वार्षिक प्रतिवेदन

ANNUAL REPORT

2018-19

ICAR-Indian Institute of Maize Research

P.A.U. Campus, Ludhiana-141004, India

Nurturing diversity, resilience, livelihood & industrial inputs

वार्षिक प्रतिवेदन

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Organogram of ICAR-IIMR

Director General
ICAR

↓

Deputy Director General
Crop Sciences

↓

Research Advisory Committee → Director ← Institute Management Committee

↓

RESEARCH SECTION
- Crop Improvement
- Crop Production
- Crop Protection
- Extension and Outreach

AICRP (Maize)
- 20 States
- 32 Centres

SERVICE SECTIONS
- Administration
- Finance & Accounts
- Technical Cell
- ARIS Cell
- Library
- Farm & Building

IIMR-Ludhiana
- Regional Maize Research and Seed Production Centre, Begusarai, Bihar
- Winter Nursery Centre, Hyderabad, Andhra Pradesh
- Delhi Unit Office Pusa Campus, New Delhi

प्राक्कथन

भारत में जलवायु परिवर्तन के अंतर्गत फसल विविधीकरण और कृषि स्थिरता के लिए मक्का में बहुत अधिक संभावना है। मक्का उन फसलों में से एक है जो खाद्य, सब्जी, चारा और उद्योगों में व्यापक रूप से उपयोग में आती है। भा.कृ.अनु.प.-भारतीय मक्का अनुसंधान संस्थान द्वारा चलाये जा रहे अखिल भारतीय समन्वित अनुसंधान परियोजना (एआईसीआरपी) एवं उनके समन्वय केंद्रों सहित सार्वजनिक क्षेत्र में भारत का अग्रणी मक्का अनुसंधान संस्थान है। अखिल भारतीय समन्वित अनुसंधान परियोजना (मक्का) को देश में अपनी तरह का पहला कार्यक्रम होने का गौरव प्राप्त है, जो सन् 1957 में शुरू हुआ था । इसकी स्थापना के बाद से, यह कार्यक्रम देश में मक्का की खेती और उत्पादन प्रौद्योगिकियों के विकास में लगातार योगदान दे रहा है। यह कार्यक्रम प्रासंगिक पारिस्थितिकीयों में मक्का के उत्पादन और दीर्घकालीनता, दोनों को बढ़ावा देने के लिए हमेशा प्रयत्नशील है। इस कार्यक्रम की सफलता का अनुमान इस बात से लगाया जा सकता है कि जहाँ वर्ष 1950-51 के दौरान देश में मक्का का कुल उत्पादन मात्र 1.73 मिलियन टन था जो वर्ष 2017-18 में बढ़कर 28.75 मिलियन टन हो गया है। खाद्य और उद्योगों के विभिन्न क्षेत्रों में मक्का की तेजी से बढ़ती मांग के साथ यह कार्यक्रम देश में फसल के पर्याप्त उत्पादन को सुनिश्चित करने के लिए वर्तमान चुनौतियों का सामना करने के लिए महत्वपूर्ण भूमिका निभा रहा है। मुख्य रूप से एकल-क्रॉस संकरों को अपना कर भविष्य में मक्का में सुधार की और भी व्यापक संभावनाए हैं। फसल दीर्घकालीनता का संसाधन-कुशल प्रबंधन कार्यप्रणाली द्वारा प्रबंधन किया जाना चाहिए।

मक्का के जर्मप्लाज्म को विभिन्न समन्वय केंद्रों में वितरण करना संस्थान की निरंतर गतिविधि रही है। भारतीय मक्का अनुसंधान संस्थान, राष्ट्रीय पादप आनुवंशिक संसाधन ब्यूरो एवं पौधा किस्म और कृषक अधिकार संरक्षण अधिनियम के साथ आनुवंशिक स्टॉक, संकर आदि को पंजीकृत करके योगदान दे रहा है। भारतीय मक्का अनुसंधान संस्थान विभिन्न तकनीकियों को कृषक समुदाय तक पहुँचाने के लिए विस्तार कार्यक्रमों के तहत् हमेशा प्रयास-रत है। अनुसंधान के परिणामों को हितधारकों तक ले जाने के लिए सरकार की विभिन्न योजनाओं जैसे- अग्र पंक्ति प्रदर्शन, आदिवासी उप-योजना, अनुसूचित जाति उप-योजना और मेरा गाँव मेरा गौरव का पूर्णतया पालन किया जा रहा है।

बदलते जलवायु परिवेश में मक्का की फसल भारत और दुनिया भर में नई चुनौतियों का सामना कर रही है। इसमें चिंता का मुख्य कारण हाल ही में एक नए विनाशकारी कीट, फॉल आर्मीवार्म का आक्रमण है, जिसका दुष्प्रभाव पिछले साल दक्षिण भारत में देखा गया था। संस्थान ने इस पर बिना देरी किये शीघ्रता से कार्य किया है और देश के विभिन्न हिस्सों में कीट के दुष्प्रभाव से बचने के लिए जागरूकता कार्यक्रम चलाये जा रहे है । कीट के आक्रमण से बचने के लिए केंद्र और राज्य सरकार के विभागों को कीट की निगरानी और नियंत्रण उपायों के प्रति जागरूक बनाया जा रहा है। मक्का की बढती मांग को पूरा करने के लिए फाल आर्मीवर्म के साथ अन्य कीटों और रोगजनकों को नियंत्रित करना बहुत महत्वपूर्ण है, जिनका आक्रमण दिन-प्रतिदिन बढ़ता जा रहा है। इसके अलावा, लोगों की खान पान की आदतों में मक्का को बढ़ावा देने के लिए, विशेष मक्का पर अनुसंधान किया जा रहा है। साथ ही डेयरी उद्योग को बढ़ावा देने के लिए, चारा मक्का पर भी जोर दिया जा रहा है। संस्थान द्वारा कुशल पोषक तत्व प्रबंधन तकनीकियों का विकास किया जा रहा है और किसानों को मक्का आधारित फसल प्रणाली की ओर स्थानांतरित और प्रोत्साहित करने के लिए संरक्षण कृषि मॉडयूल विकसित किया जा रहा हैं, जिससे पर्यावरणीय स्थिरता में योगदान मिलेगा।

मैं सम्पूर्ण मक्का परिवार की ओर से डॉ. त्रिलोचन महापात्र, सचिव डेयर और महानिदेशक, भा.कृ.अनु.प. का भारत में मक्का अनुसंधान कार्यक्रम को बढ़ावा देने में उनके व्यापक समर्थन और अमुल्यवान मार्गदर्शन के लिए हार्दिक धन्यवाद और कृतज्ञता प्रकट करता हूँ। मैं डॉ. ए. के. सिंह, उप महानिदेशक (बागवानी और फसल विज्ञान), डॉ. आर. के. सिंह, सहायक महानिदेशक (एफएफसी) और आईसीएआर के सभी अधिकारियों का भी मक्का अनुसंधान कार्यक्रम को मज़बूती प्रदान करने हेतु उनके निरंतर प्रोत्साहन और उत्साह के लिए धन्यवाद करता हूँ। मैं संपादकीय मंडल और भारतीय मक्का अनुसंधान संस्थान और मक्का के एआईसीआरपी केंद्रों के सभी कर्मचारियों को उनके निरंतर सहयोग के लिए धन्यवाद देता हूं।

(सुजय रक्षित)

MISSION

Enhancing the productivity, profitability and competitiveness of maize and maize-based farming systems with economic and environmental sustainability

VISION

Rapid growth in the food, feed and industrial application of maize and maize-based products, for generation of wealth and employment in farming and industrial sectors, and for all those who are directly or indirectly associated with maize cultivation and utilization

Preface

Maize in India has high potential in crop diversification and agricultural sustainability more under changing climate. It is one of the few crops that finds its use in a broad range of applications as food, vegetable, feed, fodder and in industries. ICAR-Indian Institute of Maize Research (IIMR), along with its coordinating centres under All India Coordinated Research Project (AICRP) on maize is leading public sector maize research in India. The ACIRP on Maize has the honour of being the first of its kind which started in 1957. Since its inception, the program has been contributing towards development of maize cultivars and production technologies in the country. The program works both for increasing the production and sustainability of the crop in relevant ecologies. The success of the program can be gauged from the fact that during 1950-51, the maize production of country was 1.73 million metric tonnes (mt). The same has now reached 28.26 mt in 2017-18. With the rapidly increasing demand of maize in various sectors of food and industry, the program is working to meet current challenges to ensure sufficient production of the crop in the country. There is a large scope of further improvement, primarily by facilitating the adoption of single-cross hybrids. The issue of crop sustainability needs to be handled by resource-efficient management practices.

Sharing of maize germplasm to various coordinating centres has been a consistent activity of the institute. IIMR is contributing by registering genetic stocks, hybrids etc. with the NBPGR and PPV & FRA. IIMR is involved in extension efforts to reach to the farming community. Various programs like Front line demonstration (FLD), Tribal Sub-plan (TSP), Scheduled Caste Sub-Plan (SCSP) and Mera Gaon Mera Gaurav (MGMG) being taken up to carry the results of research to the stakeholders.

Maize in India and worldwide, is facing new challenges. A cause of concern has been the attack of a new invasive pest, fall armyworm (*Spodoptera frugiperda*), which was reported in South India last year. The institute has quickly acted and has been conducting awareness programs across various parts of the country. The centres and state departments have been sensitised regarding the pest attack to scouting and control measures. Containing fall armyworm attack along with other pests and pathogens is very important to meet the demand of maize, which is increasing every day. Further, to promote maize in the food habits of people, work on specialty corn has been taken up. To support the dairy industry, fodder maize is being emphasized. Efficient nutrient management technologies are being developed. Conservation agriculture modules are being developed to encourage farmers to shift towards maize-based cropping systems and contribute to environmental sustainability at the same time.

On behalf of the entire maize fraternity I express sincere gratitude to Dr. Trilochan Mohapatra, Secretary, DARE & DG, ICAR for his extensive support in promoting maize research in India. I also convey thanks to Dr. A.K. Singh, DDG (Crop Sciences), Dr. R.K. Singh ADG (FFC) and all officials of ICAR for their consistent encouragement and enthusiasm for supporting maize research in India. I thank the editorial team and all staffs of IIMR and AICRP-Maize for their continuous support.

(Sujay Rakshit)

Mandate

Basic and strategic research aimed at enhancement of productivity and production of maize, including specialty corn.

Coordination of multi-disciplinary and multi-location research to identify appropriate technologies for varied agro - climatic conditions.

Dissemination of improved technologies, capacity building and developing linkages.

Coordination of the All India Coordinated Research Project (AICRP) on Maize and to carry out extension and outreach programmes

विशिष्ट सारांश

फसल सुधार

भा.कृ.अनु.प.-भारतीय मक्का अनुसंधान संस्थान देश में मक्का उत्पादन और उत्पादकता में वृद्धि हेतु पूर्ण रूप से प्रतिबद्ध है। मक्का जननद्रव्य में आनुवंशिक वृद्धि संस्थान के अनुसंधान का प्रमुख केंद्र बिंदु रहा है। फसल सुधार कार्यक्रम के अंतर्गत प्रमुख गतिविधियों में जननद्रव्य का क्रय एवं उसका गुणानुवर्णन करना, जैविक एवं अजैविक तनावों के लिए प्रतिरोधी जननद्रव्य विकसित करना, गुणवत्ता में सुधार लाना और देश की विभिन्न कृषि-पारिस्थितिकियों के लिए नयी संकर किस्मों को विकसित करना है । संस्थान, मक्का पर अखिल भारतीय समन्वित अनुसन्धान परियोजना (एआईसीआरपी) में भी समन्वयन करता है ताकि मक्का से संबद्ध प्रादेशिक तथा राष्ट्रीय मुद्दों का समाधान किया जा सके । संस्थान ने फसल सुधार कार्यक्रम के अंतर्गत महत्वपूर्ण अनुसंधान प्रगति को प्राप्त किया है जो नीचे उल्लेखित है:

जन्नद्रव्य आधार का सुदृढ़ीकरण

किसी भी फसल के प्रजनन कार्यक्रम की सफलता उसकी उपलब्ध जननद्रव्य की समर्धता पर निर्भर करती है । विदेशी जननद्रव्य का पदार्पण करना और नवीनतम आनुवंशिक संसाधन विकसित करना एक निरंतर प्रक्रिया है । भारतीय मक्का प्रजनन कार्यक्रम को सुदृढ़ करने हेतु सी. आई. एम. एम. वाई. टी. (CIMMYT), मैक्सिको से उच्च जैव भार की पांच वंशावलियां, भा.कृ.अनु.प-राष्ट्रीय जैविक तनाव प्रबंधन संस्थान से यूकलैना मेक्सिकाना की 19 वंशावलियां और मक्का आनुवंशिक संग्रह केंद्र, इलिनोइ विश्वविद्यालय, अमेरीका से मक्का के 24 उच्च एमाइलोज निहित वंशावलियों का समावेश किया गया।

शीतकालीन पौधशाला सुविधा और जन्नद्रव्य का वितरण

ए आई सी आर पी केन्द्रों एवं अन्य सार्वजानिक संस्थानों के बीच जन्नद्रव्य साझा करना भा.म.अनु.स. के प्रमुख अधिदेशों में से एक है। भा.कृ.अनु.प.-भा.म.अनु.स. और भा.कृ.अनु.प.-राष्ट्रीय पादप आनुवंशिक संसाधन ब्यूरो ने संयुक्त रूप से 25 सितंबर, 2018 को शीतकालीन पौधशाला केंद्र, हैदराबाद में मक्का जननद्रव्य प्रक्षेत्र दिवस का आयोजन किया और राष्ट्रीय पादप आनुवंशिक संसाधन ब्यूरो के राष्ट्रीय जीन बैंक से 295 मक्का वंशावलियों का प्रतिभागियों के चयन के लिए प्रदर्शन किया गया । इसके अलावा, मार्च 1-2, 2019 के दौरान शीतकालीन पौधशाला केंद्र, हैदराबाद में मक्का प्रजनन के लिए मक्का जन्नद्रव्य प्रक्षेत्र दिवस के साथ प्रशिक्षण कार्यक्रम का आयोजन किया गया जिसमें कुल 3187 मक्का वंशक्रमों (भा.म.अनु.स., ए.आई.सी.आर.पी. तथा सी.आइ.एम.एम.वाई.टी द्वारा योगदान की गयी) का प्रतिभागियों के चयन के लिए प्रदर्शन किया गया। इसके अलावा, टियोसिंटे के जन्नद्रव्य (जिया मेज उपप्रजाति पार्विग्लुमिस, जिया मेक्सिकाना और जिया लग्जुरियंस) और भूरी मध्य रेखा वाले वंशक्रमों को भी कोयंबटूर और लुधियाना के वैज्ञानिकों के साथ साझा किया गया। शीतकालीन पौधशाला केंद्र, हैदराबाद उत्तरी भारत के दो भा.कृ.अनु.प. संस्थानों और पांच ए.आई.सी.आर.पी. केंद्रों के लिए मक्का अनुसंधान के लिए गैर मौसमी जरूरतों को पूरा करता है।

अनुवांशिक संसाधनों का रखरखाव और विविधीकरण

संस्थान में विभिन्न परिपक्वता के 1830 पीले अंतर्जात वंशक्रम, गुणवत्ता प्रोटीन मक्का (क्यूपीएम) के 238 अंतर्जात वंशक्रम, सफेद मक्का के 450 अंतर्जात वंशक्रम और सफेद मक्का की 31 समष्टियों का अनुरक्षण किया गया। चयनित भू-प्रजातियों से निकाले गये 600 से अधिक वंशक्रम उन्नति के विभिन्न चरणों में हैं। इसके अलावा, 150 अगेती मक्का के अंतर्जात वंशक्रम (S7) स्थापित किये जा चुके हैं और सात विभिन्न अगेती समष्टियों से नई अंतर्जात वंशक्रम (S4) को विकसित किया गया है। 24 क्यूपीएम और 24 सामान्य वंशक्रमों में क्यूपीएम जननद्रव्य के संकीर्ण आनुवंशिक आधार में विविधता लाने के लिए आणविक विविधता की जांच की गई। उपलब्ध आनुवंशिक अंतर जानकारी द्वारा जनकों का चुनाव एवं उनको आपस में क्रॉस करके विविधतापूर्ण समष्टियों को प्राप्त किया जा रहा है । सफेद मक्का के जननद्रव्य का विविधिकरण करने के लिए, सफेद मक्का की 16 प्रजातियों का स्वप्रजनन किया गया तथा दो विशिष्ट सामान्य और चयनित स्वीट कॉर्न अंतर्जात वंशक्रमों का आपस में संकरण करके नये वंशावली क्रॉस बनाये गये हैं। बेबी कॉर्न और चारा मक्का विकास के लिए भी समान प्रयास किए गए हैं ।

संकर विकास कार्यक्रम

वर्ष 2018-19 के दौरान तीन संकर, DMHR 1305, IMHB 1532 और IMHB 1539 को केंद्रीय किस्म विमोचन समिति (CVRC) द्वारा विमोचित और अधिसूचित किया गया है। एक पीली संकर मक्का को AVT I से AVT II में प्रोन्नत किया गया तथा नौ पीले संकरों को क्रमशः खरीफ 2018 और रबी 2017-18 के दौरान NIVT से AVT I में प्रोन्नत किया गया । इसके अलावा, दो गुणवत्ता प्रोटीन मक्का (QPM) संकरों को जोन II और जोन V में AVT I से AVT II में प्रोन्नत किया गया। खरीफ 2019 के लिए NIVT से AVT I में चार क्यूपीएम संकरों को भी प्रोन्नत किया गया। इसके अलावा दो चारा मक्का संकरों को भी एआईसीआरपी चारा परीक्षण में IVTM से AVTM में प्रोन्नत किया गया।

जैविक तनावों के उन्मूलन के लिए जन्नद्रव्य

बीमारियों के लिए संवेदनशील क्षेत्रों (हॉट स्पॉट) में कृत्रिम टीका विधि द्वारा विभिन्न बीमारियों के लिए चयनित अंतर्जात वंशक्रमों का मूल्यांकन किया गया। सभी क्षेत्रों में औसत रोग स्कोर के आधार पर तीन अंतर्जात

वंशक्रमों, जो कि टीएलबी (NN42050-1, EC440638 और CM 117-3-4-1) और एमएलबी (JCY 6, BGS337 और UMI 1220) और चार अंतर्जात वंशक्रमों (MRCHY5158-2, G18seqcef74-2-1, PML-41 और EC440609) को चारकोल रॉट के लिए प्रतिरोधी पाया गया। इसके अलावा, खरीफ 2018 में लुधियाना में एमएलबी और चारकोल रोट रोगों के विरुद्ध 48 अगेती मक्का जीन प्ररूपों (जीनोटाइप्स) की जांच की गई। केवल एक जीनोटाइप ने एमएलबी के लिए मध्यम रूप से प्रतिरोधी और 34 जीनोटाइप ने चारकोल रोट के प्रति मध्यम प्रतिरोधी प्रतिक्रिया दिखाई।

खरीफ 2018 के दौरान प्रतिरोधी चेक के साथ 27 जीनोटाइप्स को काइलो पार्टेलस के विरुद्ध कृत्रिम संक्रमण के तहत जांच की गई । दो जीनोटाइप्स, [(E13043/V373) BIO9544]-4-2-1-2 (2.5) एवं [(E13118/V373) BIO9544]-5-1-2-2-1(2.5) प्रतिरोधी पाए गए तथा 11 जीनोटाइप्स काइलो पार्टेलस के विरुद्ध मध्यम प्रतिरोधी थे । खरीफ 2018 में तना छेदक (स्टेम बोरर) के विरुद्ध 30 जल्दी पकने वाली अंतर्जात वंशक्रमों की जांच की गई । इनमें से, अंतर्जात वंशक्रम 70120, 70159, 70175 और 70227 ने स्टेम बोरर के विरुद्ध प्रतिरोधी पाए गये । रबी 2018-19 के दौरान सेसमिया इन्फेरेंस (Sesamia inferens) के विरुद्ध कृत्रिम संक्रमण के तहत 68 अंतर्जात वंशक्रमों और 29 भू-प्रजातियों का मूल्यांकन किया गया केवल एक जीनोटाइप 382-1 (2.2) प्रतिरोधी पाया गया और 22 वंशक्रम सेसमिया इन्फेरेंस के विरुद्ध मध्यम प्रतिरोधी थे । समष्टियों में, 17 मध्यम प्रतिरोधी थी और 12 सेसमिया इन्फेरेंस के विरुद्ध अतिसंवेदनशील थी।

अजैविक तनावों के उन्मूलन के लिए जननद्रव्य की जांच

नत्रजन (N) फसल उत्पादकता के लिए एक महत्वपूर्ण पोषक तत्व है। मक्का अंतर्जातों वंशक्रमों में नाइट्रोजन उपयोग दक्षता की जांच करने के लिए, 21 चयनित अंतर्जात वंशक्रमों की लगातार दूसरे वर्ष खरीफ 2018 के दौरान पर्याप्त नाइट्रोजन और अपर्याप्त नाइट्रोजन की दशाओं के अंतर्गत जाँच की गई। अनाज उपज और अन्य भौतिक-जैव रासायनिक लक्षणों के आधार पर दो विषम वंशक्रमों (DMI 56ः नाइट्रोजन-तनाव के प्रति अत्यधिक सहिष्णुय DMI 8ः नाइट्रोजन-तनाव के प्रति अतिसंवेदनशील) की पहचान की गयी और नाइट्रोजन-तनाव के लिए इनकी प्रतिक्रिया की हाइड्रोपोनिक संवर्धन से पुनः पुष्टि की गई। नाइट्रोजन की तरह फास्फोरस (P) भी फसल वृद्धि के लिए एक महत्वपूर्ण पोषक तत्व है। फास्फोरस उपयोगी दक्ष वंशक्रमो की पहचान करने के लिए क्रत्रिम कांच घर (ग्लास हाउस) परिस्थितियों में अनुकूलित हाइड्रोपोनिक संवर्धन का उपयोग करके कम फॉस्फेट तनाव के अंतर्गत 40 वंशक्रमो का मूल्यांकन किया गया तथा उच्च फॉस्फेट उपयोग दक्षता के साथ BML 5 की सहिष्णु वंशक्रम रूप में तथा BML 10 की कम फॉस्फेट उपयोग दक्षता के साथ अति संवेदनशील वंशक्रम के रूप में पहचान की गई।

गुणवत्ता के लिए प्रजनन

उच्च तेल समष्टि की कुल 224 वंशक्रमो का तेल तत्व के लिए एनएमआर द्वारा मूल्यांकन किया गया । 4.54% औसत मान के साथ तेल की मात्रा 2.89 से 5.86% के मध्य पाई गयी । अगली पीढ़ी में अग्रेषण के लिए भूट्टे के वजन, भूट्टे की लंबाई और तेल तत्व का सर्वोच्च सूचकांक दर्शाने वाले शीर्ष 45 वंशक्रमों का चुनाव किया गया। चयनित वंशक्रमों में तेल की औसत मात्रा 5.13% थी। इसके अलावा, बीज में मेथियोनीन की मात्रा के लिए 116 अंतर्जात वंशक्रमों के एक सेट का मूल्यांकन किया गया । 10 अंतर्जातों के ऊतक नमूने में मेथिओनिन की सांद्रता 0.25 ग्राम /100 ग्राम से ज्यादा दर्ज की गई ।

स्टार्च प्रोफाइल, अर्थात स्टार्च, एमाइलोज और एमाइलोपेक्टिन के लिए 100 जीनोटाइप्स का मूल्यांकन किया गया । संकर मक्का में स्टार्च तत्व की मात्रा 67.19% (AQH 8) से 73.18% (BIO 274) के बीच एवं एमाइलोज सांद्रता 19.10% (PMH 2) से 35.10% (CP 777) के बीच थी । वंशक्रमों में स्टार्च की मात्रा 69.3% (LM 16) से 72.1% (LM 15) के बीच, जबकि एमाइलोज की मात्रा 20.95% (HKI 193-1) से 34.70% (LM 13) के बीच थी ।

क्यूपीएम परियोजना में 238 पीली क्यूपीएम वंशक्रमों के एक सेट की ट्रिप्टोफैन तत्व के लिए जांच कर बेहतर नारंगी लाइनों की पहचान की गई, नारंगी क्यूपीएम के अलावा सफेद क्यूपीएम वंशक्रमो की भी पहचान की गई थी।

मक्का में परिपक्व भ्रूण आधारित इनविट्रो पुनर्जनन प्रोटोकॉल का मानकीकरण

परिपक्व भ्रूण का उपयोग करते हुए मक्का में इनविट्रो पुनर्जनन प्रोटोकॉल ने प्रतिवेदित वर्ष के दौरान आशाजनक प्रगति दिखाई है इनविट्रो कैलस इंडक्शन और पुनर्जनन क्षमता के लिए कुल 28 जीनोटाइप का मूल्यांकन किया गया । 28 जीनोटाइप्स में से, चार जीनोटाइप्स (BML 6, DHM 117, DMRH 1308, DMRH 1301) में अच्छा इन-विट्रो कैलस प्रेरण पाया गया और DMRH 1308 (61%) और DMRH 1301 (31%) में सर्वश्रेष्ठ पुनर्जनन परिणाम प्राप्त किये गए ।

मक्का साइलेज की गुणवत्ता नियंत्रण के लिए फीड-एडिटिव एंटीबायोटिक्स के मूल्यांकन के लिए इन सिलिको अभिलक्षणन

माइकोबैक्टीरियम, एम. बोविस और एम. टुबरकुलोसिस जानवरों से मनुष्यों में और विपरीत क्रम में संक्रमण करते हैं। मक्का साइलेज के माध्यम से क्षय रोग के संचरण को रोकने के लिए, एक विकल्प के रूप में फीड-एडिटिव एंटीबायोटिक दवाओं का उपयोग किया जा सकता है । इस संबंध में, एम. बोविस और एम. टुबेरोकुलोसिस के राइबोन्यूक्लेज-पी की संरचना का प्रतिरूप तैयार किया गया है। प्रोटीन घटक को जानने के लिए एमिनोग्लाइकोसाइड एंटीबायोटिक के जुडाव को समझा गया । पहले से विकसित प्रतिरोधों की चुनौतीयों से निपटने और नई चिकित्साविधान का पता लगाने के लिए, आरएनए घटक को कंप्यूटर द्वारा अभिलक्षित किया गया।

