize and pigeonpea system @ 90-50-40 kg NPK/ha for rainfed Vertisols	40-50-40 kg NPK/ha as basal, and top dressing with 20 kg N/ha either at knee high or tasseling stage	This practice gave on par economic returns compared to the RDF (90-50-40 NPK kg/ha) and is more profitable during the years of uneven rainfall distribution due to saving of 30 kg N/ha

Recommended technology	Refined technology	Impact
Maize (cv Kargil)+pigeonpea (cv local) (5:1) for rainfed Vertisols	Maize (cvs DHM 105/107)+ pigeonpea (cvs PRG 100/Maruthi)	The system yielded Rs.6254 as additional returns. About 60% small and marginal farmers are using improved varieties of pigeonpea along with hybrids cvs Kargil and DHM 105/107. Adoption of this practice can be extended by ensuring availability of quality seed
Sowing of cotton across the slope in Vertisols	Formation of ridges and furrows prior to sowing; additional 20 kg N/ha after relief of dry spell at vegetative stage	These drought management practices enhanced profitability by Rs 3000 to 5000/ha as compared to farmers practices. About 10% farming community has adopted this technology
Excessive (10 to 12) spraying of systemic insecticides to control pest and diseases in cotton	The IPM module consisting of tolerant variety (cv MECH-12), pheromone traps, cultivation of border crops (maize/sorghum in 4 rows), trap crops (castor/ marigold), nipping shoot tips between 80-100 days, spraying neem seed kernal extract and HaNPV, use of Tricogramma egg parasite and need based application of insecticides	IPM module enhanced the profitability (Rs.2,000/ha) compared to the use of chemical pesticides. About 10% of cotton growing farmers are adopting the IPM modules for the last 2 years at IVLP site
Drought and pest tolerant varieties of chickpea Jyothi, ICCV-2 and Swetha	cvs KAK-2 followed by ICCV-2	On an average, these verities gave 330 kg additional yield/ha and recorded additional returns of Rs. 2000/ha. At present, 30 farmers in IVLP site are using these varieties for the last one year
Pusa Chary and local sorghum under limited irrigation (*rabi*)	African Tall (fodder maize) followed by Pusa Chary (fodder sorghum)	Fodder maize (African Tall) and fodder sorghum (Pusa Chary) yielded 1.2 t and 0.8 t/ha additional fodder yield, respectively over local sorghum
Grazing+concentrate feeding @ 1.5 kg/day/animal for milch animals	Grazing + concentrate @ 1.5 kg/ day/animal + mineral mixture @ 50 g/animal /day	This practice improved milk yieldby 1.6 L/day/animal and profitability by Rs.1300/animal
Feeding of rice straw alone during scarcity period to milch animals	Treatment of rice straw with 4% urea	Enhanced milk yield (21%) and net returns (Rs.400/animal)
Feeding of rice straw to milch animals	Rice straw+*adlibitum* urea molasses mineral block	Improved the productivity (25%) and profitability (Rs.200/animal over the period of 60 days)

Recommended technology	Refined technology	Impact
Bangalore		
Fingermillet blast resistant varieties GPU-28, GPU-26 and PR-202 with moderate levels of fertilizers in rainfed Alfisols	Cv GPU-28 is more acceptable than GPU-26. Balanced nutrition in fingermillet by correction of potassium and Zn deficiencies. Better water management by application of tank silt and deep ploughing	Increased profitability and productivity by 22-34%. About 90% farmers are growing this variety for food security. Adopted in 56 and 112 ha in IVLP and adjoining villages, respectively
Sole fingermillet	Crop diversification through vegetable pigeonpea (cv BRG-1) with timely sprays and better nutrition. Introduction of drumstick, mango and sapota with protective irrigation	Increment in yield by cv BRG-1 (169 %) over HY-3-C (450 kg/ ha) as part of vegetable yield (3500 kg/ha). The income generated from vegetable pigeonpea was sufficient for one year. Net income increased to Rs.35,000-40,000/ha/year by using drumstick
Fifty per cent nutrients through soil+ foliar spray of 0.2% zinc sulphate + 0.1% boric acid + 0.5% K_2SO_4+ 0.5% urea; using Teepol as surfactant in banana	Acid lime fruit juice is acidic and it was effective in adjusting the pH (5.5-6.0). One fruit juice per 15 L water was sufficient	Increase the additional returns compared to control
Eight to nine sprays of systemic insecticide (Endosulphan) to reduce incidence of diamond cap mug in cabbage	Use of pongamia soap 1% / neem seed 7.5% at 20, 30, 40 and 50 days after planting	Enhanced the productivity by 44 t/ha and showed B:C ratio of 3.87, compared to spraying of non-target chemicals
Soil application of Carbofuran to control ash weevil and nematodes; sprays of Cyper-methrine to control fruit borer in brinjal under irrigated conditions	Soil application of neem and pongamia cakes @250 kg/ha at the time of planting and at 30-45 days interval reduced ash weevil and fruit borer incidence	Incidence reduced by 45-80% with neem cake application
Stem injection and sprays of Monocrotophos for coconut mite	Keeping neem cake (330 g) in cloth bags at three places all around the crown area of coconut trees and repeated at 45 days interval	Reduced mite incidence signifi-cantly. In neem cake applied trees, yield increased to more than 100 nuts/tree as compared to 20-30 in control trees
Vengurle		
Rice varieties RTN-8, Sahayadri and Masuri to improve the productivity in sandy loam soil	Cv RTN-3 was found efficient to get stable yield compared to local Walai. Hybrid rice gave higher yield and profit than locals	Increase in productivity and net returns by 12 and 18%, respectively. Adoption of this variety can be extended by ensuring availability of quality seed
Improved rice varieties Dongra and Ratnagiri-24, Ratnagiri-1 under upland conditions	Cvs Ratnagiri- 1 and 24	Fine grain variety Ratnagiri-24, enhanced productivity (55%) compared to cv Dongra

Recommended technology	Refined technology	Impact
Improved varieties Bela, Palgar-1, Phondaghat-1 for mid land conditions	Cvs Phondaghat-1 and Palgar-1	Phondaghat-1 has better potential (133%) and good green quality compared to the local, Bela
Groundnut varieties Konkan Gaurav, Pulepragati, TG-6 and TG-26 for higher productivity in sandy loam soil	Cvs Pragati, Konkan, Gauravfor *kharif* and cvs SB-11 and TG-26 for *rabi*	Cv Pragati enhanced productivity (44%) followed by Gaurav (30%). HYTG-26 increased yield (47%) over local followed by cv SB-11 in *rabi*
Improved chilli varieties Pusa Jwala, Konkan, Kirthi and Phule Jyothi for higher yield and income	Cvs Jwala and Konkan Kirthi for green chilli and local cultivar for red chilli	Enhanced productivity by 20% over local
Paclobutrande @ 3 mL/l canopy diameter + RDF (3 kg urea+ 3 kg SSP+1 kg MOP) to minimize the alternate bearing in mango in lateritic soils	Paclobutrande @ 3mL/l canopy diameter + double dose of fertilizers (6 kg urea + 6 kg SSP + 2 kg MOP)	15% increase in yield over recommended practice
Solapur		
Micro catchments before onset of monsoon in *ber* to mitigate drought	Micro catchments for *in situ* conservation and dry grass mulch around the trunks	Higher ber productivity by 33%. About 30-35% of orchard owners are adopting this technology
Use of 20 kg urea/ha+BF+NP 12.5 and 25 kg/ha in pigeonpea on Vertisols in *Kharif*	Use of 20 kg urea/ha+BF+ NP 0 and 12.5 kg/ha with compartmental bunding	Enhanced yield (33%) over the farmers practice
Sunflower and pigeon pea intercropping system 2:2, 3:3, 2:1 and 1:1 in Inceptisols (*Kharif*)	Sunflower + pigeonpea (2:1)	Enhanced profitability (53%) over 2:2 and 3:3 proportion (Rs.4270); adopted by 45 farmers
Cvs TAG-24 and TG-26 (100 kg seed/ha) BF+NP (20:40 kg/ha) Trichoderma (@5g/kg seed) Dimethoate (@0.05%) and Endosulphan (@0.07%) in rainfed groundnut	Cvs TG-26 (100 kg seed /ha), BF+NP (20:40 kg/ha) Trichoderma (@ 5 g/kg seed) Dimethoate (@0.05%) and Endosulphan (@0.07%)	Enhanced productivity of 69%
Baswant -780 with FYM 3 t + BF + NPK 100:50:50 and IPM module	Cv Baswant-780 with FYM 3t+ BF+Vermi compost 4 t + PK 50:50 kg/ha+IPM module with Trichoderma and two sprays each of Blitox (2 kg/ha) and Monocrotophos (750 m/ha)	Enhanced productivity (156%) and profitability (143%) over local (4.76 t/ha)
Two harrowings before sowing and compartmental bunding before onset of monsoon in pigeonpea+sunflower system to minimize drought impact in rainfed deep Vertisols	Two harrowings before sowing, and ridges and furrows before the onset of monsoon	Ridges and furrows across the slope enhanced net returns by Rs.2793/ha compared to the farmers practice (tilling by harrowing before sowing). About 70% of of farmers adopted this practice

Recommended technology	Refined technology	Impact
Rabi sorghum cvs M-35-1, Phule, Vashoda of for rainfed, medium dry, clay loam soils	Phule, Vashoda followed M-35-1	Enhanced productivity by 55%. About 60% farmers are adopting this variety in the project and nearby villages
In-situ moisture conservation by compartmental bunding, and opening of ridges and furrows during first fortnight of August for *rabi* sorghum	Formation of compartmental bunds, followed by opening of ridges and furrows	*In-situ* moisture conservation technology of compartmental bunding and opening of ridges and furrows enhanced production and net returns by 28 and 14%, respectively over no conservation technology (Rs.6404 /ha)
Onion varieties N-2-1 and Phule Safed for *rabi* onion under limited irrigation in Inceptisols	N-2-4-1 followed by Phule Safed	N-2-4-1 gave higher net returns (31%) over Phule Safed
Cowpea-sorghum, blackgram-sorghum, and soybean- sorghum in Vertisols	Soybean-sorghum followed by blackgram-sorghum	Blackgram-sorghum system and soybean-sorghum yielded 105 and 252% more over *kharif* fallow-*rabi* sole sorghum
Use of NP 100:30 kg/ha in maize under limited irrigation in Insecptisols	Bio-fertilizer + NP 50:15 kg/ha	Enhanced profitability (45%) over farmers practice (N 25 kg/ha)
One spray of Endosulphan followed by Fenvelarate to control pod borer of pigeonpea in rainfed deep clay loam soils	IPM module (clean cultivation, pheromone trap, 10 Heliolure, 5% neem seed extract and 250 mL NPV/ha)	IPM module enhanced the yield of pigeonpea (49%) compared to the farmers practice. About 30% of the farmers adopted this technology
Dharwad		
Cotton+soybean/greengram/ groundnut (1:2) for rainfed Vertisols	Cotton+peas/greengram (1:2) followed by cotton and mungbean (1:2)	Three times higher returns (Rs.2,260/ha) than soybean+ cotton (2:1). About 60% of the farming community is adopting this practice
Cv TNAU-63 and RDF (40:20 NP kg/ha) in rainfed Vertisols	Local variety of millet with 40:20 NP kg/ha; TNAU-63 with 40: 20 NP kg/ha	Increase in productivity of local and TNAU - 63 by 7 and 9%, respectively over no fertilizer
Sole little millet in Vertisols	Little millet-horsegram, Little millet+ pigeonpea (5:1), Littlemillet+ Pigeonpea-horse gram	Higher net income was obtained by littlemillet, pigeonpea and horsegram (Rs.5972/ha) followed by littlemillet and pigeonpea (5:1) with Rs.5206/ha over sole millet
Seed treatment with *Rhizobium* to groundnut and soybean in rainfed *kharif* Vertisols	Soil application of *Rhizobium* bio-fertilizer @ 5 kg/ha	This technology was on par with seed treatment

Recommended technology	Refined technology	Impact
Farming system for medium farmers: 34% of area under food grains, 29% under commercial crops, 33% under oilseeds and 4% under vegetables	Farming system: 27% under food grains, 9% under commercial crops, 33% under oilseeds crops in mango, 5% under vegetable/pulse crops, 5% under fodder, potato and 21% under mango	Improved module enhanced net income from Rs.17,358 to Rs.23,074
Farming system: 32% area under food grains, 56% under commercial crops, 5% under oilseeds and 7% under vegetables	Farming system: 26% area under food grains, 31% with commercial crops, 18% with horticulture crops, and 17% of mango and oilseed crops as intercrop, 9% vegetables for small farmers in Vertisols	Enhanced profitability from Rs.7,329 and Rs.10,107 and B:C ratio from 2.32 to 3.58
Ten to twelve sprays of insecticides to control cotton pests under rainfed Vertisols	IPM module with okra as a trap crop, pheromone traps HaNPV and 3 sprays of insecticides	Increased productivity by 26% and additional BC ratio of 2.4 over farmers practice
Jhansi		
Groundnut varieties ICGS-44 and TAG-24	Cv ICGS-44 followed by cv TAG-24	cv ICGS-44 registered additional pod yield of 52% compared to the local variety (1150 kg/ha)
Soybean cvs JS-335, JS-90-41 and PK-10-42	Cvs JS-335 and PK-10-42	Cv JS-335 enhanced productivity (91%), followed cv PK-10-42 (68%) compared to the local (1230 kg/ha). About 25% of the farmers adopted these varieties at project site
Wheat cvs HD-2285, HD-2189 and WH-147 for rainfed Alfisols	Cvs HD-2189 and HD-2285	Enhanced productivity by HD-2189 (79%), followed by HD-2285 (63%) over local. Each farmer under the project sites increased the acreage with these varieties
Chickpea cvs Avrodhi, BG-256 and KWR-108 for Vertisols	Cvs BG-256 and Avrodhi	Higher productivity under BG-256 (114%) and Avrodhi (91%) over local (1050 kg/ha). Majority of the farmers adopted these varieties at project site
Barley cvs Jagrithi, Jyothi, Lakhan and K- 560 for rainfed Vertisols	Cvs K-560 and Jagrithi	These varieties increased the yield from 89 to 108% over local and additional net returns from Rs.8,160 to 9,975/ha
Mustard cvs Pusa Bold, Pusa Barani and Vaibhav for Budhelkand region (rainfed Alfisols)	cvs Vaibhav and Pusa Bold	Increased yield (20-25%) compared to local (1050 kg/ha). About 55% of farmers are using these varieties at IVLP site

Recommended technology	Refined technology	Impact
Use of fodder crops: berseem, cv Wardan, Hybrid, Maize cv vijay and guinea gras (Gattan)	Berseem (cv Warden), maize (Vijay) and Hybrid napier (N,b)	Enhanced net returns of Rs.27,796 with Bersem cv Wardan followed by Maize (Vijay) (Rs.8,225/ha)
Nutrient management of 20:30:60 kg of NPK /ha	Vermicompost (1.5 t/ha) + NPK 20:60:30 kg/ha	Additional net returns Rs.2,500/ ha, compared to the recommended practice
Udaipur		
Use of improved wheat varieties Raj-3077, Raj-3765 and 4037	Cvs Raj-3765 and 4037	These varieties increased yield (7%) and profitability (Rs.5700/ ha) over local. Farmers preferred cv Raj-3765 due to less shattering of grain, white grain and higher market price
Use of improved groundnut varieties GG-2, DH-26, and TAAG-24 for summer cultivation	Cvs DH-26 and TAG-24.	Increase in pod yield from 69 to 81% over local (642 kg/ha) with net monitory advantage of Rs.7000 to Rs.9000/ha.
Pulses based Production System		
Kanpur		
20 kg N and 45 kg P_2O_5/ha+ *Rhizobium* in chickpea under	10 kg N + 20 kg P2O5/ha+ *Rhizobium*	About 20% of the chickpea growers are adopting this practice
Chickpea cvs KWR-108, JG-315, JG-322, JG-74 and DCP-92-3 for rainfed monocropping	cvs DCP-92-3 and JG-315 for clay and clay loam soils cvs JG-315, JG-322 under irrigation and cvs JG-322 and JG-315 for double cropping with pre-sowing irrigation	These varieties are wilt tolerant and adopted by 256 farmers in 145 ha in IVLP and 204 ha with 336 farmers of nearby villages, respectively
Use of local pigeonpea varieties for rainfed clay loam soils of Budhelkand	Narendra Arhar -1 and Amar	These varieties enhanced productivity by 30-37%. About 80% of the farmers covering 80 ha cultivation by these varieties in the project and nearby villages
Urdbean cvs IPU-94-1, Azad-urd-1, Shekher urd-1 for clay loam and loam soils of upland double cropping areas	Cv IPU-94-1	Increase in productivity (120%) over other varieties. This variety was adopted in 12 and 120 ha area with 41 and 68 farmers in IVLP and non-IVLP villages, respectively. This variety is tolerant to yellow mosaic virus
Mungbean varieties Samrat, PDM-54 and NM-1 in clay loam and loamy soils of rainfed uplands	Cvs Samrat and PDM-54	These varieties are tolerant to yellow mosaic virus and enhanced productivity (300 to 500 kg/ha). About 654 and 52 ha was adopted in IVLP and nearby IVLP villages

Recommended technology	Refined technology	Impact
Sesame varieties TKG-22, Type-78, Type-13 and Type-4 for loam and sandy loam soils of the uplands	Cvs TKG-22 and Type-78	These varieties enhanced productivity (64%) and profitability (Rs.6,000-7000/ha) over the local. Farmers preferred these varieties due to more number of branches and bright white coloured capsules. About 60 and 20 ha in IVLP and non-IVLP villages adopted these varieties
10 kg N+25 kg P_2O_5/ha for chickpea under rainfed Vertisols	10 kg + 25 kg P_2O_5/ha+ *Rhizobium*	Higher productivity over farmers practice and 5% increased productivity over RDF
Mixed cropping of chickpea and linseed	Intercropping of chickpea + linseed (6:2)	Higher profitability by 30% over farmers practice
Lentil varieties DPL-62, JL-1 and IPL-81 in rainfed Vertisols	Cv DPL-62 followed by, IPL-81	Higher productivity of 30-35% over local. These varieties are tolerant to root wilt
Wheat varieties WH-147 Lok-1, Raj-1555, Narhar under limited irrigation in Vertisols	Cv Lok-1 followed by cv Raj-1555	In mungbean-wheat crop rotation, 75% of wheat area is under this variety. 23 farmers from nearby villages procured

CHAPTER

10

Documentation of Success Stories

The TAR IVLP centers under Rainfed Agro Eco system documented 87 success stories covering 26, 13, 13, 32, and 3 in Rainfed rice, Oilseeds, Cotton, Nutritive cereal and Pulse based production systems, respectively (**Annexure III**). The theme-wise success stories are as follows:

Theme area	No. of success stories documented
Crops and cropping systems	32
Rainwater management	06
Integrated nutrient management	02
Integrated pest management	09
Farm machinery	02
Horticulture	12
Livestock	10
Livelihoods	10
Crop diversification	02
Gender issues	02
Total:	87

The documentation of success stories in selected centers of IVLP clearly indicated that use of blast resistant GPU-28 with improved nutrient and conservation technology recorded 3.8 t/ha towards food security of small and marginal farmers. As a result, the farmers in the project villages diverted 30-40% of area for cash crops like dual purpose pigeonpea, dolichos bean, maize and drumstick. The area under alternate crop of banana increased from 1 to 30 ha. The technology of *Trichoderma* for nematode control was spread to the farmers as far as 25 km from the adopted village of Kestur. Above 30 kg of *Trichoderma* packets were sold to the farmers, indicating the confidence of farmers towards the biopesticide. At Cuttack, rainwater harvesting through bunding 50 X 25 cm surrounding the field improved the drainage and yield of rice in the rainfed environment. At Akola, simple soil and Water Conservation Technologies like sowing across the slope along with the alternate furrow opening in cotton spread to 80% of the the project area. About 60% of traditional sorghum growing farmers at Dharwad shifted towards cultivation of soybean for higher and stable yields. At Kanpur, farmers in the IVLP villages produced 3 t of improved varieties of chickpea and lentil and sold to the neighboring villages @ Rs.50/kg by adopting seed village concept. Some of the success stories which created impact on improvement in productivity, profitability and sustainability among the farmers in Rainfed Agro eco system are given below.

1. Technology Changes Life for Judhistir Behera

Sri Judhistir Behera is a poor farmer with 2 acres of land under paddy cultivation at Barena village of Cuttack district, Orissa. He had to feed a family of eight of which only three are working. The 5-8 q of rice he used to harvest from his land was hardly sufficient to feed the entire family. Sri Behera and his two sons used to work as casual labourers in others' fields.

The TAR-IVLP team from Central Rice Research Institute (CRRI), Cuttack identified Sri Behera for imparting skill oriented training on improved production technology for rainfed rice. On-farm participatory trials were conducted during 1999-2002 on various aspects of rice production technology. Of the two acres land owned by Sri Behera, improved variety *Vandana* was grown on one acre. The crop was planted (direct seeding) during second week of June in rows (20 cm apart) behind country plough with a seed rate of 75 kg/ha. At the time of sowing, he applied 0.8 t/ha FYM and 8 kg of P_2O_5 in the form of super phosphate and 8 kg of K_2O in the form of mureate of potash. Twelve kg of nitrogen was applied in two equal splits at 3 and 6 weeks after sowing.

Gayatri on lowlands (left) and Vandana on uplands (right) on Sri Behera's field

He controlled the weeds by adopting integrated weed management package involving finger weeder between lines after 20 days and a hand weeding at 30 days after germination.

On the remaining one acre, he cultivated photosensitive low land rice cv *Gayatri* in *kharif*. On the same piece of land, he also grew *summer* rice by utilizing spring water flowing by the side of his land. Good crop stand was ensured by line transplanting and application of 16:18:18 kg of NPK in low land rice and 32:16:16 kg NPK for *dalua/summer* rice. Thus, in one year, Sri Behera could produce 5 t of rice (1.2 t from upland and 1.8 t from lowland during *kharif* and 2 t from *dalua/ summer*).

In addition to rice, he also produced vegetables like tomato, poi, cucumber on one acre of upland. Thus, following the adoption of improved technology, Sri Behera could not only produce sufficient rice for his family, but also earned additional income to meet his other livelihood needs. During the past two years, the Behera's familycould live happily sustaining the same level of production besides engaging themselves year round. The Beheras no longer work as labourers on others' fields.

2. The Incredible Success of Binjhis in Lac Culture

Sri Shiv Narayan Binjhis and his wife Parvati, residents of Jarea village in Jamchuan Panchayat, Jharkhand belong to poor tribal community. Traditionally, they are engaged in lac culture. However, due to poor yields, the family was unable to sustain a decent livelihood. It was then, the TAR-IVLP team from Birsa Agricultural University (BAU), Ranchi came to Jarea. The team had a series of discussions with the local tribals and identified the reasons for low productivity of lac. The tribals were using local brood lac and were not exploiting the naturally occurring host trees such as *ber, palas and kusum*. In order to improve the productivity, a well designed training programme was implemented where in crucial practices such as quality broodlac, timely pruning and pest management were addressed.

Sri Shiv Narayan and his wife took these practices to their heart and started implementing what they had learnt. In April 2001, they pruned *palas* (*Butea monosperma*) that is a favourable *rangini* host. By October, the trees had put up good vegetative growth and were ready for lac infestation. They infested 15 kg good quality brood *rangini* lac supplied by Indian Lac Research Institute (ILRI) on to the *palas* trees in the first week of October. They also infested the *palas* trees available in the nearby forest area with 15 kg more broodlac purchased from local market.

Rangini lac on palas tree

It was the time for Shiv Narayan's brother's marriage in May, 2002. The family was in dire need of money. He wanted to harvest all the lac, from his homestead trees and those in the forest. The IVLP scientists advised him to wait for another month so that he could get higher yield and better price. He waited for some time and harvested lac from few trees. The waiting really paid him. They got 4 times more from the trees near the homestead. Parvati harvested 50 kg lac and sold it in the local market at Rs.60/kg earning Rs.3,000/-.

One third of the plants near the homestead that were not harvested in May were left for self-infestation. This portion was harvested in October. The results were spectacular for the Binjhis. All the villagers gathered to see the harvest and were taken by surprise. This time Parvati did not have to peel the lac from sticks. The harvest was about 75 kg of which 15 kg brood was kept as culture for the next crop. The remaining 50 kg sold in the market at Rs.130/kg fetched her Rs.6,500/-. The expenditure incurred on the indigenous practice was Rs.900/- and that on improved practice was Rs.1,200/-. The former earned the finally Rs.3,000/- while the latter Rs.8,700/-. The return per rupee invested was Rs.3.30 with farmers practice and Rs.7.25 in the improved practice.

This experience was enough for Shiv Narayan and Parvathi to adopt timely pruning, partial harvesting followed by complete harvesting and using quality broodlac.

3. Marigold - A Blooming Boom in Ranchi Villages

Jharkand state is bestowed with climate suitable for growing vegetables and flowers. But the potential remained under-exploited. Marigold, rose and dahlia have emerged as important flower crops for generating employment and returns to farmers and entrepreneurs. However, due to rising costs, the net returns were falling and farmers were looking for opportunities to further enhance their income. The TAR-IVLP team from Birsa Agricultural University (BAU), Ranchi analyzed the problem through PRA in Jamchuan and Rampur villages of Rajaulatu Panchayat, Namkum block, Ranchi district. Use of low yielding, traditional varieties was found as the major constraint for low profitability. Hence two superior varieties of marigold viz., *Orange Drop* and *Lemon Drop* were introduced in these villages and farmers were trained on improved production technology.

Farmers raised these two varieties with improved practices along with traditional varieties under their own situation for comparison. On an average, 35 flowers per plant were produced in *Lemon Drop* and *Orange Drop*, in contrast to 18 flowers per plant in farmers' variety. Hundred flower weight was 312 g in *Lemon Drop* and 310 g in *Orange Drop,* while in local variety the same was 234 g. The total fresh flower production was 1.87 and 1.82 t/ha from *Lemon Drop* and Orange *Drop* as compared to 1.0 t from the local variety. The B:C ratios were 4.14, 4.02 with improved varieties as compared to 2.66 from the local variety. Apart from productivity and profitability, the improved varieties fetched more price in Kolkata and Ranchi flower markets. In view of these benefits, most farmers in Jamchuan and Rampur villages replaced their traditional marigold varieties with *Lemon Drop* or *Orange Drop* resulting in widespread gains for the village as a whole.

Improved marigold varieties Lemon Drop (left) and Orange Drop (right)

4. Etwari Toppo Motivates Tribal Women to Grow Mushrooms

In the tribal region of Jharkhand, wild mushroom is very popular. It is available only in two months i.e. July-August. However due to adoption of traditional methods, the yields are very low.

A core team of TAR-IVLP from Birsa Agricultural University (BAU), Ranchi trained 50 rural women on

wild mushroom cultivation. A young lady, Etwari Toppo, aged 38 of Chatwal village undertook this enterprise with all seriousness and commitment, She has only 0.5 acres of land, not quite enough to support the family. She was married to an alcoholic, who does not do any work. In 1999, she took up this enterprise. After training, she cultivated mushrooms and created 45 man-days of additional employment per year and on an investment of Rs.15 on spawn and other raw materials. She received Rs.100/- through production of 2.5 kg of mushroom in three flushes sold @ Rs. 40 per kg. In this way, she could earn an additional income of Rs.3,500/- per year. Besides working in other fields as agricultural labourer, she could earn Rs.3,500/- at her own house in a limited area. The returns on rupee invested were Rs.2.58/-. Subsequently, she imparted training to other members of Mahila Mandal who took up this enterprise as Cooperative venture. Her success has motivated a number of women in her village to take up mushroom cultivation.

Smt. Etwari with her homestead mushroom cultivation

5. Technology Doubles Fingermillet Yields

Fingermillet (*Elusine coracana*) is an important crop in uplands of Jharkand plateau next only to rice in area and production. Tribal farmers use fingermillet to make bread, *Haria*, an indigenous drink and also as feed to pigs. This crop is grown by traditional method by broadcasting seeds and the yields are very low (1,000-1,100 kg/ha).

Scientists from TAR-IVLP team of Birsa Agricultural University visited few villages in Mandar block of Jharkhand plateau and assessed the production constraints and opportunities for improvement. Two farmers Sri Jattu Mahto and Sri Birsa Munda were chosen for participatory evaluation of improved technology. The most important intervention was transplantation of fingermillet instead of direct seeding. Fingermillet nursery was raised on their fields with the improved variety *A-404* during June. They transplanted 25 day-old seedlings in the main filed with 15 X 15 cm spacing. Fertilizers @ 25 kg N, 30 kg P_2O_5 and 20 kg K_2O per ha were applied in furrows as basal dose. 25 kg N/ha was applied in two equal splits at 30 and 60 days after transplanting. Hand weeding was done once at 30-35 days after transplanting. For comparison, they also broadcasted seeds of local fingermillet by traditional method. About 1 t/ha of FYM was applied at the time of land preparation.

Improved ragi (A-404) under improved practice

The crop stand in improved practices block was so attractive that farmers in the neighbouring villages came to see their plots. They also sought some quantity of seed from them. In presence of the neighbouring farmers, the two farmers harvested 2,200 kg/ha of fingermillet grain from the block with improved technology, while only 1,100 kg/ha could be harvested from plots where the traditional method was followed. The return per rupee was Rs.2.85 under improved practice and Rs.1.15 under farmers practice. This message spread to many farmers of neighbouring villages of Karge panchayat. The technology gained momentum, as *ragi* is the staple food of the people of the area. In

subsequent years they adopted the technology of improved seed and management practices of fingermillet cultivation. The variety A-404 has thus become very popular in the locality. The impact was so evident that media representatives visited the villages and gave wide publicity on the success of these two farmers.

6. Tarra Becomes a Mushroom Village

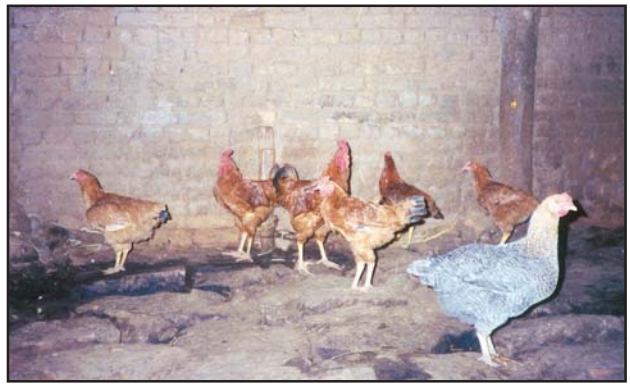
Sri Ratiram Verma is a farmer and a part-time Ayurvedic practitioner in Tarra village of Dharsiva block in Raipur district, Chhattisgarh. He has 7 acres of rainfed land, which was barely sufficient to meet his family needs. The TAR-IVLP team from Indira Gandhi Krishi Vishwavidyalaya (IGKV), Raipur, as part of crop diversification, conducted a training course on oyster mushroom production, which was attended very keenly by Sri Verma. He took the idea very seriously, followed all scientific methods and converted the big hall in his house into a mushroom growing facility. He also created the humidity maintenance mechanism through an indigenous water dripping system. He evaluated different substrates for growing mushroom and finally found that paddy straw was most suitable for oyster mushrooms under his conditions. He started producing around 6 kg/day oyster mushroom and supplying the same to local villagers (Rs.40/kg) and hotels (Rs.60/kg). He also tried mushrooms for treating his patients and found it useful in those suffering from gout, arthritis, diabetes and general weakness.

By this, he has been able to augment his income by Rs.3,500 to 4,000/- month. He has now expanded his enterprise and is able to grow 25 kg mushroom each day. Honourable minister for Higher Education, Government of Chhattisgarh presented an award to Sri Verma recognizing his contributions in mushroom production. Due to efforts of Sri Ratiram, mushroom cultivation spread to a large number of small farmers in Tarra village now. Tarra has now become a 'mushroom village'.

7. Vanaraja Brings Fortune to Koraput Villages

Backyard poultry is an important enterprise for tribal farmers of Koraput. Though well adapted, the local birds have a lower body weight and lay only 60 eggs per annum in four clutches. The eggs are also small in size. The potential for higher income generation from such an enterprise is low. Therefore, an effort was made to introduce the improved strain *Vanaraja* to enhance the productivity from backyard poultry. A total of fifty farmers i.e. 25 each from two IVLP adopted villages of Sundhiput and Pakjholla were supplied with six day old *Vanaraja* chicks (3M+3F). The male and female attained body weight of 4.2 and 3.5 kg, respectively at the age of six months. The average egg production was 180 per annum and the average egg weight was 55g in comparison to 40g in local birds. Out of the six chicks supplied, two male chicks were sold at Rs.500/- at the age of 6 months @ Rs.250/- each. All the three hens and one cock were maintained by the farmers for egg production. From these hens, the farmer got 12 eggs/ week which fetched him Rs.36/- @ Rs.3/- each in the weekly local market. Thus he earned a total Rs. 2,200/- in a year with a small investment of Rs.60/-. The intervention helped 50 landless tribals on a similar scale.

Scientists admiring Ratiram's mushrooms



A healthy Vanaraja bird in backyard

A farmer named Jaganath Nayak of Sundhiput is selling the *Vanaraja* eggs to the farmers of his village as well as in near by villages @ Rs.5/- each for hatching purpose. Very soon 300 chicks have been hatched out of these eggs and their performance was much better than the local birds. The success of the intervention was highlighted in a workshop of the Veterinary Assistant Surgeons of Koraput district. Success of the backyard poultry in Sundhiput attracted many SHGs of Koraput district NGOs and other implementing agencies have started requisitioning for birds from KVK and ATMA project. The demand in 2003 increased to 1.5 lakh birds. Realizing the increased awareness, the District Rural Development Agency (DRDA), Koraput has sanctioned Rs.2.0 lakhs to Chief Veterinary Officer, Koraput for revival of the hatchery at Koraput and rear *Vanaraja* parent stock to ensure supply of day old chicks to farmers.

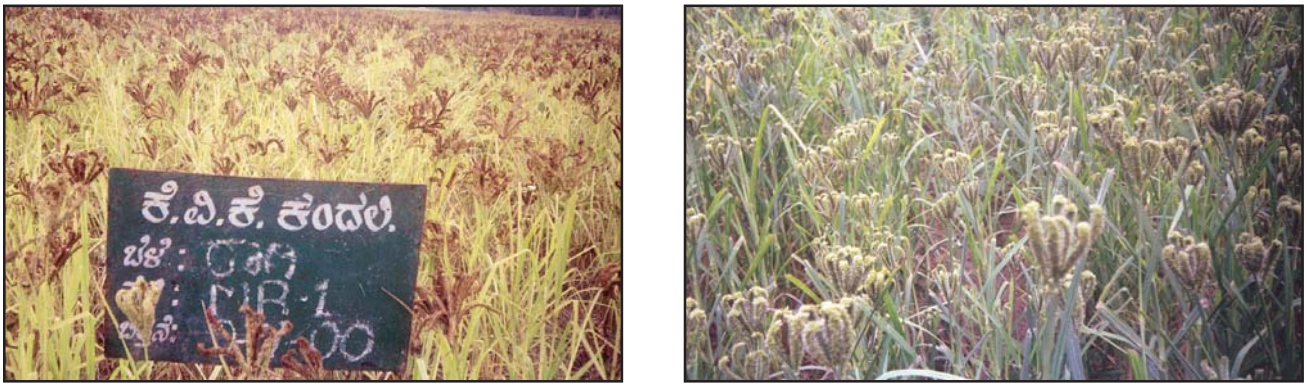
Two years ago, when the *Vanaraja* bird was first introduced by KVK, Semiliguda, Koraput district, no body ever thought that it will catch up on such a large scale.

8. Technology Aids Hassan Farmers Face Fingermillet Blast

Fingermillet is an important staple food crop for farmers in Hassan District of Karnataka. Farmers still grow PR-202, a variety released during mid eighties, which became susceptible to blast and farmers continue to suffer severe losses year after year. Further, farmers follow square planting, which gives them low yields (1,200 kg/ha) due to sub optimum plant population. Moreover, the May sown crop of PR-202 is generally caught in rains at harvest during September-October, resulting in grain dropping, sprouting of earheads and rotting. Because of this, the grain and fodder quality deteriorates. The TAR-IVLP team from KVK, Hassan organized the farmers of Malali village and imparted skill oriented training programme on improved production technologies in collaboration with KVK, Hassan. The focus of the training was on high yielding medium and short duration varieties along with improved crop management practices.

As a part of the improved package, blast tolerant fingermillet varieties GPU- 28 and MR-1 were introduced during *kharif* 1999-2000. Achieving optimum plant population was another challenge. Farmers adopt wide spacing of 12 X 12" or 15 X 15" in square transplanting (15 - 20 seedlings/hill). They did not accept the suggestion of the scientists team for close spacing of 9 X 4" (with 3 - 4 seedlings/hill) as they need to change all the intercultural equipments that were in use over the years. Therefore, the intervention was refined with a row spacing of either 12" or 15" with reduced intra row spacing of 6" (with 3 - 4 seedlings/hill). With this modification, the plant population was doubled and yield of fingermillet increased by 43 per cent.

This improved practice was repeated for another two years in the same villages. The yield advantage gained by the farmers attracted the attention of neighboring villagers and the extension personnel from Department of Agriculture. The Agricultural Minister of Government of Karnataka, participated in a field day and appraised of the technological interventions. This refined package became a subject of KVK training programmes in Hassan



Blast tolerant fingermillet varieties MR-1 (left) and GPU-28 (right) with improved row spacing

district. This success story was also disseminated through mass media. Due to these efforts, the practice of altered spacing and use of blast tolerant varieties was adopted by more than 80 per cent fingermillet farmers in Hassan District. The average productivity of the crop in the district increased from 1,200 kg/ha to 2,000 kg/ha.

9. Poly Houses Enable Farmers Produce Off-season Vegetable Seedlings

There is a good demand for vegetables during *rabi* season in Assam. However heavy rainfall during the month of August is a major constraint in raising vegetable nurseries. Excess water damages the seedlings. Although farmers complete early harvesting of paddy, they are unable to take up *rabi* vegetables, owing to non availability of vegetable seedlings. Raising of vegetable nurseries in open fields has not succeeded in the district due to continuous rainfall. The TAR-IVLP team from the Central Brahmaputra Valley Zone Research Station of Assam Agricultural University at Nagaon realized that, if only the farmers are able to raise seedlings and grow vegetables during early *rabi,* they can make handsome profits due to high demand and remunerative prices.