फसल सुरक्षा

रोग और कीट प्रबंधन

तीन संकर (VH18605, VH18838 और VH171220) चारकोल रोट (ChR) के प्रति प्रतिरोधी और एक लाइन [(E13118 / CML474) PMH1, -4-1-1-1-3, मेडीस लीफ ब्लाइट (MLB) के विरुद्ध मध्यम प्रतिरोधी पायी गई । विभिन्न विकसित मॉड्यूलों में, आईडीएम मॉड्यूल ट्राइकोडर्मा हर्जियनम (10 ग्राम/किग्रा बीज) का बीज उपचार, बुवाई के 45 दिन बाद स्यूडोमोनास फ्लोरेसेंस (10 ग्राम/लीटर पानी) का पर्ण स्प्रे, बुवाई के 50 दिन बाद अजोक्सिस्ट्रोबिन 18.2%+ डिफेंकोनाजोल 11.4% w/w एससी (एमीस्टार टॉप 325 एससी) 1 मिली/लीटर पानी का पर्ण स्प्रे, बुवाई के 60 दिन बाद गोमूत्र (20%) का पर्ण स्प्रे प्रभावी पाया गया और इससे दिल्ली और करनाल में बैंडेड लीफ और शीथ ब्लाइट (बीएलएसबी) के विरुद्ध रासायनिक मापांक से भी बेहतर तरीके से रोग को नियंत्रित किया गया । यह मॉड्यूल मेडीस लीफ ब्लाइट (MLB) के विरुद्ध भी प्रभावी था । तीन वर्षों (2016-2018) में परीक्षित किए गए विभिन्न जैव उत्पादों में ऐजाडीरिक्टा इंडिका (नीम अर्क) @ 10%, एलियम सैटिवम (लहसुन की कली) / 10%, पॉलीअल्थिया लोन्गीफोलिया (फाल्स अशोक) @ 10% और पार्थेनियम हिस्टीरोफोरस (कांग्रेस घास) @ 10% एमएलबी के विरुद्ध प्रभावी पाए गए। अरेखित चेक की तुलना में बीएलएसबी के प्रबंधन में रेखित पत्ती तकनीक प्रभावी थी।

फसल सुरक्षा कार्यक्रम में पोषक पादप प्रतिरोधकता आधारित दृष्टिकोणों पर जोर दिया गया, जो कि एकीकृत कीट प्रबंधन का एक महत्वपूर्ण घटक है। मक्का जीनोटाइप्स की जैव रासायनिक प्रोफाइलिंग से पाया गया कि सेसीमिया इन्फेरेंस के विरुद्ध मक्के के रक्षा तंत्र में बाउंड फेनोलिक्स, पी-सीए (p-CA), फेरुलिक एसिड और कुल टैनिन तत्वों का योगदान है। जीनोटाइप-बाय-बायोकैमिकल कारक बाइप्लॉट से ज्ञात हुआ कि विभिन्न ऊतकों और अवस्थाओं में मापे गये जैव रासायनिक मापदंडों का डेटा मक्का जीनोटाइप्स को सेसीमिया इन्फेरेंस के विरुद्ध प्रतिक्रिया के अनुसार समूह में व्यवस्थित कर सकता है।

बेसिलस थुरिंजीनेसिस (किस्म कुर्स्ताकी), यानि BB1 (76.29 पीपीएम) और BB2 (74.41 पीपीएम) के मूल उपभेदों की घातक खुराक (LC50) संदर्भ तनाव HD1 (63.31 पीपीएम) के साथ बराबर पाई गई। जोकि काइलो पार्टेलस के नवजात लार्वा के ऊपर निर्धारित किया गया ।

नये विनाशक कीट, फॉल आर्मीवर्म स्पोडोप्टेरा फ्रुजीपरडा (जे.ई.स्मिथ), के जीवन चक्र का अध्ययन प्रयोगशाला परिस्थितियों में बेबी कॉर्न पर किया गया। अध्ययन में पाया गया की कीट की औसत ऊष्मायन, लार्वा और प्यूपा अवस्था की अवधि क्रमशः 4.60, 15.53 और 7.66 दिन थी । नर और मादा की औसत दीर्घायु 4.49 और 5.44 दिन, जबकि नर और मादा वयस्कों की कुल जीवन अवधि क्रमशः 32.33 और 33.27 दिन थी तथा नर और मादा का लिंगानुपात 1.00: 1.28 पाया गया ।

फसल उत्पादन

फसल प्रणाली और पोषक तत्व प्रबंधन

सिंधू-गंगा मैदानी क्षेत्र में चावल-गेहूं प्रणाली की तुलना में, मक्का-गेहूं प्रणाली में कुल प्रणाली उत्पादकता (33% तक), लाभप्रदता (50% तक) और पानी की बचत (82%) अधिक पायी गई । जैविक पोषक तत्व प्रबंधन उपचारों का बेबी कॉर्न की उपज में कोई सार्थक प्रभाव नहीं देखा गया जब कि स्वीट कॉर्न में जैविक पोषक स्रोतों के प्रयोग से दूसरे वर्ष में नकारात्मक प्रतिक्रिया देखी गयी। जैविक पोषक तत्व प्रबंधन के तहत सामान्य मक्का और गेहूं में क्रमशः 43 और 75% तक उपज पर नकारात्मक प्रभाव पड़ा । खरीफ मक्का में 33% बुनियादी नाइट्रोजन अनुप्रयोग के बाद ग्रीन-सीकर निर्देशित नाइट्रोजन अनुप्रयोग से मक्का में पारंपरिक अनुशंसित तीन बार विभाजित नाइट्रोजन अनुप्रयोग की बजाय उपज में 6.9% की वृद्धि देखी गई । संरक्षण कृषि में अवशेषों के अवधारण से मक्का की पैदावार में बिना अवशेष के अनुप्रयोग की तुलना में 12.6% वृद्धि पायी गयी।

मक्का पर अखिल भारतीय समन्वित अनुसंधान परियोजना

फसल सुधार

खरीफ 2018 के दौरान, अखिल भारत समन्वित परीक्षणों में 311 मक्का प्रविष्टियों का मूल्यांकन किया गया उनमें से सार्वजनिक क्षेत्र द्वारा 220 और निजी क्षेत्र द्वारा 91 प्रविष्टियों का योगदान दिया गया। विभिन्न अवस्थाओं में मूल्यांकित की गई 311 प्रविष्टियों में से, 264 सामान्य मक्का की और 47 विशेष मक्का की थी। इन सभी प्रविष्टियों का परीक्षण 13 प्रजनन परीक्षणों में किया गया। प्रत्येक क्षेत्र (जोन) की सफलता दर की गणना रिपोर्ट किए गए परीक्षणों बनाम प्रतिवेदित परीक्षणों के आधार पर की गई और यह खरीफ 2018 प्रजनन परीक्षणों के लिए 88.9% थी। खरीफ 2018 के दौरान परीक्षण किए गए 305 संकरों में से, 105 संकरों को प्रोन्नत किया गया और किस्म पहचान समिति के द्वारा 11 संकरों की पहचान की गयी जो अपने संबंधित क्षेत्रों में केंद्रीय किस्म विमोचन समिति (CVRC) द्वारा खेती के लिए विमोचित की जाएंगी। रबी 2017-18 के दौरान, एआईसीआरपी में बहु-स्थानीय मूल्यांकन के लिए कुल 107 प्रविष्टियाँ पछेती, मध्यम और गुणवत्ता प्रोटीन मक्का (QPM) परीक्षणों के तहत प्राप्त हुईं । प्राप्त 107 परीक्षण प्रविष्टियों में से 104 सामान्य मक्का और 3 प्रविष्टियाँ गुणवत्ता प्रोटीन मक्का (QPM) परीक्षणों के लिए प्राप्त हुईं। कुल छह अलग-अलग प्रजनन परीक्षणों का गठन किया गया और चार क्षेत्रों (जोन) में 24 परीक्षण केंद्रों पर मूल्यांकन के लिए लगाया गया। प्रत्येक क्षेत्र की सफलता दर की गणना, रिपोर्ट किए गए परीक्षणों बनाम प्रतिवेदित परीक्षणों के आधार पर की गई जो की 92.7% थी। रबी 2017-18 के दौरान पदोन्नति के लिए 90 प्रविष्टियाँ उपलब्ध थीं जिनमें से केवल 49 प्रविष्टियों को ही उनके अग्रमि परीक्षण के लिए पदोन्नत किया गया।

फसल उत्पादन

इस अवधि के दौरान, पूर्व-विमोचित जीनोटाइप्स को दो पादप घनत्व

(अनुशंसित और उच्च) और दो पोषक तत्व स्तर (RDF और 150% RDF) पर परीक्षित किया गया। रबी 2017-18 में, IM 8013 की पैदावार उत्तर-पश्चिमी मैदानी क्षेत्रों (एनडब्ल्यूपीजेड) में सर्वश्रेष्ठ चेक से ज्यादा पाई गयी। NEPZ में, मध्यम अवधि BLH 109 की पैदावार सर्वश्रेष्ठ चेक से अधिक पायी गयी। खरीफ 2018 में, लंबी अवधि के जीनोटाइप डीकेसी 9178, उत्तर-पश्चिमी मैदानी क्षेत्र (एनडब्ल्यूपीजेड) और प्रायद्वीपीय क्षेत्र (पीजेड) में 150% आरडीएफ खुराक के साथ साथ उच्च पादप घनत्व (83,000) में सर्वश्रेष्ठ चेक से बेहतर प्रदर्शन किया। फच्ड जीनोटाइप, IMHQPM 1530 ने NHZ क्षेत्र में, सर्वश्रेष्ठ चेक से 150% RDF खुराक पर बेहतर प्रदर्शन किया। ASKH1, स्वीट कॉर्न जीनोटाइप ने NWP में चेक से बेहतर प्रदर्शन किया।

पोषक तत्व प्रबंधन की प्रतिक्रिया को देखने हेतु एक दीर्घकालिक प्रयोग किया गया एवं पाया गया की स्थान-विशेष पोषक तत्व प्रबंधन एवं अनुशंषित नाइट्रोजन की 60% खुराक् ग्रीन-सीकर निर्देशित पोषक तत्व अनुप्रयोग से उत्पादकता एवं कुल लाभ में वृद्धि होती है। हालांकि उत्पादन पर जुताई का प्रभाव विभिन्न स्थानों एवं फसल प्रणालियों में अलग अलग पाया गया।

मक्का- गेहूं की फसल प्रणाली में एकीकृत पोषक तत्व प्रबंधन पर दीर्घकालिक परीक्षण के पाँच वर्ष बाद पाया गया कि 100% आरडीएफ. (5 टन/हेक्टेयर गोबरखाद (एफवाईएम) के उपयोग से अधिक उपज (5. 26 टन / हेक्टेयर) प्राप्त हुई। मक्का की जैविक खेती में एफवाईएम 10 टन/हेक्टेयर. एजोटोबेक्टर के साथ मक्का+चवली को इंटर क्रॉप के तौर पर उपयोग करने पर सबसे अधिक शुद्ध लाभ एवं लागत लाभ अनुपात (1.89) मिला। पूर्वी भारत के लिए पोटेशियम उर्वरक के अनुकूलन परीक्षण के तीन साल पूरे होने के बाद परिणामों में पाया गया कि मक्का ने धौली में उच्च पोटेशियम की खुराक (120 किलोग्राम / हेक्टेयर) और उसके बाद कल्याणी (90 किलोग्राम/हेक्टेयर) और रांची और अंबिकापुर में कम खुराक (60 किलोग्राम / हेक्टेयर) पर सकारात्मक प्रतिक्रिया दी है। पारिस्थितिक गहनता (EI) को अपनाने से, मक्का की उपज में 48. 6/ की वृद्धि हुई, जो की विभिन्न कृषि-पारिस्थितिकीयों, लुधियाना में 5. 1% से लेकर इम्फाल में 145.3% तक किसानों की मौजूदा कार्यप्रणाली से अधिक थी ।

मक्का में ऑप्टिकल सेंसर आधारित नाइट्रोजन अनुप्रयोग के लिए भा.म. अनु.सं. में विकसित अंशांकन वक्र पर सत्यापन प्रयोग खरीफ 2017 में शुरू किए गए थे। यह पाया गया कि बाजोरा और लुधियाना में मक्का की घुटने तक और नर मंजरी अवस्था में 33% बेसल नाइट्रोजन+ग्रीन सीकर निर्देशित नाइट्रोजन के अनुप्रयोग की सिफारिश से अनुशंसित उर्वरक खुराक के समान परिणाम प्राप्त हुए। सभी स्थानों पर नाइट्रोजन की बचत/अनुकूलन देखा गया और इससे यह कहा जा सकता है कि विकसित ग्रीन-सीकर निर्देशित अनुप्रयोग वक्र सफल है।

फसल सुरक्षा

मक्का में प्रमुख बीमारियों के विरुद्ध प्रतिरोधी जननद्रव्य स्रोतों की पहचान करने के लिए, रबी 2017-18 और खरीफ 2018 दोनों में 369 संकर और 385 अंतर्जात वंशक्रमों सहित 35 परीक्षणों में मेडीस लीफ ब्लाइट (एमएलबी), टर्सिकम लीफ ब्लाइट (टीएलबी), बैंडेड लीफ और शीथ ब्लाइट (बीएलएसबी), सोरघम डाउनी मिल्ड्यू (एसडीएम), राजस्थान डाउनी मिल्ड्यू (आरडीएम), कर्वुलरिया लीफ स्पॉट (सीएलएस), पोस्ट फ्लावरिंग डंठल सड़ांध (पीएफएसआर), चारकोल रोट (ChR), फ्यूजेरियम डंठल सड़ांध (एफएसआर), सामान्य रस्ट (सीआर), पॉलीसोरा रस्ट (पीआर) और बैक्टीरियल डंठल सड़ांध (बीएसआर) के लिए हॉट-स्पॉट पर कृत्रिम रूप से उत्पन्न की गई पादप-महामारी (एपिफाइटिक) के अंतर्गत जांच किया गया। खरीफ 2018 के दौरान 74, 18 और 27 अंतर्जात वंशक्रमों को क्रमशः टीएलबी, एमएलबी और आरआर के खिलाफ प्रतिरोधी / मध्यम प्रतिरोधी पाया गया । रबी मौसम में 16 संकर, टीबीबी, एसडीएम, आरआर और एफएसआर के विरुद्ध प्रतिरोधी/मध्यम प्रतिरोधी पाए गए। मक्का पर एआईसीआरपी में प्रमुख कीट विज्ञान (एंटोमोलॉजिकल) शोध में खरीफ 2018 के दौरान काइलो पार्टेलस (स्विन्होए), रबी 2017-18 के दौरान सेसमिया इन्फेरेंस (वॉकर) और बसंत 2018 के दौरान एथरिगोना प्रजाति के विरुद्ध प्रतिरोध स्रोतों की खोज पर ध्यान केंद्रित किया। खरीफ 2018 के दौरान, NEPZ में कुल 91 प्रविष्टियाँ, NWPZ में 103, PZ में 135 और CWZ में 122 और 40 अंतर्जात वंशक्रमों का मूल्यांकन काइलो पार्टेलस के विरुद्ध किया गया । रबी 2017-18 के दौरान, 30 पछेती परिपक्वता, 11 मध्यम परिपक्वता और 7 गुणवत्ता प्रोटीन मक्का (फच्ड) प्रजातियों को कृत्रिम संक्रमण के अंतर्गत PZ (हैदराबाद) और NWPZ (करनाल) में सेसमिया इन्फेरेंस के विरुद्ध जांच किया गया । सेसमिया इन्फेरेंस प्रतिरोध के लिए पहले से जांच की गई छह अंतर्जात वंशक्रमों को रबी 2017-18 के दौरान कृत्रिम संक्रमण में जांच किया गया । दिल्ली में बसंत 2018 के दौरान शूटफ्लाई, एथेरिगोनस्प और लुधियाना में मछली भोजन के प्रति आकर्षित होने वाले एथेरिगोन कानवीस्टेस्कलाट के प्राकृतिक संक्रमण के तहत 65 अंतर्जात वंशक्रमों का मूल्यांकन किया गया तथा 11 अंतर्जात वंशक्रमों की पहचान की गई। सभी स्थानों में काइलो पार्टेलस के प्रबंधन के लिए क्लोरेंट्रानिलिप्रोएल 18.5 एससी @ 0.3 मिली/ लीटर पानी को प्रभावी पाया गया। काइलो पार्टेलस की आबादी की निगरानी खरीफ 2018 के दौरान सात एआईसीआरपी स्थानों पर दो जीनोटाइप के ऊपर की गई। फ्लूवेनडामाइड (Flubendiamide) 480 एससी @ 0.2 मिली/ लीटर पानी को पत्ती की क्षति मूल्यांकन और अनाज की पैदावार के मामले में सेसमिया इन्फेरेंस के विरुद्ध प्रभावी पाया गया। खरीफ 2018 के दौरान मक्का के जीनोटाइप्स में फॉल आर्मीवर्म के आक्रमण की निगरानी कोयम्बटूर, हैदराबाद और कोल्हापुर में की गई।

विस्तार और जानकारी

भा.कृ.अनु.प.-भा.म.अनु.स किसानों और अन्य हितधारकों के पास प्रौद्योगिकी हस्तांतरण, महत्व पूर्ण इनपुट वितरण और क्षमता निर्माण हेतु मजबूत आउटरीच गतिविधियाँ को अपनाता है। राष्ट्रीय खाद्य सुरक्षा मिशन (एनएफएसएम) के अंतर्गत 16 राज्यों में 972 किसानों के साथ 386.6 हेक्टेयर क्षेत्र में अग्र-पंक्ति प्रदर्शन किए गए। अग्र-पंक्ति प्रदर्शन मुख्यतः एकल क्रॉस संकर, सूक्ष्म पोषक तत्व अनुप्रयोग, अंकुरण पश्चात खरपतवार प्रबंधन, एकीकृत कीट प्रबंधन और अंत-फसल

(इंटरक्रॉपिंग) पर केंद्रित थे। किसान प्रचलित कार्यप्रणाली से, अग्र-पंक्ति प्रदर्शन से खरीफ, रबी और बसंत में उपज लाभ क्रमशः 31.9%, 24.3% और 63.4% रहा। अनुसूचित जनजाति घटक (STC) के अंतर्गत, देश के विभिन्न हिस्सों में 2026 किसानों को प्रशिक्षण दे कर लाभान्वित किया गया तथा 200 हेक्टेयर से अधिक क्षेत्रफल पर अग्र-पंक्ति प्रदर्शन आयोजित किए गए । इनपुट बीज, जैव उर्वरक / जैवकीटनाशकों / वनस्पतिक, रासायनिक उर्वरक, पौध संरक्षण रासायनिक और कृषि उपकरणों सहित अनुसूचित जनजाति घटक (STC) कार्यक्रम में बीज-से-बीज मक्का उत्पादन को संबोधित करने पर जोर दिया गया।

पूर्वात्तर पर्वतीय (एनईएच) कार्यक्रम के तहत, सात राज्यों में 25 प्रशिक्षण/राष्ट्रीय कार्यशालाएं आयोजित की गईं और 1932 किसानों/हितधारकों को लाभान्वित किया गया। एनईएच कार्यक्रम में 372 हेक्टेयर पर अग्र-पंक्ति प्रदर्शन आयोजित किए गए और आने वाले सीजन में > 500 हेक्टेयर पर अंत-फसल (इंटरक्रॉपिंग) और गुणवत्ता प्रोटीन मक्का की अग्र-पंक्ति प्रदर्शन के संचालन के लिए इनपुट वितरित किए गए। सुअर, याक और मिथुन पर राष्ट्रीय अनुसंधान केन्द्रों के साथ ''सतत पशुधन उत्पादन के लिए एनईएच क्षेत्रों में मक्का उत्पादन'' पर एक सहयोगी कार्यक्रम भी शुरू किया गया था। जहां एनईएच क्षेत्र में पशुओं की स्थिरता के लिए मक्का खाद्य और चारा पर जोर दिया गया । संस्थान ने पंजाब, हरियाणा, बिहार और तेलंगाना के 6 जिलों में अपनाए गए 20 गांवों में दौरा, ईमेल, फोन कॉल, संदेश आदि के माध्यम से मेरा गाँव मेरा गौरव (MGMG) कार्यक्रम को लागू किया। अनुसूचित जाति उप-योजना (एससीएसपी) कार्यक्रम भी चलाया गया जिसके अंतर्गत अनुसूचित जाति समुदाय के 202 किसानों को लाभान्वित करने के लिए 3 प्रशिक्षण एंव इनपुट वितरण कार्यक्रम आयोजित किए गए।

Executive Summary

CROP IMPROVEMENT

ICAR-IIMR is exclusively committed for improvement of the maize production and productivity in the country. Genetic enhancement of maize germplasm has been the major focus of the institute. Germplasm introduction, characterization, single cross hybrid development for different agro-ecologies with resistance to biotic and abiotic stresses and quality improvement are the focused area of research under crop improvement program. The institute also coordinates the All India Coordinated Research Project (AICRP) on Maize to address the regional as well as national issues related to maize. The institute accomplished significant research progress under the crop improvement program which is mentioned below:

Strengthening of germplasm base

Strong germplasm base is the key to success of the breeding program of any crop. Introduction of exotic genetic resources and development of new germplasm is a continuous process. To enrich the Indian maize breeding program, five accessions of high biomass from CIMMYT, Mexico, 19 accessions of *Euchlaena mexicana* from ICAR-National Institute of Biotic Stress Management and 24 maize high amylose accessions from the Maize Genetic Stock Center, University of Illinois, USA were introduced.

Winter nursery facility and germplasm distribution

Distribution of maize germplasm among the AICRP centres and other public organization is one of the major mandates of ICAR-IIMR. ICAR-IIMR and ICAR-NBPGR jointly organized Maize Germplasm Field Day at WNC, Hyderabad on September 25, 2018, and displayed 295 maize accessions from the National Gene Bank of NBPGR for selection by participants. Further, Maize Germplasm Field Day cum Training Programme on maize breeding was also organized at WNC, Hyderabad during March 1-2, 2019. A total of 3187 maize lines (contributed by ICAR-IIMR, AICRP, and CIMMYT) were displayed for selections by the participants. Further, germplasm of Teosinte (comprising of *Zea mays ssp. parviglumis*, *Zea mexicana,* and *Zea luxurians*) and brown mib rib lines were also shared with scientists from Coimbatore and Ludhiana. The WNC catered the offseason requirement for two ICAR institutes and five AICRP centres from northern India.

Maintenance and diversification of genetic resources

At the institute 1830 yellow inbreds of various maturity, 238 Quality Protein Maize (QPM) inbreds, 450 white maize inbred lines, and 31 white maize populations were maintained. Over six hundred lines derived from selected landraces are under various stages of advancement. Further, 150 early maize inbred lines have been fixed (S7) and seven different early pools/populations have also been used for extracting new inbred lines (S4). To diversify the narrow genetic base of QPM germplasm molecular diversity in a set of 24 QPM and 24 normal lines was investigated. Obtained genetic distance information is being used to select parents to cross among themselves to derive diverse pools. To diversify the sweet corn germplasm, 16 cultivars of sweet corn were selfed and new pedigree crosses between two elite normal and selected sweet corn inbred lines were attempted. Similar efforts have been made for baby corn and fodder maize development.

Hybrid development program

During the years 2018-19, three hybrids, *viz*., DMRH 1305, IMHB 1532 and IMHB 1539 have been released and notified by the CVRC. One yellow maize hybrid was promoted from AVT-I to AVT-II and nine yellow hybrids were promoted from NIVT to AVT-I during *kharif* 2018 and *rabi* 2017-18, respectively. Further, two QPM hybrids were also promoted from AVT I to AVT II in Zone II and Zone. Four QPM hybrids have also been promoted from NIVT to AVT I for testing during *kharif* 2019. In addition to that two fodder maize hybrids were also promoted from IVTM to AVTM in AICRP fodder trial.

Germplasm for combating biotic stresses

Selected Inbred lines were evaluated for different diseases under artificial inoculation at hot-spot locations. Based on mean disease score across locations three inbred lines, each for TLB (NN42050-1, EC440638 and CM 117-3-4-1) and MLB (JCY 6, BGS337 and UMI 1220) and four inbred lines for charcoal rot (MRCHY5158-2, G18seqcef74-2-1, PML-41, and EC440609) were found resistant. Further, 48 early maize genotypes were also screened against MLB and Charcol rot diseases at Ludhiana in *kharif* 2018. Only one genotype showed a moderately resistant reaction to MLB and 34 genotypes showed moderately resistant to charcoal rot.

Twenty-seven genotypes along with resistant checks were screened under artificial infestation against *Chilo partellus* during *kharif* 2018. Two genotypes, viz., [(E13043/V373) BIO9544]-4-2-1-2 (2.5) and [(E13118/V373) BIO9544]-5-1-2-2-1 (2.5) were found resistant and 11 were moderately resistant against *C.*

partellus. In *kharif* 2018, 30 early inbred lines were also screened against stem borer. Among these, inbred lines 70120, 70159, 70175, and 70227 recorded a resistant reaction against stem borer. Sixty-eight inbreds and 29 land races were evaluated under artificial infestation against *S. inferens* during *rabi* 2018-19. Only one genotype 382-1 (2.2) was resistant *and* 22 lines were moderately resistant against *S. inferens*. Among the population, 17 were moderately resistant and 12 were susceptible against *S. inferens.*

Germplasm screening for combating abiotic stresses

Nitrogen (N) is an important nutrient for crop productivity. To identify Nitrogen use efficiency (NUE) in maize inbreds, 21 selected inbred lines were screened for the second consecutive year under N sufficient and N deficient conditions during *kharif* 2018. Based on the grain yield *per se* and other physio-biochemical traits, two contrasting lines (DMI 56: highly tolerant to N-stress; DMI 8: highly susceptible to N-stress) were identified and their response to N-stress was further confirmed in hydroponic culture. Like nitrogen Phosphorus (P) is also an important nutrient for crop growth. To identify P-use efficient (PUE) lines, 40 inbreds were evaluated under low phosphate stress using optimized hydroponic culture under glass house conditions. The study identified BML 5 as a high phosphate use efficient line and BML 10 as a susceptible line with low phosphate use efficient line.

Breeding for quality

A total of 224 individuals from high oil population were evaluated for oil content through NMR. Oil content ranged from 2.89 to 5.86% with a mean value of 4.54%. Top 45 individuals with the highest index representing ear weight, ear length, and oil content were selected to advance next generation. The mean oil content of selected individuals was 5.13%. Further, a set of 116 inbred lines were evaluated for kernel methionine content and 10 inbreds recorded methionine concentration of more than 0.25 g /100 g of the tissue sample.

One hundred genotypes were evaluated for the starch profile, viz., starch, amylose, and amylopectin. The starch content of maize hybrids ranged from 67.19% (AQH 8) to 73.18% (BIO 274). Amylose concentration ranged from 19.10% (PMH 2) to 35.10% (CP 777). The starch content of inbreds ranged from 69.3% (LM 16) to 72.1% (LM 15), whereas the amylose content ranges from 20.95% (HKI 193-1) to 34.70% (LM 13).