After examining several options, the scientists team came out with the idea of erecting LDPE poly houses. Poly houses of 50 sq m were found ideal to grow vegetable seedlings even during heavy rains. Four poly houses were erected in the villages of Jamkhola and Bhomoraguri and entrusted to 4 groups of farmers each consisting 4 farmers during 2000-01. The farmers were trained on maintenance of poly houses in addition to production technology of the vegetable seedlings. The approach became highly successful and all the groups were able to grow a number of *rabi* vegetable seedlings in the district. They produced enough seedlings of cauliflower, cabbage and tomato, not only to meet their demand, but sell to other farmers in the neighboring villages. The LDPE poly houses thus became excellent avenues for income generation to the farmers and also to the unemployed youth in the villages. Farmers realized the net income of Rs.1,920/-, 2,510/- and 3,775/- during the years of 2000-01, 2001-02 and 2002-03, respectively per poly house. By 2002-03, the technology has replicated to 6 neighboring villages of the Nagaon district.

10. Marigold Turns Gold for Smt. Padam Singh

Smt.Padam Singh is a small farmer in Khajuri village, Bhopal district, Madhya Pradesh. She owns 2 ha irrigated land. Soybean is the main *kharif* crop in the village. In the past few years, due to late onset and erratic distribution of rainfall, she has witnessed repeated crop failures. Delayed sowing, resulting in high pest infestation was causing losses to Smt. Singh. Since then, she was looking for some alternate crop that can come up well under delayed *kharif* and give her some assured income.

When the TAR-IVLP team from Central Institute of Agricultural Engineering (CIAE), Bhopal trained a group of farmers that included Smt. Padam Singh on the alternate options for late monsoon conditions, Smt. Singh was particularly excited to know about the cultivation of marigold cv. *Pusa Basanti*, which adapts well to delayed rains. She made sure that all the information about cultivation practices was made available to her through repeated interactions with scientists' team. Cv. *Pusa Basanti*, which has been performing well in the surrounding areas was a natural choice. She raised marigold seedlings and transplanted

Farmers of Jamkhola and Bhomoraguri villages with their poly houses

them on her 2 ha plot. She also adopted seed treatment with *Trichoderma viride* and followed the recommended package of practices from transplanting to harvesting.

Smt. Singh adopted an innovative strategy to achieve higher profit. She ensured that the harvesting of marigold coincides with the festive season so that she would get the best price. Thus, the crop sown in the second week of July was ready for picking in September. She could realise an average selling price of Rs.30/kg for her flowers (13.2t/ha) and earned a net profit of Rs.25,000/ha. In the past she used to earn barely Rs.5,000/ha by growing soybean. Smt. Padam Singh is now a happy and successful woman. Many farmers in the village flock to her for advice on growing marigold.

Smt. Padam Singh harvesting her marigold crop

11. Managing Gram Pod Borer - The IPM Way

Gram is an important *rabi* crop in rainfed Vertisols of Bhopal district. It's yield fluctuates due to infestation of pests. Pod borer is one of the major pests of chickpea that inflicts severe economic damage to the crop. It can cause losses upto 30-40% if not controlled on time. Farmers of Mugalia village near Bhopal have been growing gram for many years. They are now a worried lot as pod borer has become a major menace. The small holders cannot afford expensive chemical pesticides nor do they have knowledge about other methods of pest management.

The TAR-IVLP team from Central Institute of Agricultural Engineering (CIAE), Bhopal analyzed this

A happy Patidar in his chickpea field

constraint and organized several training courses on pod borer control, particularly on Integrated Pest Management (IPM). Sri Shaligramji Patidar was among the few farmers who took IPM seriously and put the practices in to use. Sri Patidar is a small farmer and wanted to try IPM on his 2 ha plot initially. In the *rabi* 2002, he cultivated gram and mustard as intercrops with 7:2 row ratio.

This simple practice resulted in a dramatic reduction in pod borer infestation. The infestation was brought down to just 12% in the intercropped field, while it was around 30% in sole chickpea. Now he is able to appreciate that the pungent aroma of mustard crop repelled the pod borer larvae. He also realised that mustard flowers attracted a lot of pollinators and natural enemies including birds, which perched on tall mustard crop. As a result, Sri Patidarcould harvest 1,230kg chickpea and 510 kg mustard. This was a clear 42% benefit over chickpea sole crop. Now Sri Patidar is a happy man, because he could raise his farm income by Rs.6,750/ha by the simple practice of intercropping. His success has enthused many farmers in Mugalia and neighboring villages.

12. Mugalia Farmer Earns More Through Mechanization

Cleaning, grading and storing of agriculture produce are important aspects of post harvest practices. Generally, farmers clean the produce by hand winnowing in open air and manual separation of stones and broken grains by hand sieves. It is a labour intensive practice costing nearly Rs.100/t of grain. Moreover, the quality

Cleaning soybean through cleaner cum grader

Women decorticating groundnut pods

of the produce is poor and often fetches lower price in the market. The situation is not different in Mugalia and Khajuri villages near Bhopal, which grow mainly soybean. Recognizing this, the TAR- IVLP team from Central Institute of Agricultural Engineering (CIAE), Bhopal imparted skills in operation and maintenance of power operated soybean cleaning and grading machine. The machine can clean and grade soybean, wheat and pulses like chickpea.

Sri Hariprasad Sahu of Khajuri village has a special aptitude for machines. He evinced keen interest in learning the operation of the soybean cleaner. He was given the machine on loan for some time. During that period, he used the machine to clean and grade soybean, chickpea and wheat. From his 16 ha land, he harvested 20 t soybean, 30 t wheat and 10 t chickpea. He used the machine for the entire 60 t produce investing only 20 man-days at a cost of Rs.1,000/- For the same work he would have spent nearly Rs.6000/- towards manual harvesting. Due to the better quality of produce, Sri Sahu got a higher price upto 10%. Together with savings on man days, it fetched him an additional Rs.10,000/-. Impressed by this, he has now come forward to own a cleaning and grading machine for himself.

13. Farm Level Value Addition in Groundnut

Due to lack of proper device for decortication of groundnut pods, farmers are often forced to sell either dry or fresh pods without adding any value to their produce. The selling price for groundnut pods is Rs.4-5/kg for fresh and Rs.12-15/kg for dry pods. But most farmers store 100-500 kg pods for seed purpose. The pods are normally hand decorticated which requires 10-12 manhours at a cost of Rs.0.80/kg pods. Manual decortication is not only laborious but also results in damage to seeds.

The TAR-IVLP team from Central Institute of Agricultural Engineering (CIAE), Bhopal observed this problem and introduced hand operated groundnut decorticator. The team also trained selected farmers in the operation of the decorticator some of whom are women. On observing the keen interest shown by Sri Jitendra Sahu, a resident of Mugalia hat, the team decided to give a hand operated decorticator to him on loan basis.

Sri Sahu used the decorticator for shelling 4,000 kg pods and turned out 2720 kg kernels. He sold the kernels at Rs.24/kg. Together he realized Rs.69,280/-. He spent Rs.1000/- towards 20 mandays for decortication, separation of kernels and cleaning. Had he sold the groundnut pods without decorticating, he would have realized only Rs.60,000/- @ Rs.15/kg. Thus, Sri Sahu could realize and additional Rs.8200/-. This translates into an additional Rs.2/kg. Farmers in Mugalia hat are now convinced on the importance of value addition. Many in the village are now considering to buy the hand operated groundnut decorticators. Small investment but significant value addition!

14. Bhagat Singh Turns 'Bhagirath' Singh

Sri Bhagat Singh is a well-to-do farmer in Bhagora village of Indore in Madhya Pradesh. He has 9 ha land

and owns a tractor. The year 2001 was particularly very bad for him too. The rains were inadequate and his tubewell had almost dried. Soybean, potato, garlic, onion and chickpea are the crops generally grown by him. However he was not able to grow these profitably as he had severe water crisis. At this juncture he came in contact with the TAR-IVLP team from National Research Centre for Soybean (NRCS), Indore.

The team of scientists exposed Sri Singh to various rainwater harvesting practices through a well designed training programme. He took keen interest and went ahead with saving almost every drop of rainwater that fell on his farm. First of all, he stalked sand filled gunny bags (*bori bandh*) across the canal, which runs along the boundary of his farm taking with it a huge amount of run off. The run off thus collected was diverted to open wells through pipes laid underground. The excess water was diverted to a small percolation ditch around the borewell. For facilitating percolation, he dug up ditches of 5 m depth and 3 m diameter. First 2 m of the ditch was filled with small (40 mm) pebbles followed by smaller pebbles (20 mm) in another 2 m depth. The top most 1m was filled with coarse sand. Then, a casing pipe (4 m length) with holes all around was wrapped with coir and inserted in to the tube well so that it recharged the tubewell with water devoid of soil and sand particles.

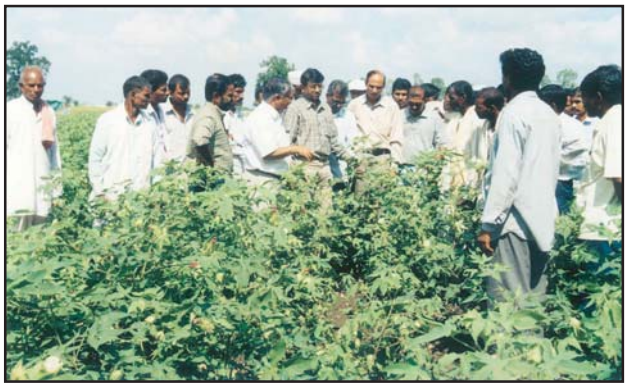
Thanks to the ingenuity of Sri Bhagat Singh, the water availability in the tube well now has been extended from February to May. However, it cost him Rs.70,000/- besides his hard work. But he realized that the efforts were worth it. Before adopting *in situ* rainwater harvesting, Sri Bhagat Singh used to cultivate soybean on 4.5 ha and groundnut on 2 ha during *kharif* and potato on 2 ha, chickpea on 6 ha and garlic on 1.5 ha during *rabi*. Now the area under potato has increased to 7 ha during *rabi* and accordingly his income.

Sri Bhagat Singh is not only beneficiary of his efforts. Nearly 20 tubewells owned by other farmers in adjacent area have also been recharged. They are excited now and have been convinced beyond doubt that investing in rainwater harvesting can pay rich dividends.

Impact of rainwater harvesting on yields and income of Sri Bhagat Singh

Season	Crop	Before the Project Initiation			After the Project Initiation		
		Area (ha)	Yield (kg/ha)	Gross Income (Rs/ha)	Area (ha)	Yield (kg/ha)	Gross Income (Rs/ha)
Kharif	Soybean	4.5	1600	26,045	4.5	2600	52,000
	Groundnut	2.0	5000	45,000	2.0	5500	55,000
Rabi	Potato	2.0	14500	1,26,875	7.0	23400	2,45,700
	Garlic	0.5	6800	1,08,800	0.5	12600	1,89,000
	Chickpea	6.0	6000	9,000	0.5	26000	1,04,000

In situ water harvesting and storage structures on Bhagat Singh's fields



Explaining the IRM strategy to farmers

Pheromone trap - a component of IRM technology

15. Dhanraj Faces Cotton Pests - Thanks to IRM

Sri Dhanraj, a 45-year-old farmer of Tishti village in Kalmeshwar Taluk of Nagpur district has been cultivating cotton for the past 25 years. However, for him, managing the cotton pests was becoming difficult every year. Initially, he used to spray 3 to 4 times during the crop season, but gradually with resistance build up, he had to spray more than 12 times. In 1997, he gave 14 sprays, but still failed to control the pests and suffered heavy losses. He almost decided to give up cotton cultivation. At this stage he came in contact with TAR-IVLP team from Central Institute of Cotton Research (CICR), Nagpur who introduced to him the IRM (Insecticide Resistance Management) strategy. The IRM approach aims to slow down the resistance treadmill, thereby extending the usefulness of available chemicals. The scientists explained all the components of the IRM package to the farmer.

Sri Dhanraj tried this package during 2002. Immediately after the previous crop, he allowed animal grazing in fields and removed cotton stubble, followed by deep ploughing to expose the carry-over population of bollworms. He planted *Ankur-651* hybrid in his field. The seed was treated with Imidacloprid @ 5g per kg to protect the crop from sucking pests up to 45 days. He completed sowing in last week of June 2002. A fertilizer dose of 60:30:30 NPK was given to the crop. Since he did not spray his field up to 45 days, he could observe natural enemies like ladybird beetles, syrphids and *Chrysopids*, which suppressed the pests to some extent. He gave one spray of Neem Seed Kernel Extract (NSKE) + neem oil 50 days after sowing. During early reproductive phase, he under took regular scouting on 50 plants. Three pheromone traps were set up to monitor bollworm population. During September, he gave one spray of HaNPV and also released 10 *Tricho* cards in the field. When the *Heliothis* incidence crossed the ETL, he gave one spray of Endosulphan. As advised by the TAR-IVLP team, he handpicked larvae for 2-3 days after the insecticide spray. One more spray of synthetic pyrethroid was given during early November. His crop was ready for first picking in the last week of November. To start with, he could not believe that cotton pests could be managed with only 3-4 sprays of insecticides, but having practiced himself and saw the results, he was fully convinced. He could gain an additional Rs. 7,800/- per ha, through adoption of IRM strategy.

Today Sri Dhanraj has realized as to why he was running into heavy loses even after spraying his crop 14 times in a season. He has understood how indiscriminate spraying can harm the beneficial insects.

16. Warangal Farmers Turn to Short Duration Cottons

Cotton production in Warangal district of north Telangana region of Andhra Pradesh suffers from high pest incidence and low yields. It is not surprising that large number of farmers ended their life due to sever indebtedness owing to the vicious circle of high investment - crop failures - low returns. At this stage, TAR-IVLP team members from Acharya N.G.Ranga Agricultural University (ANGRAU) from Warangal met the farmers and helped them to come out of the difficult

Performance of Narasimha variety on farmers field

situation. About 20 farmers from Kommala and Vishwanathapuram villages of Warangal district were trained on cultivation of short duration improved variety, *Narasimha* instead of long duration hybrids during 1999-2000. Besides the crop agronomy, IPM was an important component of the training.

Sri Maila Narsaiah of Kommala village cultivated *Narasimha* on his 1 ha of land. Subsequently 5 other farmers also adopted *Narasimha*. On an average *Narasimha* yielded 2,111 kg/ha of kapas compared 1596 kg/ha realized from hybrid *Brahma* in 20 test sites. The additional benefit due to the intervention was Rs.10,300/ha with a benefit cost ratio of 1.94 compared to 1.39 in farmers' practice. The cost of cultivation for growing hybrid, *Brahma* was Rs.42,220/ha compared to Rs.31,920/ha with *Narasimha*.

These interventions were witnessed by farmers of neighbouring villages. They were convinced about the superior performance of the *Narasimha* variety in their village. A field day was also conducted in Kommala to popularize this intervention. Kommala and Viswanathapuram farmers were advised to gin the kapas and supply the seed to the farmers in neighbouring villages. This became a successful and timely intervention for the farmers in the district. However, they expressed the desire to have varieties with bigger boll size than in *Narasimha*. Taking this feed back, cotton scientists have recommended two more varieties NA-1598 and NA-1678. These varieties were evaluated during 2002 and were found promising.

17. Improved Ragi Production Technology Ensures Household Food Security

Ragi (fingermillet) is the staple food of the people of Bangalore rural district in the eastern dry zone of Karnataka. A group of 20 marginal farmers in Kestur village of Bangalore rural district who own just around 1 ha each always struggled to meet their needs. The land they owned was highly degraded and deficient in nutrients. The ragi (cv *Indaf*-5) they had been growing for years was suffering due to blast. Farmers were able to harvest just about 1.5 t/ha. At this stage the TAR-IVLP team from Indian Institute of Horticultural Research (IIHR) and University of Agricultural Sciences (UAS), Bangalore visited Kestur and had detailed discussion with the farmers. Poor water holding capacity and fertility status of the soils and heavy incidence of blast disease were identified as major constraints for ragi cultivation in Kestur.

Ragi crop (GPU-28) with balanced nutrition on the field of Sri Ramaiah

Sri Muniappa's field with tank silt application

The TAR-IVLP core team organized a training programme to expose the farmers to improved practices of fingermillet cultivation. The training programme was followed by helping the farmers to procure the seeds of GPU-28, a blast resistant variety developed by UAS, Bangalore. Besides encouraging the farmers to apply critical inputs to correct the observed deficiencies (K & Zn), they were also motivated to incorporate tank silt. Farmers applied around 4 tractor loads of tank silt /acre at a cost of Rs.600/-.

Use of a disease resistant variety, correction of deficiencies in soil coupled with enhancement of water holding capacity of soil by tank silt application doubled the ragi yields. Farmers were very happy as they had never harvested such a yield from their crop. They liked blast resistant variety and understood the importance of micronutrient and tank silt application. Each family now is able to produce enough ragi (800 kg/family/year) but also generate some cash income. They began to divert a part of their land to fruits. This clearly shows that once the household food security is met, farmers tend to think of diversification on their own.**Ragi crop (GPU-28) with balanced nutrition on the field of Sri Ramaiah**

18. Kestur Farmers Produce More Banana

Kestur in Bangalore rural district is a vegetable producing village. Farmers suffer from highly fluctuating vegetable yields and prices. Some farmers also cultivate banana. But it was not profitable as they are unable to take ratoon crops. The TARIVLP team from IIHR, Bangalore analyzed the problem and found that the soils were heavily infested with nematodes and pathogenic fungi due to repeated monocropping.

Following a critical study and analysis, the team suggested the following remedies to the farmers.

- Application of *Trichoderma viridae* multiplied in FYM @ 2 kg/tree, once at planting and 3 months after first application.
- Fifty per cent nutrient application through foliar sprays and 50 per cent through soil.
- Growing of short duration vegetables like coriander, french bean, spinach in the first six months of planting the main crop and first 3 months after harvesting of ratoon crop.

Sri Krishnappa among many farmers understood and practiced the recommendations and reaped good profits in first cycle itself. He planted the first crop of banana in 1996 and took 6 ratoon crops earning Rs.17.1 lakh/ha over a six year period. Enthused by this, Sri Murthy who owns just 0.75 acres, planted banana and intercropped it with french beans. Later, he took three ratoons growing coriander as an intercrop. He earned a total of Rs.26,000 through intercrops, besides Rs.54,000 from the banana in the first four years. Sri Murthy says that foliar application of nutrients to banana not only fetched him higher yield but also fruits with better keeping quality. Now, more farmers in Kestur village are taking ratoon crop of banana.

Sri K.P. Krishnappa, the banana farmer with his sixth ratoon crop

Coriander as an intercrop in ratoon banana

19. Improved Pitcher Irrigation Saves on Water

Diversification of agriculture by including tree crops such as tamarind or mango is an insurance against drought. Tree crops have the advantage of using off-season rainfall and taking up nutrients

from deeper layers of soil. Integrated tree farming provides resilience to the rainfed farming system. However, it is challenging to establish tree crops under rainfed conditions. The case in point was Ranga Reddy district, A.P, which has poor soils and receives erratic rainfall. Farmers face frequent crop failures here due to drought. Keeping this in mind, the TAR-IVLP team from CRIDA trained farmers on low cost irrigation systems to establish fruit trees on marginal lands. Sri Chintapalli Narendra Reddy was attracted towards pitcher irrigation system. With this he thought he could fulfil his desire of planting tamarind plants on his farm. He dug out pits of 30x30x60 cm at 10 m distance during January, 1999 in his 2 ha farm. He filled the pits with a mixture of native soil, tank silt and FYM in 1:1:1 ratio. He added 200 g DAP and 50 g furadan granules to each pit. He planted the tamarind saplings (PKM-1) made available to him by CRIDA in July, 1999. He cultivated pigeonpea and mungbean during the first year and castor and cowpea during the second year in the inter spaces. During December, 1999 when a dry spell started, he arranged pitcher irrigation by keeping one pitcher over the ground near every plant. Each pitcher was connected with thin (2 cm dia) PVC catheter (30 cm long) that supplied water droplets at the root zone around the plant. This is the key improvement over the normal pitcher system that supplies water through the wick. In order to minimize evaporation of water from root zone, he also spread rice husk in the basin. Simultaneously a small portion of tamarind plantation was irrigated from Jan-May, 2000 at 10 days interval by pouring water in the basin through pitchers. Both groups of plants performed on par. Sri Reddy observed that through the modified pitcher irrigation, he could save 80% water and labour cost.