As part of the QPM project, a set of 238 yellow QPM lines were screened for tryptophan content and the promising orange lines were identified. In addition to orange QPM lines, white QPM lines were also identified.

Standardization of in vitro regeneration protocol in maize using mature embryo

In vitro regeneration protocol in maize using mature embryos has shown good lead during the reporting year. A total of 28 genotypes were evaluated for *in vitro* callus induction and regeneration capability. Out of 28 genotypes, good *in vitro* callus induction was obtained in four genotypes (BML6, DHM117, DMRH1308, DMRH1301) and best regeneration result was recorded in DMRH1308 (61%) and DMRH1301 (31%).

In silico characterization to screen feed-additive therapeutics for quality control of maize silage

Mycobacterium complex organisms include *M. bovis* and *M. tuberculosis*, which cause infection in animals and humans and vice versa. To prevent transmission of tuberculosis through maize silage, feed-additive antibiotics may be explored as an option. In this regard, ribonuclease P of *M. bovis* and *M. tuberculosis* has been structure modelled. Binding affinities of aminoglycoside antibiotics has been deciphered for protein component. To explore novel therapeutics in order to address the challenge of already developed resistances, RNA component has been characterized computationally.

CROP PRODUCTION

Cropping system and Nutrient management

Compared to the rice-wheat system, increased system productivity (up to 33%), profitability (up to 50 %) and water saving (82 %) was observed in the maize-wheat system in Indo-Gangatic plains. The yield of baby corn was not significantly affected by different organic nutrient management treatments, while sweet corn has given a negative response with organic nutrient sources in the second year of the experiment. Normal maize and wheat suffered yield reduction under organic nutrient management with up to 43 and 75%, respectively. The application of the 33% basal nitrogen followed by Green Seeker guided N application in maize significantly increased the grain yield of *kharif* maize by 6.9% over the traditional recommended three split N application (RDN). The enhancement in maize yield was significantly higher with the retention of the residue by 12.6% over no-residue application in conservation agriculture.

CROP PROTECTION

Disease and pest management

Three hybrids (VH18605, VH18838, and VH171220) were found resistant against charcoal rot (ChR) and one line [(E13118/CML474) PMH1]-4-1-1-1-3] was moderately resistant against maydis leaf blight (MLB). Among different modules developed, IDM module [Seed treatment with *Trichoderma harzianum* (10gm/kg of seed), foliar spray of *Pseudomonas fluorescens* (10gm/L of water) at 45 DAS, foliar spray of Azoxystrobin 18.2% + Difenconazole 11.4% w/w SC (Amistar Top 325 SC) 1ml/L of water at 50 DAS, foliar spray of cow urine (20%) at 60 DAS] was effective and showed significant disease control against banded leaf and sheath blight (BLSB) over chemical module in Delhi and Karnal. The same module was effective against MLB as well. Among different bio-products tested over three years (2016-2018), *Azadiracta indica* (neem extracts) @10%, *Allium sativum* (garlic cloves) @10%, *Polyalthia longifolia* (False Ashoka) @10% and *Parthenium hysterophorus* (congress grass) @ 10% were found effective against MLB. Leaf stripping technique was effective in the management of BLSB compared to unstripped check.

The crop protection program gave emphasis on Host Plant Resistance based approaches which are an important component of integrated pest management. Biochemical profiling of maize genotypes indicated that bound phenolics, *p*-CA, ferulic acid, and total tannin content contributes to the maize defense mechanism against *S. inferens*. Genotype-by-biochemical factor biplot showed that the data of biochemical parameters measured in different tissues and stages could be able to group the maize genotypes according to their reaction to *S. inferens*.

The lethal dose (LC_{50}) of native strains of *Bacillus thuringiensis* (var. kurstaki), *viz.*, BB1 (76.29 ppm) and BB2 (74.41 ppm) was found at par with the reference strain HD1 (63.31 ppm), determined on neonate larvae of *C. partellus*.

Biology of new invasive pest, fall armyworm [*Spodoptera frugiperda* (J.E.Smith)] was studied on baby corn under laboratory conditions. The average incubation, larval and pupal periods of fall armyworm were 4.60, 15.53 and 7.66 days, respectively. The average longevity of male and female was 4.49 and 5.44 days whereas total life period was 32.33 and 33.27 days for male and female adults, respectively. Sex-ratio of male to female was 1.00:1.28.

AICRP on Maize

Crop Improvement

During *kharif* 2018, 311 maize entries were evaluated in all India coordinated trials, among them, 220 were contributed by public and 91 by the private sector. Out of 311 entries evaluated in different stages, 264 were normal and 47 in specialty corns. All these entries were tested in 13 breeding trials. The success rate of each zone was calculated based on trials allotted versus reported and overall it was 88.9% for *kharif* 2018 breeding trials. Out of 305 hybrids tested during *kharif* 2018, 105 hybrids were promoted and 11 hybrids were identified by Varietal identification Committee and further these will be released by CVRAC for cultivation in their respective zones. During *rabi* 2017-18, total of 107 entries were received for multi-location evaluation in AICRP under late, medium and quality protein maize (QPM) trials. Of 107 test entries, 104 were received in Normal and 3 entries in QPM trials. Total six different breeding trials were constituted and put for evaluation at 24 test centres across the four zones. The success rate of each zone was calculated based on trials allotted versus reported and overall it was 92.7%. There were 90 entries available for promotion during *rabi* 2017-18, out of which only 49 entries were promoted to their advance stage of testing.

Crop Production

During the period, pre-released genotypes were tested at two densities (recommended and high) and two nutrient levels (RDF and 150% RDF). In *rabi* 2017-18, IM 8013 showed significantly higher yields over best check in NWPZ. In NEPZ, the medium duration BLH 109 was significantly superior over best checks. In *kharif* season 2018, long duration genotype DKC 9178 performed significantly better to 150% RDF dose with high plant density (83,000) over best check in North Western Plain Zone (NWPZ) and Peninsular Zone (PZ). QPM genotype IMHQPM 1530 in NHZ showed superior performance at 150% RDF over best checks. In sweet corn, in NWPZ, genotype ASKH1 was significantly superior over best checks.

In long-term experiment at different agro-ecologies, mixed response of nutrient management was observed and it was found that Site-specific nutrient management (SSNM) and 60% recommended a dose of nitrogen + green seeker (GS) guided nutrient application significantly increased yield and net returns over RDF. However, effect of tillage is inconsistent across locations and cropping system.

Completion of five years of experimentation in integrated nutrient management in maize-wheat cropping system, significantly higher maize grain yield (5.26 t/ha) was obtained with 100% RDF + 5 t/ha FYM. On the contrary, the economic analysis showed a new path for organic cultivation of maize and in the third consecutive year, it was found that maize + cowpea as an intercrop with FYM 10 t/ha + Azotobacter resulted in highest net returns and Benefit to Cost (B:C) ratio of maize (1.89). Completion of three years of experimentation in optimization of potassium fertilization for eastern India, results showed that maize responded positively to higher potassium doses at Dholi (120 kg/ha) followed by at Kalyani (90 kg/ha) and to lower dose at Ranchi and Ambikapur (60 kg/ha).

Results revealed that by the adoption of ecological intensification (EI), maize yield increased by 48.6%, ranging from 5.1% at Ludhiana to as high as 145.3% at Imphal over the existing farmers' practices in various agro-ecologies.

In validation experiments on the calibration curve developed at IIMR for optical sensor-based nitrogen application in maize were initiated in *kharif* 2017, it was found that the application of nitrogen (N) as 33% basal N + Green Seeker (GS) based N application at knee high and tasselling stages at Bajaura and Ludhiana resulted in at par performance with Recommended Dose of Fertilizers (RDF). Nitrogen saving/optimization was observed at all locations and thus it can be inferred that the GS based application curve developed is working.

Crop Protection

To identify resistant germplasm sources against major diseases, 35 trials including 369 hybrids and 385 inbred lines in both *rabi* 2017-18 and *kharif* 2018 were screened against maydis leaf blight (MLB), Turcicum leaf blight (TLB) , banded leaf and sheath blight (BLSB), sorghum downy mildew (SDM), Rajasthan downy mildew (RDM), curvularia leaf spot (CLS), post-flowering stalk rot (PFSR), charcoal rot (ChR), fusarium stalk rot (FSR), common rust(CR), polysora rust (PR) and bacterial stalk rot (BSR) under artificially created epiphytotics at hot spot locations. During *kharif* 2018 74, 18 and 27 inbred lines were resistant /moderately resistant against TLB, MLB and ChR, respectively. In *Rabi* season, 16 hybrids were found resistant/ moderately resistant against TLB, SDM, ChR and FSR.

The major entomological research in AICRP on maize focused on the search for resistance sources against *Chilopartellus (Swinhoe)* during *kharif* 2018, *Sesamia inferens* Walker during *rabi* 2017-18 and *Atherigona* sp. *Spring* 2018. During *kharif* 2018, a total of 91 entries in NEPZ, 103 in NWPZ, 135 in PZ and 122 in CWZ and 40 inbred lines were evaluated against *C. partellus.* Thirty late maturity, 11 medium maturity, and 7 QPM cultivars were screened under artificial infestation against *S. inferens* at PZ (Hyderabad) and NWPZ (Karnal) during *rabi* 2017-18. Six inbred lines shortlisted earlier for *S. inferens* resistance were screened under artificial infestation during *rabi* 2017-18. Sixty-five inbred lines were evaluated against shoot fly, *Atherigona sp. during Spring 2018 at Delhi and Atherigonanaqvii Steyskal* at Ludhiana under natural infestation with fish meal attractant and 11 inbred lines were identified. Chlorantraniliprole 18.5 SC @ 0.3ml/l was found effective for the management of *C. partellus* across the locations. The population dynamics of *C. partellus* was monitored on two genotypes during *kharif* 2018 at seven AICRP locations. Flubendiamide 480 SC @ 0.2ml/l was found effective against *S. inferens* in terms of leaf injury rating and grain yield. The incidence of fall armyworm was monitored in maize genotypes during *kharif* 2018 at Coimbatore, Hyderabad and Kolhapur.

EXTENSION AND OUTREACH

The ICAR-IIMR has strong outreach activities involving the technology transfer, critical input distribution and capacity building for maize farmers and other stakeholders. The frontline demonstrations (FLDs) under NFSM were conducted on 386.6 ha area spread over 16 states involving 972 farmers during three seasons. The FLDs were focused on single cross hybrids, micronutrient application, post-emergence weed management, integrated pest management and intercropping. The yield gains in FLDs over the farmer practice were 31.9%, 24.3% and 63.4% during *kharif*, *rabi* and spring season, respectively. Under Scheduled Tribe Component (STC), 36 farmers training programmes were conducted in different parts of the country benefiting 2026 tribal farmers and FLDs were conducted on over 200 ha. Inputs including seed, biofertilizer/ biopesticides/ botanicals, chemical fertilizer, plant protection chemical and farm implements were emphasized to address seed-to-seed maize production in the STC programme.

Under the NEH programme, 25 trainings/national workshops were conducted in seven states and 1932 farmers/stakeholders were benefited. FLDs were conducted on 372 ha in NEH programme and inputs were distributed to conduct intercropping and quality protein maize FLDs on > 500 ha in the coming season. A collaborative programme on "*Maize production in NEH region for sustainable livestock production*" was also initiated with NRC on a pig, NRC on Yak and NRC on Mithun, where the emphasis was laid on fodder and feed on maize for the livestock sustainability in the NEH region. The institute implemented the Mera Gaon Mera Gaurav (MGMG) program in 20 villages adopted in the 6 districts of Punjab, Haryana, Bihar, and Telangana through visits, email, phone calls, messages, etc. Scheduled Caste Sub-Plan (SCSP) program was also carried out and three training/input distribution programme were conducted benefiting 202 farmers of Scheduled Caste community.

Regrowth of maize after one cut in a cross of wild progenitor with modern Maize

1 CROP IMPROVEMENT

Maize Genetic Resource Management

Introduction of germplasm

To enrich the existing maize germplasm at ICAR-IIMR, Ludhiana, five accessions possessing high biomass of Jala landraces (Import Permit No. 010/2018) were procured from CIMMYT, Mexico through standard material transfer agreement (SMTA) in June 2018. The procured germplasm was assigned exotic collection (EC) number *i.e.* EC949677 to EC949681 by NBPGR, New Delhi to maintain the germplasm identity. Nineteen accessions of *Euchlaena mexicana* were also procured from ICAR-National Institute of Biotic Stress Management (IC0512014 to IC0512024 and IC0512026 to IC0512034) during July 2018. In addition to these 24 maize high amylose accessions were imported from the Maize Genetic Stock Center, University of Illinois, USA.

Characterization of germplasm

Two hundred and ninety five accessions from NBPGR Gene Bank were characterized and evaluated during *kharif* 2018 in augmented block design along with four checks, *viz*., LM 13, LM 14, PMH 1 and Prabhat at WNC, Hyderabad. The details of promising accessions are given in **Table 1.1**.

Table 1.1: The list of promising accessions from NBPGR Gene Bank identified at Hyderabad during *kharif* 2018

Trait	Accession Number(s)
Days to anthesis (Early 41 days)	IC0262026, IC0262034, IC0262352, IC0262027
Days to Silking (41 days)	IC0262034, IC0262027
1000 seed weight (g)	IC0075113 (280)
Grain yield per plant (g)	IC0282317 (128)
Plant height (cm)	IC0282359 (76)
Ear length (cm)	IC0282339 (20.3)
Ear width (cm)	IC0282339 (5.7)
Cob yield per plant (g)	IC0075144 (390)

Documentation of information on germplasm

Characteristics of inbred lines of the institute are being systematically documented and maintained in the form of a Decision Support System of Maize Inbred Germplasm. During 2018-19, 113 maize inbred lines with full pedigree were documented in the research database. The database is now hosted on the ICAR server at https://krishi.icar.gov.in/wnciimr. The database has been provided with information regarding Growing Degree Days (GDD), season and year of evaluation along with other characteristics.

Sharing of germplasm

ICAR-IIMR and ICAR-NBPGR jointly organized Maize Germplasm Field Day at Winter Nursery Centre of ICAR-IIMR, Hyderabad on 25th September 2018 **(Figure 1.1)**. Two hundred ninety five maize accessions from the National Gene Bank (NGB) of NBPGR, New Delhi under the CRP-Agro biodiversity project were displayed. A "Germplasm Information and Field Data Book" containing the passport information of the accessions and the data recorded in the current season was provided to the participants in order to help them in making selections. Thirty two participants participated in the field day.

Figure 1.1: Maize Germplasm Field Day at Winter Nursery Centre, Hyderabad

Further, Maize Germplasm Field Day cum Training Programme on Maize Breeding was also organized at

Winter Nursery Centre of ICAR-IIMR, Hyderabad during March 1-2, 2019 **(Figure 1.2)**. Forty eight participants from public sector participated in the field day. A total of 3187 maize lines (contributed by IIMR, AICRP and CIMMYT) were displayed for selections by the participants. Participants indented the selected germplasm. The participants were provided on hand training on various maize breeding aspects including handling of automation system **(Figure 1.3)**

Figure 1.2: Maize Germplasm Field Day cum Training Programme on Maize Breeding organized at Winter Nursery Centre, Hyderabad

Figure 1.3: Hands on training of participants on maize automation system

Further, germplasm of Teosinte (comprising of *Zea mays ssp. parviglumis*, *Zea mexicana* and *Zea luxurians*) and brown mib rib lines were also shared with scientists from Coimbatore and Ludhiana.

Development, maintenance and diversification of genetic resources

Maintenance

Genetic resources are the backbone of any breeding programme. At the institute 2250 yellow maize inbred lines of early, medium and late duration including some released inbreds, 238 QPM, 450 white and 40 popcorn inbred lines were maintained through self-pollination. In addition 31 white maize populations were also maintained through bulk pollination. Further, 16 parents of 15 released/pipeline hybrids, RILs mapping population of size 283 for MLB and popping trait and 278 for MLB and yield contributing traits, and 376 and 197 families for drought tolerance and high tryptophan contents traits, respectively are being maintained.

Diversification and advancement

Six hundred and eight lines derived from selected landraces from National Gene Bank, NBPGR are under various stages of advancement. Further, 150 early maize inbred lines have been fixed through generation advancement (S7) and seven different early pools/populations have been used for extracting new inbred lines through selfing (generation S4). Wild species are also being used in crosses to derive new inbred lines. The 32 F_2 single plant selection derived from cross between 60 inbred lines and wild species, *Zea mexicana* after selfing are being advanced during *rabi* 2017-18 **(Figure 1.4)**.

Figure 1.4: Diversification of maize inbred lines using the wild species; a: IC621036 Zea mexicana, b: IC621038 Zea mexicana; c: IC621049 Zea mexicana

To diversify the narrow genetic base of QPM germplasm using normal inbred lines a set of 24 QPM and 24 normal

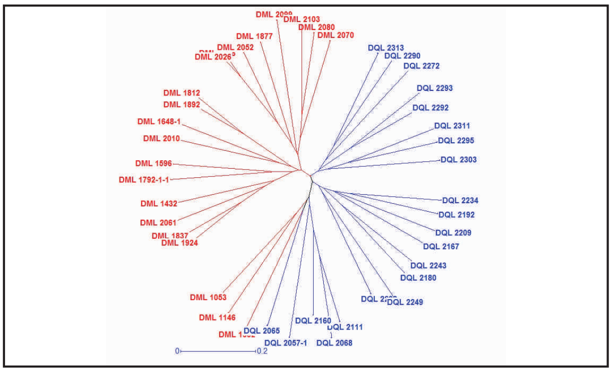


Figure 1.5: Grouping of QPM and normal maize germplasm using SSR markers

lines were used for molecular characterization with SSR markers **(Figure 1.5)**. The genetic distance of QPM and normal lines based on diversity analysis is being used to select parents to cross among themselves to derive diverse pools.

In order to diversify the sweet corn germplasm, 16 sweet corn cultivars were selfed for development of novel sweet corn germplasm. The name of hybrids and OPVs which were selfed for inbred line development are Mishthi, Mithas, Hybrid Golden Sweet Corn, Hybrid 2, Nuzi 205, Top Sweet, Sugar Sweet, BSCH-416084, BSCH 320, BSCH-416078, BSCH-119, FSCH 91, FSCH75, Priya, Madhuri and WOSC. In addition, new pedigree crosses between two elite normal maize inbred lines and selected sweet corn inbred lines were attempted to further widen the sweet corn germplasm base. The details of the pedigree crosses are LM 13 × D 37-3, LM 13 × M11, LM 13 × M4, LM 13 × M6, LM 13 × M9-T1, LM 13 × SCS1, LM 14 × D 37-3, LM 14 × M11, LM 14 × M4, LM 14 × M6, LM 14 × M9-T2 and LM 14 × SCP-1-T2.

Hybrid development programme

Hybrids released/notified

During the years 2018-19, three hybrids of ICAR-IIMR **(Figure 1.6a, 1.6b and 1.6c)** have been released and notified by the 80th CVRC meeting held on 10th August, 2018. The details of the hybrids are given below in **Table 1.2**.

Hybrids promoted under AICRP testing

One yellow maize hybrid (IMHBG-17K-15) was promoted from AVT-I to AVT-II and nine yellow hybrids (IMHSB-17R-9, IMHSB-17R-16, IMHSB-17R-8, IMHSB-17R-17, IMHSB-17R-5, IMHSB-17R-14, IMHSB-17R-19, IMHSB-17R-3, IMHSB-17R-4 and IMHSB-17R-8) were promoted from NIVT to AVT-I during *kharif* 2018 and *rabi* 2017-18, respectively. Further, two QPM hybrids (IIMRQPMH 1705 and IIMRQPMH 1708) were promoted from AVT I to AVT II in Zone II and Zone V for testing during *kharif* 2019 and four QPM Hybrids, *viz*., IQPMH-18-1 (Zone II), IQPMH-18-2 (Zone II, II & V), IQPMH-18-3 (Zone II), and IQPMH-18-4 (Zone II) have been promoted from NIVT to AVT I for testing during *kharif* 2019. In addition to that two fodder maize hybrids (IMHBG-18KF-1 and IMHBG-18KF-2) were also promoted from IVTM to AVTM in AICRP fodder trial.

Heterotic grouping of inbred lines-Medium to late group

A set of 54 inbred lines were crosses to four testers, *viz*., LM 13, LM 14, LM 17 and LM 19 to understand the behaviour of inbred lines and testers with respect to general and specific combining ability. The testcrosses were evaluated at three locations, *viz*., Hyderabad, New

Table 1.2: Hybrids released during 2018-19

Sl. No.	Hybrid Name	Type of corn	Yield (t/ha)	Growing season	Maturity Group	Growing ecologies
1	DMRH 1305	Field corn (Yellow)	6.0	*Kharif*	Early	Northern Hill Zone
2	IMHB 1532	Baby corn	2.0#	*Kharif*	Medium	North West Plain & Central Western Zone
3	IMHB 1539	Baby corn	1.5#	*Kharif*	Early	Northern Hill Zone

dehusked baby corn

(a) (b) (c)

Figure 1.6: Hybrids (a: DMRH, b: IMHB 1532 c: 1305IMHB 1539) released during 2018-19 by ICAR-IIMR

Delhi and Ludhiana during *kharif* 2018. The grain yield data of test-crosses were analysed location-wise and over locations (combined analysis) and GCA and SCA parameters were estimated. The GCA of testers varied from location to location for inbred lines and testers. The GGE biplot based on location-wise and also combined analysis consistently has shown LM 13 and LM 14 in opposite direction (group), which indicates that LM 13 and LM 14 are highly heterotic to each other and they can be used for grouping of inbred lines into different heterotic groups **(Figure 1.7)**.

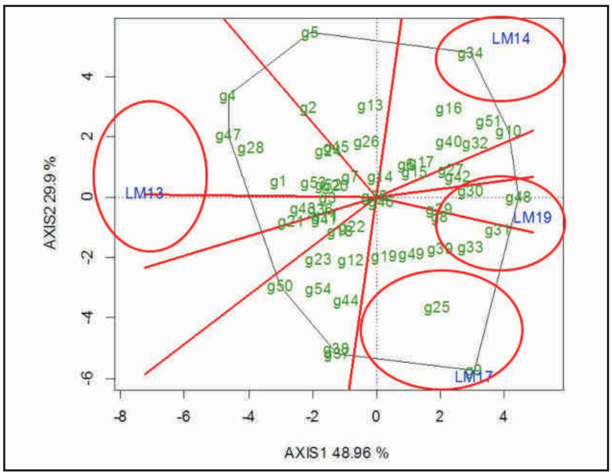


Figure 1.7: Heterotic pattern of inbred lines and testers based on pooled analysis

Heterotic grouping of inbred lines - Early group

Further, to classify the early maize inbred lines in heterotic groups, 45 lines have been crossed with testers of two maturity groups (early: V 373 and V 390, late: LM 13 and LM 14) to generate 180 hybrid combinations during *spring* 2018. The hybrids were evaluated in *kharif* 2018 at Ludhiana, Ambikapur and Pantnagar. The information of heterotic pattern of the lines is described as below:

Heterotic grouping with V 373 and V 390

At Ambikapur Group A (V 373) has inbred lines 70098, 70117, 70255, and 123005, whereas Group B (V 390) has 70485, 70062, and 104003 lines. At Pantnagar Group A (V 373) has 70098, 70062, 70117, 123005 and 104003 inbred lines, whereas Group B (V 390) has 70485 and 70255 lines. At Ludhiana, Group A (V 373) has 70098, 70485, 70303, 70156, 70065, 70562, 104020, 70151, 70381, and 70217 inbred lines, whereas Group B (V 390) has 70600, 70062, 70117, 70458, 70547, 70255, 123005, 104003, 70513, and 104118 inbred lines. Individual inbred line found to change its grouping in different locations.

Heterotic grouping with LM 13 and LM 14

At Ambikapur Group A (LM 13) has inbred lines 70156, 70545, 123023, 70304, 70147, 70150 and 70217 whereas Group B (LM 14) has 70600, 70117, 70458, 70547, 70595, 70255, 70307, 70301, 123005 and 104003 lines. At Pantnagar group A (LM 13) has 70117, 70156, 70545, 70255, 70304, 70301, 70150, and 123023 inbred lines, whereas group B (LM 14) has 70217, 70458, 70547, 70595, 70600, 104003, 70147, 123005, and 70307 lines.

Multilocation testing of experimental yellow maize hybrids

Early hybrid trial

In *spring* 2018, 30 early maize inbred lines were crossed with two testers (V 373 and V 391). Number of hybrids could be developed was 47. In *kharif* 2018, these 47 hybrids were evaluated with two checks, VH 45 and VH 47. Though seven hybrids showed superiority over the best check, however none of the hybrids were significantly superior over the check **(Table 1.3)**.

Table 1.3: Hybrid performance compared to the best check (VH-47)

Sl. No.	Hybrids	Grain Yield/ha (Kg)	Superiority (%)
1	70257 × V-391	6680	34
2	70377 × V-391	6444	30
3	70082 × V-373	5969	20
4	70082 × V-391	5836	17
5	70351 × V-391	5607	13
6	70483 × V-391	5576	12
7	70117 × CML425	5583	12
	VH-47 (Check)	4971	-
	CD (5%)	2141	-

Medium and late hybrid trial

Fifty six single cross experimental maize hybrids of medium and late maturity were developed and evaluated along with four standard checks at Begusarai, Dholi and Sabour during *rabi* 2017-18. The same set of hybrids was also evaluated under bigger plot size (12 m^2) in demonstration plot. Eleven hybrids showed superiority for mean yield over the best check over the three locations, whereas 8 hybrids at Begusarai, 10 hybrids at Sabour and 18 hybrids at Dholi out yielded the best check hybrid **(Table 1.4)**.