Modified indigenous pitcher system with PVC delivery pipe

Tamarind plants irrigated with pitcher intercropped with stylo

Sri Reddy could realize Rs.2,446/ha by cultivating pigeonpea and mungbean and Rs.500/ha from castor in spite of severe drought from the inter spaces. He is hopeful that the tamarind plants will grow and give him bountiful returns in future.

20. Drumstick Nursery Provides Livelihood to Hymavathi

Farmers in rainfed areas find it hard to meet their livelihood needs by growing food crops only. Nursery of horticulture/vegetable crops provides employment and income to all members of the family. Keeping this in view, the TAR-IVLP team from Central Research Institute for Dryland Agriculture (CRIDA), Hyderabad organized training programmes on nursery raising techniques to the IVLP villagers. Smt. B.Hymavathi wife of Sri B.Janardhan Reddy of Meerkhanpet village (Yacharam mandal, Ranga Reddy district) took to raising drumstick seedlings in her nursery. Drumstick being a very popular vegetable has a good market both within and outside the village.

The scientists' team helped Smt. Hymavathi to procure the seeds of improved variety PKM-1 in early 1999. She raised about 500 successful drumstick seedlings by incurring a total expenditure of Rs.616/-, which includes Rs.208/- on manures Rs.200/- on labour, Rs.120/- on irrigation and Rs.88/- other expenses. The cost of producing each seedling was Rs.2.13/-. She sold each seedling for Rs.5/-. Besides, she also planted

Farmer's drumstick (PKM-1) nursery

Well-grown drumstick plants on Hymavathi's field

drumstick on her 0.4 ha plot in July, 2000. She transplanted tomato seedlings in between the drumstick rows. With this, she earned a net income of Rs.6,000/- from her plot. She also collected seeds (10 kg) which could be sold to neighbouring farmers. This gave her ample confidence that through production of seedlings in her nursery she can sustain her livelihood and help other farmers in the village.

21. More Crop per Drop - Rami Reddy - Opts for High Value Crop

Sri A. Rami Reddy from Nasdik Singaram village of Ranga Reddy district in Andhra Pradesh is a small farmer owning just 2.0 ha land. Of this, 0.4 ha is under well irrigation. He used to grow rice on his 0.4 ha irrigated land and leave the remaining land fallow. Shortage of water in the well during *kharif* 1999 placed him in great distress, as he was not knowing what to do with little water. At this juncture, he came in contact with TAR-IVLP team from Central Research Institute for Dryland Agriculture (CRIDA), Hyderabad who suggested crop diversification. The team analysed his problem and suggested to go for curry leaf cultivation with limited irrigation. He took the advice seriously and planted 400 seedlings of curry leaf (cv *Suvasini*) in August 1999 which were supplied by the TAR-IVLP team, CRIDA. He followed complete package of practices like 1m x 1m spacing, fertilizer use, irrigation, harvesting etc as advised by the scientists. Consequently, he mastered the cultivation and progressively increasing yields every year.Curry leaf plantation on Rami Reddy's farm

During first year, he harvested 750 kg fresh leaf/ha, which increased to 1875 and 2375 kg/ha, respectively during the second and third years. He incurred an expenditure of Rs.11250, 3000 and 3000 during the first, second and third years and earned a net profit of Rs.6458/ha/year. By growing rice earlier he used to get Rs.3000/ha/year. He has also been successful in marketing the fresh leaves in nearby urban markets at good price. Many farmers in the villages look towards Sri Rami Reddy with admiration. Some of them intended

Curry leaf plantation on Rami Reddy's farm

Fenugreek as intercrop in curry leaf plantation

to go for crop diversification to use limited water more efficiently.

22. Mohite Produces More Ber

Sri Ravindra Arjun Mohite has around 200 seedlings of *ber* in his orchard in Wadala village near Solapur. This area suffers from poor (550-750 mm) and erratic rainfall. The soils are shallow and coarse loamy, and are not fit for profitable grain crop production. It is difficult to grow even horticulture crops without rainwater conservation methods as the water holding capacity of these soils is very poor. Besides, the organic matter content of the soils was also very low. Thus, it was a fit case for alternative land use.

At this stage, Sri Mohite came in contact with TAR-IVLP team from Mahatma Phule Krishi Vidyapeeth (MPKV), Solapur and learnt about different *in situ* rainwater conservation methods which can help him efficiently use these lands to meet his livelihood needs. He wanted to apply this knowledge in his ber orchard.

Mohite's ber orchard with compartmental bunding

The training programme, besides emphasizing *in situ* rainwater conservation in orchards also dealt about pruning, use of organics like vermicompost and balanced fertilizers, protective irrigation, IPM/IDM and grading of the produce. These interventions proved very useful to Sri Mohite and he did not take time to implement these on his farm. Compartmental bunding before the onset of monsoon and grass mulching around the trunk of the plant after withdrawal of the monsoon helped to conserve maximum moisture. This resulted in higher fruit retention and larger fruit size. Application of *Vermicompost* (15 kg/tree) and fertilizers (500:250:250 g NPK/tree) also contributed to increased quality and quantity of fruits. As a result, he harvested 45 kg fruits/tree even during drought (2001). During the following year, he continued with these practices and obtained a yield of 27,115 kg fruits/ha. With this he earned Rs.1,22,018/ha spending Rs.46,870/-. Thus, his net profit was Rs.75,148/ha. He could engage all his family members in his orchard during most parts of the year. He has now built a new house and is a proud owner of a motor bike.

The message of Sri Mohite's success has spread across the IVLP village and 10 more farmers have come forward to adopt water conservation techniques to improve yields in their ber orchards.

23. Narayan Dambare Becomes a Goat Breeder

Small ruminants are an important component of rainfed farming system in drought prone areas. They are the friends of the poor and insurance against

Graded ber fruits (left) and proud members of Mohite family

An Osmanabadi buck in Dharpal village

Sri Narayan Dambare explaining the benefits of Osmanabadi buck to thevisitors

adversaries. *Osmanabadi* is a popular and hardy goat breed in rainfed areas of Marathwada. However, due to inbreeding and mixing, the productivity of local breed has declined over the years. In order to regain the purity of the breed and bring back glory to goat farmers in Maharashtra, the TAR-IVLP team from Mahatma Phule Krishi Vidyapeeth (MPKV), Solapur introduced pure *Osmanabadi* bucks to Darphal village in Solapur district. Sri Narayan Dambare of Darphal participated actively in this effort. He not only was successful in rearing the introduced animals but also succeeded in purifying the breed.

Earlier Sri Dambare had as many as 10 goats, 15 kids and a buck in his herd. Based on the advice of the TAR-IVLP team, he included an *Osmanabadi* buck in his herd having 20 does (she-goats). He now has about 65 does and 30 bucks in his herd. He took five years to achieve this. He followed all improved practices for goat production including nutrition and health care.

There is a good demand for the goats of his herd. He takes special care to maintain the purity of the breed by culling the off-types. He is now into the fifth generation of pure *Osmanabadi* goat rearing. Over the last few years, he is able to generate an annual income of Rs.7,000/- from goat rearing. Sri Dambare's success shows the potential of local herds-men as selectors and breeders of goat and other small ruminants. The improved goatery not only provides cash income in times of need but also contributes to conservation of popular local breeds.

24. Large Gains from Little Millet

Sri Basavaraj Hajeri of Madanbhavi village near Dharwad, Karnataka is a small farmer. In his rainfed land he was growing a local variety of littlemillet for several years. He was struggling to meet the family needs as the yields were very low. When he came in contact with TAR-IVLP team from the University of Agricultural Sciences (UAS), Dharwad, he was excited to know about an improved variety of littlemillet TNAU-63. The scientists of UAS, Dharwad gave about 3 kg of this improved littlemillet seeds and encouraged Sri Hajeri to go for seed production on his 1 acre plot in *kharif* 2001. On the remaining part of his land, he decided to grow the local variety. With little further support, he

Performance of littlemillet (TNAU-63) in IVLP villages of Dharwad

realized 550 kg littlemillet from his 1 acre plot while he could harvest only 400 kg/ac from the adjoining area where he grew the local type. Sri Hajeri was also happy with the superior quality of fodder of TNAU-63.

He retained 100 kg littlemillet for himself and sold the remaining quantity as seed to his neighbours and relatives in the IVLP village. The TAR-IVLP team also purchased about 100 kg seeds of TNAU-63 and distributed it to other IVLP farmers. Thus, the improved variety spread to about 60 ha in *kharif* 2002 within and outside IVLP village. Within two years, the improved variety has spread far and wide by a simple intervention through TAR-IVLP. Now most of the farmers who came to know about this variety are growing and selling a part of their produce for seed purpose to other farmers at higher price. This initiative has not only improved the grain and fodder yield of littlemillet but also triggered the most needed local village level seed production and distribution.

25. Rejuvenation of Old Cashew Garden Ushers in New Era in Hodawade

Hodawade villagers in Konkan region grow cashew in homesteads. However, these cashew trees are non descript local seedlings with low productivity and poor quality. Sri Ramachandra Balwant Parab, a farmer from the village got in touch with TAR IVLP team from Konkan Krishi Vidyapeeth, Vengurle. The scientists examined the problem and decided to try the novel technique of coppice grafting (top working) developed at the Regional Forest Research Station (RFRS), Vengurle to improve the productivity of local cashew plants with least expense and to realize the benefits quickly.

Coppice grafted cashew trees

The high yielding cashew varieties introduced are *Vengurla*-4 and *Vengurla*-7. Local seedlings of 5 to 10 years age were selected and stumped at the height of 75 cm from ground level in the month of December. The stumped trees were treated with 0.1 per cent Carbaryl to protect the tree from cashew stem and root borer. A number of shoots sprouted around the cut stump within 45 days. About 3 to 4 shoots from each plant were grafted by using scion sticks of new varieties of *Vengurla*-4 and *Vengurla*-7. The survival of the grafts was more than 80 per cent. The grafted trees started yielding with in two years. From the grafted shoots, only 2 shoots were allowed to grow. Necessary measures were taken to control tea mosquito bug.

After two years, the grafted trees produced 2-3 kg mature nuts/plant, twice as much as produced by old trees. As a result, other farmers in the village showed great interest towards adoption of this technology. Sri Balwant Parab and several other farmers in the village rejuvenated old cashew plants in their homesteads and grafted with improved high yielding varieties. Thus coppice grafting ushered in a new era of homestead cashew cultivation in several villages of Konkan region.

26. Mohan Dangi Triggers Onion - Revolution in Morjhai

Farmers in Morjhai village in Udaipur district, Rajasthan have been growing onions for several years, though on a limited scale. After witnessing good cash returns recently, they wanted to expand the area. However, since the variety they are growing is a local non-descript they are unable to improve productivity despite their best efforts.

At this stage, they came in contact with the TAR-IVLP team from the Maharana Pratap University of Agriculture and Technology (MPUAT), Udaipur. The team of scientists explained to the Morjhai farmers that there are possibilities of increasing their income through adoption of better varieties and improved production technology. During *kharif* 2000, the seed of cv. *Nashik*

Improved onion 'Nashik Red' on Dangi's field

Cotton (LRK-516) on shallow vertisols

Red was distributed to 10 farmers in the village.

Sri Mohan Dangi one of the progressive farmers explained that he has been growing local onion largely for home consumption. He received 500 g seed of variety *Nashik Red* from the scientists. He was also trained on raising nursery, and scientific package or practices, time of sowing, fertilizer dose, spacing and plant protection. Sri Dangi harvested 135 t/ha of *Nashik Red* variety , which was 38% more than his local (98 t/ha) with a B:C ratio 1.58 compared to 1.20 with local onion.

Sri Dangi earned Rs.3,200/- from 0.05 ha area. He further explained that, though his family prefers *desi* variety due to its lower pungency, he opted for *Nashik Red* for cash income. More than 20 other farmers of the area have adopted this variety. Now, the farmers are brining the seed of *Nashik Red* on their own without any assistance from the University. The farmers observed that the keeping quality of *Nashik Red* was better as compared to *desi* variety. Now the variety is rapidly spreading in the surrounding villages.

27. Matching Cotton Variety to Land Capability

Cotton is one of the most common crops of Vidarbha region in Maharashtra. Nearly 60% of the area is deep and medium deep vertisols where hybrid cotton can produce sustainable yields. On the remaining 40% of the area with shallow soils also farmers grow hybrid cotton despite the fact that the soil depth and water storage capacity of the soil do not support long duration cotton hybrids. Since Vidarbha region experiences long dry spells during October-November, which coincides with square and boll development, cotton crop suffers significant yield losses. Major problem in this region is the boll shedding in cotton hybrids. Moreover, due to sub optimal nutrient application, farmers realize only 70% of the yield potential.

The TAR-IVLP team from the National Bureau of Soil Survey and Land Use Planning (NBSS&LUP) from Nagpur visited Kaniyadol village in Nagpur district and met three farmers Sri Gokul Uttane, Sri Manohar Dongare of Kokarda and Sri Anil Band. These farmers were growing hybrids in shallow soils and suffering losses. The scientist discussed with the farmers various options available to overcome the constraints faced by them. The key intervention was introduction of variety LRK 516, adoption of closer spacing of 60 X 60 cm and balanced nutrition through INM. This variety was more suitable to shallow to medium deep soils as compared to hybrids. The improved technology was demonstrated on 8 farmers' fields during 2001-02 and 13 farmers' fields during 2002-03. The intervention became highly successful. LRK 516 in shallow soils gave Rs.28,000/- higher net returns than the existing hybrids. This additional yield of 40% was realized with only 14% of additional investment. The success of the 3 farmers in Kaniyadol and Kokarda villages motivated several other farmers in neighbouring villages to adopt the technology.

28. Pulse Seed Village

Bundelkhand region of U.P contributes 30% of the total pulse production in U.P. Most of this area is rainfed. Farmers in this region normally grow local

varieties and retain their own seed for next year planting. The local seeds used by the farmer are not only genetically inferior but also is a mix of many varieties. Though improved varieties have been introduced on a limited scale, the availability of seed still remains a major constraint in the region due to lack of seed production efforts and distribution system.

Scientists from TAR-IVLP project of Indian Institute of Pulses Research (IIPR), Kanpur visited one of the villages and trained the farmers on producing their own seed of improved varieties. The village of Vidokhar in Hamirpur district was selected during 2000-01 to introduce the seed village concept. Chickpea and lentil are the major *rabi* pulses in the village. Based on the soils and prevailing cropping pattern the scientist team introduced JG 315 and KWR 108 of chickpea and DPL 62 of lentil. Farmers were also trained on proper storage of seed for next year planting. During 2001-02 the farmers were provided with 1000 kg of chickpea and 400 kg of lentil. Some of the farmers who were supplied of chickpea and lentil during the year 2000-01 retained the seed for their own use and made the rest available to other farmers. Through these efforts by the *rabi* season of 2001-02, the total area covered under chickpea and lentil in the village went upto 40 and 5 ha, respectively.

Observing the performance of the improved varieties over the local seed, farmers from the neighboring villages purchased 55 q of JG 315 from Vidokhar village. The seed production gained further momentum during *rabiseason (*2002-03) when 115 q of JG 315, 70 q of JG 322 and 20 q of KWR 108 of chickpea and 26 q of DPL 62 of lentil were produced in the Vidokhar village. The farmers not only met their seed requirement but also sold more than 100 q of chickpea seed and 6 q of lentil to farmers in the neighbouring villages of Pandhari, Tikrouli, Ingohta, Patanpur, Nandhera, Mawei, Banda, Bhabhaunra, Devgaon in Sumerpur block of Hamirpur district. In the Vidokhar village itself, 319 ha under chickpea and 80 ha under lentil was covered during 2002-03 with quality seed. Vidokhar farmers experienced the performance of improved varieties of chickpea and lentil and they are convinced that the best approach to get seeds of these varieties is to produce them in their own village.

Wilt resistant DPL 62 variety of lentil (left) and
Chickpea (right) grown in a large scale for seed production

CHAPTER

11

Training, Capacity Building and Documentation

Capacity Building

New Technological interventions in rainfed agriculture are necessary to augment productivity, profitability and livelihoods of farm families. This calls for updating the knowledge and skills of the farm families through various means, modes and methods. It necessiated organizing programmes wherein the stakeholders could be getting a first hand information about the potential of new intervention in improving the efficiency over existing techniques, reduction in cost of cultivation, additional benefit in economic terms, substitution of farm labor in peak seasons, starting new enterprises etc., In this context TAR-IVLP centers conducted (1,185) training programmes on crop production, cropping systems, IPM, dryland horticulture, improvement in productivity of livestock with participation of (40,925) farmers from the inception of the project activities. The details are depicted in **Annexure IV**. Besides training on crop production technology, focus was given to skill oriented programmes for farm women, reduction of drudgery in agricultural operations, importance of weaning for infants, care during feeding and poshak preparation, use of millets in diet, nutritious food for children and hygienic practices, entrepreneurship for women self help groups and training on vermin culture, mushroom production, etc.

Training programmes conducted under TAR-IVLP in Rainfed Agro-Ecosystem

Publications

Information on new crop varieties, breeds and suitable techniques assessed successfully were disseminated through publications, All India Radio and Doordarshan. Publications were made in 34 referred journals and as technical bulletins, (8) extension bulletins/folders/brochures, (34) Training manuals, (6) Popular articles, (67) News letters (15) Leaflets (46) and data base in the form of CD in video coverage (2). Pamplets/leaflets were broughtout in Telugu, Orria, Hindi, Marathi, Kannada and English. Besides this, 59 scientific/technical papers were presented in symposia and seminars for highlighting the achievements. The list of publication are shown in **AnnexureVI** and **Annexure VII** which include referred journals, technical bulletins, pamplets etc. Mass media channels in the form of Ratio Talk (8), Television broadcasts (19) and New papers (50)

Farmers attending training on mushroom cultivation and vermi compost

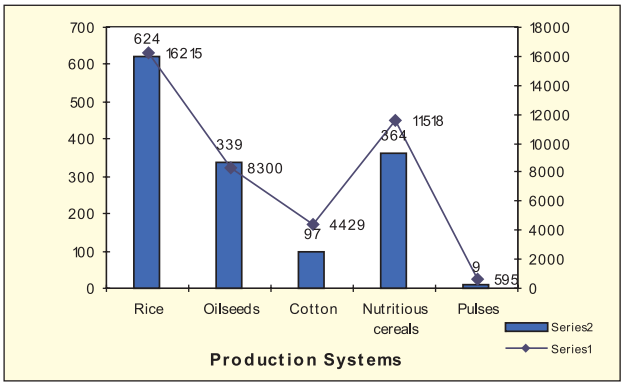


Fig 23. Training programmes conducted under TAR-IVLP in Rainfed Agro-Ecosystem

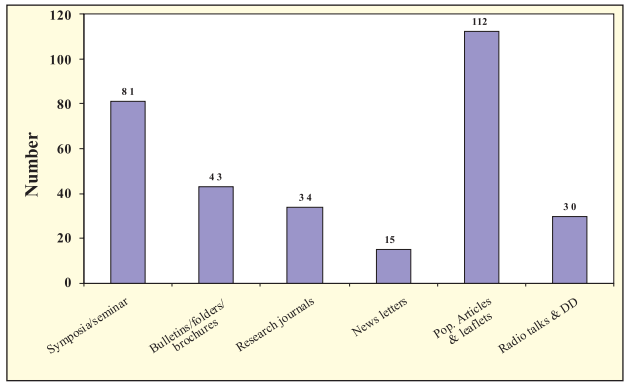


Fig 24. Publications from TAR-IVLP under Rainfed Agro-ecosystem (1999-2005)

were utilized for wider reach to the stakeholders and to generate interest among the rural mass about new developments in rainfed agriculture. The important technologies popularized through Radio includes appropriate varieties and cropping systems in rainfed uplands of Ranchi (Jarkhand), role of farm women in field of agriculture, mushroom cultivation, commercial cultivation of tomato in Koraput and Bhubaneswar (Orissa), integrated pest management on cotton at Akola and Nagpur, control of pod borer in pigeonpea at Hyderabad, IPM technologies in pulses at Kanpur, backyard poultry at Koraput and Ranchi, fodder production technology at Jhansi, watershed management of sorghum based cropping systems, and drought management at Nagpur and Hyderabad. The adopted villages were visited by eminent dignitaries like World Bank Team and higher officials viz., National Director/ Coordinator (NATP), Deputy Director General/ Assistant Director General of ICAR from time to time for overall review of programme, interaction with the farmers, to appraise themselves of the ground level impact.