Table 1.4: Superior single cross maize hybrid combinations under multilocation testing during rabi 2017-18

S.No.	Hybrid combination	Grain yield (Q/ha)					Superiority over best Check(%)
		Begusarai	Sabour	Dholi	Begusarai (Demonstration)	Mean	
1	IMLSB-406-2 x T3	119.00	90.20	83.00	121.92	103.50	14.29
2	IMLSB-406-1 x T9	113.60	109.8	68.30	109.75	100.40	10.79
3	IMLSB-1119 x T4	109.90	96.50	85.90	106.00	99.60	9.89
4	IMLSB-343-3 x T4	103.50	91.50	86.70	105.83	96.90	6.94
5	IMLSB-83-1 x T4	107.50	91.10	74.80	109.08	95.60	5.55
6	IMLSB-173-2 x T4	95.30	95.80	82.00	102.33	93.90	3.59
7	IMLSB-457-2 x T9	104.20	89.50	75.50	103.50	93.20	2.82
8	IMLSB-617 x IMLSB-406	112.60	90.60	65.40	103.33	93.00	2.65
9	IMLSB-274-1 x T4	92.00	101.80	73.40	104.58	92.90	2.57
10	IMLSB-342-2-1 x T4	94.70	94.90	79.00	101.17	92.40	2.04
11	CMG x 180 x IMLSB-310-1	86.00	97.60	83.80	100.33	91.90	1.45
	DHM-117 (Check-1)	79.90	85.00	74.40	82.08	80.30	-
	BIO-9544 (Check-2)	80.00	95.40	69.10	91.50	84.00	-
	P-3396(Check-3)	98.40	93.50	69.60	97.50	89.70	-
	DKC-9081 (Check-4)	102.10	87.30	75.10	98.00	90.60	-
	Mean	**89.60**	**83.13**	**71.14**	-	**81.29**	-
	CV	**13.64**	**18.53**	**19.61**	-	**17.26**	-
	CD (5%)	**7.71**	**9.61**	**10.68**		**9.33**	-

White maize hybrid trial

Two sets of diallel crosses (Set-1: 171 and Set-2: 210) were generated from 19 (early to medium) and 21 (Late maturity) inbred lines. These two sets along with checks (Set-1: BIO605, DKC 7074, BIO 9544; Set-2: NK 6240, CMH-08-282, CMH-08-287, BIO 9682) were evaluated in four different locations (Set-1at Ludhiana, Delhi, Udaipur and Godhra; Set-2 at Ludhiana, Delhi, Hyderabad and Udaipur) during *kharif* 2018. Four hybrids in Set-2 and six in Set-1 were identified with >5% and >10 % superiority over the best check, respectively **(Table 1.5)**. Inbred line, GM 137C1 and CML 340 in Set-1and GM 243C5 and GM 61C2 in Set-2 were identified as best combiner with high GCA.

Table 1.5: Superior white maize hybrids over best check

Sl. No.	SET-2			Sl. No.	SET-1		
	Hybrids	Yield	Superiority (%)		Hybrids	Yield	Superiority (%)
1	S2H162	104.99	14.45	1	S1H14	74.50	29.95
2	S2H17	99.97	8.98	2	S1H50	71.24	24.26
3	S2H168	99.27	8.22	3	S1H162	69.59	21.38
4	S2H133	98.30	7.16	4	S1H171	66.64	16.24
5	BIO9682 (check)	91.73	-	5	S1H122	64.97	13.33
				6	S1H125	63.24	10.32
				7	BIO9544 (check)	57.33	
	CD (5%)	**12.53**			**CD (5%)**	**10.03**	

QPM hybrid trial

A trial of 330 QPM experimental hybrids was conducted during *kharif* 2018 at two locations *i.e.* Ludhiana and Hyderabad. Five and fifteen hybrids showed significant superiority over the check at Ludhiana and Hyderabad, respectively **(Table 1.6)**.

Table 1.6: Promising QPM hybrids identified

Ludhiana			Hyderabad		
Sl. No.	Entry	Yield (Q/ha)	Sl. No.	Entry	Yield (Q/ha)
1	DQL 2032 × DQL 2292	83.40*	1	DQL 2170-2 × DQL 2313	108.20*
2	DQL 2105-1 × DQL 2309	76.50*	2	DQL 2124 × DQL 2292	104.00*
3	DQL 2105-1 × DQL 2311	74.70*	3	DQL 2241 × DQL 2292	101.60*
4	DQL 2097 × DQL 2311	74.30*	4	DQL 2018 × DQL 2317	100.60*
5	DQL 2070 × DQL 2316	73.30*	5	DQL 2192 × DQL 2311	98.30*
6	DQL 2113-1 × DQL 2313	72.30	6	DQL 2111 × DQL 2292	96.00*
7	DQL 2160 × DQL 2307	72.10	7	DQL 2180 ×DQL 2302	95.40*
8	DQL 2018-1 × DQL 2292	71.10	8	DQL 2180 × DQL 2311	95.20*
9	DQL 2170-2 × DQL 2292	70.40	9	DQL 2234 × DQL 2293	94.80*
10	DQL 2070 × DQL 2302	69.80	10	DQL 2234-1 × DQL 2292	94.50*
11	DQL 2157 × DQL 2299	68.50	11	DQL 2014 × DQL 2301	93.50*
12	DQL 2017-1-1 × DQL 2311	68.10	12	DQL 2234-1 × DQL 2304	93.20*
13	DQL 2205 × DQL 2292	67.50	13	DQL 2262 × DQL 2316	92.40*
14	DQL 2157 × DQL 2317	67.10	14	DQL 2234 1 × DQL 2303	92.10*
15	DQL 2260 × DQL 2306	66.30	15	DQL 2157 × DQL 2306	91.90*
	HQPM 7 (Check)	58.00		HQPM 7 (Check)	81.20
	CD (5%)	**14.40**		**CD (5%)**	**10.60**
	CV	**18.50**		**CV**	**19.20**

were found to be sterile, 23 were semi-fertile and 49 were totally fertile **(Figure 1.8)**. The 27 lines producing sterile test crosses were grouped as B line while 49 lines giving fertile test crosses were grouped as R line. With respect to baby corn traits, CMS lines will be used in commercial baby corn hybrid production. The identified maintainer lines are being converted to CMS background.

Specialty corn breeding

Baby corn breeding

A total of 99 Indian maize lines were test crossed with CMS lines. Based on the tassel morphology, seed setting upon selfing and pollen viability test, 27 test crosses

For diversification and derivation of new baby corn inbred lines, 45 new early generation segregants are being derived (S_2 and S_3 stage) from double crosses and through selfing of hybrids. In *kharif* 2018, 37 hybrids

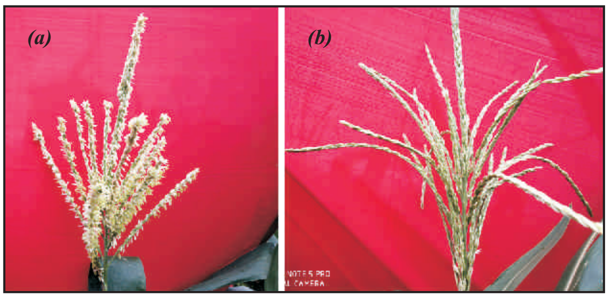


Figure 1.8: Fertile (a) and sterile (b) tassels of testcrosses of maize lines with CMS lines

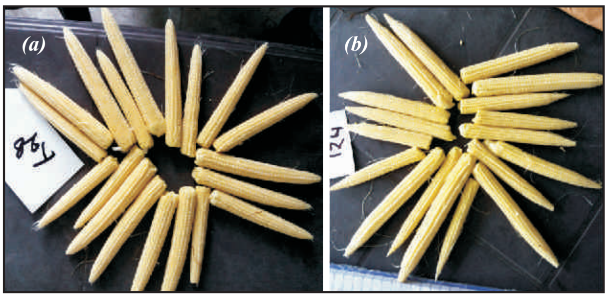


Figure 1.9: Superior baby corn hybrids (a: 0598C1-30 × 0651C1-30; 0555C1-30 × 0598C1-30) over the commercial checks

including three checks were evaluated at three locations, *viz*., Ludhiana, Pantnagar and Ambikapur. Among the 37 hybrids, two (0598C1-30 × 0651C1-30 and 0544C1-30 × 0651C1-30) were found superior over the commercial checks with good baby corn traits **(Figure 1.9)**.

Sweet corn breeding

Thirty experimental sweet corn crosses were evaluated at New Delhi in RBD design with three replications during *kharif* 2018 against check hybrid Mishthi, a popular sweet corn hybrid. Based on single year and single location data, four hybrids, *viz*., M4 × M11, M11 × D37-3, M4 × M2, M11 × M6, and M11 × SP1T1 showed 8.6 to 16 % superiority over Mishthi for green ear yield with yield range between 10.0 and 10.8 t/ha.

Fodder maize breeding

A trial for evaluation of 47 landraces with African Tall as check was conducted under RBD with three replications in *spring* 2018 at IIMR, Ludhiana. Out of 47, 9 superior landraces with >10% superiority were identified. These are PAU17128, 157-NLM-59 (2), 126-NLM-13 (A), 153-NLM-58 (4), 132-NLM-21 (A), 134-NLM-22, 137-NLM-25, 143-NLM-51 and 151-NLM-58 (2) . The biochemical analysis of these superior landraces revealed that 137-NLM-25 has better digestibility with low lignin (4.7%) and Neutral Detergent Fibre (NDF: 58.5%) as compared to check, African Tall (Lignin: 5.7% and NDF: 67.5%). To harness the tillering and multi-cut ability, crosses with promising fodder maize inbred lines and composites were attempted with *Zea parviglumis* in *kharif* 2018. The wide crosses (F_1s) exhibited tillers (also regrowth over cut) in the range of 1-14 in different genetic backgrounds which are being advanced through repeated backcrossing and selection to develop multi-tiller and multi-cut fodder maize cultivars **(Figure 1.10)**.

Figure 1.10: Wide crosses between Zea parviglumis and promising fodder maize inbred lines exhibiting higher tiller numbers

Germplasm screening for biotic stress

Resistance against major diseases

Multi-disease phenotyping trials

Three different set of inbred lines with common entries were evaluated for different diseases under artificial infested conditions at hot-spot locations under alpha-design in two replications (except in Almora and Bajaura). Four hundred and fifty genotypes for TLB at Almora, Bajaura, Dharwad and Mandya, 300 for MLB at Karnal, Ludhiana and Dholi, and 156 for charcoal rot were evaluated at Ludhiana and Hyderabad. The mean disease reaction differed significantly among inbred lines in all the locations for all the diseases except for TLB at Mandya. Based on mean disease score data across locations three inbred lines each for TLB (NN42050-1, EC440638 and CM 117-3-4-1) and MLB (JCY 6, BGS337 and UMI 1220) and four inbred lines for charcoal rot (MRCHY5158-2, G18seqcef74-2-1, PML-41 and EC440609) were found resistant with disease rating of 3.0.

Further, 48 early maize genotypes were also screened against MLB and Charcol rot diseases at Ludhiana in *kharif* 2018. One resistant check (LM 13) and one susceptible check (CM 600) were used, for charcoal rot susceptible check (CM-600) showed moderately susceptible and resistant check (LM 13) showed moderately resistant disease reactions but for MLB both checks shown moderately susceptible disease reaction. Only one genotype (70061) showed MR reaction to MLB and 34 genotypes (70052, 70053, 70055, 70056, 70057, 70061, 70078, 70080, 70081, 70082, 70097, 70100, 70107, 70110, 70111, 70115, 70116, 70118, 70120, 70121, 70158, 70159, 70173, 70175, 70227, 70231, 70235, 70236, 70241, 70242, 70256, 70257, 70274 and 70280) showed moderately resistant reaction to charcol rot.

In addition to the multi-disease phenotyping trial germplasms were also screened for individual diseases separately.

Charcoal rot (CR)

A total of 155 hybrids were evaluated under ICAR-CIMMYT collaboration program against Charcoal rot (CR) under artificially created epiphytotic conditions. Out of these hybrids, three (VH18605, VH18838 and VH171220) were resistant and 98 were moderately resistant against CR. Besides these, 67 inbred lines were also screened against CR, out of which 58 were moderately resistant.

Maydis leaf blight (MLB)

Fourty eight lines were evaluated against maydis leaf blight (MLB) out of which only one line [(E13118/CML474) PMH1]-4-1-1-1-3] was moderately resistant against the disease.

Turcicum leaf blight (TLB)

Two newly developed maize inbred lines IMLSB-720 and IMSB-2119 showed resistance against TLB whereas 45 other inbreds were moderately resistant during *kharif* 2017.

Resistance against major insects

Stem borer [Chilo partellus (Swinhoe)]

Twenty seven genotypes along with resistant (DMRE 63, CM 500) and susceptible checks (BML 6) were preliminary screened under artificial infestation against *Chilo partellus* during *kharif* 2018. The resistant, moderately resistant and susceptible lines are defined by LIR values of 1-3, 3.1-6 and 6.1-9, respectively. Two genotypes, *viz*., [(E13043/V373) BIO9544]-4-2-1-2 (2.5) and [(E13118/V373) BIO9544]-5-1-2-2-1 (2.5) were found resistant against *C. partellus, 11* were moderately resistant and 14 were susceptible. In *kharif* 2018, 30 early inbred lines were also screened against stem borer at WNC, Hyderabad. Among these, inbred lines 70120, 70159, 70175, and 70227 recorded resistant reaction against stem borer.

Pink stem borer [Sesamia inferens (Walker)]

Sixty eight inbreds and 29 land races along with resistant (DMRE 63, CM 500) and susceptible checks (BML 6) were evaluated under artificial infestation against *S. inferens* during *rabi* 2018-19. The resistant, moderately resistant and susceptible lines were defined by LIR values of 1-3, 3.1-6 and 6.1-9, respectively. Among the lines screened, only one genotype 382-1 (2.2) was found resistant against *S. inferens and* 22 lines were moderately resistant while 45 were susceptible. None of the landraces were found resistant against *S. inferens*. However, 17 were moderately resistant and 12 were susceptible.

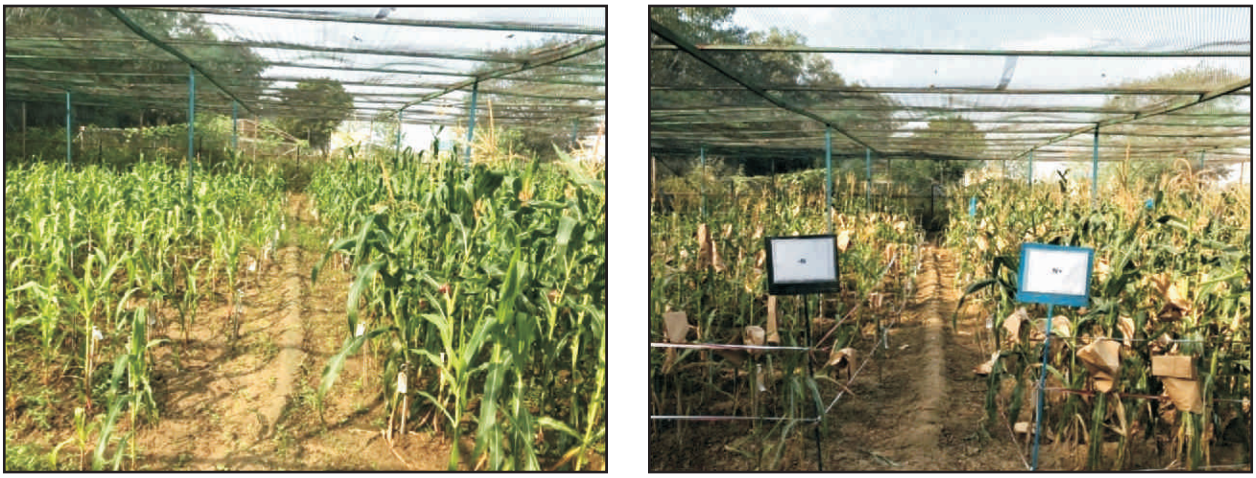
Germplasm screening for abiotic stress

Physio-biochemical basis of nitrogen use efficiency (NUE) in maize

Nitrogen is a constituent of amino acids, proteins, chlorophyll and many of vitamins. It plays a key role in photosynthetic activity and yield capacity in field crops. However, not all available nitrogen in the soil is utilized by the crops. The nitrogen use efficiency (NUE) of maize is less than 50% and rest of the fertilizer-derived N in soil is lost either through nitrous oxide emission or ammonia volatilization. To understand the basic mechanism of NUE in maize, 21selected inbred lines were screened for 2[nd] consecutive year under N sufficient (residual N + 180 Kg/ha) and N deficient (residual N + 23.5 Kg/ha) condition during *kharif* 2018 **(Figure 1.11)**. The lines were extensively phenotyped for major physiological parameters (plant height, stem girth, number of leaves, chlorophyll content, dry matter accumulation, LAI),

(A) Seedling stage

(B) Vegetative stage



(C) Flowering stage **(D) Grain filling stage**

Figure 1.11: Field view of maize genotypes grown under N sufficient and deficient conditions at seedling stage (A), vegetative stage (B), flowering stage (C) and grain filling stage (D)

biochemical parameters (total soluble proteins, free amino acids content, nitrate reductase activity, glutamine synthase activity) and yield traits [cob position, Anthesis silking interval (ASI), grain yield and its attributes]. Significant reduction in plant height (37.8%), stem girth (23.4%), LAI (41.7%), chlorophyll content (27.2%), total soluble proteins (54.7%), nitrate reductase (34.0%) and glutamine synthase activity (50.7%) and grain yield (71.83) across the genotypes at flowering stage under nitrogen deficient conditions was recorded. However, ASI prolonged to the magnitude of 93.8% under N deficient conditions. Based on the grain yield *per se* and other physio-biochemical traits, two contrasting lines (DMI 56: highly tolerant to N-stress;

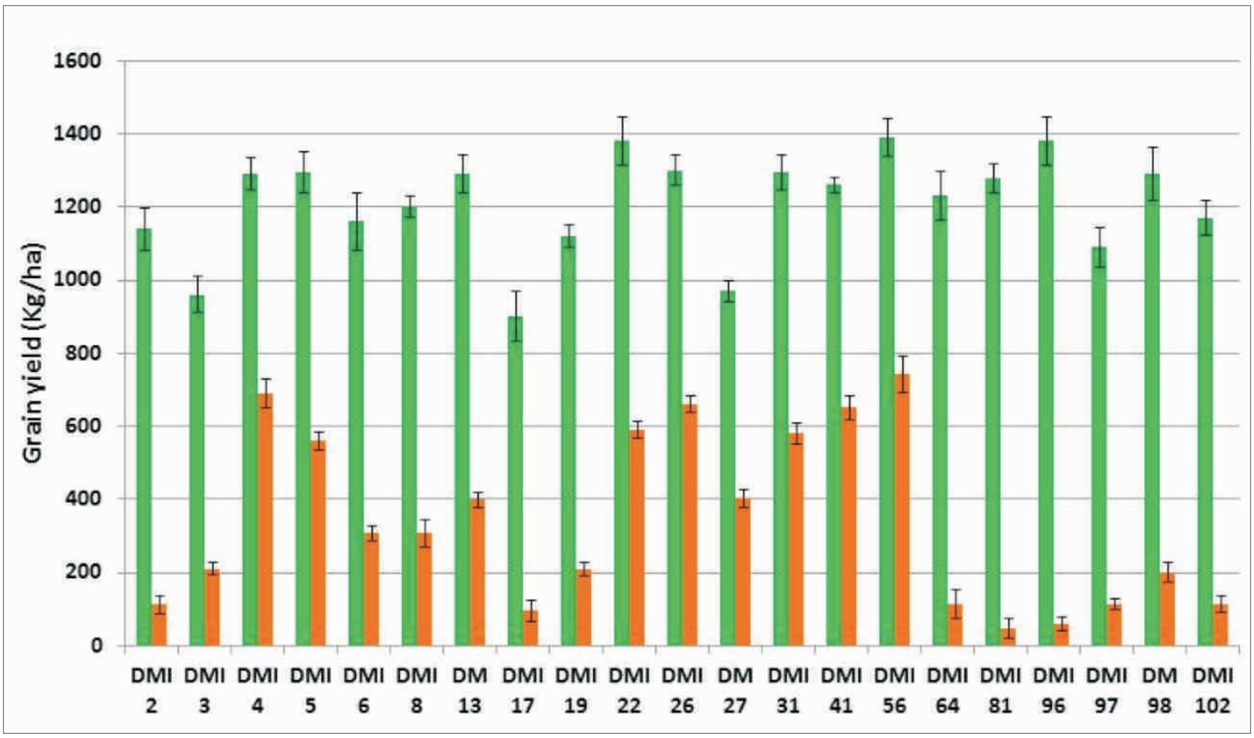


Figure 1.12: Effect of N-stress on grain yield in maize genotypes

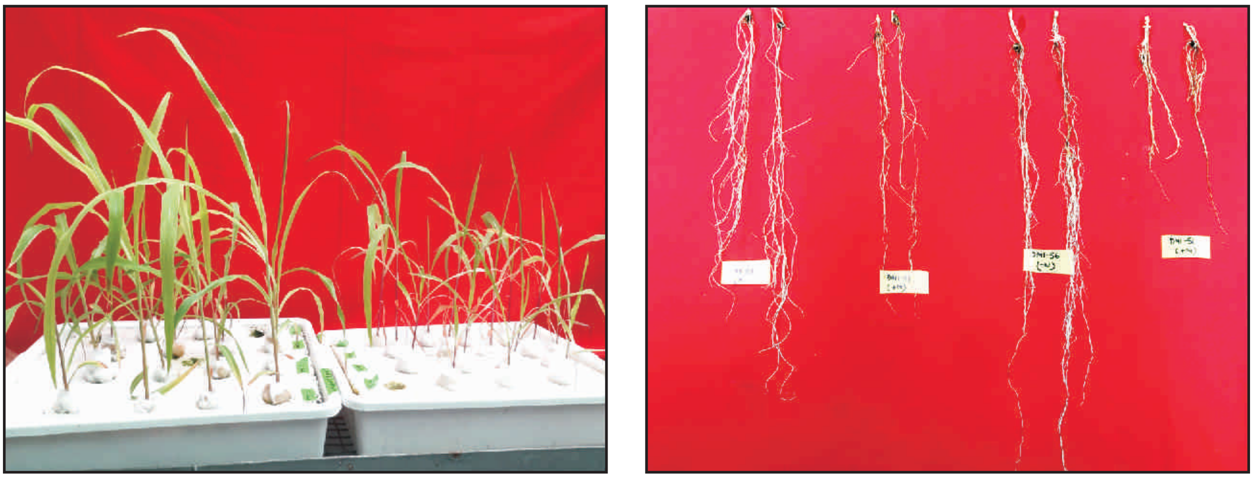


Figure 1.13: Effect of N-stress on shoot (A) and root (B) growth of two contrasting lines under hydroponic culture.

Table 1.7: Effect of N-stress on shoot and root growth of two contrasting lines under hydroponic culture.

Parameter	DMI-56		DMI-81	
	N (+)	N (-)	N (+)	N (-)
Shoot biomass (g)	1.83 ± 0.09	1.42 ± 0.05	1.77 ± 0.06	1.31 ± 0.07
Root biomass (g)	1.52 ± 0.13	3.23 ± 0.21	1.61 ± 0.09	2.97 ± 0.17
Root length (cm)	34.4 ± 1.50	72.5 ± 3.60	45.7 ± 2.10	56.7 ± 4.80

DMI 8: highly susceptible to N-stress) were identified and their response to N-stress was further confirmed in hydroponic culture **(Table 1.7; Figure 1.12)**. For hydroponic culture, the seeds of two contrasting lines (DMI 56 and DMI 81) were surface sterilized with 0.1% $HgCl_2$ and germinated on wet germination paper at room temperature (25 ± 2°C). The germinated seeds were grown hydroponically in modified Hoagland solution with (N+) or without (N-) supplemented with 2 mM KNO_3. The observations on root-shoot biomass and root length were recorded on 21 days old plants. The N-stress adversely affected both shoot and root growth. Shoot biomass decreased under N (-) conditions, but the decrease was significantly less in DMI 56 as compared to DMI 81 **(Figure 1.13A)**. On the other hand both root biomass and length increased under N (-) conditions and this increase was significantly less in DMI 56 as compared to DMI 81 **(Figure 1.13B)**.

Identification of contrasting genotypes under low-phosphate stress in maize

Hydroponics-based method of screening for low-phosphate stress tolerance in maize has been optimized by changing concentrations of various nutrients in Hoagland's solution. Quantifiable phosphate stress was imposed in maize inbreds by using optimized hydroponic culture. Forty maize inbreds were screened for phosphate stress (phosphate use efficiency, PUE) using optimized hydroponic culture under optimum (1 mM KH_2PO_4) and deficient (5 µM KH_2PO_4) phosphate supplement for 22 days (**Figure 1.14**). Data were recorded on various parameters, *viz*., fresh weight, dry weight, length, stem girth and shoot: root ratio. Based on root and shoot parameters, BML 5 was identified as high PUE line and BML 10, VQL 2 and CM 152 as low PUE lines (**Figure 1.15**). Significant reduction in shoot and

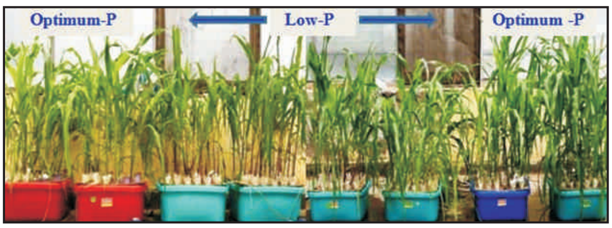


Figure 1.14: Screening of maize inbreds phosphate stress using optimized hydroponic culture under optimum and deficient condition for 22 days

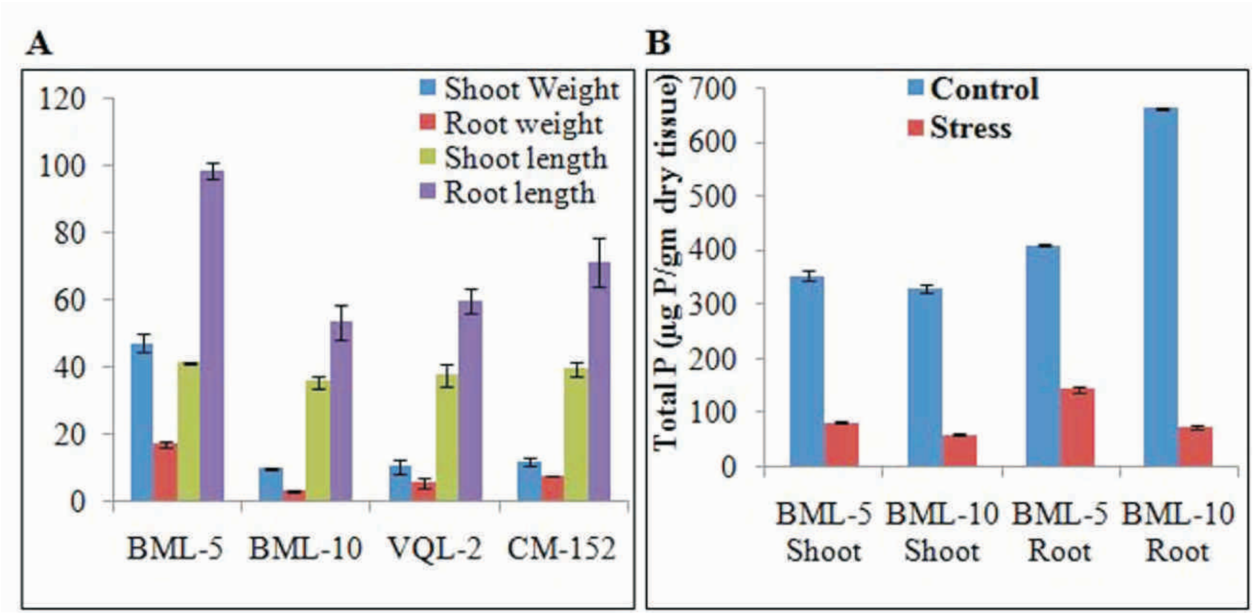


Figure 1.15: Reduction in shoot and root parameters in the susceptible and tolerant genotypes under low-phosphate stress

root parameters were observed for the susceptible genotype compared to the tolerant under low-phosphate stress (**Figure 1.15**). Under low-phosphate stress, phosphate accumulation was significantly higher in the tolerant line (BML 5) as compared to the highly susceptible (BML 10) genotype (**Figure 1.15**). Severe phosphorus deficiency symptoms (purple colouration in root and shoot) were observed in BML 10 as compared to BML 5 plants under hydroponic conditions (**Figure 1.16**). The identified contrasting lines can be utilized in breeding programme for developing phosphate use efficient hybrids and to study molecular mechanisms involved in phosphate stress tolerance.

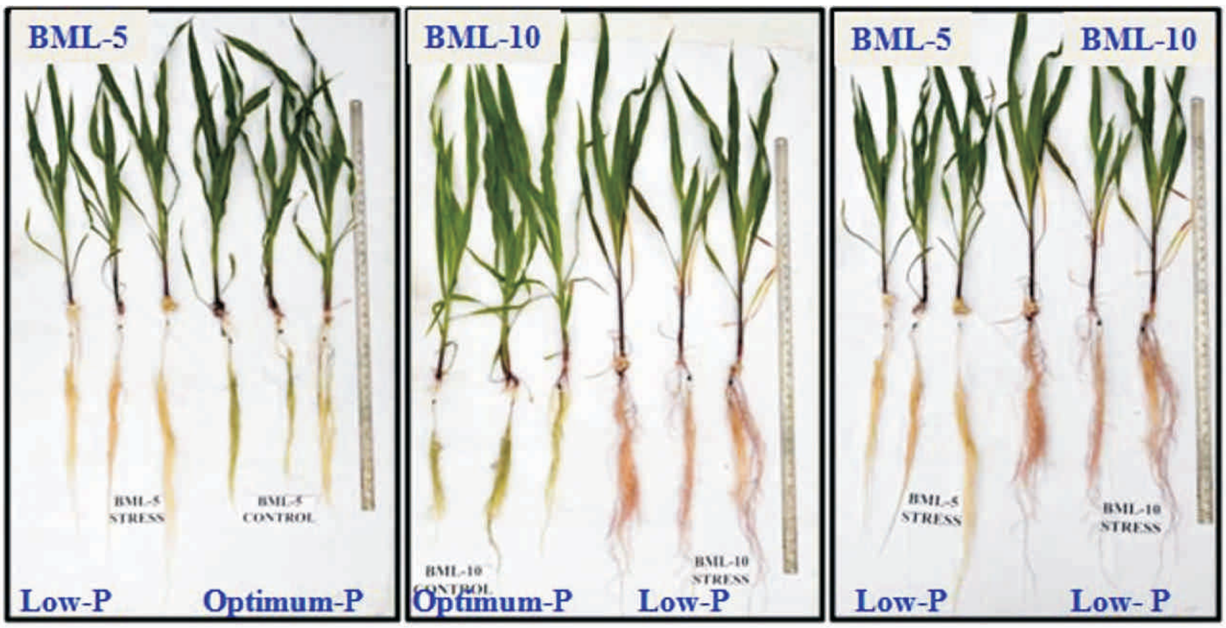


Figure 1.16: Phosphorus deficiency symptoms (purple colouration in root and shoot) in BML 10 and BML 5 under hydroponic conditions

Evaluation and improvement of maize germplasm for quality traits

Oil and methionine

A composite population was developed for high oil with good ear traits (ear weight and ear length). A total of 224 individuals from the population were evaluated for oil content though NMR. Oil content ranged from 2.89 to 5.86% with a mean value of 4.54%. An index was formulated using ear weight, ear length and oil content with the weightage of 0.22 each for ear weight and ear length and 0.56 for oil content. Top 45 individuals with highest index value were selected and 50 seeds from each were composited to constitute next generation of population. The mean oil content of selected individuals was 5.13%. The distribution of values for different traits is given in **Figure 1.17**.

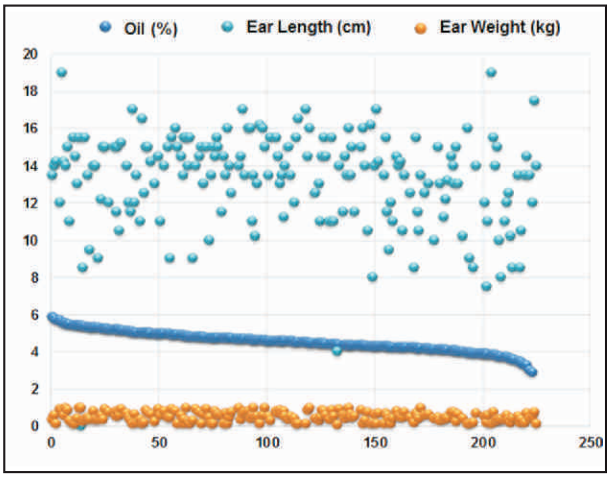


Figure 1.17: Values of different traits (oil, ear length and ear weight) in the population

A set of 116 inbred lines (15 from CIMMYT and 101 QPM lines derived from 18 F_2 populations received from CIMMYT) were evaluated for kernel methionine content through spectrophotometric method. Ten

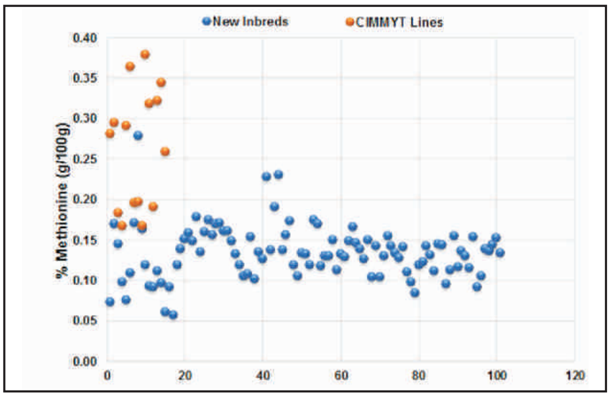


Figure 1.17: Inbreds recorded methionine concentration of more than 0.25 g /100 g

inbreds recorded methionine concentration of more than 0.25 g /100 g of tissue sample **(Figure 1.18)**. Out of these 10 lines one inbred was among the newly developed opaque lines. The results are being verified through UPLC method.

Amylose and amylopectin

During the period under review 86 genotypes consisting mostly of hybrids along with some inbreds (parents of public sector hybrids) were evaluated for starch profile, *viz*., starch, amylose and amylopectin. The starch content of maize hybrids ranges from 62.5% (PUSA HM 9) to 74.63% (NK 6240). A total of 7 hybrids exhibited more than 74% starch. Amylose concentration of the experimental hybrids ranges from 17.85% to 31.25% **(Figure 1.19)**. The normal range of amylose in maize was reported to be around 25-30%. None of the genotype was found to possess higher concentration of amylose

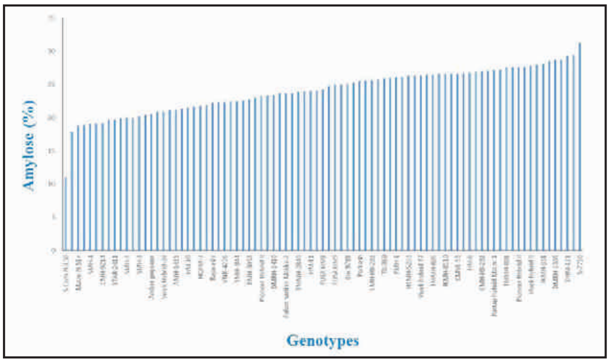


Figure 1.19: Variation in amylose content in analysed hybrids

indicating the non-availability of natural variation for amylose in the commercially available genotypes.

Lysine and tryptophan

Under QPM project 238 yellow QPM lines were screened for tryptophan content and the following promising lines (orange) were identified (**Table 1.8**). In addition to orange QPM inbred lines some white QPM lines were also identified and these lines will also be used by developing white QPM hybrids to deliver white QPM hybrids in areas where white maize is still preferred as food (**Table 1.9**).

Winter nursery facility

The following ICAR Centres, *viz*., VPKAS, Almora; Maize Genetic Unit and Maize Pathology, IARI ; NBPGR, New Delhi; and AICRP Centres, *viz*., Bajaura, Kangra, Pantnagar, Ludhiana and Srinagar utilized the off-season nursery at Hyderabad centre during *rabi* 2018-19.

Table 1.8: List of promising orange QPM lines

S. No.	Inbred Line	Opaqueness (%)	Protein (%)	Tryptophan (% of Protein)
1	DQL 2300	100	7.92	0.69
2	DQL 2029-1	50-75	7.09	0.98
3	DQL 2323	50-75	8.42	0.97
4	DQL 2104	50-75	8.24	0.89
5	DQL 2081	25-50	7.08	0.96
6	DQL 2322	25-50	10.11	0.92
7	DQL 2034-1	25	10.64	0.92
8	DQL 2015-1	25	10.21	0.84
9	DQL 2082	25	8.42	0.84
10	DQL 2305	25	7.99	0.79
11	DQL 2333	25	7.21	0.78
12	DQL 2016-1	25	10.46	0.77
13	DQL 2068	25	8.72	0.73
14	DQL 2262	25	8.11	0.7
15	DQL 2238	< 25	8.11	0.69
16	DQL 2240	25	7.76	0.67
17	DQL 2244	25	7.91	0.67
18	DQL 2306	50	7.72	0.65

Table 1.9: List of promising white QPM lines

S. No.	Inbred Line	Opaqueness (%)	Protein (%)	Tryptophan (% of Protein)
1	DQL 32-1-1-2-3-1	75-100	8.56	0.90
2	DQL 111-1-1-2-1	25	7.84	0.82
3	DQL 218-1-1-1	25	8.63	0.68
4	DQL 205-1-3-5	25	8.32	0.66
5	DQL 32-1-1-2-1	25	8.63	0.66
6	DQL 267-1-2-3-1	25	8.29	0.64
7	DQL 295-1-1-1	25	8.48	0.62
8	DQL 110-1-1-1	25	7.93	0.61
9	DQL 2003	25	8.33	0.60
10	DQL 2007	25	7.74	0.60

Regeneration of shoots from callus in tissue culture

2 BASIC SCIENCES

Standardizing reproducible *in vitro* regeneration protocol in maize using mature embryo

Twenty three different tropical maize inbred lines and five hybrids were evaluated for *in vitro* callus induction using mature embryo as explant. High *in-vitro* callus induction was recorded in three hybrids and one inbred (callusing percentage ranging from 29% to 40%). Further, these genotypes were evaluated for regeneration in media containing 22 different combinations of auxin and cytokinin hormones. The promising results related to regeneration were achieved in two hybrids **(Figure 2.1)**. The standard regeneration protocol has been repeated twice in both the genotypes. The average regeneration percentage of 31% to 61% was achieved in hybrids. Further repetition of the work is underway.

In silico characterization of mycobacterial ribonuclease P to explore feed-additive therapeutics for quality control of maize silage

Maize silage has immense potential for supporting dairy industry of the country. Silage ensures long-term availability of high quality feed for cattle. Greater economic prospects through popularity of maize silage is important for enhanced farmer remuneration as well as crop diversification. Maize silage making requires a process of ensiling, where physico-chemical parameters and microbial dynamics change during the course of processing. At the same time, due to a multitude of factors, silage can get potentially infected with harmful pathogens like *Mycobacterium bovis* (*M. bovis*), which causes bovine tuberculosis in animals. Feeding of infected maize silage can prove detrimental to cattle health. Many studies have linked the epidemiology of bovine tuberculosis with infected feed. Due to sturdy nature of the organisms of *Mycobacterium* complex, they can remain dormant for long times. Apart from *M. bovis*, *M. tuberculosis* can also potentially survive in silage. Environmental factors transmit the organisms of *Mycobacterium* complex, and *M. tuberculosis* infection has implications for human health as well. It has been shown that transmission of tuberculosis can occur from either of the organisms to both humans and cattle. In view of the above, it becomes extremely important to devise quality control strategies for preventing transmission of harmful organisms to cattle.

Generation of computational model of M. bovis RNase P protein and characterization of its interaction with aminoglycosides

In order to evaluate the prospects of utilizing feed-additive antibiotics for quality control of maize silage along with a consideration of the increasing drug resistance of the *Mycobacterium* complex, an essential enzyme of the pathogen- Ribonuclease P (RNase P) was computationally characterized. RNase P is a ribonucleoprotein complex, which is ubiquitous and indispensable enzyme for survival of all organisms. It is one of the first molecules that processes precursor tRNA (pre-tRNA) leading to the formation of mature tRNA that takes part in protein synthesis. It contains one RNA

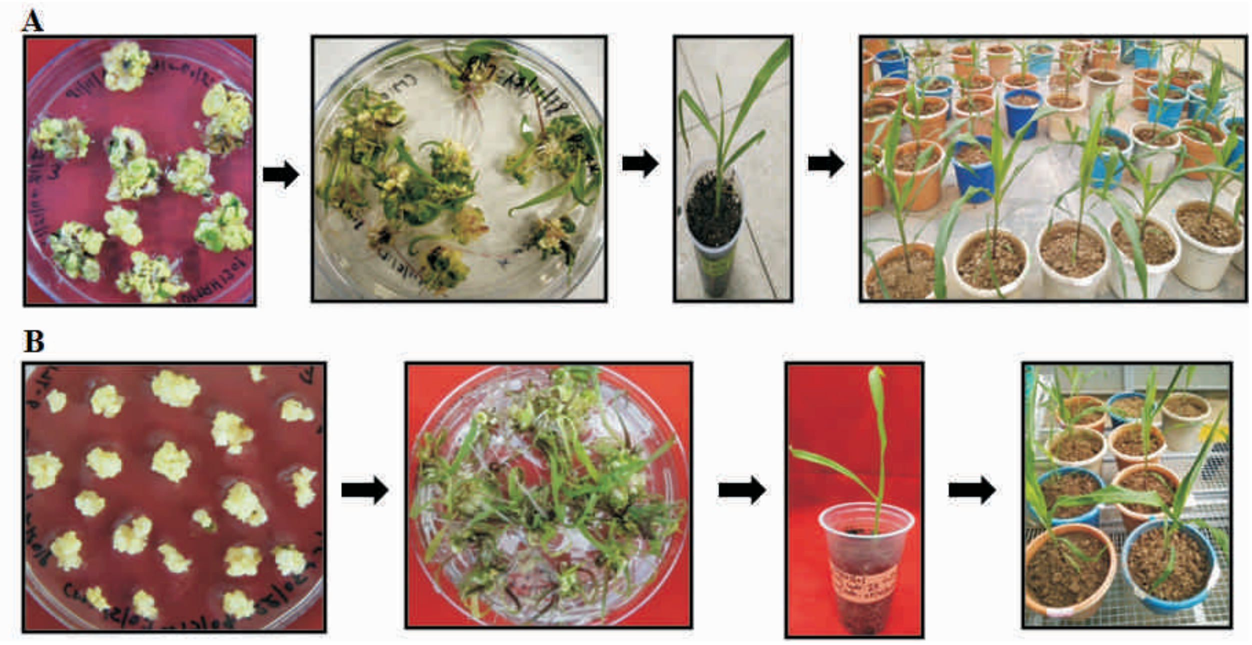


Figure 2.1: Callusing and regeneration from split node derived embryogenic calli in different hybrids under testing

component and one or more protein components, depending on the organism. While the bacterial RNase P contains one protein, the number increases to four or five in case of archaea and upto ten in case of eukaryotes. The RNA component is the catalytic component as it contains the active site where the phosphodiester bond cleavage takes place to generate the mature tRNA product from pre-tRNA molecule. The RNA component can process pre-tRNA alone, without the RNase P protein, under high ionic concentrations *in vitro*. The bacterial and eukaryotic RNase P RNA components differ substantially. The RNase P protein is indispensable under *in vivo* conditions. Aminoglycosides have been used for treating infections since long. The computational homology model of *M. bovis* RNase P protein was prepared (**Figure 2.2**). The protein contains conserved central cleft domain and α-helical motif. Like the protein of *M. tuberculosis*, *M. bovis* protein also contains a histidine in place of an arginine in most organisms. The sequence of *M. bovis* RNase P protein matches with that of *M. tuberculosis*. It has been shown that *M. tuberculosis* RNase P protein is capable of adopting a conformation that enables it to cleave Alanine pre-tRNA without the necessity of RNA subunit. We find that the RNase P protein of *M. bovis* is a druggable target. One of its pockets has druggability probability of 0.94 ± 0.01, based on analysis by PockDrug-Server (Hussein et al. Nucleic Acids Research 2015). Twenty eight residues line up this important protein pocket. Preliminary interaction analysis with basic aminoglycosides has shown that aminoglycosides are able to bind to *M. bovis* RNase P protein with an affinity of -7.4 to -8.1 kcal/mole. Many new aminoglycosides are known, which can be tested for their interaction with *M. bovis* RNase P protein to act as feed-additives for ensuring safety of maize silage.

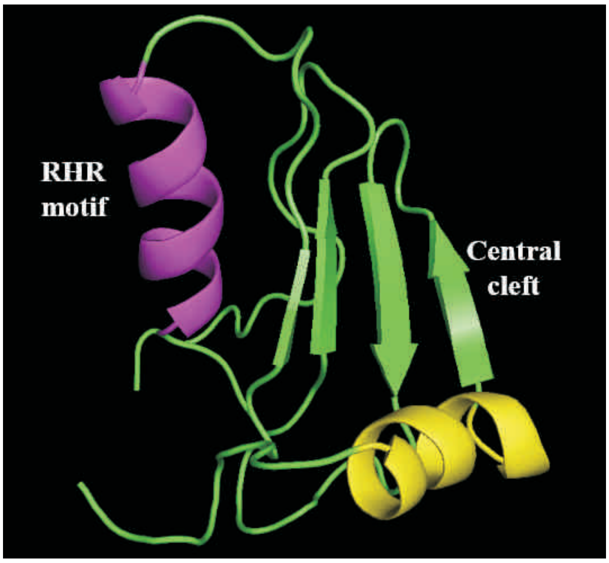


Figure 2.2: Protein model of *M. bovis* RNase P. The conserved central cleft (β-sheets shown in green colour) and RHR motif (α-helix shown in magenta colour) interact with pre-tRNA leader sequence and RNase P RNA, respectively.

Characterization of 3-dimensional structures of RNase P RNA of Mycobacterial RNase P RNAs

In order to explore novel therapeutics, 3-dimensional architecture of mycobacterial RNase P RNA was characterized. Because of the differences in RNase P of humans and mycobacteria, RNase P becomes a good drug target. RNA-based therapeutics are coming as new molecular agents against disease-causing agents. As they are novel, they are not expected to suffer from the conventional resistances that have already developed with antibiotics. Amongst bacteria, the RNase P RNA of *Escherichia coli* (*E. coli*) is very well-studied. It consists of both single-stranded and double-stranded bases, arranged in the form of helices. The helices from P7 to P12 compose the specificity domain, which determine substrate specificity of the enzyme, while other helices from P1 to P6 and P13 to P18/P19 constitute that catalytic domain, which catalyse the phosphodiester bond cleavage and result in maturation of pre-tRNA molecules. There is a characteristic pseudoknot structure, referred to as helix P4 and a cruciform structure formed of helices from P7 to P11. The computational structure of *M. tuberculosis* RNase P RNA matches that of *E. coli*, with differences in certain helices. **Figure 2.3** shows the annotation of pre-tRNA substrate in complex with *M. tuberculosis* RNase P RNA, based on *E.coli* RNase P RNA: pre-tRNA complex. Mycobacterial RNase P RNA is distinct from both Type A and Type B RNase P RNAs, characteristic of *E. coli* and *Bacillus subtilits*, respectively. There are differences with respect to helices P12, P15.1, P18 and P19. Analysis of the distinct helices reveals their importance in catalysis and thermostability. The length of helices appears to be optimum and any alterations result in impaired enzymatic activity under *in vitro* conditions. The distinct regions of the mycobacterial enzymes are potential targets and can be utilized to design specific therapeutics that inhibit only the mycobacterial enzyme, leaving other organisms unaffected. This would extend the practical application of feed-additive therapeutics from start of the process till is Quality Control.

The RNase P RNA of *M. bovis* has been modelled and it also shows the characteristic P4 pseudoknot and P7-11 cruciform structures. *M. bovis* RNase P RNA is composed

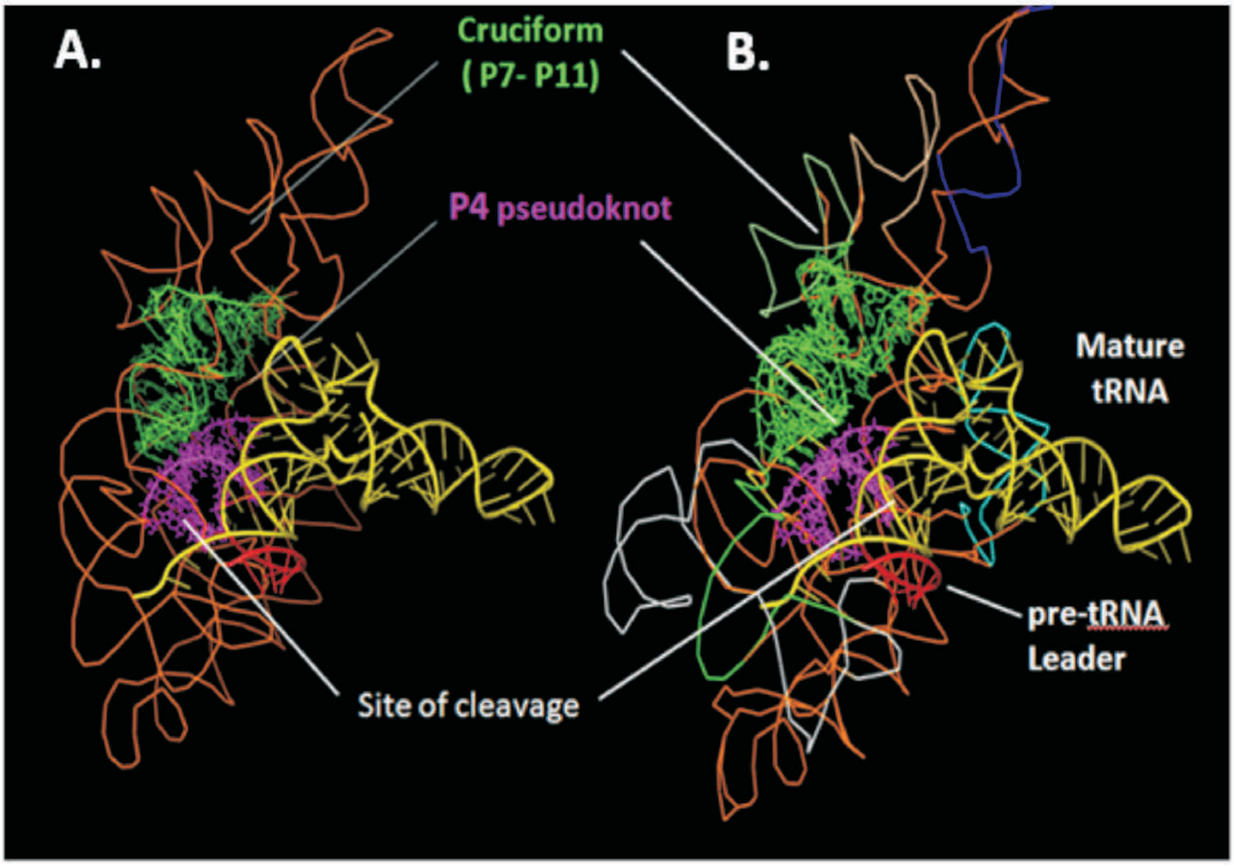


Figure 2.3: 3-dimensional structure of RNase P RNA of (A) *E. coli*, and (B) *M. tuberculosis*. The characteristic features P4 pseudoknot and P7-P11 cruciform are shown in green and purple, respectively. The pre-tRNA is modelled in the structure, with leader sequence shown in red and mature sequence depicted in yellow.

Figure 2.4: *M. bovis* RNase P RNA aligns with that of *M. tuberculosis* with an RMSD of 0.195. The backbone deviations in *M. bovis* with respect to *M. tuberculosis* is represented with red colour.

of 422 ribonucleobases and is 12 bases shorter that the RNA of *M. tuberculosis* RNase P. Analysis of the RNAs of *M. bovis* and *M. tuberculosis* through Needleman-Wunsch algorithm reveals 97% similarity between the two sequences. Helix P3 of the catalytic domain is shorter in *M. bovis* RNA as compared to *M. tuberculosis* RNA. The structures of *M. tuberculosis* and *M. bovis* align closely with a root-mean-squared-deviation (RMSD) of only 0.195 angstroms (**Figure 2.4**). This shows that any strategies designed for one organism will work for another as well, offering protection against all organisms of the *Mycobacterium* complex.

Impact of residue retention (right) as compared to no-residue (left) on waterlogging after heavy rainfall

3 CROP PRODUCTION

Maize is expanding in new areas in India, replacing other non-remunerative crops. However, the enhanced acreage will not be sustaianable in the absence of suitable resource-use efficient cropping systems and component technologies. Hence, development of the resource-use efficient cropping systems and production practices is essential for enahncing the productivity of maize in traditional areas as well as its expansion in new niches.

Development of precision conservation agriculture practices in cereal-based system in Indo-Gangetic Plains

Rice-wheat (RW) cropping system in north-west India, although provides food security in the country, has also led to soil degradation and over-exploitation of underground water resources. The diversification of RW systems with maize-based systems, alternate soil and crop management practices could help enhance the system productivity, sustain soil health and environment quality, save irrigation water and labour costs, provide palatable fodder and meet increased demand of maize grains from poultry and piggery industries.