Dr.P.Das, DDG(Agril.Extension) interacting with team members of IVLP at Raipur

Dr.H.P.Singh, Rainfed AED, discussing with IVLP farmers at Udaipur

CHAPTER

12

Monitoring and Evaluation

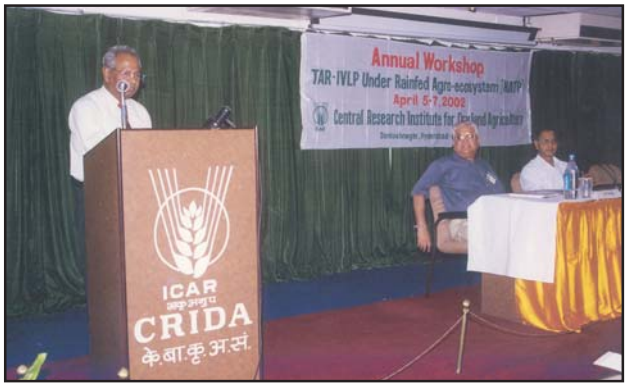
A structured monitoring and evaluation (M&E) system was followed to review the progress of TAR-IVLP projects under Rainfed Agro Ecosystem during the last 5 years. It was mainly based on the "Guidelines for Monitoring and Concurrent Evaluation of sub projects under NATP" brought out by IASRI, and PIU, NATP. The M &E of TAR-IVLP projects consisted of following: Annual workshops organized by AED, Site Committee Meetings for internal review of the projects at SAU/ICAR institute level, and Peer Review Teams (PRTs) for external review consisted by SAP/AED.

Annual Workshops

As per NATP guidelines, monitoring and evaluation were initiated by AED, (Rainfed) from 1999 onwards. The technical programme of different TAR-IVLP centers under different production systems were discussed and finalized in April 1999 and February, 2000 at CRIDA followed by University of Agricultural Sciences, Dharwad during November, 2002, IIPR, Kanpur in February, 2003 and CRIDA, Hyderabad in November, 2004. These workshops were organized by Director, AED (RF) under the chairmanship of DDG Extension, ICAR. (**Annexure IX**)

Project Review Teams

The PRTs were constituted with the members of the nominee of the ICAR (DDG, Agricultural Extension) representative from Rainfed Agro-Ecosystem Directorate headed by external member as a chairman to monitor the progress of TAR-IVLP centers. The team visited selected centers of Hassan (KVK, Hassan), Bangalore (IIHR, Bangalore) Dharwad (UAS, Dharwad), Solapur (MPKV, Rahuri), Koraput (OUAT, Bhubaneswar) and Warangal (ANGRAU, Hyderabad)) from July-November, 2002. The progress of the activities in terms of budget utilization, procurement of equipments, implementation of technology modules were reviewed.



Dr.S.V.Patil welcoming delegates during TAR-IVLP workshop

Participants acquainting the activities at IVLP villages at Dharwad

Dr.Y.S Ramakrishana, Director Rainfed Agro-Ecosystem brifing the activities of NATP during World Bank team visit at CRIDA

Site Committee Meetings

The Nodal Officers of SAUs and ICAR institutes organized the site committee meetings to review the progress of the various activities of various PSR projects including TAR-IVLP from 1999-2000 onwards. The core team members of NATP Directorate, Rainfed Agro Ecosystem participated in the meetings and suggested measures to improve the quality of the technology modules along with improvements to be made in administrative and financial aspects. (**Annexure VIII**)

Annual Progress Reports

Progress of the TAR-IVLP centers under Rainfed Agro Ecosystem was monitored and evaluated through quarterly, half-yearly and annual progress reports in each year. Further, the progress of the activities was reviewed by preparing consolidated report of TAR-IVLP centers for the years 1999-2001, 2001-02, 2002-03 and 2003-04. Besides, Rainfed Agro Ecosystem documented the impact of this technology by documenting 87 success stories over three years. (**Annexure V**)

Visit of core team members of AED (RF) to TAR-IVLP centers

As a part of monitoring and evaluation AED (RF), PPSS, NATP and Coordinator (TAR-IVLP) visited centers at Ranchi (BAU, Ranchi), Koraput (OUAT, Bhubaneswar) and CRRI, Cuttack, Warangal, (ANGRAU), Solapur (MPKV), Udaipur, (MPUAT), Ajmer (RAU, Bikaner), IIHR, Bangalore, IIPR, Kanpur, UAS, Dharwad, Vengurle, (KKV, Dapoli), Jabalpur (JNKVV, Jabalpur) and NRCRM, Bharatpur during 2001 to 2003. The progress of the above centers was reviewed for technical, financial and administrative parameters.

Monitoring of peer review team at Vengurli (left) Solapur (right)

Acronyms

AAU	Assam Agricultural University
AED	Agro Ecosystem Directorate
AES	Agro-Eco System
ALU	Alternate Land Use system
ANGRAU	Acharya N.G. Ranga Agricultural University
ATMA	Agricultural Technology Management Agency
AWC	Available Water holding Capacity
BAU	Birsa Agricultural University
B:C	Benefit Cost Ratio
BGA	Blue Green Algae
CAZRI	Central Arid Zone Research Institute
CIAE	Central Institute of Agricultural Engineering
CRIDA	Central Research Institute for Dryland Agriculture
CRIJAF	Central Research Institute for Jute and Allied Fibers
CRRI	Central Rice Research Institute
CS	Cropping System
DDG	Deputy Director General
FMD	Foot and Mouth Disease
HYV	High Yielding Variety
ICAR	Indian Council of Agricultural Research
ICM	Integrated Crop Management
ICT	Intermittent Contour Trenches
IGAU	Indira Gandhi Agricultural University
IGFRI	Indian Grassland and Fodder Research Institute
IIHR	Indian Institute of Horticultural Research
IIPR	Indian Institute of Pulses Research
INM	Integrated Nutrient Management
IPM	Integrated Pest Management
IPNM	Integrated Plant Nutrient Management
IPNS	Integrated Plant Nutrient System
ITD	Innovative Technology Dissemination
ITK	Indigenous Technical Knowledge
IWM	Integrated Weed Management
JNKVV	Jawaharlal Nehru Krishi Vishwa Vidhyala
KVK	Krishi Vignan Kendra
LGP	Length of Growing Period
LPS	Livestock Production System
MAU	Marathwada Agricultural University
MPUA&T	Maharana Pratap University of Agriculture & Technology
MPKV	Mahatma Phule Krishi Vidyapeeth
NATP	National Agricultural Technology Project
NCAP	National Center for Agricultural Economics and Policy Reserach
NGO	Non Government Organization
NPV	Nuclear Polyhydrosis Virus
NRCG	National Research Center for Groundnut
NRCRM	National Research Center for Rapeseed & Mustard
NRCS	National Research Center for Sorghum
NRM	Natural Resource Management
NSKE	Neem Seed Kernal Extract
OFT	On Farm Trials
OUAT	Orissa University of Agriculture and Technology
PDKV	Punjabrao Deshmukh Krishi Vidyapeeth
PHT	Post Harvest Technology
PHVA	Post Harvest Value Addition
PLA	Participatory Learning and Action
PPSS	Principal Production System Scientist
PRA	Participatory Rural Appraisal

PRT	Peer Review Team
PSB	Phosphate Solubilizing Bacteria
PSR	Production System Research
RAU	Rajasthan Agricultural University
RDF	Recommended Dose of Fertilizers
RF	Rainfed
SAP	Scientific Advisory Panel
SAT	Semi Arid Tropics
SAUs	State Agricultural Universities
SHG	Self Help Groups
TAR-IVLP	Technology Assessment and Refinement through Institute Village Linkage Programme
UAS	University of Agricultural Sciences

Annexure I

Details of the TAR-IVLP centers under rainfed agro ecosystem

S.No	Name of the TAR-IVLP	Implement-ing center	Started during	Adopted villages
Rice based production system				
1.	Technology assessment and refinement through Institute Village Linkage Programme for central and western plateau, agro climatic zone in Ranchi district (RFIVLP-01)	BAU, Ranchi	1999	Karge, Rege, Chatwal, Hatma, Keshkani-Kumbatoli, Rajaulatu, Tutihara, Chene, Rampur, Sogod, Sinjusereng, Jamchuan, Jariya-Saritoli, Chhota Kawaii & Bara Kawaii
2.	Technology assessment and refinement in southern rainzone of Hassan district under rainfed agro ecosystem (RFIVLP-05)	KVK, Hassan	1999	Doddagaddavallil, Chikkagaddavalli, Kalkere Hosur, Sanenahalli, Anuganallu, Kudaragundi, Jogipura, Kittinakere, Kattahalli, Anachalli, Kindipura, Thimmanahalli
3.	Technology assessment and refinement of rice based production system through institute village linkage programme under rice based production system for chattisgarh plains (RFIVLP-07)	IGAU, Raipur	1999	Chatiud, Tarra, Dhansoli, Torgaon, Malia, Saragaon, Murethi, Barbanda, Jaroda, Pacheda
4.	Technology assessment and refinement of rice based production system through institute village linkage programme for rainfed areas of Cuttack district, Orissa (RFIVLP-08)	CRRI, Cuttack	1999	Berena, Mangrapur, Kuchalanuagaon, Ramchandrapur, Raghunathprasadm, Ambili Jhari
5.	Technology assessment and refinement of rice based production system through institute village linkage programme under NATP in eastern ghat highland zone of the rainfed ago-ecosystem (RFIVLP-09)	KVK, Koraput	1999	Tutuliguda, Kakeriguda, Pakjhola, Sundhiput and Aligaon OUAT, Bhubaneswar
6.	Technology assessment and refinement of rice based production system through Institute Village Linkage Programme in the rainfed Agro-Eco system of central Brahmaputra Valley zone of Assam (RFIVLP-11)	AAU, Naogaon	1999	Bhomoraguri, Naltoli, Jamkhola, Santipur, Deuri Chilabondha and Jengoni Salpara
Oilseed based production system				
1.	Technology assessment and refinement of oilseed based production system through Institute Village Linkage Programme (RFIVLP-12)	NRCG, Janagadh	1999	Zanjarda, Umatwada, Nandarkhi and Vachavi

S.No	Name of the TAR-IVLP	Implementing center	Started during	Adopted villages
2.	Technology assessment and refinement of oilseed based production system through Institute Village Linkage Programme under oilseed based rainfed AES in Vindhyachal Plateau of MP (RFIVLP-16)	CIAE, Bhopal	2000	Mugalia-hat, Kurana, Ratibad, Khajuri, Binapur and Ratatal
3.	Technology assessment and refinement of oilseed based production system through (RFIVLP-17)	NRCRM, Bharatpur	2000	Khanua, Jogi Ka Nagla, Kalua Ka Nagla, Odi Ka Nagla, Banjara Ka Nagla
4.	Technology assessment and refinement of oilseed based production system through Institute Village Linkage Programme for Malwa region (RFIVLP-18)	NRCS, Indore	2000	Bhagora, Borekhedi, Ambachandan, Kutkut Khedi
5.	Technology assessment and refinement of oilseed based production system through IVLP under rainfed AES of Narsinghpur & Jabalpur district of MP (RFIVLP-19)	JNKVV,	2000	Khajuri, Dhamna, Supla, Malahpiparia Jabalpur
Cotton based production system				
1.	Technology assessment and refinement of cotton based production system through Institute Village Linkage Programme under rainfed agro eco system (RFIVLP-03)	PDKV, Akola	1999	Akola, Patur, Gorwha, Shiwapur
2.	Technology assessment and refinement of cotton based production system through Institute Village Linkage Programme under rainfed agro eco system (RFIVLP-13)	ANGRAU, Warangal	1999	Kommala and Viswanthapuram
3.	Technology assessment and refinement of cotton based production system through Institute Village Linkage Programme under rainfed agro eco system (RFIVLP-14)	KVK, Ajmer	1999	Saradhana, Mayapur, Tabiji, Daurai and Nadi
4.	Technology assessment and refinement of cotton based production system through Institute Village Linkage Programme under rainfed agro eco system (RFIVLP-15)	CICR, Nagpur	2000	Telgaon and Tisti
Nutritious Cereals based production system				
1.	Technology Assessment and Refindment of Nutritive cereal based Rainfed Agro-Eco system (RFIVLP-02)	CRIDA, Hyderabad	1999	Nallavelli, Naziksingaram, Manmarri, Antaram
2.	Technology Assessment and Refinement through Institute Village linkage programme in Eastern Dry Zone of Karnataka (RFIVLP-04)	IIHR, Bangalore	1999	Kestur, Neralegatta, Menasi, Kuntanahalli, Somashettahalli

S.No	Name of the TAR-IVLP	Implementing center	Started during	Adopted villages
3.	Technology Assessment and Refinement through Institute Village Linkage Programme in Sindhudurg district (Maharashtra) (RFIVLP-10)	KVK, Dapoli	1999	Hodawade, Tulas
4.	Technology Assessment and Refinement through Institute Village Linkage Programme under Rainfed Agro-Eco system (RFIVLP-06)	MPKV, Solapur	1999	Wadala, Darphal, Ratanjan, Hatij, Raleras
5.	Technology Assessment and Refinement of Nutritive Cereal based Rainfed Agro Eco-system through Institute Village Linkage Programme for Northern Karnataka (RFIVLP-21)	UAS, Dharwad	2000	Mugali, Madanbhavi, Hosatti, Kurubagatti, Mangalagatti, Mulamuttala
6.	Technology Assessment and Refinement through Institute Village Linkage Programme for Nutritive Cereal based Rainfed Agro Eco-system for Bundelkhand Region (RFIVLP-22)	IGFRI, Jhansi	2000	Algi, Sanora, Garera and their hamlets in Datia/Shivapuri districts
7.	Technology Assessment and Refinement (TAR) through Institute Village Linkage Programme for Sub-Humid Southern Plan and Aravali Hills for Rainfed Agro-Ecosystem (RFIVLP-23)	MPAU, Udaipur	2000	Bhopalpura, Siyakhedi, Dhamania, Roopawali, Bagthal
8.	Technology Assessment and Refinement of Cereal Based Agro Eco-System through Institute Village (Kokarda and Kaniyadol) Linkage Programme in Eastern Maharashtra Plateau (RFIVLP-24)	NBSSLUP, Nagpur	2000	Kokarda, Kaniyadol
Pulse based production system				
1.	Technology Assessment and Refinement of Pulse-based Rainfed Agro-Ecosystem through Institute Village Linkage Programme for Buldelkhand Region (U.P)" under Production System Research Mode (RFIVLP-20)	IIPR, Kanpur	2000	Makaron, Vidokhar

Annexure II

Progress indicators of TAR-IVLP under different Rainfed Agro Ecosystem(1999-05)

Parameters	Rice (6)	Oilseeds (5)	Cotton (4)	N.Cereals (8)	Pulses (1)	Total (24)
OFTs						
1999-00	129	4	48	104	-	285
2000-01	128	66	54	177	27	452
2001-02	132	72	70	223	38	535
2002-03	194	160	114	283	36	787
2003-04	142	79	88	192	20	521
2004-05	116	63	70	200	0	449
Total	841	444	444	1179	121	3029
VTs						
1999-00	117	4	30	72	0	223
2000-01	117	58	54	148	15	392
2001-02	141	89	71	166	34	501
2002-03	144	109	70	238	35	596
2003-04	55	37	46	115	15	268
2004-05	50	36	24	68	0	178
Total	624	333	295	807	99	2158
Area in ha						
1999-00	1472	28	371	531	-	2402
2000-01	1504	301	408	770	315	3298
2001-02	1537	437	534	1208	315	4031
2002-03	1889	656	1040	1359	288	5232
2003-04	1889	656	1040	1359	288	5232
2004-05	622	2014	1091	1401	0	5128
Total	8913	4092	4484	6628	1206	25323
No.of farmers						
1999-00	3679	70	928	1327	0	6004
2000-01	3760	753	1020	1924	787	8244
2001-02	3842	1093	1336	3021	787	10079
2002-03	6349	2370	3450	4484	750	17403
2003-04	6349	2370	3450	4484	750	17403
2004-05	5109	1120	1622	5290	0	13141
Total	29088	7776	11806	20530	3074	72274
No.of Villages Covered						
1999-00	24	4	5	7	-	40
2000-01	23	16	5	23	3	70
2001-02	30	16	7	26	3	82
2002-03	20	10	6	17	1	54
2003-04	20	10	6	17	1	54
2004-05	49	27	24	23	0	123
Total	166	83	53	113	8	423

Values in parentheses indicate number of centers involved.

Annexure III

List of TAR -IVLP success stories

1. Rice-based production system

A. Crops and cropping systems

1. Profitability of hybrid rice in Konkan region of Maharashtra - Vengurle
2. Sali rice variety for timely sowing of rabi crops- Nagaon
3. Production technologies refined by IVLP- TAR brought prosperity in the life of rainfed farmers - Cuttack
4. Double cropping in rainfed areas of Jharkhand - Ranchi
5. Double the yield of fingermillet in Jharkhand - Ranchi
6. Marigold as alternative crop in upland rainfed areas- Ranchi
7. Increased productivity of ragi under rainfed condition - Hassan
8. Increased productivity of maize under rainfed situation -Hassan
9. New high yielding groundnut varieties to boost yield -Vengurle

B. Integrated nutrient management

1. Integrated nutrient management in *Sali* rice- Nagaon

C. Rainwater management

1. Increased productivity of rice under tank fed irrigation - Hassan

D. Integrated pest management

1. Integrated disease management for high yields of potato - Hassan

E. Horticulture

1. Plasticulture for raising vegetable seedlings - Nagaon
2. Sustaining mango yield by paclobutrazol and blossom protection- Vengurle
3. New genotype of chilli for bumper yield in IVLP villages of Vengurle - Vengurle
4. Coppice grafting for bumper yield of cashewnut - Vengurle

F. Livestock

1. Crossbred goat rearing boost poor farmers economy in Jharkhand region - Ranchi
2. Boosting farmer's economy through improved pig rearing in Jharkhand - Ranchi
3. Sheep upgradation - A new avenue of income generation of triba1's of Korput - Koraput
4. *Vanaraja* poultry bird in backyard - A boon for tribal farmers of Koraput region (15) - Koraput
5. Improved management technology of picsiculture - Nagaon

G. Livelihoods

1. Lac culture: A boon for tribal fanners of Jharkhand - Ranchi
2. Mushroom production: A gainful employment for farm women - Ranchi
3. Economic upliftment of rural women through income generating activities - Ranchi
4. Introduction of apiary unit in Nagaon - Nagaon
5. Mushroom production for income generation - Raipur

2. Oilseed-based production system

A. Crops and cropping system

1. Groundnut + pigeon pea cropping system - Junagadh
2. Benefits of deep tillage in groundnut - Junagadh
3. Participatory seed village programme in soybean - Indore
4. Improved management practices on productivity of wheat in groundnut based system - Junagadh
5. Marigold as alternate crop for soybean - Bhopal

B. Rainwater management

1. Rainwater management in rain fed Vertisols - Indore

C. Farm machinery

1. Use of power cleaner-cum-grader as post harvest technology - Bhopal
2. Use of groundnut decorticator for cost reduction - Bhopal

D. Integrated pest management

1. Management of collar rot and stem rot in groundnut - Junagadh
2. Management of yellowing in groundnut - Junagadh
3. Management of pod borer in chick pea through intercropping in mustard - Junagadh

E. Horticulture

1. Inter cropping of turmeric in mango orchard - Bhopal
2. Hybrid tomato for higher profitability - Bhopal

3. Cotton-based production system

A. Crops and cropping systems

1. Improved cotton variety for higher yields- Warangal
2. Optimal plant density for higher payoffs in cotton - CICR, Nagpur
3. Marigold in citrus based inter-cropping system- CICR, Nagpur
4. Bt Cotton brings the smile - CICR, Nagpur
5. Cotton variety LRK-516 for rainfed shallow to medium deep Vertisols - NBSS & LUP, Nagpur
6. Maize + fieldbean system for high profitability with cotton - Warangal

B. Integrated nutrient management

1. Integrated nutrient management in cotton hybrid (NHH -44) - NBSS & LUP, Nagpur

C. Integrated pest management

1. Management of pink bollworm through cotton-sesamum crop sequence - Warangal
2. nsecticide resistance management: environment friendly way - CICR, Nagpur
3. Integrated pest management in cotton (65) - Dharwad

D. Livestock

1. Improved poultry breeds for better economic returns in backyards - Warangal
2. Agri-sheep farming system in marginal agricultural lands - Warangal
3. Osmanabadi goat for bringing cheers in rainfed farmers - CICR, Nagpur

4. Nutritious cereal-based production system

A. Crops and cropping systems

1. Tank silt application for increasing ragi yield in rainfed Alfisols - IIHR, Bangalore
2. Impact of introduction of new variety of little millet- Dharwad
3. Pigeonpea as an intercrop in littlemillet - Dharwad
4. Transfer of sorghum production technology - NBSS & LUP, Nagpur
5. Performance of improved sorghum variety in Bundelkhand region - Jhansi
6. Hyderabad-3c pigeonpea - a boon to cash starved farmers -IIHR, Bangalore
7. Transfer of soybean production technology - NBSS &LUP
8. Improved fodder maize and sorghum - A boon to dairy farming - NBSS &LUP
9. Better results in limited irrigation in wheat - Jhansi
10. Chickpea is a rich source of protein for rainfed farmers of Bundelkhand - Jhansi
11. Multipurpose crop - Barley - Jhansi

B. Rain water management

1. Rain drops for wealth drops - Hyderabad
2. In-situ rainwater conservation on bumper ber harvest - Solapur
3. Rainwater conservation leads to wealth generation - Solapur
4. Signal grass on bunds for low cost forage production - Dharwad

C. Integrated pest management

1. Soap from non-edible oil as a botanical for increasing marketable yield of cabbage - IIHR, Bangalore

D. Horticulture

1. Pitcher irrigation for establishment of tamarind in rainfed Alfisols - CRIDA
2. Reintroduction of brinjal in vegetable based cropping system - IIHR, Bangalore
3. More ratoons and better land utilization for higher income in banana based cropping systems - IIHR, Bangalore
5. Foliar nutrition to establish banana as an alternate crop in resource poor situation - IIHR, Bangalore
6. *In-situ* method of grafting - a cost effective and sustainable technology for successful establishment of mango orchards in rainfed, marginal/eroded soils - Dharwad
7. Benefits of improved varieties of onion - Udaipur

E. Livestock

1. Improvement in local goat herd through Osmanabadi buck - Solapur
2. Response of mineral mixture supplementation in lactating cows/buffaloes - Jhansi

F. Livelihood

1. Farmer- led nursery and crop diversification - CRIDA , Hyderabad
2. Concept of seed village (castor) in IVLP villages of Rangareddy District - CRIDA, Hyderabad
3. Vermicomposting - for sustainability of family income and productivity of orchards - NBSS &LUP, Nagpur
4. Vermicomposting - A boon for farmers - Udaipur

G. Crop diversification

1. Curryleaf production under limited irrigation - CRIDA, Hyderabaad
2. Drumstick as an alternate crop under crop diversification in dryland - IIHR, Bangalore

H. Gender issues

1. Poshak - Food for infants - Dharwad
2. Ball bearing chuffier - a boon to farm women - Udaipur

5. Pulse-based cropping system

A. Crops and cropping systems

1. Intercropping for achieving higher profit- Kanpur

B. Integrated pest management

1. Management of pod borer in pulses through neem based products - Kanpur

C. Livelihood

1. Pulse Seed Village - Kanpur

Annexure IV

Training programmes organized and number of farmers covered

	1999-01		2001-02		2002-03		2003-04		2004-05		Total	
	A	B	A	B	A	B	A	B	A	B	A	B
Crop Production- Varieties, Cropping System, INM, etc.	1	50	75	1444	80	2459	53	1584	91	3692	300	9229
Pest and disease management	1	50	22	492	47	1491	40	1936	51	2534	161	6503
Horticulture, medicinal plants, agro- forestry, etc.	-	-	19	464	17	477	14	334	27	1034	77	2309
Livestock production	-	-	32	687	28	1058	23	996	38	1641	121	4382
Integrated farming system/NRM/ organic farming	166	6093	5	75	12	402	12	603	10	428	205	7601
Women- SHG, value addition, mushroom production etc	-		78	1042	27	834	20	722	39	1692	164	4290
Others	-		34	293	36	1811	37	1695	50	2812	157	6611
Total	168	6193	265	4497	247	8532	199	7870	306	13833	1185	40925

A - Nos of training; B - Nos of farmers covered

Annexure V

List of documents brought out by AED (Rainfed)

S.No.	Title	Year	No. of pages
1.	Annual progress report TAR - IVLP (1999-2001)	April, 2002	95
2.	Indigenous technical knowledge in Rainfed Agriculture	October, 2002	69
3.	Annual progress report TAR - IVLP under Rainfed Agro-ecosystem (2001 -2002)	May, 2003	94
4.	TAR - IVLP success stories	December, 2003	32
5.	Achievements at a glance - TAR-IVLP	March, 2004	8
6.	Annual progress report TAR - IVLP under Rainfed Agro-ecosystem (2003 -2004)	October, 2004	90
7.	A new concept in better technology adoption	2004	30

Annexure VI

Research Publications

Research Journals

Baura, N. C., Dehuri, P. K., Dixit, L. and Parida, G. S. 2002. Effects of deworming and mineral supplementation on growth performance of lambs. *Indian Journal of Animal Production and Management*. 18(1-2): 60-62.

Bhagat, R.K., Singh Ratan, R.P., Choudhary, B.M. And R.K. Singh, 2001. Profitability of late sown wheat under small production system. *Journal of Research* (BAU) 13 (2), 141- 143.

Choudhary B.M.,Singh, B.M.,Singh, Rattan, R.P. and Bhagat, R.K. (1998). Optimization of productivity and profitability of rainy season tomato through intervention of wilt resistant varieties and balanced nutrition in small production systems. (In) Indian Society of Agronomy & Indian Council of Agricultural Research, New Delhi PP 141.

Dash S.K., and Mohanty, S. N. 2003. Hot air dehydration characteristics of garlic. *Journal of Research, Orissa Univ. Agric*. Tech. Vol. 21(1).

Dash, K. and. Chandra P, 2003. Computer simulation of the environment in an evaporative cooled storage structure. *Journal of Institution of Engineers (India), 84, 33-38.*

Jyothi Sahare (2003). Women for women in agriculture extension programme. *Maharashtra Journal of Extension Education* (1): 51-53.

Gajbhiye, Hemcahndra, Katole, R.T. and Jyothi Sahare. 2002. "Alienation from work among entrepreneurship in agriculture." *MANAGE Extension Research Review 3:93-99.*

Krishna Moorthy, P.N., Krishna Kumar, N.K., Selvaraj, C and John Sathiasheelan Daniel, 1998. Neem seed kernel extract applications for diamondback moth management: Transfer of technology for mechanized farming. *Pest Management in Horticultural Ecosystems.* 4, 128-130.

Kumari, K. Singh Ratan, R.P. 1999. Farmer participatory assessment of late sown wheat production technologies. *Journal of Research, BAU 11* (2): 167-172.

Mishra, M and Mohanty, C. R. 2003. Comparative estimates of genetic divergence in dahlia. *Indian Journal of Horticulture.* 60 (3): 296-302.

Mishra.M and Mohanty C. R., 2003. Heterosis studies in African marigold. *Journal Research of Ornamental Horticulture*. 6 (1): 55-57.

Mohanty, A. and Mohanty, C. R. 2003. Combining ability for yield and its components in marigold. *Journal of Research Ornamental Horticulture*. 6: 34-38.

Mohapatra, A. K. B. and Dixit L., 2003.Effect of nutrients and mulching on growth and yield of turmeric (*Curcuma longa* L.). *Journal of Researc,h Orissa University Agric. Tech*. 21(1): 9-11.

Nimje, P.M. and Agrawal, Vijay. 2002. Effect of solarization on weed density and growth of chilly, brinjal and marigold. *Indian Journal of Weed Sciences*. 34 (3&4): 324-326.

Nimje, P.M. 2003. Effect of phosphorus fertilization on soybean based cropping sequences under rain fed conditions. *Indian Journal of Agricultural Sciences.* 73(4) 191-193.

Nimje, P.M., Agrawal. and Soni, R.D. 2003. Effect of planting density and Improved seeding devices on yield and economics of soybean. *Indian Journal of Agronomy*. 48 (4): 47-50.

Rao, K.S., Annie Poonam, K.P. Jha and Sasomal, 2005. Participatory evaluation and refinement of rain fed upland rice production technology through Institute Village Linkage Programme, *Oryza* 42 (1): 62-63.

Rageshwaran, R., Wasnikar, A.R., Prasad, R.D., Anjula, N. and Sunanda, C.R. 2002. Isolation of endophytic bacteria control of wilt pathogen. *Journal of Biological Control*. 16 (2): 125-135.

Reddy, B.M.K., Subba Reddy, G., Rama Rao, C.A., Srinivasa Rao,M and M.Sreerekha, 1999. Diagnosing farmer's problems using participatory approach. *Indian Journal of Dry land Agric. Research* Dev. 12 (1): 43-50.

Shrivastava, R.K., Prasad, R.D., Rageshwaran, R., Wasnikar, A.R., Singh, S.P. and Rao, N.D. 2002. A rapid *in vivo* bioassay method for testing and selection of fungal antagonist of plant pathogen. *Journal of Biological Control*. 16 (2): 171-173.

Singh, Maharaj, Meena, B.S., Pandey, Sadhna, Dwivedi, R.N. and Sharma, Purushottam. 2004. Farmers'

preferences for different crops in IVLP villages of Bundelkhand. *Indian Research Journal of Extension Education*. 4(1&2): 21-23.

Singh, S. K. and Roy Burman, R. 2003. Assessment and introduction of improved chickpea varieties in existing pulse -based rain fed cropping system in Hamirpur District (U.P.). *Indian Research Journal of Extension Education*. 3 (2): 6-11.

Singh, R.K. , Kumari, K. and Singh Ratan, R.P. 1991. Farmers' knowledge of late sown wheat production Technology. *Indian Journal of Extension Education*, XXXV (3&4), 255-258.

Singh, S. K., Roy Burman, R., Ansari Md Shamim, Choudhary, R. G. and Singh, K. K. 2003. Refinement of nutrient management in lentil under limited farmers' resources through farmers' participatory approach. *Indian Research Journal of Extension Education*. 4 (1&2): 34-36.

Singh, S. K., Roy Burman, R., Ansari, Md. Shamim, Choudhary, R. G. and Singh, K. K. 2004. Farmer participatory approach in developing need based and location specific Technology in Pulse Based Rainfed Cropping System in Hamirpur District (U. P.). *Farm Science Journal*. 13 (1): 32-35.

Singh, S. K., Roy Burman, R., Choudhary, R. G., Singh, K. K. and Ansari, Md. Shamim. 2005. Impact of usable technologies identified under TAR-IVLP. *Indian Journal Pulses Research.* 18 (1).

Tayade Arjun, Gajbhiye, H. and Katole, R.T. 2004. Knowledge competency of extension personnel as influenced by training. *Maharashtra Journal of Extension Education*.(in press)

Yargattikar, A.T., Ashwatham, V.H. and Budihal, R.A. 2004. Response of little millet to production technologies under rain fed on farm conditions *Karnataka Journal of Agricultural Sciences*. 17(3): 536-538.

Yargattikar, A.T., Budihal, R.A. and Patil, S.A. 2003. Performance of different production technologies of kharif crop in northern transition zone of KarnatakaJL. *Karnataka Journal of Agricultural Sciences*. 16(1): 81-86.

Yargattikar, A.T., Budihal, R.A.. and Patil, S.A.. 2003. Response of crops to production technologies under on farm condition in Northern Transition Zone of Karnataka. *Karnataka Journal of Agricultural Sciences*. 16(4): 588-590.

Yargattikar, A.T., Ashwatham, V.H. and Budihal, R.A. 2004. Response of little millet to production technologies under rain fed on farm conditions, *Karnataka Journal of Agricultural Sciences*. 17(3): 536-538.

Yargattikar, A.T., Budihal, R.A. and Patil, S.A. 2003. Performance of different production technologies of kharif crop in northern transition zone of Karnataka. *Karnataka Journal of Agricultural Sciences*. 16(1): 81-86.

Velayutham M. Ramamurthy, V.and M.V. Venugopal. (2002). Agricultural land use planning: From theoretical perspectives to participatory action plan in the Indian Context. *The Land*, 6(4); 45-60.

Annexure VII

List of Technical and Extension Bulletins/Folders/Training Mannuals

Technical Bulletins

Budihal, R.A. and Yargattikar, A.T.2002."TAR-IVLP - Achievements so far- Technology Assessment of Nutritive Cereal based Rainfed -Agro Eco-system through Institute Village Linkage Programme for Northern Karnataka, Technical Bulletin University of Agricultural Sciences (UAS), Dharwad. PP. 1-33.

Ghewande, M.P., Devi Dayal, Nandagopal. Satishkumar., Sojitra, V, G.D., Chavda, V.K V.N and Basu, M.S. 2005. Groundnut based Technologies for Farmers, National Research Centre for Groundnut, Junagadh. PP;1-15.

Dhore, R.N, Ingole, P.G., Thakare, S.N., Deshmukh, S.V., Bharad, S.G. Diwane, L.P and Kalaskar, A.P., 2004 Technical Bulletin TAR-IVLP Achievements. Directorate of Extension Education, PDKV, Akola, PP. 1-15.

Dwivedi, R.N., Maharaj Singh, Purushottam Sharma, Sadhna Pandey, Meena, B.S., Tamankar, R.K., and Upadhyay, J..P., 2004. Nutritive Cereal Based Rainfed Agro-Ecosystem for Bundelkhand Region, Technology Assessment and Refinement through Institution Village Linkage Programme, IGFRI, Jhansi. PP. 1-48.

Subba Reddy, G., Reddy, B.M.K., Mishra, A.K., Prabhakar, M., Sambrajyam, A, Venkateshwarlu, B., Srinivasa Rao, Ch, Ramesh, G and Yella Reddy, D. 2005. TAR-IVLP, Technology Assessment and Refinement through Institute Village Linkage Programme of Nutritious Cereal Based Production System for Sourthern Telangaaa Zone of A.P., India., NATP,CRIDA, , PP.1-54.

Edward Raja, M, P.N. Krishna Moorthy, Prabhakar, S. and K.J. Chandre Gowda , 2002. A New Concept In Better Technology Adoption (TAR-IVLP), IIHR, Bangalore. PP;1-18.

Nimje, P.M, Sahayay K.M., Bandarkar D.M, Dhubey A.K. and Nirmal Kumar, 2004,

Achievements under TAR-IVLP under Rainfed Ecosystem through Institute Village Linkage Programme of Oilseed Based Production System. CIAE, Bhopal, M.P. PP;1-138.

Patil B.P., Wadkar, S.S., Bhole, S.R., Kapkal, B.B., and Sawant,, B.N. 2004. Farmers Participation Technology Assessment and Refinement through Institute Village Linkage Programme, Directorate of Extension Education, Dr.BSKKV, Dhapoli, PP;1-63.

Extension bulletins/ Folders/Brochures

1. Improved technique for maize cultivation. K.V.K Extension bulletin 50/2001, OUAT ,Bhubaneswar
2. Improved practice for upland paddy cultivation. K.V.K Extension bulletin 52/2001, OUAT, Bhubaneswar
3. Efficient use of phosphatic fertilizer in acid soil. K.V.K Extension bulletin 51/2001, OUAT, Bhubaneswar.
4. Rice - bean cultivation. K.V.K Extension bulletin 49/ 2001 OUAT Bhubaneswar.
5. Mixed cropping for dangar and pada lands. K.V.K Extension bulletin 53/2001,OUAT Bhubaneswar.
6. Bio-fertilizer use. K.V.K Extension bulletin 47/2001 OUAT Bhubaneswar
7. Profitable groundnut cultivation. K.V.K Extension bulletin 54/2001, OUAT Bhubaneswar
8. Italian honey bee cultivation. K.V.K Extension bulletin 55/20012001, OUAT Bhubaneswar
9. Techniques to get higher production from niger. K.V.K Extension bulletin 48/2001,OUAT Bhubaneswar
10. Mushroom cultivation. K.V.K Extension bulletin 56/ 2001, OUAT Bhubaneswar
11. Broiler farming for self-employment. Booklet 2003-04, OUAT- Koraput
12. Improved management practices for backyard poultry rearing. Booklet 2003-04, OUAT- Koraput

13. Oyster mushroom cultivation for increasing family income. Extension bulletin No. 67, KVK, Koraput.
14. Mushroom cultivation. Extension bulletin No. 60, KVK, Koraput.
15. Rearing of Banaraja poultry birds in backyard. Extension bulletin No. 68, KVK, Koraput.
16. Broiler farming for self employment. Extension bulletin No.58, KVK, Koraput.
17. Goat farming for self employment. Extension bulletin No.56, KVK, Koraput.
18. Sheep rearing for self employment. Extension bulletin No. 57, KVK, Koraput.
19. Improved management practices for backyard poultry rearing. Extension bulletin No.55, KVK, Koraput.
20. Diseases and pests of brinjal and their integrated management. Extension bulletin No. 61 , KVK, Koraput.
21. Harmful insects pests of brinjal and their integrated control. Extension bulletin No. 63, KVK, Koraput.
22. Groundnut cultivation. Extension bulletin No. 62, KVK, Koraput.
23. Application of micronutrient in cabbage. Extension bulletin No. 66, KVK, Koraput.
24. Cultivation of marigold. Extension bulletin No. 65, KVK, Koraput.
25. Intercropping of arhar in ragi. Extension bulletin No. 69, KVK, Koraput.
26. Italian honeybee keeping for self employment. Extension bulletin No. 64, KVK, Koraput.
27. Organic cotton production and soybean cultivation (Marathi)
28. Water management in groundnut based cropping system, Junagadh, pp21.
29. Soil health card, NBSS&LUP.
30. Usable technologies of nutritive cereal based rainfed agro ecosystem of Northern Karnataka (RF IVLP21) (In English) - UAS, Dharwad.
31. Usable technologies of nutritive cereal based Rainfed Agro Ecosystem of Northern Karnataka (RF IVLP 21) (In Kannada) - UAS, Dharwad.
32. Metta sagulo melukuvalu (Telugu), CRIDA, Hyderabad.
33. Improved dryland technologies in sorghum and pigeonpea (Telugu), CRIDA, Hyderabad
34. IPM in cotton, (Telugu), CRIDA, Hyderabad.