System productivity was higher under maize-wheat system compared to rice-wheat. In comparison to rice-wheat system, the system productivity was 33% (15% in 1st year) and 25% (11% in 1st year) higher in conservation and conventional maize-wheat system, respectively in the 2nd year **(Figure 3.1)**. The Benefit:Cost (B:C) ratio was also highest in conservation maize-wheat system (2.67 and 3.35) followed by conventional maize-wheat system (2.03 and 2.75) and least in rice-wheat system (1.88 and 2.24). Further, the maize-wheat system was also water-use efficient as it reduced water consumption by 82.8% as compared to rice-wheat system. Maize-wheat system can be grown 5-6 times, with the same amount of water that is used to grow one cycle of rice-wheat system. Hence, replacement of rice-wheat system with maize-wheat, increased system productivity (up to 33%), profitability (up to 50 %) and also resulted in huge (82%) water saving.

Among different fertilizer management treatments, higher system yield and B:C ratio were obtained under Recommended Dose of Fertilizer (RDF) closely followed by Site-specific Nutrient Management (SSNM) and Green Seeker-based application (GS), whilest lowest were under Farmer Fertilizer Practice (FFP) **(Figure 3.2)**. In second year, GS outperformed SSNM. Soil organic carbon (SOC) content were highest under SSNM and lowest under RDF.

Study of different organic nutrient sources in maize and specialty corn

Presently, there is increased demand of organic product due to their better nutrition value and quality. However, no concrete information is available for organic maize production with special reference to specialty maize. A long term experiment is initiated on a fixed site at IIMR Ludhiana to measure the effect of fertilizer *vis-a-vis* different organic sources in maize and specialty corn i.e. baby corn and sweet corn **(Table 3.1).** The yield of baby corn was not significantly affected by different nutrient management treatments, while sweet corn has given negative response with organic nutrient sources in second year. Yield reduction to the level of 43% and 75% was observed for normal maize and wheat, respectively under organic nutrient management. Hence, organic cultivation is mainly viable for baby corn cultivation.

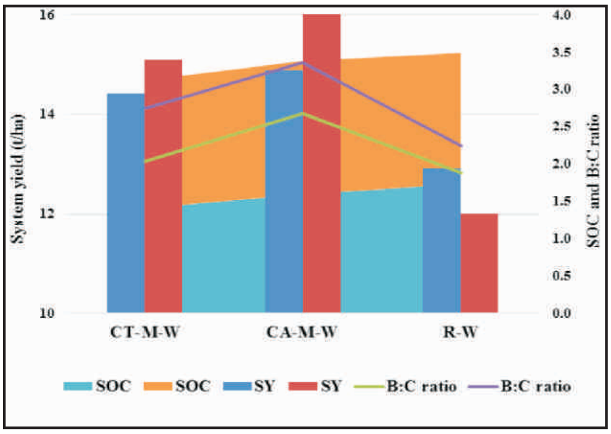


Figure 3.1: System yield (SY), B:C ratio and Soil organic carbon (SOC) under different tillage and cereal-based cropping systems. FFP – Farmer Fertilizer Practice, RDF – Recommended Dose of Fertilizer, GS – Green Seeker-based application, SSNM – Site-specific nutrient management.

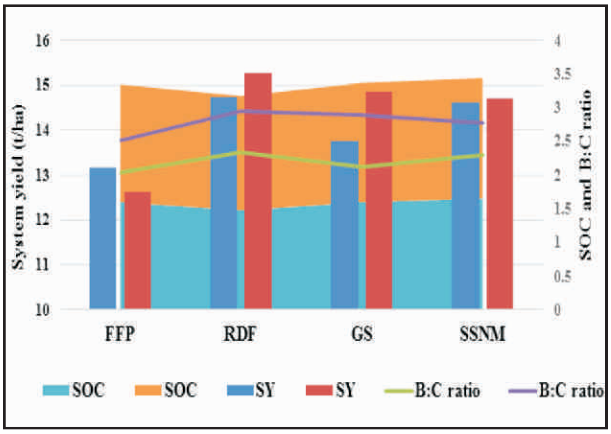


Figure 3.2: System yield, B:C ratio and Soil organic carbon (SOC) as affected by different nutrient management practices. FFP – Farmer Fertilizer Practice, RDF – Recommended Dose of Fertilizer, GS – Green Seeker-based application, SSNM – Site-specific nutrient management.

Table 3.1: Effect of different organic nutrient sources in maize and specialty corn followed by wheat

Maize type	Treatment	Maize (2017)	Maize (2018)	Wheat (2017-18)	Wheat (2018-19)
Baby corn	RDF	7570	8876	3492	3885
	100% FYM	6585 (-13)	7721 (-13)	1676 (-52)	2224 (-42)
	50% FYM + 50% VC	6268 (-17)	7349 (-17)	1680 (-52)	2042 (-47)
	25%FYM + 25%VC + 1/3Straw	6598 (-12)	7736 (-12)	934 (-73)	1563 (-59)
	LSD (P = 0.05)	NS	NS	168.8	206.1
Sweet corn	RDF	9986	12642	3957	4434
	100% FYM	9417 (-5)	8751 (-30)	2119 (-46)	2646 (-40)
	50% FYM + 50% VC	9121 (-8)	8510 (-32)	2440 (-38)	2453 (-44)
	25% FYM + 25% VC+1/3 Straw	8635 (-13)	7561 (-40)	956 (-75)	1398 (-68)
	LSD (P = 0.05)	NS	1272.8	168.8	206.1
Normal maize	RDF	6435	9706	3146	4072
	100% FYM	4453 (-30)	6428 (-33)	1847 (-41)	2315 (-43)
	50% FYM+ 50% VC	4487 (-30)	5621 (-42)	1731 (-44)	1892 (-53)
	25% FYM + 25% VC+1/3 Straw	4518 (-29)	5514 (-43)	840 (-73)	1574 (-61)
	LSD (P = 0.05)	290.1	2306	168.8	206.1

Data in parenthesis indicating percent yield reduction as compared to RDF

Sensor guided nitrogen management in maize based cropping system under conventional and conservation agriculture practices

The maize-wheat cropping system is the third most important cropping system in India and its intensification with legumes has promising perspectives. However, for meeting the oilseed, cereal and pulses requirement, cropping system like maize-mustard-mungbean can be potentially utilized, which also have less water requirement. The efficiency of the resources in these maize systems can be further improved with the precise application of the nutrient input, especially nitrogen. The precision nitrogen management in conservation agriculture becomes more relevant for adjusting the demand of the nutrient, based on the residue input. The Green Seeker optical sensor guided nitrogen management practices have been developed in conventional and conservation agriculture practices for enhancing productivity, resource use efficiency and profitability of intensive maize systems. The options of precision nitrogen management were explored in the experiment of conservation agriculture started in *kharif* 2012.

The application of residue [Permanent Bed + Residue (PB + R)] increased the crop health with enhanced values of Soil Plant Analysis Development (SPAD)-based chlorophyll readings and canopy temperature depression (CTD) at critical crop stages of maize as compared to no residue application (PB - R) (**Table 3.2**). The application of the 33% basal nitrogen followed by Green Seeker guided N application (33 + GS) in maize significantly increased the grain yield of *kharif* maize by 6.9% over the traditional three-split recommended N application [Recommended Dose of Nitrogen (RDN)]. The enhancement in maize yield with the application of the residue was 12.6% over no residue application in conservation agriculture. However, in the 7th year, maize grain yield was not significantly affected by cropping system, but the CTD at 60 DAS and partial factor productivity of applied N (PFP_N) was improved significantly with maize-wheat-mungbean (MWMb) system.

Significant interaction effect of residue incorporation and the nitrogen management practices was observed in maize

Table 3.2: Effect of the Green Seeker optical sensor guided N application under different residue management and cropping system scenarios on performance of *kharif* maize during 2018.

Particulars	SPAD (30 DAS)	SPAD (45 DAS)	SPAD (60 DAS)	CTD (30 DAS)	CTD (45 DAS)	CTD (60 DAS)	Grain yield (kg/ha)	PFP_N
Cropping system								
Maize-mustard - mungbean	33.61	50.17	53.79	-2.01	-2.50	-3.19	5538	34.7
Maize-wheat-mungbean	34.55	50.62	55.86	-2.25	-2.48	-4.49	5609	35.3
LSD (P = 0.05)	NS	NS	NS	NS	NS	0.53	**NS**	0.46
Residue management								
PB - R	34.83	49.60	53.14	-1.91	-1.88	-3.73	5243	31.7
PB + R	33.34	51.19	56.51	-2.35	-3.10	-3.95	5905	38.3
LSD (P = 0.05)	1.12	NS	0.93	0.20	0.15	0.06	247.92	1.57
N management								
RDN	33.44	50.82	54.31	-2.30	-2.46	-3.90	5489	36.6
33 + GS	33.40	51.44	55.78	-1.58	-2.60	-3.94	5869	37.6
50 + GS	33.69	49.38	55.03	-2.26	-2.31	-3.77	5577	35.5
70 + GS	35.80	49.94	54.18	-2.38	-2.59	-3.74	5360	30.5
LSD (P = 0.05)	NS	NS	NS	NS	NS	NS	241.47	1.52

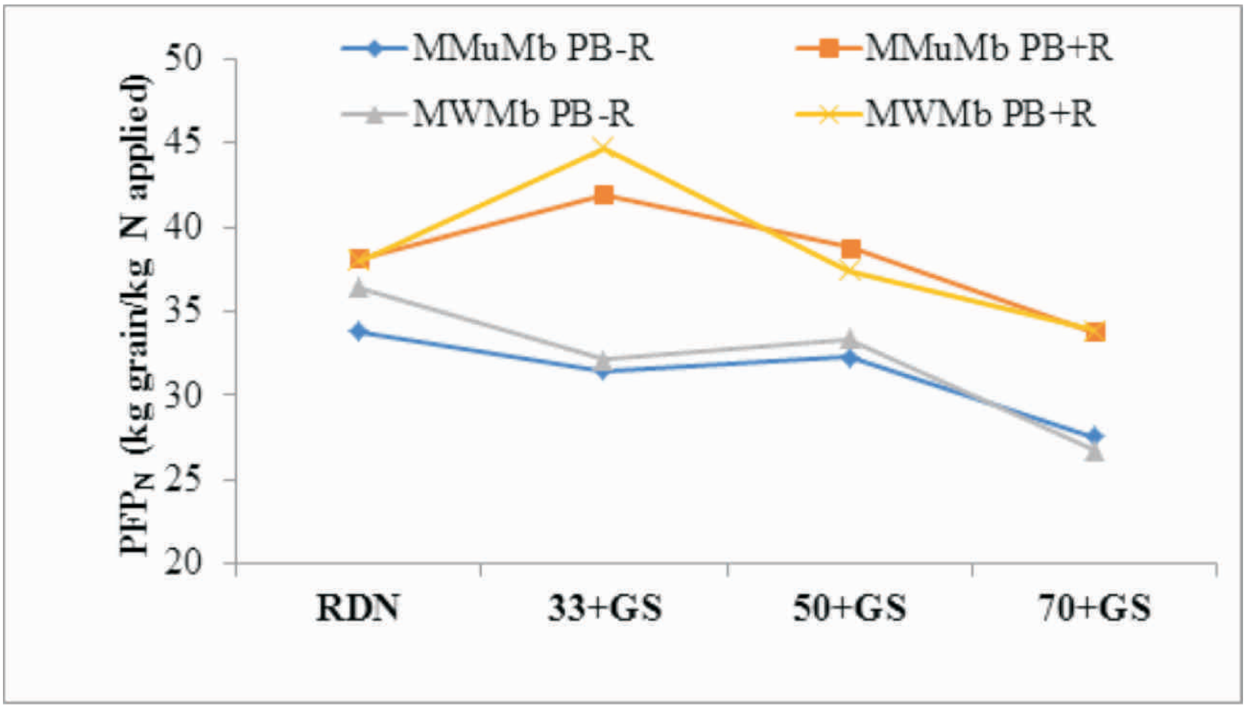


Figure 3.2: Interaction effect of the Green Seeker (GS) optical sensor guided N application under different residue management and cropping system scenarios on partial factor productivity of applied nitrogen (PFP_N) in *kharif* maize during 2018.

Table 3.3: Effect of the Green Seeker (GS) optical sensor guided N application on the yield, economics and nitrogen use efficiency of conventionally tilled grown maize during *kharif* 2018 at Delhi.

Treatment Description	Grain yield (kg/ha)	Net returns ('000 Rs/ha)	BC ratio	PFP_N (kg grain/ kg N applied)
RDF	3861.00[bc]	48.19[c]	1.47[c]	25.74[def]
STCR	5241.33[a]	72.92[a]	1.96[abc]	20.88[f]
NE-SSNM	5032.00[a]	74.03[a]	2.34[a]	35.94[bc]
33% Basal N + GS at KH and TS	3813.33[c]	47.78[c]	1.48[c]	23.38[ef]
60% Basal N + GS at KH	3894.33[bc]	50.28[bc]	1.60[bc]	30.24[cde]
70% Basal N + GS at KH	3880.00[bc]	49.58[bc]	1.55[bc]	29.65[cde]
60% Basal N + GS at TS	3691.33[c]	45.84[c]	1.45[c]	32.62[cd]
70% Basal N + GS at TS	4514.00[abc]	62.84[abc]	1.97[abc]	33.34[c]
30% Basal N + 30% N at 25 DAS+ GS at TS	4785.67[ab]	68.14[ab]	2.11[ab]	44.55[a]
35% Basal N + 35% N at 25 DAS +GS at TS	4895.33[a]	71.08[a]	2.24[a]	41.95[ab]
p-Value	0.0118	0.0196	0.0316	<.0001
LSD (P = 0.05)	945.04	19.846	0.6166	7.1972

Values with same letter are not statistically different

for partial factor productivity of applied nitrogen (PFP_N). The PFP_N was significantly increased under MWMb system having PB + R having 33 + GS based N application (45 kg grain/kg N applied). However, the PFP_N decreased in PB - R under both cropping system for various N management practices (**Figure 3.2**).

Application of the N under conventional tillage practices based on soil test crop response (STCR) gave highest yield, net returns and B:C ratio which was statistically at par with nutrient expert-SSNM, 70% basal N + GS at tasseling stage, 30% basal N + 30% N at 25 DAS + GS at tasseling stage and 35% basal N + 35% N at 25 DAS + GS at tasseling stage treatments (**Table 3.3**). However, the PFP_N was significantly high with 30% basal N + 30% N at 25 DAS + GS at tasseling stage, which was at par with 35% basal N + 35% N at 25 DAS + GS at tasseling stage. Thus, the sensor guided N application has potential to optimize the N requirement of maize under conventional tillage as well.

The application of residue and adoption of Conservation Agriculture (CA) in maize has not increased the infestation of the termite and pink borer in 7th crop of wheat grown in MWMb system (**Table 3.4**). However, slightly higher values of pest incidence were observed in residue removal treatment.

Table 3.4: Effect of the different residue management scenario on incidence of termite and *Sesamia* in 7th crop of wheat during *rabi* 2018-19.

Treatment description	Pink borer infested tillers/30.5 m^2	Termite infested tillers/30.5 m^2	Pink borer (% infestation)	Termite (% infestation)
Residue management				
PB – R	5.25	6.17	0.036	0.043
PB + R	4.42	4.08	0.029	0.027
LSD (P=0.05)	N.S.	N.S.	N.S.	N.S.

Conservation agriculture experiment of maize

Artificial inoculation to study disease development in maize

4 CROP PROTECTION

Disease management

Banded Leaf and Sheath Blight (BLSB) is a major disease of maize with no sources of resistance. It causes significant damage to the crop. Maydis Leaf Blight (MLB) is also a major disease of maize. Efforts were made to develop control strategies against BLSB and MLB. Three disease management modules [Organic, chemical and Integrated Disease Management (IDM)] were tested against banded leaf and sheath blight (BLSB) at four locations and MLB at two locations of Zone II.

Efficacy of modules for management of BLSB

Different modules were tested for management of BLSB. Chemical module was composed of seed treatment with Salicylic acid [100 ppm] + Foliar spray with Azoxystrobin 18.2% w/w + Difenoconazole 11.4% w/w SC (@ 0.1% using 500 l water/ha; twice at 3 and 15 days after infection (DAI). There were two organic modules. Organic module I consisted of soil amendment with *Trichoderma* and neem formulation [@ 6t/acre FYM + seed treatment with *Trichoderma* formulation @ 20 g/Kg seed + Foliar spray with Neem leaf extract @ 1%; twice at 3 and 15 DAI], while Organic module II was composed of soil amendment with *Trichoderma* formulation alone [@ 6t/acre FYM] + seed treatment with *Trichoderma* formulation @ 20 g/Kg seed and foliar spray with *Trichoderma* formulation @ 1%; twice at 3 and 15 DAI]. Integrated disease management (IDM) module was represented by soil amendment with *Trichoderma* formulation @ 6t/acre FYM + seed treatment with Salicylic acid (100 ppm) + Foliar spray with Azoxystrobin 18.2% w/w + Difenoconazole 11.4% w/w SC @ 0.1% using 500 l water/ha at 3 DAI and Neem leaf extract @ 1%, at 15 DAI.

Disease control by chemical module ranged from 54.55 to 62.37%, followed by IDM (51.85 to 68.18%) and organic modules (I and II) (5.56 to 50.01%) with significantly higher yield over check in chemical module (23.46 to 95%), organic module (15.30 to 55%) following IDM module (29 to 67%).

Efficacy of modules for management of MLB:

Three modules were tested for management of MLB. Chemical module was composed of seed treatment with Thiram (@ 3gm/kg of seed), foliar spray of Mancozeb 75 WP (2.5g/L of water) at 45 DAS, foliar spray of Azoxystrobin 18.2% + Difenconazole 11.4% w/w SC (Amistar Top 325 SC) @ 1ml/L of water at 55 DAS. Organic module consisted of seed treatment with *Trichoderma harzianum* (@ 10gm/kg of seed), foliar spray of *Pseudomonas fluorescens* (@ 10gm/L of water) at 45 DAS and foliar spray of cow urine (20%) at 60 DAS and 15 DAI. Integrated disease management (IDM) module was represented by seed treatment with *Trichoderma harzianum* (10gm/kg of seed), foliar spray of *Pseudomonas fluorescens* (10gm/L of water) at 45 DAS, foliar spray of Azoxystrobin 18.2% + Difenconazole 11.4% w/w SC (Amistar Top 325 SC) 1ml/L of water at 50 DAS, foliar spray of cow urine (20%) at 60 DAS.

Disease control by chemical module ranged from 52.17 to 55.6%, followed by IDM (30.43 to 48.9%) and organic module (13.04 to 35.3%) with significantly higher yield over check in chemical module (14.78 to 36.60%), organic module (5.30 to 24.30%) and IDM module (5.66 to 33.7%).

Efficacy of bio extract/plant products for management of MLB

Ten bio-extracts/natural products were evaluated for management of MLB at Delhi (CM 600) during *kharif* 2016 to 2018. The perusal of data revealed that *Azadiractaindica* (neem extracts) @ 10%, *Allium sativum* (garlic cloves) @ 10%, *Polyalthialongifolia* (False Ashoka) @ 10% and *Parthenium hysterophorus* (congress grass) @ 10% recorded 20.75%, 20.75%, 15.09% and 15.09% of MLB respectively with yield advantageof 52.74%, 42.64%, 38.44% and 35.48% respectively.

Efficacy of leaf stripping in management of BLSB

Stripping of 2-3 basal leaves was tested for management of BLSB at Ludhiana on six maize hybrids, *viz*., PMH 1, PMH 2, PMH 4, PMH 5, Prakash and DKC 9164 during *kharif* 2018. It was observed that removal of 2-3 basal leaves (stripping) provided significant disease control (up to 24.55%) as compared to unstripped check.

Development of web enabled forewarning models for BLSB

Forewarning models for BLSB were developed on crop age at first appearance of disease, crop age at maximum severity of disease and maximum severity of diseases in the seasons at Ludhiana, New Delhi and Pant Nagar locations. Weekly weather data on maximum temperature, minimum temperature, relative humidity in morning and relative humidity in evening and rainfall along with disease severity on Banded Leaf and Sheath Blight were obtained from 2011-16 for Ludhiana and 2006-2016 from Pantnagar and New Delhi centres. The forewarning models on crop age at first appearance of disease [weather data utilised from 27 standard

Table 4.1: Efficacy of leaf stripping on severity of banded leaf and sheath blight of maize during *kharif* 2018

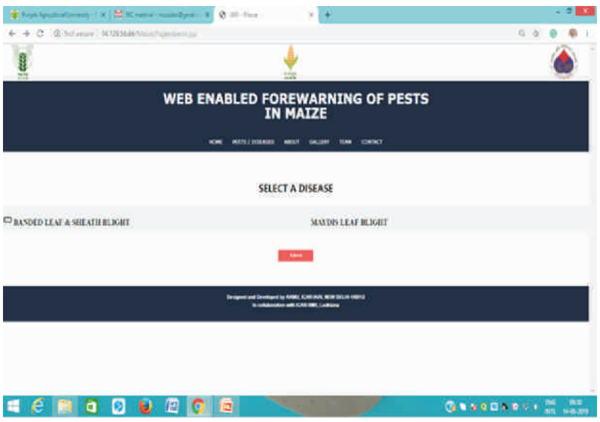
S. No.	Genotype	Disease index (%) Unstripped	Disease index (%) Stripped	Disease control (%)	Mean
1	**PMH 1**	87.6	71.5	18.4	**79.5**
2	**PMH 2**	97.6	73.0	25.2	**85.3**
3	**PMH 4**	97.6	72.6	25.6	**85.1**
4	**PMH 5**	96.5	74.4	22.8	**85.5**
5	**Prakash**	90.7	69.6	23.3	**80.2**
6	**DKC 9164**	94.6	64.6	31.7	**79.6**
	Mean	**94.1**	**71.0**	**24.55**	-
	LSD (0.05)	**Genotype**			**15.82**
		Stripping	**3.39**		

Disease severity [Leaf stripping × Hybrids]

Factor	Factor levels	Factor level means	SEM	p-value	Whether significant or not
Leaf stripping	Stripped leaves	71.0^{1}	2.1	<0.0001	Yes
	Unstripped leaves	94.1^{2}			
Hybrids	PMH 1	79.5^{a}	2.1	0.907	No
	PMH 2	85.3^{a}			
	PMH 4	85.1^{a}			
	PMH 5	85.5^{a}			
	Prakash	80.2^{a}			
	DKC 9164	79.6^{a}			

**Values within experiments followed by the same letter are not significantly different at P = 0.05*

meteorological week (SMW) to 32 SMW], crop age at maximum severity of disease (weather data utilised from 27 SMW to 34 SMW) and maximum severity of diseases (weather data utilised from 27 SMW to 34 SMW) in the seasons has been done. The models were validated for two subsequent years (2017-18 and 2018-19). Predictions and forecasts are in close agreement indicating the stability of the model. In the web enabled forecast system developed, the users have to fill the form by choosing the disease, location and seasons by accessing the website through the portal, wherein the developed site specific statistical model will fetched at back-end utilizing the weather file uploaded by the administrator.



Forewarning system for BLSB in maize

Insect Management

Biochemical profiling of identified resistant and susceptible maize germplasm against *Sesamia inferens*

In an attempt to decipher biochemical basis of resistance against *Sesamia inferens*, total soluble phenolics, bound phenolics, cell wall bound hydroxycinnamic acids *p*-coumaric acid (*p*-CA), ferulic acid (FA), total tannin content and total flavonoid content were measured in leaf at 10 and 20 days after germination (DAG), in stem at 20 and 40 DAG and, in pith and rind tissues at 60 DAG (stem differentiated). The amount of bound phenolic acids were consistently higher in resistant genotype DMRE 63 in leaf at 10 DAG (2.89 mg/g) and 20 DAG (5.32 mg/g) and also in stem at 20 DAG (2.07 mg/g) and 40 DAG (1.58 mg/g) . In case of total soluble phenolics, susceptible genotype, BML 6 had higher concentrations (2.78 mg/g) while moderately resistant genotype WNZ Exotic Pool contained lower quantity (0.33 mg/g) in stem tissue at 20 DAG. The genotype, WNZ Exotic Pool showed consistently higher level of *p*-CA in leaf (0.83 and 0.92 mg/g at 10 and 20 DAG), stem (0.87 mg/g at 40 DAG), rind (3.65 mg/g) and pith (1.16 mg/g) at different stages except in stem at 20 DAG (0.10 mg/g). DMRE 63 had higher levels of FA in leaf (0.43 and 0.61 mg/g) and stem (0.34 and 0.27 mg/g); higher total tannins in leaf (1.05 and 2.52 mg/g) and stem (1.19 and 1.35 mg/g) tissue. However, higher levels of flavonoid content were detected in CM 202 consistently in leaf (0.11 and 0.25 mg/g), stem (0.11 and 0.09 mg/g) and pith (0.14 mg/g). Total bound phenolic content showed negative correlation with Leaf Injury Rating (LIR). Highly significant strong positive correlation (r = 0.98, p = *0.01*) was observed between LIR and total soluble phenolics in leaf tissue at 20 DAG. Similarly highly significant strong positive correlation between LIR and total tannins (r = 0.94, p = *0.01*) and flavonoids (r = 0.96, p = *0.01*) in pith at 60 DAG was observed. Significant strong negative correlation between LIR and *p*-CA (r = -0.84, p = *0.05*) in stem at 40 DAG was observed. Genotype-by-biochemical factor biplot showed that the data of biochemical parameters measured in different tissues and stages could be able to group the genotypes according to their reaction to *S. inferens* **(Figure 4.1)**.

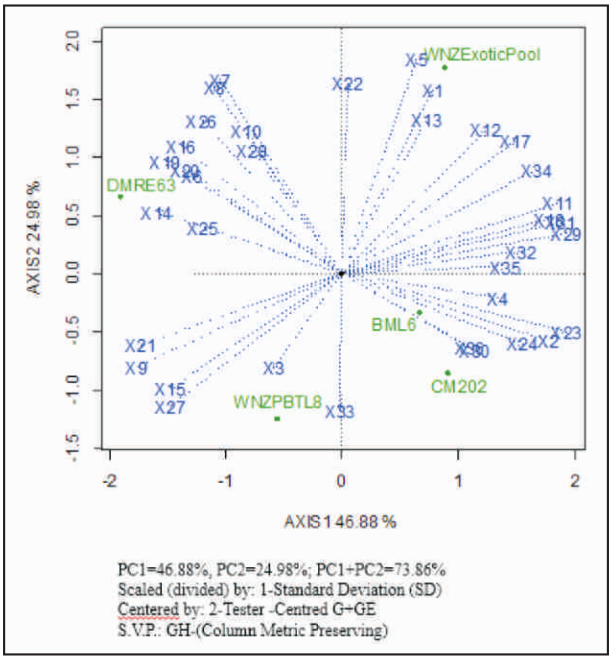


Figure 4.1: Genotype-by-biochemical factor biplot of maize genotypes tested for biochemical parameters and reaction to *S. inferens*.