Training Manual

1. Integrated Pest Management in Groundnut, NRCG, Junagadh, pp.22.
2. Integrated Nutrient Management in Groundnut, NRCG, Junagadh, pp. 21.
3. Water Management in Groundnut based Cropping System, Junagadh, pp. 21.
4. Soil Health Card published by NBSS&LUP
5. Participatory Rural Appraisal For Rain Fed Farming. MPKV - Solapur.
6. State Level Collaborative Training Course on Participatory Rural Appraisal for Rainfed Farming, Dec. 9-14, 2004 at ZARS,Solapur.

News letters/Popular articles/Leaflets/AIR/TV

News letters

1. Pooja - A suitable paddy variety for Jolla land. KVK News Letter, 1 (1) May, 1999, Koraput.
2. Niger sticks - a suitable substrate for mushroom. KVK News Letter, 1 (3), July, 1999, Koraput.
3. Cabbage responds well to Boron. KVK News Letter, 2 (2), June 2000, Koraput.
4. Malpura Cross Ram - An introduction of KVK, Koraput. KVK News Letter 2(2), June 2000, Koraput.
5. Raised bed-planting doubles the yield of turmeric. KVK News Letter, 2 (2), June 2000, Koraput.
6. Italian honeybee cultivation K.V.K Newsletter Vol.II. No.2, OUAT Bhubaneswar.
7. Singh 'Ratan' R.P. 1978, Economic up-liftmen of women through income generating activities: an IVLP Experience. ICAR News latter (July to September). Center 1 BAU- Ranchi. Pp: 03-04

8. On-farm evaluation of groundnut and pigeon pea intercropping system using PRA techniques in Sourashtra Region of India. International News letter (IAN) no. 24:52:13.
9. Commercial processing of pulses II. Dharitri, Nov 19, 2003, IIPR, Kanpur.
10. Commercial processing of pulses II. Dharitri, Nov 19, 2003, IIPR, Kanpur.
11. Commercial processing of pulses. Dharitri, Nov 12, 2003, IIPR, Kanpur.
12. Commercial production of dried ginger. Dharitri, Sep 10, 2003, IIPR, Kanpur.
13. Necessity of air circulation in grain storage structures. Sambad, Oct 11, 2003, IIPR, Kanpur.
14. Preparation of dried ginger on a commercial basis . Krishak Bandhu Annapurna 10(10): 16.
15. Beneficial uses of agricultural by-products. Yojana (Oriya) 11(3): 45,47.

Popular Article

1. Chandre Gowda, M.J., Prabhakar B.S. and Krishna Moorthy P.N.. 1999. Red gram for stable income. *Prajavani*. (3rd March 1999)
2. Krishna Moorthy, P.N., Srishna N.K Kumar, Edward Raja, M.Prabhkar B.S and Chandre Gowda M.J 2000. Management of brinjal pests using Neem production. *Prajavani* (May 7, 2000).
3. Krishna Moorthy, P.N., Chandre Gowda M.J.and Krishna N.K.Kumar, 1999, Management of cabbage pests using Neem products (in Kannada). *Prajavani* (March 3, 1999).
4. Misra, A.K. ; Singh H.P. and Yadav, S.R. 2002 Krishi vanilki padhati banam badhta pasudhan. Kheti 55, 3: 9-12 (June 2002)
5. Parvatha Reddy, P., Chandre Gowda M.J and. Edward Raja.M1999. Banana cultivation in vegetable lands. *Prajavani*. (8 September, 1999)
6. Ramanamurthy, V., Jadish Prasad and K.S. Gajbhiye, 2004. Sericulture - A reason for farmers smile. Indian farming.
7. Ramanamurthy,V, Jagdish Prasad V., 2004. Farmers Field Schools - A New Participatory Approach, Agricultural Extension Review.
8. Ramanamurthy,V. 2004. Forage options for smallholder farming system. Agricultural Extension Review.
9. Unnat taknik se dhan ka vipuul utpadan. (Hindi), JNKVV, Jabalpur
10. Kaisa ho duharu pasuon ka basera. (Hindi), JNKVV, Jabalpur
11. Til ki unnat krishi karya mala. (Hindi), JNKVV, Jabalpur
12. Arkil matar ki khaiti adhik laabhkari. (Hindi), JNKVV, Jabalpur
13. Sutrakrimi dwara hone wale rog vaa nidaan. (Hindi), JNKVV, Jabalpur
14. Greehsm kaalin moong ki khiati. (Hindi), JNKVV, Jabalpur
15. Greehsm kaalin urd ki khiati. (Hindi), JNKVV, Jabalpur
16. Chane ki vaigyanik khati se adhik utpadan lae. (Hindi), JNKVV, Jabalpur
17. Massor ki unaat khiati (Hindi), JNKVV, Jabalpur
18. Kaise badayeen alsi ki paidawar utewra fasal padhati mein. (Hindi), JNKVV, Jabalpur
19. Aaloo ko safal utpadan taknik (Hindi), JNKVV, Jabalpur
20. Adhunik khaiti haitu potash urvarak (Hindi), JNKVV, Jabalpur
21. Soybean ke rog lakshan aiavam nidaan (Hindi), JNKVV, Jabalpur
22. Role of bacterial fertilizer in agriculture. JNKVV, Jabalpur
23. Economics of wheat varieties under different seed rates and fertilizer dosed in central Madhya Pradesh. JNKVV, Jabalpur
24. Self employment of farm women through KVK. Chasira Sansar. 39 (5), 45-48, JNKV, Jabalpur..
25. Green manuring in crops. (Assamese), AAU, Assam
26. Use of bio-fertilizers in crops. (Assamese), AAU, Assam
27. Production technology of Vermicompost. (Assamese), AAU, Assam
28. Crop protection in vegetables. (Assamese), AAU, Assam

29. Wheat cultivation with zero tillage. (Assamese), AAU, Assam

30. Cultivation of high yielding green gram variety (Pratap). (Assamese), AAU, Assam

31. Maintenance of Agricultural machines. (Assamese), AAU, Assam

32. Water management under shallow tubles irrigation. (Assamese), AAU, Assam

33. Kishan Mahila Prashikshan Karyakarm in Dainik Bhaskar, Saturday, 31 May 2003

34. Jogipura Me Kishan Va Mahila Prashikshan in Rajasthan Patrika , Saturday, 31 May 2003

35. I V L P Ke Tahat Kishano Evam Mahilaon Ko Jankari Di in Dainik Jagran, Agra, 31 May 2003

36. Rashaynik Urwarkon Ke Khatere Kishano Ko Batai in Amar Ujala, Saturday, 31 May 2003

37. Khanua Me Kishano Va Pashupalkon Ka Shivir in Rajasthan Patrika, Tuesday, 27 May 2003

38. Kishano Aur Phashupalkon Ke Liye Shivir Ayojit in Dainik Bhaskar, Saturday, 24 May 2003

39. Pashu Palak Sangosthi Sampanna in Amar Ujala, Friday, 23 May 2003

40. Do Diwasiya Mahila Krishak Prashikshan Shivir Sampanna in Amar Ujala, Friday, 23 May 2003

41. Pashu Palan Kishano Ke Jiwan Ka Abhinna Anga in Dainik Bhaskar, Thursday, 22 May 2003

42. Fish cultivation with modern technologies. (Assamese), AAU, Assam

43. Self-employment of farmwomen through KVK. Chasira Sansar. 39 (5), 45-48.

44. Precautions during application of Agril. Chemicals. (Assamese), AAU, Assam

45. Pakjholla - A Successful village in mushroom cultivation, Published in Chasira Sansara, July-August, 2003

46. Cultivation of Oyster mushroom for self-employment. Published in Yojana (Oriya) October, 2003

47. Commercial production of dried ginger. Published in Krushaka Bandhu Annapurna, Oct, 2003, P-16

48. Necessity of air circulation in grain storage structures. Published in Sambad, October 11, 2003

49. Commercial processing of pulses-I. Published in Dharitri, November 12, 2003

50. Commercial processing of pulses-II. Published in Dharitri, November 19, 2003

51. Dal processing. Published in Chasira Sansar Sept-Dec, 2003

52. Beneficial uses of agricultural by-products. Published in Yojana (Oriya), December, 2003

53. Fruits and vegetables processing in Orissa-an analysis. Published in Yojana (Oriya) January, 2004

54. Biofertilisers. Published in Chasira Sansara Sept-Dec, 2003

55. Italian honeybee cultivation in Orissa. Yojana (Oriya) Sept, 2003.

56. Pakjholla- a successful village in mushroom cultivation. Chasira Sansar. 38 (4), 34-38.

57. Biofertilisers. Chasira Sansara (OUAT).

58. Cultivation of Oyster mushroom for self-employment. Yojana (Oriya) , 33-34.

59. Italian honeybee keeping- a profitable and promising agro-enterprise for farmers of Koraput district. *In* Agri-Vision- Souvenir for Silver Jubilee of RRTTS (OUAT), Semiliguda, Koraput.

60. Pest control by spider. Chasira Sansara (OUAT). 39 (5), 20-22

61. Fruits and vegetables processing in Orissa- an analysis. Yojana (Oriya) 11(4): 58-60.

62. Processing of Basmati rice. Sambad, July 17, 2004.

63. Modern machines for milling of Basmati rice. Chasira Sansara, OUAT, Bhubaneswar 39(5): 33-36.

64. Post harvest operations of turmeric. Chasira Sansara, OUAT, Bhubaneswar 39(3-4) : 18-21.

65. Needs of precision farming. Chasira Sansara (OUAT). 39 (1-2), 14-16

66. Mohapatra, S. C. 2004. Process of organic ginger and turmeric cultivation in Koraput district. Saara Barta, 34(3), 6-10.

67. Cultivation of mango-ginger. Chasira Sansara, OUAT, Bhubaneswar 39(5): 14-16.

68. Hemchandra Gajbhiye, R.T. Katole. 2004. *Barani kapas ki shushk bowai.* Unnat Krishi, 12-14, NBSSLUP, Nagpur

Leaflets

1. Green manuring in crops, AAU, Nagaon.
2. Use of bio-fertilizers in crops, AAU, Nagaon.
3. Production technology of vermicompost, AAU, Nagaon.
4. Crop production in vegetables, AAU, Nagaon.
5. Wheat cultivation with zero tillage, AAU, Nagaon.
6. Cultivation of high yielding green gram variety (Pratap), AAU, Nagaon.
7. Maintenance of agricultural machines, AAU, Nagaon.
8. Water management under shallow tubeless irrigation, AAU, Nagaon.
9. Fish cultivation with modern technologies, AAU, Nagaon.
10. Precaution during application of agricultural chemicals, AAU, Nagaon.
11. Integrated shoot and fruit borer control in brinjal, CIAE, Bhopal.
12. Integrated pod borer control in chickpea, CIAE, Bhopal.
13. Smut disease control in irrigated wheat, CIAE, Bhopal.
14. Using optimum planting density in soybean pay high, CIAE, Bhopal
15. Integrated management of animals for high milk productivity, CIAE, Bhopal.
16. Rejuvenation techniques for improving productivity of old orchards, CIAE, Bhopal.
17. Smokeless cooking through use of improved briquette technology, CIAE, Bhopal.
18. Soil and water conservation techniques for higher productivity in rainfed lands, CIAE, Bhopal.
19. For optimum planting density in groundnut & pigeonpea use of inclined plate planter, CIAE, Bhopal.
20. Improved cultivation technology of pigeonpea, CIAE, Bhopal.
21. Integrated pest control in pigeonpea, CIAE, Bhopal.
22. Integrated wilt disease control in pulse crops, CIAE, Bhopal.
23. Rainfed Agri- horticultural system for improving economic condition of farmers, CIAE, Bhopal.
24. Improved cultivation technology of groundnut, CIAE, Bhopal.
25. Integrated weed management in soybean, CIAE, Bhopal.
26. Improving yield of soybean-wheat cropping system through integrated plant nutrient management, CIAE, Bhopal.
27. Ways to reduce drudgery of farm women, CIAE, Bhopal.
28. Unnat taknik se dhan ka vipuul utpadan (Hindi), JNKV, Jabalpur.
29. Kaisa ho duharu pasuon ka basera (Hindi), JNKV, Jabalpur.
30. Til ki unnat krishi karya mala. (Hindi), JNKV, Jabalpur.
31. Arkil matar ki khaiti adhik laabhkari (Hindi),JNKV, Jabalpur.
32. Sutrakrimi dwara hone wale rog vaa nidaan (Hindi), JNKV, Jabalpur.
33. Greehsm kaalin moong ki khiati (Hindi)JNKV, Jabalpur.
34. Greehsm kaalin urd ki khiati (Hindi), JNKV, Jabalpur.
35. Chane ki vaigyanik khati se adhik utpadan lae. (Hindi), JNKV, Jabalpur.
36. Massor ki unaat khiati (Hindi), JNKV, Jabalpur.
37. Kaise badayen alsi ki paidawar utewra fasal ptdhati mein. (Hindi), JNKV, Jabalpur.
38. Aaloo ko safal utpadan taknik (Hindi), JNKV, Jabalpur.
39. Adhunik khaiti haitu potash urvarak (Hindi), JNKV, Jabalpur.
40. Soybean ke rog lakshan aiavam nidaan (Hindi), JNKV, Jabalpur.
41. Role of bacterial fertilizer in agriculture. (English), JNKV, Jabalpur.
42. Improved sorghum cultivation (Marathi), NBSSLUP, Nagpur.

43. Rainfed cotton management (Marathi), NBSSLUP, Nagpur.
44. Soil based improved soybean cultivation (Marathi), NBSSLUP, Nagpur.
45. Use of vermicompost in farming (Marathi), NBSSLUP, Nagpur.
46. Drumstick for higher income (Telugu), CRIDA, Hyderabad.
47. Scientific management of sheep and goat (Telugu), CRIDA, Hyderabad.
48. Plant protection measures in kharif crops (Telugu), CRIDA, Hyderabad.
49. enrichment of paddy straw through urea treatment(Telugu), CRIDA, Hyderabad.
50. Alternatively perennial crops in rainfed lands(Telugu), CRIDA, Hyderabad.

Book Chapter

Misra, A.K., Reddy, B.M.K., Rekha, M.S., Reddy, G.S. and Singh, H.P. 2000. Sheep and goat farming in rainfed areas. Constraints and options for improvement on small holder production systems. In: Smallholder Livestock Production Systems in Developing Countries. C.K. Thomas and N.S.R.Sastry (Eds). Kerala Agricultural Univeristy, Thrissur.Pp. 135-144.

Misra, A.K., Singh, H.. and Yadav, S.R. 2001. Baran I chetron men krishi vanilki padhati dwara pasudhan utapadan kr naye aayam. In: Prakratik Sansadhano ke Prabandha Maen Krashi Vaniki Ka Yoagdan. K.S. Dhadhawal and K.R.Solanki (Ed) NRCAF, Jhansi, India Pp: 147-152.

Misra, A.K. 2005. Contingency planning for feeding and management of livestock during drought. In: Drought Management. K.D.Sharma and K.S. Ramasastri (Eds). Allied Publishers Private Limited Newe Delhi.Pp. 276-286.

Subba Reddy, G., Mishra, A.K. and Singh, H.P. 2002. Phasal pasudhan smakalan dwara ardh sushk chetron ki vikrit bhoomiyon ka prabhandahn. In: Varsha Aadharit Krishi Chetro Mein Bhoomi Vikritikaran Ki Samasyain Avam Samadhan. H.P.Singh, S.K.Yadav, K.L.Sharma and A.K.Mishra (Eds) CRIDA, Hyderabad, India Pp 156-165

Nigam, R.K., Singh, S.K. and Roy Burman, R. 2003. Impact of transfer of technology in pulses. In New Perspective (Ed. Ali Massod, Singk, B.B., Shiv Kumar and Vishwa Dhar). Indian Society of Pulses Research and Development, IIPR, Kanpur. Pp. 494-502.

Nigam, R.K., Singh, S.K. and Roy Burman, R. 2004. Dalhan prodyogiki Hastantaran (Hindi). In Dalhan (Hindi) (Eds. Ali Masood, Gupta Sanjeev and Naimuddin), IIPR, Kanpur. Pp. 361-375.

Radio talks

1. Coverage in press, TV, Radio, IGAU, Raipur.
2. Honeybee in All India Radio, Jeypore - Krs. P.Acharya, , 15.02.2003, OUAT, Koraput.
3. Role of farm women in field of agriculture in All India Radio, Jeypore - Mrs.P.Acharya, 19.09.2004, OUAT, Koraput.
4. Mushroom cultivation in All India Radio, Jeypore - Mrs. M.Swain, 24.09.2002, OUAT, Koraput.
5. Nutritional gardening for better living in All India Radio, Jeypore - Mrs. M.Swain, 16.11.2002, OUAT,Koraput.
6. Commercial tomato cultivation in All India, Jeypore - Dr.C.R.Mohanty, 07.12.2004., OUAT, Koaput.
7. Low cost technologies for crop production in All India Radio, Jhansi- R.N.Dwivedi, 06.04.2003, IGFRI, Jhansi.
8. Improved cultivation of wheat in All India Radio, Chhatarpur - R.N.Dwivedi, 10.11.2003, IGFRI, Jhansi.

TV Coverage

1. Mushroom cultivation in E TV - Mrs. P.Acharya, 26.06.2002, OUAT, Koraput.
2. Preparation of sauce, chutney and ketchup from tomato in E TV - Mrs. P.Acharya, 27.02.2004, OUAT, Koraput.
3. Mushroom cultivation in E TV - Mrs. M.Swain, 27.06.2002, OUAT, Koraput.
4. Kitchen garden in E TV - Mrs. M.Swain, 05.08.2002, OUAT, Koraput.
5. Preservation of winter vegetables and fruits in E TV - Mrs. M.Swain, 01.03.2004, OUAT, Koraput.
6. Rearing of Vanaraja poultry in backyard in DD-6 - Dr.N.C. Behura, 10.11.2004, OUAT, Koraput.
7. IVLP at a aglance, in E TV, Uttar Pradesh - R.N.Dwivedi, 15.12.2003, IGFRI, Jahansi.
8. Production technologies of Oats in E TV, Uttar Pradesh - R.N.Dwivedi, 17.12.2002, IGFRI, Jhansi.
9. Production technologies of Berseem in E TV, Uttar Pradesh - B.S.Meena, 18.12.2003, IGFRI, Jhansi.
10. Round the year fodder production in E.TV, Uttar Pradesh - R.N.Dwivedi, 18.12.2003, IGFRI, Jhansi.
11. Vermicompost - A rich source of plant Nutrient in E TV, Uttarpradesh - B.S.Meena, 15.12.2003, IGFRI, Jhansi.
12. Silage making in E TV, Uttar Pradesh - B.S.Meena, 17.12.2003, IGFRI, Jhansi.
13. Endo & Ecto parasite control in E TV, Uttar Pradesh - Purushottam Sharma, 16.12.2003, IGFRI, Jhansi.
14. Balance feeding of animal in E TV, Uttar Pradesh - Purushottam Sharma, 18.12.2003, IGFRI, Jhansi.
15. Drudgery reducing technologies E TV, Uttar Pradesh - Sadhna Pandey, 18.12.2003, IGFRI, Jhansi.
16. Sunflower and pearl millet cultivation, E TV Anna data 2004-05 at IVLP village Ratanjan, MPKV, Solapur.
17. Custard apple + Stylo technology as alternate land use system on entisol, MPKV, Solapur.
18. Sowing of seeds with two-bowl ferti seed drill, MPKV, Solapur.
19. Up gradation of local goat stock through osmanibadi buck, MPKV, Solapur.