Efficacy of native strains of *Bacillus thuringiensis* (var. kurstaki) against *Chilo partellus* (Swinhoe)

Spore crystal complex of native strains of *Bacillus thuringiensis* (var. kurstaki) was tested for efficacy against neonate larvae of *Chilo partellus.* The strain HD1 was taken as international reference. HD1 and the native strains, *viz*., BB1 and BB2 caused 100 % mortality and VKK13 caused 85 % mortality of neonate larvae at 1000 ppm (Mean Square 3911.82**). The lethal dose (LC_{50}) of BB1, BB2 and VKK13 was determined on neonate larvae of *C. partellus* and it was found that the native strains BB1 (76.29 ppm) and BB2 (74.41 ppm) are at par with the reference strain HD1 (63.31 ppm) when observed 120 hours after treatment (Table 4.2).

Biology of Fall Armyworm [*Spodoptera frugiperda* (J. E. Smith)]

The biology of FAW was studied on baby corn husk from August 2018 to February 2019 under laboratory conditions (**Figure 4.2**). The average pre-oviposition, oviposition and post-oviposition periods of FAW were

Table 4.2: Effective dose of (LC_{50}) of spore crystal complex of *Bacillus thuringiensis* (var. kurstaki) strains against *Chilo partellus*

S. No.	LC_{50} (Fiducial Limits 95%)	SLOPE	CHI^2	DF
HD1	63.31 (44.76-82.23)	0.081±0.201	6.820	3
BB1	76.29 (55.38-98.64)	0.082±0.198	0.889	3
BB2	74.41 (50.52-99.91)	0.079±0.193	5.602	3
VKK13	1784.03 (92.7-700x10^7)	0.075±0.179	2.873	3

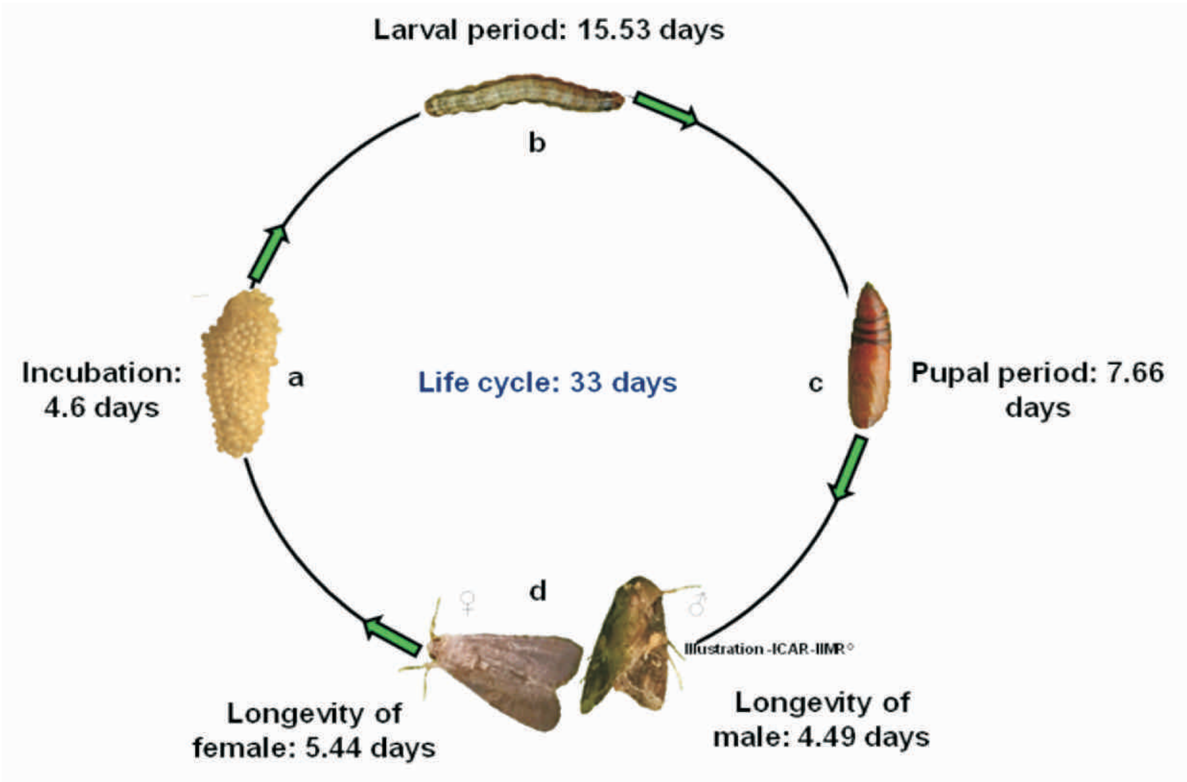


Figure 4.2: Life cycle of armyworm under natural condition from August 2018 to February 2019 at WNC, Hyderabad

3.66 ± 0.49, 2.66 ± 0.49, 2.08 ± 0.66 days, respectively. The average incubation period, larval and pupal periods were 4.60, 15.53 and 7.66 days, respectively.The average longevity of male and female was 4.49 and 5.44 days whereas total life period was 32.33 and 33.27 days for male and female adults, respectively. Sex-ratio of male to female was 1.00: 1.28.

Fall armyworm female on a maize plant

Awareness generation for Fall armywarm management

5 EXTENSION AND OUTREACH

The ICAR-IIMR has strong outreach activities involving transfer of technology, critical input distribution and capacity building for maize farmers and other stakeholders. The Scheduled Tribe Component (STC), North Eastern Hill (NEH)-component, Scheduled Caste Sub-Plan programme (SCSP) component of the ICAR and Mera Gaon Mera Gaurav (MGMG) are being followed by the institute for capacity building, technology demonstration and input distribution in maize areas. The institute also has frontline demonstration (FLD) programme sponsored by Department of Agriculture and Cooperation, Government of India under National Food Security Mission (NFSM) for pan-India demonstration of the improved maize production technology. All these activities were focused on the aspiring districts identified by Government of India, including new production areas of maize and low maize productivity traditional areas in the country.

Front Line Demonstrations

The frontline demonstrations (FLDs) under NFSM were conducted on 386.6 ha area spread over 16 states involving 972 farmers during three seasons (Table 5.1). In *rabi* 2017-18, FLDs was conducted on 157.6 ha in 338 farmers field in ten states (Bihar, Rajasthan, Telangana, Madhya Pradesh, West Bengal, Karnataka, Tamil Nadu and Odisha) by 12 centres. The FLDs were focused on single cross hybrids, micronutrient application, post-emergence weed management, integrated pest management and intercropping. The average yield in FLDs was 62.0 q/ha, which was significantly higher than those obtained by farmer followed practices (49.9 q/ha) during *rabi* season. It was found that the yield gains over the farmer practices in different states in *rabi* season ranged from 7.4 to 84.8%. In spring 2018, the FLDs were conducted in four states benefitting 122 farmers. The yield under FLDs was 26.2 q/ha which was much higher than farmer practice of 16.6 q/ha having average yield gaps of 63.4% (8.9 to 173.6%). In *kharif* 2018, FLDs were conducted in 12 states by 14 centres on 173.4 ha fields of 472 farmers. The results of the frontline demonstrations (FLDs) conducted in *kharif* showed a wide variation in the yield gaps of 5.5 to 197.9% across states averaging 31.9%. The average yield in *kharif* season under FLDs was 45.7 q/ha, while in spring it was 42.7 q/ha.

Across the season, highest yield of 90 q/ha under FLDs was reported during *rabi* 2018-19 at West Bengal. The seasonal averages of the FLDs were 20 and 25 q/ha, higher than national average yield of maize during *rabi* and *kharif* season, respectively, which showed the potential of enhancing maize productivity in both the seasons with available technology targeting in niche areas.

Spring maize demonstration at Haryana

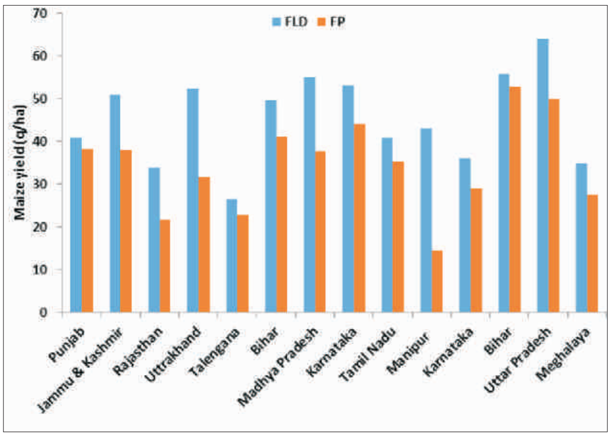


Figure 5.1: Maize yield during kharif 2018 in FLDs and farmers practices (FP) in various states.

Micronutrient and IPM demonstrations conducted at Dharwad Karnataka

Table 5.1: State-wise, season-wise performance of FLDs conducted in maize during 2018-19.

S. No.	Name of the centre	FLDs area (ha)	Yield in FLDs (q/ha)	Yield q/ha in farmer practice (q/ha)	Yield gains (%)	No. of Beneficiaries
1.	TCA, Dholi, Bihar	10	71.0	66.1	7.4	25
2.	MPUAT, Banswara, Rajasthan	10	73.4	42.8	71.6	25
3.	MPUAT, Udaipur, Rajasthan	8	66.3	58.2	13.8	20
4.	WNC-IIMR, Hyderabad, Telangana	10	56.0	47.3	18.5	20
5.	JNKVV, Chhindwara	25	29.2	22.7	28.5	30
6.	BCKV, Kalyani, West Bengal	20	90.8	76.9	18.0	44
7.	UAS, Dharwad, Karnataka	8	61.8	56.2	9.9	20
8.	TANU, Coimbatore, Tamil Nadu	10	72.1	60.0	20.2	25
9.	RMRSPC, Begusarai, Bihar	20	72.7	59.9	21.4	44
10.	OUAT, Bhubaneswar, Odisha	15	51.2	27.7	84.8	38
11.	PJTSAU, Hyderabad, Telangana	13.2	57.2	48.5	18.1	26
12.	RVSKVV, Jhabua , Madhya Pradesh	8.4	42.6	32.4	31.3	21
Total/mean (*Rabi 2017-18*)		**157.6**	**62.0**	**49.9**	**24.3**	**338**
13.	CCSHAU, Karnal, Haryana	10	64.0	38.7	65.4	20
14.	NDUAT, Baharaich , Uttar Pradesh	20.6	36.6	23.7	54.4	74
15.	IIMR, Ludhiana, Punjab	21	29.8	27.4	8.9	18
16.	CAU, Imphal, Manipur	4	40.5	14.8	173.6	10
Total/mean (Spring 2018)		**55.6**	**42.7**	**26.2**	**63.4**	**122**
17.	PAU, Ludhiana, Punjab	20	40.8	38.2	7.0	48
18.	SKUAST, Srinagar, Jammu and Kashmir	10.2	50.9	38.0	33.9	25
19.	MPUAT, Udaipur , Rajasthan	20	33.9	21.5	57.4	40
20.	VPKAS, Almora, Uttrakhand	10	52.4	31.6	65.8	64
21.	PJTSAU, Hyderabad, Telangana	10	26.5	22.8	16.3	25
22.	DrRPCAU, Dholi, Bihar	10	49.7	41.1	20.9	25
23.	JNKVV, Chhindwara , Madhya Pradesh	10	55.1	37.7	46.1	25
24.	UAS, Dharwada, Karnataka	11	53.1	44.1	20.6	25
25.	TANU, Coimbatore , Tamil Nadu	10	40.9	35.2	16.2	50
26.	CAU, Imphal, Manipur	10	43.2	14.5	197.9	10
27.	UAS, Mandya, Karnataka	20	30.0	38.5	28.3	50
28.	BAU, Sabour, Bihar	10	55.7	52.8	5.53	25
29.	BHU, Varanasi , Uttar Pradesh	14	64.0	50.0	28.0	50
30.	ICARRC NEH region, Barapani, Meghalaya	8.2	34.8	27.4	26.4	10
Total/mean (*Kharif 2018*)		**173.4**	**45.7**	**34.6**	**31.9**	**472**

Field days conducted for FLDs at Pratapgarh, Rajasthan

Demonstration of hybrid maize in Manipur

Demonstration of post-emergence weed management at Telangana

The variation in the yield of *khairf* 2018 season FLDs versus farmer practices was more than 50% in Manipur, Uttrakhand and Rajasthan while less than 20% in Telangana, Bihar, Punjab and Tamil Nadu **(Figure 5.1)**.

Scheduled Tribe Component (STC)

Scheduled Tribe Component (STC) is funded by ICAR to enhance economic profitability of tribal farmers. The institute implemented STC programme in maize in various tribal belts across the country through approved budget under IIMR and AICRP on maize. The programme focused on the training for capacity building, input distribution and frontline demonstrations on the best crop management with improved high yielding maize cultivars. The programme was implemented mostly in the tribal dominated aspirational districts in 13 states, *viz.*, Chhattisgarh, Himachal Pradesh, Maharashtra, Manipur, Odisha, Madhya Pradesh, Jammu and Kashmir, Jharkhand, Uttar Pradesh, Gujarat, Rajasthan, Bihar and West Bengal. Under STC programme, 32 districts were covered for capacity development of tribal maize farmers in these states.

During the period, 36 farmers training programme were conducted in different parts of the country, benefiting 1933 tribal farmers on various aspects of scientific maize production **(Table 5.2)**. Inputs were also distributed to the farmers during these training programme for following improved maize production practices in order to enhance farm profitability.

Inputs were distributed among farmers. Five categories of inputs included seed, biofertilizer/ biopesiticides/ botanicals, chemical fertilizer, plant protection chemical and farm implements were emphasized to address seed-to-seed maize production. Modern farm implements for maize production like plough, trench hoe, sickle, manual maize sheller, power operated maize sheller, sprayer, etc. and storage bins for reducing post-harvest losses were distributed in the STC programme.

Demonstrations on the scientific maize cultivations were conducted under STC programme on over 300 hectares. High yield gaps of the farmer adopted practices and the demonstration were noticed (62% in Raygada, Odisha, 75% in Varanasi, U.P and 93% in Koraput, Odisha).

Table 5.2: Training conducted by AICRP on maize centres under TSP programme.

Centre	Place	Date/s	Topic	Farmers benefited
Maize Research Station, Godhra (Gujurat)	Bhilpaniya	August 10, 2018	Scientific and beneficial improved cultivation practices of Maize	65
	Vislanga	August 18, 2018	Scientific and beneficial improved cultivation practices of Maize	59
	Goth	August 30, 2018	Scientific and beneficial improved cultivation practices of Maize	50
	MMRS, Godhra	February 25, 2019	Scientific and beneficial improved cultivation practices of Maize	60
AAU Gossaigaon	Lakhibazar, Baksa, Assam	March 20, 2019	Scientific cultivation of Maize	33
	Goreswar, Baksa, Assam	March 23, 2019	Scientific cultivation of Maize	40
BCKV, Kalyani, West Bengal	Aatgharah	November 24, 2018	Scientific cultivation of Maize	25
	Paschim Simla	February 7, 2019	Scientific cultivation of Maize	15
BHU, Varanasi	Varanasi	May 21, 2018	Maize production technology	100
	CAU, Imphal	October 06, 2018	Promoting improved technology of maize production among the tribal farmers under TSP	50
CAU Imphal	CAU, Imphal	October 12, 2018	Promoting improved technology of maize production among the tribal farmers under TSP	50
	CAU, Imphal	November 22, 2018	Promoting improved technology of maize production among the tribal farmers under TSP	60
	CAU, Imphal	November 25, 2018	Promoting improved technology of maize production among the tribal farmers under TSP	60
	CAU, Imphal	November 27, 2018	Promoting improved technology of maize production among the tribal farmers under TSP	60
	CAU, Imphal	November 30, 2018	Maize based intercropping system for the sustainable livelihood of tribal farmers	60
IIGKV, Ambikapur	KVK Korba	February 20, 2019	Maize production technology	30
	KVK Korba	March 12, 2019	Maize production technology	63

Centre	Place	Date/s	Topic	Farmers benefited
	KVK Rajnandgaon	March 16, 2019	Maize production technology	93
	KVK Narayanpur (Narayanpur)	February 01, 2019	Maize production technology	25
	KVK Narayanpur (Narayanpur)	February 17, 2019	Maize production technology	25
	KVK Narayanpur (Kondagaon)	December 9, 2019	Maize production technology	25
	KVK Narayanpur (Kondagaon)	February 06, 2019	Maize production technology	25
	KVK Dantewada (Dantewada)	February 24, 2019	Maize production technology	30
	KVK Dantewada (Dantewada)	February 24, 2019	Maize production technology	27
	KVK Dantewada (Dantewada)	February 24, 2019	Maize production technology	65
	KVK Dantewada (Sukma)	January 22, 2019	Maize production technology	25
	KVK Dantewada (Sukma)	February 22, 2019	Maize production technology	25
	KVK Kanker	March 03, 2019	Maize production technology	38
	KVK Kanker	March 22, 2019	Maize production technology	21
	KVK Kanker	March 29, 2019	Maize production technology	46
	RMD CARS Ambikapur	March 29, 2019	Maize production technology	30
	KVK Bastar (Jagdalpur)	January 20, 2019	Maize production technology	50
	KVK Bastar (Jagdalpur)	February 20, 2019	Maize production technology	55
RMRSPC, Begusarai	Katihar	November 22, 2018	Maize hybrid technology and its seed production	80
	Ranchi	February 15, 2019	Maize hybrid technology and its seed production	140
	Begusarai	January 22, 2019	Maize hybrid technology and its seed production	101
	Begusarai	March 19, 2019	Maize hybrid technology and its seed production	170
CSKHPKV, Kangra	KVK, Chamba	January 17-18, 2019	Improved Maize Production Technology	25
	KVK, Chamba	January 19-20, 2019	Improved Maize Production Technology	25
Total	**36 trainings**			**2026**

Table 4.3. Summary of key inputs distribution under STC programme in maize.

Input distributed	Quantity
A. High yielding maize cultivar seed (Kg)	7147
B. Biofertilizer/ biopesticides/botanicals	
Bio fertilizer NP consortium (litre)	32.75
Trichoderma (Kg)	200
Azadirachtin (litre)	8
Azotobacter (packet)	100
PSB (packet)	100
C. Chemical fertilizer	
Di-ammonium phosphate (Kg)	11105.6
Urea (Kg)	47292
Murate of Potash (Kg)	3903
Single super phosphate (Kg)	8650
N:P:K complex fertilizer (Kg)	5000
Zinc sulphate (Kg)	700
Boron (Kg)	200
D. Plant protection/storage pest chemicals	
Chloropyriphos (litre)	37
Atrazine (Kg)	1782.7
Phorate (Kg)	76.8
Carbofuron 3G (Kg)	62.5
Neembam (100 ml bottle)	180
Azoxystrobin (50 ml bottle)	120
Hexaclonazole (litre)	15
Trizophos (litre)	5
Celphos (packet)	15
E. Farm implement and storage bin	
Plough (No.)	35
Trench hoe (No.)	35
Sickle (No.)	25
Power operated sheller (No.)	87
Manual maize sheller (No.)	170
Sprayer (No.)	99
Storage bin (No.)	110

Training & input distribution at Chandel District of Manipur under TSP Programme

Training & input distribution at Chandel District of Manipur under TSP Programme

Distribution of sweet corn seed to tribal farmers in Ranchi, Jharkhand

Kissan Mela & Farm Implement Distribution at KVK, Gunupur, Rayagada on March 8, 2019 attended by OUAT Scientists & Govt. Officials

Demonstration at Village- Jhankarguda, Pottangi, Koraput

Maize promotion in NEH region

The institute implemented a pilot project in collaboration with ICAR-Research Complex for NEH region, Umiam, Manipur centre under NEH fund of the institute, sanctioned by ICAR on "Promoting Improved Technology of Maize in NEH region". This project was implemented in all the NEH states in collaboration with centre of the ICAR. Objective of this pilot project was to promote maize cultivation in NEH region with technology dissemination, input distribution, capacity building and technology development, training and capacity building on best management practices in maize was emphasized in all seven states. 25 trainings/national workshops were conducted in this programme benefiting 1932 farmers **(Table 5.4)**.

Table 5.4: Training programmes and workshops conducted in NEH region.

S. No.	Date	Place with state	Description of training	Beneficiaries (No.)
A. Manipur				
1.	July 31–August 1, 2018	ICAR RC for NEH Region, Lamphelpat, Imphal, Manipur	Two days National Workshop cum brainstorming session on "Unleashing the hidden potential of maize technology in NEH Region: status, options and strategies"	210
2.	September 20–21, 2018	ICAR RC for NEH Region, Lamphelpat, Imphal, Manipur	Maize-Livestock Integration for Improving Livelihood and Nutritional Security of Small and Marginal Farmers	41
3.	September 24 –25, 2018	Noney, Tamenglong, Manipur	Maize-Livestock Integration for Improving Livelihood and Nutritional Security of Small and Marginal Farmers	41
4.	October 18–19, 2018	Krishi Vigyan Kendra, Monsangpantha, Chandel, Manipur	Maize-Livestock Integration for Improving Livelihood and Nutritional Security of Small and Marginal Farmers	110
5.	October 20–21, 2018	Ukhongshang, Thoubal, Manipur	Maize-Livestock Integration for Improving Livelihood and Nutritional Security of Small and Marginal Farmers	34
6.	February 17, 2019	Serou, Kakching, Manipur	Maize based cropping system for improving livelihood and nutrition security of marginal and small farmers	86
7.	February 27–28, 2019	Ukhongshang, Thoubal, Manipur	Integration of maize with livestock farming	30
8.	March 18–19, 2019	Twi Champhai, Kangpokpi, Manipur	Technology for intensification in maize based cropping system	30
9.	March 25–26, 2019	Krishi Vigyan Kendra, Monsangpantha, Chandel, Manipur	Maize cultivation ensure food, feed and fodder	65
10.	March 27–28, 2019	ICAR RC for NEH Region, Lamphelpat, Imphal, Manipur	Technology for intensification in maize based cropping system	76
11.	March28–29, 2019	Krishi Vigyan Kendra, Pearsonmon, Churachandpur	Maize-livestock integration for ensuring food, feed, fodder and nutritional security	85
12.	March 29–30, 2019	Krishi Vigyan Kendra, Tupul, Tamenglong, Manipur	Technological intervention for enhancing maize productivity	46
13.	March 29–30, 2019	Krishi Vigyan Kendra, Hundung, Ukhrul	Scientific cultivation of maize in Manipur	61
14.	March 30–31, 2019	Krishi Vigyan Kendra, Lamphelpat, Imphal West	Improved maize production technology	45
		Sub Total (A)		**960**

S. No.	Date	Place with state	Description of training	Beneficiaries (No.)
B. Meghalaya				
1.	November 27, 2018	Farming System Research Project, ICAR Research Complex for NEH Region, Umiam	Training cum Awareness Programme on Rabi Maize	150
Sub Total (B)				**150**
C. Nagaland				
1.	September 24-26, 2018	Jharnapani, Nagaland	Promotion of Scientific Maize Cultivation Practices in Nagaland,	30
Sub Total (C)				**30**
D. Tripura				
1.	August 24, 2018	Charkalak ADC, Tripura	Improvement maize production technology	25
2.	September 07, 2018	Charkalak ADC, Tripura	Awareness programme on climate change and maize production	27
3.	November 21, 2018	North Pulinpur ADC, Tripura	Training-cum-demonstration programme on improvement maize production technology	200
4.	January 11, 2019	Madhuban VC, Tripura	Improved farming interventions and maize production for livelihood security of hill farmers	100
5.	January 19, 2019	Dumti ADC, Tripura	Improved farming interventions for livelihood security of hill farmers	100
6.	January 30, 2019	Maharanipur VC, Tripura	Improved farming interventions for livelihood security of hill farmers	100
Sub Total (D)				**552**
E. Sikkim				
1.	December 19, 2018	ICAR, Tadong	Maize based cropping system for improving livelihood and nutrition security of small and marginal farmers	30
Sub Total (E)				**30**
F. Arunachal Pradesh				
1.	January 10, 2019	Gori Farm, Basar, Leparada District, Arunachal Pradesh	Promoting Improved technology of maize production in NEH region	40
Sub Total (F)				**40**
G. Mizoram				
1.	March 05, 2019	SAMETI HALL, Aizawl, Mizoram	National workshop on Scientific maize cultivation in Mizoram	170
Sub Total (G)				**170**
Total (A+B+C+D+E+F+G)				**1932**

Demonstrations of maize were conducted on 372 hectare of the areas. It wide gap existed between farmer practice and yield with improved management practices. These demonstrations were emphasized on quality protein maize, intercropping (with groundnut, pea, rice bean, French bean, etc.), row planting, liming and integrated nutrient management. The yield gap varied from 32.7% in Tripura to as high as 96.3% in Nagaland with an average yield gap of 57.4% in NEH region (Figure 5.2). It indicates a good possibility of enhancement in maize production with available technology targeting in the least explored NEH region.

During the year 2018-19 a collaborative programme on "*Maize production in NEH region for sustainable livestock production*" was initiated with NRC on Pig, Yak and Mithun. Emphasis were laid on the fodder and feed from maize for the livestock sustainability in the NEH

Two days National Workshop cum brainstorming session on "Unleashing the hidden potential of maize technology in NEH Region: status, options and strategies" was inaugurated by Hon'ble Deputy Chief Minister Shri Y. Joykumar Singh as chief Guest and functions presided by Dr. N. Prakash, Director ICAR Research Complex for NEH Region, Umiam, Meghalaya on July 31, 2018 at ICAR Imphal, Manipur

Two days training programme on "Maize-Livestock Integration for Improving Livelihood and Nutritional Security of Small and Marginal Farmers" during September 20-21, 2018 at ICAR RC for NEH Region, Lamphelpat, Imphal, Manipur

Two days training programme on "Maize-Livestock Integration for Improving Livelihood and Nutritional Security of Small and Marginal Farmers" inaugurated by Deputy Commissioner Chandel Shri Krishna Kumar during October 18-19, 2018 Krishi Vigyan Kendra, Monsangpantha, Chandel, Manipur

Training cum Awareness Programme on "Rabi Maize" at Farming System Research Project, ICAR Research Complex for NEH Region, Umiam on November 27, 2018

Maize grown with groundnut in additive series in Churachandpur, Manipur

Demonstration of maize-pea cropping system at Churachandpur, Manipur

Maize Demonstration in Sikkim

Training on maize based cropping system

Monitoring at Basilakha Village

Monitoring at Lingtam Village

Farmer visit at ICAR farm

region. The programme also has maize technology development for pig, yak and mithun and has components on demonstration and capacity development of stakeholders.