Video Cassette and CD

1. TAR - IVLP Achievements so far
2. Improved Technologies Implemented on Farmers Fields at IVLP villages, MPKV, Solapur

Annexure VIII

Participation of the core team of Rainfed Agro Ecosystem Directorate in different Site Committee Meetings

S.No	Meetings of Institutes/ Universities	Date Held
1.	Site committee of NATP at Anand Campus	7-8th October, 2003
2.	Site committee at MAU, Parbhani	25th August, 2003
3.	Site committee of NATP at Ranchi	28-29th July, 2003
4.	Site committee of NATP at Assam Agricultural University	17-18th July, 2003
5.	4th site committee meeting cum workshop at JNKVV, Jabalpur	28-30th June, 2003
6.	PAU site committee meeting	10th June, 2003
7.	Site committee at RAU, Bikaner	23rd-24thApril, 2003
8.	Review of NATP projects under Mission mode by site committee, CAZRI	7th March 2003
9.	Site committee at CRIJAF, Barrackpore	6th March, 2003
10.	Site committee held at College of Agriculture, Narendra Deva Univ.of Agriculture and Tech., Kumarganj, Faizabad	27th December, 2002
11.	Site committee at IIPR, Kanpur	24th December, 2002
12.	5th Site committee for integration and operationalization of research programme held at MPKV, Rahuri	4-5th December, 2002
13.	3rd Site committee at CCS Haryana Agricultural Univ., Hissar, Haryana	4th August, 2002
14.	2nd site committee at CRRI, Cuttack	2nd August, 2002
15.	Site committee meeting at UAS, Directorate of Research, GKVK, Bangalore	August, 2002
16.	Site committee at IIPR, Kanpur	30th July, 2002
17.	Site committee of NATP, Assam Agricultural Univ.	17-18th July, 2002
18.	Site committee of NATP at Assam Agricultural University	15-16th July, 2002
19.	2nd site committee meeting of NATP, Assam Agricultural University	10-11th July, 2002
20.	Site committee meeting for different programmes of NATP projects held at NRCRM, Bharatpur	26-27th June ,2002
21.	Site committee meeting held at CRIDA	10th May, 2002
22.	Site committee at UAS, Directorate of Research, GKVK, Bangalore	March, 2002
23.	Site committee meeting held at NRCRM, Bharatpur	22nd & 23rd March, 2002
24.	Site committee meeting held at NCAP, New Delhi	13th March, 2002
25.	Monitoring and evaluation of NATP schemes by Site Committee, PAU	22nd February, 2002
26.	NATP workshop at IGFRI, Jhansi	1st-2nd February, 2002

Annexure IX

Project formulation, review workshops and meetings organized under TAR - IVLP

S.No.	Item	Date and venue
1	SAP meeting of NATP review TAR -IVLP under Agro-ecosystem	June 1-2, 1999
2	Orientation workshop of TAR -IVLP	October 28-31, 1999, CRIDA
3	Workshop for finalizing the project document of TAR-IVLP	March 4-6, 2000, CRIDA
4	Annual Review of TAR-IVLP programme	March 19-22, 2001, CRIDA
5	Annual Review of TAR-IVLP programme	April 5-7, 2002, CRIDA
6	Review of the TAR-IVLP programmes	Sptember 3-5, 2002, UAS, Dharwad
7	National workshop of TAR-IVLP	March 21-22, 2003, IIPR, Kanpur
8	National workshop of TAR-IVLP	December 21-23, 2003, CRIDA, Hyderabad
9	National symposium cum exhibition on enhancing productivity and stability in rainfed agro ecosystem	March 24-27, 2004, ANGRAU, Hydarabad

Annexure X

Addresses of the PI and Nodal Officers of IVLP centers

Rice Based Production System

Center	Nodal officer	Core team members	Address of IVLP center
BAU, Ranchi	Dr.A.K.Sankar Directorate of Research Birsa Agriculture University Kanke, Ranchi-834 006, Jharkhand	Dr.R.P.Singh Ratan Dr.R.K.Bhagat Dr.B.M.Choudhary Dr.R.N.Singh Dr.(Ms.)Niva Bara Dr.S.Choubey Dr.B.K.Bhagat	Head,Dept of Agril.Extension Birsa Agriculture University. Kanke, Ranchi-834 006 (Jharkanad) Ph: 0651-55080 Fax: 455850 bau@bitsmart
KVK, Hassan	The Director of Extension Education University of Agricultural Sciences, Hebbal Bangalore-560 024	Dr.D.Hanumaiah Dr.V.Veerabhadraiah Mr.Doddhanumaiah Mr.y.N.Murthy Dr.M.H.Nagesh Smt.K.V.Jammuna Mr.Siddagangaiah	Training Organizer (KVK), Krisi vigyan Kandali; Hassan-573 217 (Karanataka) Ph:08172-56092 Fax:080-330277
IGAU, Raipur	Director of Research, Indira Gandhi Agri, University, Raipur-492 012 (Chattisgarh)	Dr.S.K.Taunk Dr.P.M.Sharma Prof.M.K.Vyas Dr.S.K.Shrivastava Shri H.K.Awasthi	Directorate of Extension Education, Indira Gandhi Agricultural University, Raipur 492 102 (Chattisgarh) Ph:0771-427694, Fax:424532

CRRI, Cuttack	The Director, Central Rice Research Institute Cuttack-753 006 (Orissa)	Dr.K.Srinivasa Rao	Principal Scientist, Central Rice Research Institute, Cuttack-0771-427694 (Orrisa) Fax-0771-424532
OUAT Koraput	Director of Research Orissa University of Agricultural and Technology Bhubaneshwar- 751 033	Dr.L.Dixit DR.C.R. Mohanthy Dr.N.C Beura. Shri A.K.B.Mohapatra Mrs.P.Acharya Mrs.M.Swain	Training Organizer, Krishi Vigan Kendra, Semiliguda, PO Box No:10, Sunabeda Koraput-763002(Orissa) Ph:0674-407780
AAU, Assam	Dr.A.K.Pathak Director of Research(Agri) Nodal Officer (IVLP-TAR) Assam Agriculture University Jorhat-785 013	Dr.B.Barman (PI) Dr.R.Bhagawati, Dr.B. Guha, DR.K.K.Sarma, DR.M.C.Debnath	Prof. & Chief Scientist, P.O.Box No:33, RARS Assam Agricultural University, Shillongani, Nagaon-782001 Ph:03672-22461, Fax:03672-22861

Oilseed Based Production System

NRCG, Junagadh	The Director, National Research Centre for Groundnut, P.O.Box 5,Ivnagar Junagadh-362 001 (Gujarat)	Dr.M.P.Ghewande	Sr.Scientist (Plant Pathology) National Research Center for Groundnut, P.O.Box.5,IVNAGAR, Junagadh-362 001(Gujarat) Ph;0285-623041, Fax:0285-651550 director@nrcg.gui.nic.in
CIAE, Bhopal	The Director, Central Institute of Agriculture Engineering , Nabi Bagh, Besaria Road Bhopal 462 038	Dr.P.M.Nimie Shri K.M.Sahay Shri Bhandakar Shri A.K.Dubey Dr.Nirmal Kumar Shri S.Z.Siddiqui	Sr.Scientist &I/c KVK,Central Institute of Agricultural Engineering Nabi bagh, Berasia Road, Bhopal 462 038 (M.P) Ph: 0755-530980, Fax:534016 root@ciae.mp.nic.in
NRCRM Bharatpur	The Director, National Research Centre for Soybean, Khanadwa Road, Indore 452 017	Dr.S.K.Jha(PI), Dr.Fateh Singh, Dr.Y.P.Singh, Dr.N.S.Bhogal, Dr.A.K.Singh, Dr.Manoj Kumar, Dr.O.P.Premi	Scientist &I/c ECT, National Research Centre on Rape seed and Mustard, Sewar Bharatpur 321 303 (Rajasthan) PH:05644-24688 Fax:470520,764928
NRCS, Indore	The Director, National Research Centre for Soybean , Khandwa Road, Indore 452 017	Dr.S.S.Vinayagam Dr.B.U.Dupare Dr.S.D.Billore Dr.A.N.Sharma Dr.A.Ramesh Dr.R.Ramteke	National Research Centre for Soybean Khandwa Road, Indore 452 017(MP) Ph:0731-362835, Fax:470520,764928
JNKVV Jabalpur	The Directorate of Extension Education, Jawaharlal Nehru Krishi Viswa Vidyalaya, Krishinagar, Adhartal, Jabalpur-482 004	Dr.D.K.Pahalwan	Sr. Scientist (Sr.Grade), Agronomy Directorate of Extension, JNKVV, Krishnagar, Adhartal, Jabalpur 482 004 (MP) Ph:0761-343606,340361 Fax:342719

Nutritious Cereals Based Production System

CRIDA, Hyderabad	Dr.K.V.Subramanyam Central Research Institute of Dryland Agriculture, Santoshnagar Hyderabad-500 059	Dr.G.Subba Reddy Dr.B.M.K. Reddy Dr.A.K.Mishra Dr.M.Prabhakar Smt.A.Sammbrajyam	Central Research Institute for Dryland Agriculture Santoshnagar, Hyderabad-500059 Ph:040-4530161 root@crida.nic.in
IIHR, Bangalore	The director Indian Institute of Research Hessarghatta lake post, Bangalore 560 089	Dr.M.Edward Raja Dr.D.Srinivasa Murthy Dr.T.S.Aghora Dr.M.Balakrishna	Sr.Scientist, Indian Institute of Horticultural Research, Hessarghatta Lake post, Bangalore-560 089. Ph:080-5466420, Fax:8466291, root@iihr.kar.nic.in
BSKKV, Dapoli	Director of Research Konkan Krishi Viswavidyalaya, Dapoli,Ratnagiri- 415 712, Maharastra	Dr.B.P.Patil Dr.A.A.Rane Dr.S.R.Bhole Dr.L.Pawar Prof.P.M.Haldankar	Regional Fruit Research Station, Vengurle, Sindhudurg,(Maharastra)-416 516 Root@kvv.ren.nic.in
MPKV, Solapur	Director of Research Mahatma Phule Krishi Vidyapeeth,P.B.No11; Rahuri-413 722 Ahmednagar Dist(Maharashtra)	Dr.G.Y.Parlekar Dr.D.J.Naikawadi Prof.R.Nkate Prof.B.B.Khutal	Zonal Agricultural Research Station,97 Raviwar peth.P.B.No:207 Solapur-413 002 (Maharastra) Ph:02426-43261 Fax:43223 rbdeshmukh@ren.nic.in
UAS, Dharwad	The Director of Extension Education, University of Agriculture Science, Krishinagar, Dharwad-580 005	Dr.S.A.Patil Dr.R.A.Budihal	Honable' VC, University of Agricultural Sciences (UAS) Krishinagar, Dharwad 58 0 005 (Karanataka) vcoffice2003@eth.net sapatil_uas@rediffmail.com
IGFRI, Jhansi	The Director, Indian Grassland and Fodder Research Institute(IGFRI), Gwalior Road Jhansi, 284 003; Uttar Pradesh	R.N Dwivedi Maharaj Singh M.B.Tamankar Purushottam Sharma Isabella Agarwal Sadhan Pandey B.S.Meena J.P. Upandhyay	Sr.Scientist(Agronomy)Head, Division of Soil Science, Indian Grassland and Fodder Research, Institute, Gwalior Road, Jhansi 284 003 (Uttar Pradesh) Ph:0517-444771 Fax:0517-440833 npm@igfri.up.nic.in
MPAU, Udaipur	The Director of extension education Directorate of Extension Education Agriculture University, Udaipur P.B.No:41;Outside Surajpole, Udaipur 313 001	Dr.Indrajit Mathur Sh.M.L.Shrimal	Deputy Director Directorate of Extension Education Agricultural University, Udaipur,P.B.No:4,Outside Surajpole, Udaipur 313 001 (Rajasthan) Ph:0294-417697 Fax:0294-412515

NBSSLUP, Nagpur	The Director National Bureau of Soil Survey and Land Use Planning, Shankarnagar,PO, Amravathi Road, Nagpur 440010; Maharshtra	Dr.K.S.Gajbhiye Dr.V.Ramamurthy Dr.D.B. Tamgadge Dr.J.P.Sharma ShW.V.Bankar Dr.S.N.Goswami Dr.T.N.Hajare Sh.P.Tiwari	National Bureau of Soil Survey and Land Use Planning, Shankarnagar PO,Amaravati Road, Nagpur 440 010 (Maharastra) Ph:0712-534545,543678 Fax:0712-527813

Cotton Based Production System

PDKV, Akola	The Director Directorate of Extension Education, Dr.Panjabrao Deshmukh Krishi,Vidyapeeth, Krishinagar Akola-444 104 (Maharshtra)	Dr B.P Gomase Dr.R.N.Dhore Shri S.M.Thakre Sh.S.V.Deshmukh Shri S.k.Thakare Shri S.G.Bharad	Dr.Panjabrao Deshmukh Krishi Vidlyapeeth, Krishinagar, Akola-444 104 Maharstra Ph;0724-58587,58200 Fax:58219 vc@pdkv.mah.nic.in
ANGRAU Warangal	Directorate of Extension Education, Acharya N.G. Ranga Agricultural university Rajendranagar, Hyderabad 500 030	Dr.J.Jalapathi Rao Dr.P.Satynarayana Reddy Dr.M.Gopinath, Sri K.V.Radhakrishna	Head,Agri.Research Station ANGRAU, Warangal-506 007(AP) Ph:08712,424337 Fax:040-4015326 root@apau.ren.nic.in
KVK, Ajmer	The Director of Extension Education, Rajasthan Agriculture University, Bikaner-334 006 (Rajasthan)	Prof.Dr.G.N.Mathur Sh.K.S.Rathore Sh.S.K.Sharma Sh.P.Choudhary Dr.M.Ksharma	Chief Scientist cum Head, KVK,Tabji Farm,N.H.* Ajmer-305 001 (Rajasthan) Ph:0151-440023(o) Fax:250336, vc@rauv.raj.nic.in
CICR Nagpur	The Director, Central Institute of Cotton Research,P.Box 2,Shankarnagar PO Nagpur 440 010; Maharastra	Dr.Hemachandra Gajbhaiye Shri M.K.Meshram Dr.A.R.Raju Dr.Ramasundaram Dr.G.Majumdar Shri.A.S.Tayade Shri Gulbir Singh Dr.U.Vgalkate	Head,Extension,Central Institute for Cotton Research, P.B.No 2, Shankaranagar PO, Nagapur - 440 010 Ph:0712-532386 Fax:527813

Pulse Based Production System

IIPR, Kanpur	The Director, Indian Institute of Pulse Research Kanpur 208 024; Uttar Pradesh	Dr.S.K.Singh Dr.C.P.Yadav Dr.R.G.Chowdhary Dr.K.K.Singh Mr.R.Roy Burman Dr.G.S.Gaur Dr.P.K.Upadhaya	Sr.Scientist (Agril. EXtension), Indian Institute of Pulse Research, Kalyanpur Kanpur 208 024 Ph;0512-510146,570464 Fax:0512-572582

Annexure XI

Budgetary details of TAR-IVLP

(Rs in lakhs)

Sl. No	Items	Sanctioned Budget		Expenditure							Total
		Original	Revised	1999-00	2000-01	2001-02	2002-03	2003-04	2004-05		2005-06
A. Recurring											
1	TA	79.71	79.71	4.40	6.07	8.40	7.81	7.75	6.61	0.70	41.74
2	Workshop	6.92	6.92	2.39	0.90	1.24	0.94	2.41	1.78	0.00	9.66
3	Contractual Services	216.00	216.00	9.98	17.04	21.80	21.47	38.07	28.87	1.27	138.50
4	Operational expenses	693.07	700.58	33.58	57.52	66.21	92.70	79.80	98.50	6.18	434.49
	Sub-total A	995.70	1003.21	50.35	81.53	97.65	122.92	128.03	135.76	8.15	624.39
B. HRD component											
5	Training	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	Consultancy	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Sub-total B	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Non recurring											
7	Equipment	37.60	39.10	5.28	10.68	14.29	11.00	2.08	1.52	0.00	44.85
8	Furniture	12.75	12.75	2.52	4.40	0.17	1.27	0.42	0.00	0.00	8.78
9	Works (new/ renovation)	12.80	12.80	4.13	1.09	0.49	1.13	0.80	0.00	0.00	7.64
10	Vehicle	102.36	102.36	0.00	0.00	4.45	6.52	0.00	0.00	0.00	10.97
11	Library books/ journals	0.00	0.00	0.00	0.00	0.83	0.00	0.00	0.00	0.00	0.83
	Sub total	165.51	167.01	11.93	16.17	20.23	19.92	3.30	1.52	0.00	73.07
D. Institutional Charges		13.29	13.29	3.06	1.36	6.58	4.55	1.56	3.32	0.05	20.48
	Grand total (A+B+C+D)	1174.50	1183.51	65.34	99.06	124.46	147.39	132.89	140.60	8.20	717.94

Annexure XII

Staff of Agro-Ecosystem Directorate

S. No.	Name	Designation
1	Dr. H.P. Singh	Agro Ecosystem Director (up to 30th May, 2003)
2	Dr. Y.S. Ramakrishna	Agro Ecosystem Director (from 31th May, 2003)
3	Dr. K.P.R. Vittal	Principal Production System Scientist (up to 3-9-2001)
4	Dr. B. Venkateshwarlu	Principal Production System Scientist (from 4-9-2001)
5	Dr. G. Subba Reddy	Principal Scientist (Agronomy)*
6	Dr.A.K. Mishra	Sr.Scientist (Livestock Production & Management)
7	Dr. Ch. Srinivas Rao	Sr. Scientist (Soil Scientist)
8	Sri. S.K.C. Bose	Finance and Accounts Officer (upto 2005)
9	Sri. P. Balabrahmaiah	Finance and Accounts Officer
10	Sri. G. Lakshminarayana	Assistant Administrative Officer**
11	Smt. P. Lakshminarasamma	Technical Officer
12	Sri. P. Chandrashekar	Technical Officer
13	Smt. Hemlata Kapil	Technical Assistant**
14	Smt. M. A. Rekha	PA**
15	Sri. K.R. Srinivas Rao	Assistant
Contractual Staff		
16	Dr. G. Ramesh	Research Associate
17	Dr. D.Yella Reddy	Research Associate
18	Sri. V. Srinivas	Senior Research Fellow
19	Sri. M. D. Mazharulla	Stenographer - II
20	Sri. V. Krishna Murthy	Stenographer - II
21	Sri. Jayakanth	Stenographer - II
22	Sri. Suresh Kanth Shukla	DEO
23	Sri.Y. Bhaskara Chari	DEO
24	Sri.S.Raghava Sarma	DEO
25	Sri. Prasad	DEO
26	Ms. Lalitha Jyothi	DEO
27	Sri. D. Sridhar	Driver
28	Sri. A. Srikanth	Skilled worker

* Involved in assisting the AED for coordinating the TAR-IVLP

** Staff of CRIDA assisting the NATP cell for the effective implementation of project