Apart from this, inputs (>28 tonnes) including maize seed, biofertilizer, agrilime, vegetable and other intercrop seed were distributed in NEH programme. This have been used to conduct intercropping and quality protein maize FLDs on more than 500 ha benefitting more than 1100 farmers **(Table 5.5)**. Fertilizer input distribution to the targeted beneficiaries in Sonipat district of Haryana **(Table 5.6)**.

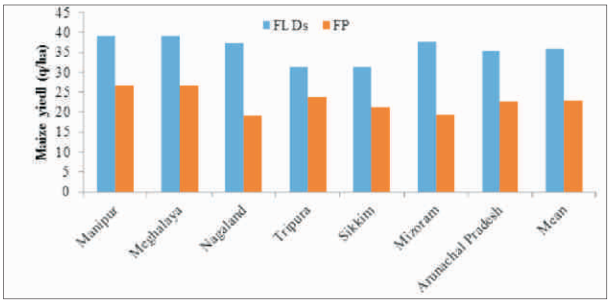


Figure 5.2: Yield gaps in farmers' practices in seven north eastern hill states of India.

Table 5.5: Distribution of quality seed and input for conduct of demonstration on quality protein maize and intercropping system in NEH region.

Input given	Quantity (kg)
Agrilime	5530
Biofertilizers (Nalpak)	379
Biopesticides	2
Broadbean	500
cowpea seed	58
DAP	2000
Frenchbean/	450
Maize seed HQPM-1	5530
Maize seed	440
MOP	3050
Mustard seed	200
Neem Cake	200
Pea seed	1770
SSP	4300
Urea	3870
Total	**28279**

Table 5.6. Fertilizer input distribution to the targeted beneficiaries in Sonipat district of Haryana.

Name	Price per unit (Rs)	Quantity (Kg)
UREA 45 kg bag	266.5	4500
DAP-50 kg bag	1450	3500
Sulphur bentonite 5 kg bag	205	250
wsf urea phosphate17-44-0 unit 1kg	70	200
Sagarika (sea weed extract) granular 10 kg bag	415	1000
Biofertiliser NPK consortia unit 250 ml	45	25

Mera Gaon Mera Gaurav (MGMG)

The IIMR and its regional stations implemented the MGMG programme in 20 villages adopted in the 6 districts of Punjab, Haryana, Bihar and Telangana. Eight teams having 30 scientists were in regular touch with the farmers of these villages through visits, messages, email, phone calls etc. Visits, interface meetings, training, literature, mobile advisories and awareness programme on contemporary problems benefited the farmers of these adopted villages **(Table 5.7)**.

Table 5.7: Summary of beneficiaries by interface meetings, literature and advisory support to the farmers under MGMG programme.

S. No.	Name of activity	No. of activities conducted	No. of farmers participated/ benefitted
1.	Visit to village by teams	5	78
2.	Interface meeting/ *Goshthies*	1	29
3.	Trainings conducted	2	50
4.	Mobile based advisories	137	127
5.	Literature support provided	59	65
6.	Awareness created	12	172
7.	Linkages developed with other agencies	5	123

The farmers were also given information on best management practices in maize including cultivar selection, specialty maize, post-emergence weed management, need of water conservation, cleanliness and adoption of conservation agriculture along with information on related government schemes of Crop Insurance and importance of Soil Health Cards. Under this programme 600 kg hybrid maize seed was also distributed to the farmers benefitting 36 farmers. Training was also given to 50 farmers on the fall armyworm and its management. Lack of awareness about the improved package of practices specially hybrid maize seed and the post-emergence herbicide based weed management was noticed during interaction with farmers.

Kissan Mela/Exhibition participation

IIMR participated in the six major Kissan mela/exhibitions during 2018-19 in various parts of the country. These exhibitions/farmers fares were organized in five different states, *viz.*, Madhya Pradesh, Uttar Pradesh, Punjab, Bihar and Delhi. The visitors appreciated the maize technologies developed for production and value addition **(Table 5.8)**.

Table 5.8: Participation of IIMR in various kissan mela and exhibitions.

Event	Place	Duration	Objective	Organized by
Cornfest 2018	Chhindwara, Madhya Pradesh	September 29 – 30, 2018	To highlight technology to farmer, entrepreneur of Madhya Pradesh and neighboring states.	District administration of Chhindwara Madhya Pradesh in collaboration with JNKVV and ICAR-Indian Institute of Maize Research
Krishi Kumbh - 2019	IISR, Lucknow, Uttar Pradesh	October 26 – 28, 2018	To display maize technology available to the farmers and other stakeholders of the Uttar Pradesh.	Government of Uttar Pradesh in association with the Government of India
106th Indian Science congress	LPU, Phagwara, Punjab	January 3 – 7, 2019	To highlight the maize technologies to the participants of the science congress and other stakeholders	Indian Science Congress Association
Krishi Kumbh-2019	Motihari, Bihar	February 9 – 11, 2019	To display maize technology available to the farmers and other stakeholders of the Bihar.	CAR-Mahatma Gandhi Integrated Farming Research Institute, Motihari, ICAR-RCER, Patna and Dr. RPCAU, Samastipur
XIV Agricultural Science Congress (ASC)	ICAR-IARI, Pusa, New Delhi	February 20 – 23, 2019	To display maize technology available to the participants of XIV ASC and other stakeholders of the NCR.	National Academy of Agricultural Sciences in collaboration with ICAR
Krishi Unnati Mela	ICAR-IARI, Pusa, New Delhi	March 5 – 7, 2019	To display maize technology available to the entrepreneurs, farmers and other stakeholders of the NCR.	ICAR-Indian Agricultural Research Institute

SCSP Plan

The SCSP (Scheduled Caste Sub plan) has been started by Government of India to benefit the scheduled caste (SC) communities of the country. The institute implemented SCSP plan in maize to benefit the maize growing farmers of SC community. Under this scheme, institute has utilized Rs. 16.04 lakh. Three following training programmes were conducted by different AICRP centres under the SCSP plan during 2018-19 **(Table 5.9)**.

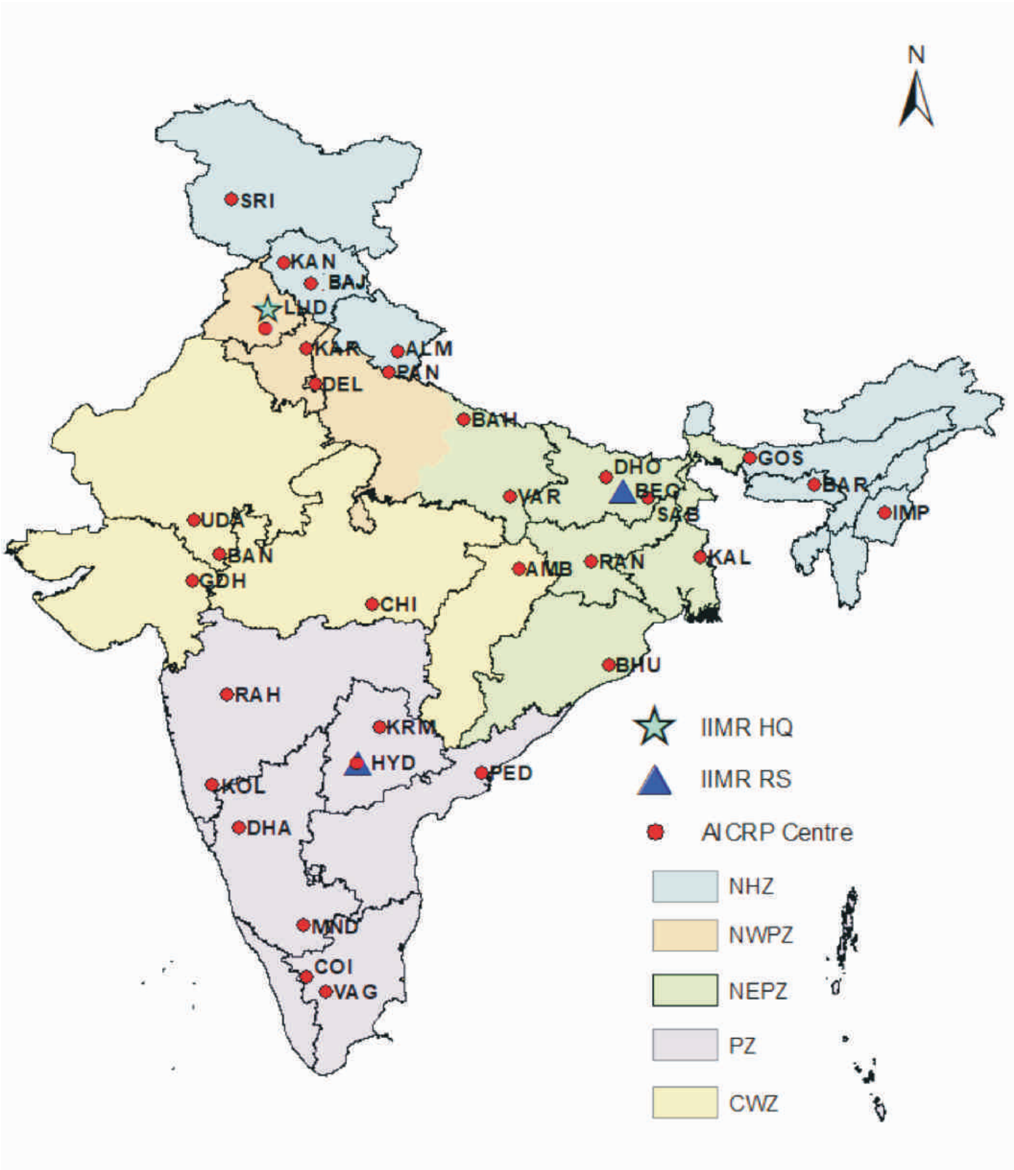
1. Farmers training programme "Improved techniques of maize production" at Kalyani, West Bengal.
2. Maize production technologies and management of fall army worm at Maize Research Centre, Hyderabad, Telangana.
3. Farmers training programme and input distribution for SC farmers under NICRA project at Kalyani, West Bengal.

A total of 202 farmers were benefitted by the trainings.

Table 5.9: Trainings organized under SCSP

S. No.	Title	State	Date	Beneficiaries
1	Farmers training programme "Improved techniques of maize production"	Kalyani Centre, West Bengal	March 05, 2019	40
2	Maize production technologies and management of fall army worm	Maize Research Centre, Hyderabad, Telangana	March 29–30, 2019	62
3	Farmers training programme and input distribution for SC farmers under NICRA project	Kalyani Centre, West Bengal	March 12, 2019	100

Farmers training under SCSP plan at different centres



All India Coordinated Research Project on Maize Network

6 AICRP ON MAIZE

All India Coordinated Research Project on Maize (AICRP-Maize) is over a six decade old AICRP in India established way back in 1957. The objective of the AICRP is to focus on development and dissemination of superior cultivars along with protection and production technologies. For better co-ordination, the entire maize growing area in India has been divided in five major zones, *viz*., northern hill zone (NHZ), north western plain zone (NWPZ), north eastern plain zone (NEPZ), peninsular zone (PZ) and central western zone (CWZ) for effective evaluation of the maize breeding materials and experimental cultivars. The AICRP on maize consists of 32 centres for testing throughout country.

Coordinated trials

Breeding

All India *kharif 2018* and *rabi 2018-19* trials which includes breeding NIVT, AVT I-II of normal maize, speciality corn and QPM trials and also entomology and pathology trials were constituted at winter nursery, Hyderabad. The seed of all the trials was dispatched to more than 30 centres all over India and presented in **Table 6.1** and **Table 6.2**. Total 14 trials trials, *viz*., NIVT-Late Maturity, NIVT-Medium Maturity, NIVT-Early Maturity, AVT-I–II-Late Maturity, AVT-I-II-Medium Maturity, AVT-I-II-Early Maturity, QPM 1-2-3, Popcorn-1-2-3, Sweet Corn-1-2-3, Baby Corn-1-2-3, Rainfed trials-Late, Rainfed trials-Medium, Rainfed trials-Early, OPV and Quality trial with 58, 74, 31, 30, 27, 7, 24, 6, 10, 7, 4, 12, 9 and 6 respectively during *kharif* 2018 and six trials, *viz*., NIVT (Late), NIVT (Medium), Popcorn, AVT-I (Late), AVT-II (Late) and AVT-I and AVT-II (Medium) with 23, 42, 8, 9, 22 and10 number of entries during *rabi* 2018-19 were constituted in different zones across the country. Normal maize entries were tested under three maturity groups, *viz*., late, medium, and early (extra early clubbed with early). Data received from various centers was reviewed and analysed critically for yield and related traits. The performance of each variety was compared with 27 relevant checks varieties of different types and maturity and promotion were done based on the set criteria (documented in 61th AMW proceedings).

Table 6.1: Detail numbers of test entries and checks evaluated in 15 different AICRP-breeding Trials during *kharif* 2018

Sl. No.	Trial	Entries	No. of locations
1.	NIVT-Late Maturity	58	25
2.	NIVT-Medium Maturity	74	25
3.	NIVT-Early Maturity	31	25
4.	AVT-I–II-Late Maturity	30	50
5.	AVT-I-II-Medium Maturity	27	62
6.	AVT-I-II-Early Maturity	7	62
7.	QPM 1-2-3	24	57
8.	Popcorn-1-2-3	6	33
9.	Sweet Corn-1-2-3	10	33
10.	Baby Corn-1-2-3	7	33
11.	Rainfed trials-Late	4	15
12.	Rainfed trials-Medium	12	15
13.	Rainfed trials-Early	9	15
14.	OPV	6	6
	Total	**305**	

Table 6.2: Details of the breeding trials constituted for *rabi* 2018-19

Sl. No.	Trial	Entries	No. of locations
	NIVT (Late)	23	20
1.	NIVT (Medium)	42	20
2.	Popcorn	8	20
3.	AVT-I (Late)	9	23
4.	AVT-II (Late)	22	23
5.	AVT-I and AVT-II (Medium)	10	23

6.

Agronomy

During *kharif* 2018 and *rabi* 2017-18, the number of entries under agronomy trial evaluated in different zones of AICRP on Maize across the country is presented in **Table 6.3**.

Pathology

During *kharif* 2018 and *rabi* 2017-18, the number of entries in pathology trial evaluated in different zones of AICRP on Maize across the country is presented in **Table 6.4**.

Entomology

During *kharif* 2018 and *rabi* 2017-18, number of entries evaluated in different zones of AICRP on maize across the country are presented in **Table 6.5**.

Table 6.3: List of entries evaluated in different zones in agronomy (AVT-II)

Sl.No.	Trial	NHZ	NWPZ	NEPZ	PZ	CWZ
				Kharif 2018		
1	Late	-	7	-	6	-
2	Medium	-	3	4	3	6
3	Early	-	-	-	-	-
4	Pop corn	2	4	4	5	
5	Sweet corn	4	4	4	7	4
6	Baby corn	-	-	2	2	2
7	QPM	6	4	-	-	-
8	Rainfed	-	-	-	3	-
				Rabi 2017-18		
1	Late	-	5	-	-	-
2	Medium	-	-	5	-	-

Table 6.4: List of entries evaluated in different zones in pathology

Sl.No.	Trial	NHZ			NWPZ			NEPZ			PZ			CWZ		
		L	M	E	L	M	E	L	M	E	L	M	E	L	M	E
								Kharif 2018								
1	NIVT	-	26	18	58	74	31	58	74	31	58	74	31	58	74	31
2	AVT I II	-	12	-	19	8	5	10	3	4	7	7	4	6	6	8
3	QPM I II III		9			18			16			19			16	
4	SC I II III		6			9			5			9			9	
5	PC I II III		4			5			5			5			5	
6	BC I II III		6			7			7			7			7	
7	Rainfed I II III		-			-			-			25			25	
8	OPV		6			-			-			-			-	
	Total		**87**			**234**			**213**			**246**			**245**	
								Rabi 2017-18								
		L	M	E	L	M	E	L	M	E	L	M	E	L	M	E
1	NIVT	-	-	-	32	38	-	32	38	-	32	38	-	32	38	-
2	AVT I II	26	8	-	26	-	-	26	8	-	26	8	-	26	8	-
3	QPM I II III		4			4			4			4			4	
	Total		**38**			**100**			**108**			**108**			**108**	

SC- Sweet corn; PC- Popcorn; BC- Baby corn; OPV- Open pollinated varieties ; L: Late, M: Medium, E: Early

Table 6.5: List of entries evaluated in different zones in entomology

Sl.No.	Trial	NWPZ			NEPZ			PZ			CWZ		
		L	M	E	L	M	E	L	M	E	L	M	E
	Kharif 2018												
1	AVT I II	7	13	24	7	8	15	7	13	13	10	13	13
2	QPM I II III		24			22			28			22	
3	PC I II III		12			12			12			12	
4	SC I II III		13			13			13			13	
5	BC I II III		13			13			13			13	
6	RAINFED I II III		-			-			35			35	
	Rabi 2017-18												
1	AVT I II	-	11	30	-	-	-	30	11	-	-	-	-
2	QPM		7			-			7			-	

SC- Sweet corn; PC- Popcorn; BC- Baby corn; OPV- Open pollinated varieties ; L: Late, M: Medium, E: Early

Achievements and recommendations

Maize Breeding

Kharif 2018

Success rate of AICRP trials is important which represent how the AICRP centres successfully conducted the trials. The success rate of each zone was calculated based on trials allotted versus reported. Overall the success rate was 88.9% for *kharif* 2018 breeding trials. The highest success rate of 96.3% was reported in CWZ and lowest in NHZ (79.2%). The zone wise detail of success rate is given in **Table 6.6**.

Table 6.6: Zone-wise details of success rate in reporting data generated during *kharif* 2018

Sl.No.	Zone(s)	Centers	Trials allotted	Trials Reported	Percent Success
1	NHZ	Srinagar, Almora, Bajaura, Barapani, Kangra, Gossaingaon, Poonch, Rajauri,Imphal, Bertin, Nagaland,Dhaulakuam, Gantok	53	42	79.2
2	NWPZ	Ludhiana, Karnal, Delhi, Pantnagar,Aligarh, Kapurthala, Gurdaspur	51	48	94.1
3	NEPZ	Dholi, Ranchi, Bhubaneswar, Varanasi, Bahraich, Sabour, Kalyani, Koraput, Majhian, Medinapur, Narendrapur, Sriniketan	81	65	80.2
4	PZ	Arabhavi, Buldana, Mandya, Karimnagar, Shegal Fou, Hyderabad, Coimbatore, Vagarai, Kolhapur, Peddapuram, Dharwad, VRDCKSSC, Shimoga, Devihosur, Dhule, Parbhani, Nasik, Rahuri,	132	125	94.6
5	CWZ	Udaipur, Banswara, Chindwara, Ambikapur, Godhra, Bhiloda, Dahod, Raipur, Jagadalpur, Ujjain, Kota, chittarkoot,	83	80	96.3
		Overall	**400**	**360**	**88.9**

Entries promoted

Two hundred and eighty four entries were available for in different trials, *viz*., IVT-Late, Maturity, NIVT-Medium Maturity, NIVT-Early Maturity, AVT-I –Late Maturity, AVT-I-Medium Maturity, AVT-I-Early Maturity, Rain fed Late Maturity, Rain fed Medium, Rain fed Early Maturity, OPV, Sweet corn, Baby corn and Popcorn evaluation during *kharif 2018*, out of which 90 entries were promoted for advance stage of testing. The trial wise detail of number of entries promoted *kharif* 2018 is given in **Table 6.7**.

***Rabi* 2017-18**

The success rate of each zone was calculated based on trials allotted versus reported and overall it was 88.8%. The highest success rate of 100.0% was reported in NEPZ and lowest in NWPZ (70.8%). The zone wise details of success rate in reporting data is given in **Table 6.8**.

Entries promoted

One hundred and seven entries were available in NIVT Late, NIVT Medium, AVT I Late, AVT I Medium and

Table 6.7: Detail of number of entries promoted during *kharif 2018*

S.N.	Trial	Entries Evaluated	Entries Promoted	Percent promoted
1.	IVT-Late Maturity	58	15	25.9
2.	NIVT-Medium Maturity	74	21	28.4
3.	NIVT-Early Maturity	31	13	41.9
4.	AVT-I –Late Maturity	30	13	43.3
5.	AVT-I-Medium Maturity	27	8	29.6
6.	AVT-I-Early Maturity	7	2	28.6
7.	Rain fed Late Maturity	4	2	50.0
8.	Rain fed Medium	12	3	25.0
9.	Rain fed Early Maturity	9	1	11.1
10.	OPV	6	2	33.3
11.	Sweet corn	10	3	30.0
12.	Baby corn	7	4	57.1
13.	Pop corn	6	3	50.0
14.	QPM	24	15	62.5
	Total	305	105	

Table 6.8: Zone wise details of success rate in reporting data generated during *rabi* 2017-18

Zone(s)	Centers	Trials allotted	Trial Reported	Percent Success
NWPZ	Ludhiana, Karnal, Kanpur, Pantnagar	24	17	70.8
NEPZ	Dholi, Ranchi, Bhubaneshwar, Bahraich, Varanasi, Sabour, Kalyani	54	46	100.0
PZ	Rahuri, Mandya, Dharwad, Karimnagar, Coimbatore, Vagarai, Kolhapur	42	42	100.0
CWZ	Banswara, Godhra	14	14	100.0
	Over all	**134**	**119**	**92.7**

QPM for evaluation, out of which only 49 entries were promoted to their advance stage of testing. Nine, sixteen, twenty two and two entries were promoted from NIVT Late to AVTI Late, NIVT Medium to AVTI Medium, AVT I Late to AVTII Late, AVT I Medium to AVTII Medium and QPM, respectively. The trial wise detail of number of entries evaluated and promoted from *rabi* 2017-18 to *rabi*, 2018-19 is given in **Table 6.9**.

Crop Protection and resistance Breeding

Table 6.9: Trial wise detail of number of entries promoted during *rabi* 2017-18

S.N.	Trial	Entries Evaluated	Entries Promoted	Percent promoted
1	NIVT Late	32	09	28.2
2	NIVT Medium	38	16	42.1
3	AVT I Late	31	22	84.6
4	AVT I Medium	3	2	40.0
5	QPM	3	-	-
	Total	**107**	**49**	**45.7**

Pathology

The hybrids identified to have disease resistance in different zones in advance trials are as follows:

1. *Northern Hill Zone (NHZ)*: Four hybrids which were resistant against TLB are IMHBG 17K-15, INDAM 1122, LMH 1016 and NMH 4053 in medium maturity group.
2. *North West Plain Zone (NWPZ):* Two hybrids showing resistance against MLB were CP 858 and DKC9185 *(IR8449)* whereas three hybrids, *viz*., JH 16081, KMH 463 and SUPER1818 were resistant against charcoal rot in late maturity group. Eight hybrids, *viz*., AH 1606, BH415100, BLH118, IMHBG 17K-22, IMHBG-17K-6, JH 16045, JKMH 4157 and NMH 4053 were having moderate resistance against MLB in medium maturity group. In early maturity group 4 hybrids, *viz*., AH 7080, BIO 605, DKC 7074 and JH 31983 were moderately resistant against MLB.
3. *North East Plain Zone (NEPZ):* Three hybrids, *viz*., DKC 9185 (IR8449), JH 16209 and RASI 3499 were resistant against MLB in late maturity group whereas 2 hybrids, *viz*., DKC 8174 (IQ8319) and LMH 1017 showed resistance to MLB in medium maturity group. Two hybrids of early maturity, *viz*., BIO 605 and JH 31947 were resistant to MLB.
4. *Peninsular Zone (PZ):* Five hybrids, *viz*., ADV 1390064, DKC 9178, DKC 9185 (IR8449), JH 15130 and JH 15135 were moderately resistant to TLB in late maturity group and 4 hybrids, *viz*., ADV 140235, BLH 118, DKC 9179 (IQ8627) and INDAM 1122 exhibited moderate resistance to TLB in medium maturity group. Only three hybrids, *viz*., BIO 605, DKC 7074, JH 31947 were moderately resistant to TLB in early maturity group.

Recommended disease management in maize:

- Azoxystrobin 18.2 w/w + Difenoconozole 11.4% w/w SC @ 0.10%, *Allium sativum* @ 10%, *Azadirachta indica* leaf extract @ 0.10% and Cow urine @ 20% were effective in management of TLB at Imphal.
- Azoxystrobin 18.2% + Difenconazole 11.4% @ 0.1% were effective in management of TLB at Dharwad.
- *Trichoderma harzianum* (TH -3) @ 0.5% as seed treatment, bioagent-fortified FYM (1:50) and spray @ 0.5%, Seed treatment with Neem extract and FS @ 10% at 45 and 60 DAS, *Trichoderma viride* fortified FYM were effective in the management of PFSR at Udaipur**.**
- Seed treatment with Neem extract and FS @ 10% at 45 and 60 DAS, *TH-3* @ 0.5% as seed treatment, bioagent-fortified FYM (1:50) and spray @ 0.5%, *Trichoderma viride (TV-3)* @ 0.5% as seed treatment, bioagent-fortified FYM (1:50) and spray 45 DAS @ 0.5% were effective in the management of CLS at Udaipur.
- VAM fungi, *Glomus fasciculatum* at 4 % as seed treatment, *Metarrhizium anisopliae* and *Trichoderma viride* at 4 % were effective in the management of cyst nematode at Udaipur.
- Panchgavaya @ 20 %, curd @ 20 % and cow urine @ 20 % w/v proved most effective to reduce the infection of maize cyst nematode at Udaipur.

Maize Entomology

During *Kharif* 2018, nine AICRP trials constituted for screening genotypes of early, medium, and late maturity, QPM, popcorn, baby corn, sweet corn, genotypes for rainfed environment and inbred lines were evaluated against *Chilo partellus (Swinhoe)* under artificial infestation. A total of 91 entries in NEPZ, 103 in NWPZ, 135 in PZ and 122 in CWZ and 40 inbred lines were evaluated against *C. partellus* in these four zones, respectively. Major findings are as follows:

- In early maturity group two entries, BIO 605 (3.00) and JH 31947 (2.87) at North East Plain Zone and one entry DKC 7074 (2.90) at Central Western Zone were found resistant against *C. partellus*.
- In medium maturity group one entry Bio 9544 (2.83) at North East Plain Zone and two entries J1006 (3.00) and RCRMH-2(2.80) at Central Western Zone were found resistant to *C. partellus.*
- Among late maturity group one entry CP 858 (3.0) at North East Plain Zone and two entries CMH 08-287 (2.8) and J 1006 (3.0) at Central Western Zone were found resistant to *C. partellus*
- Among *QPM,* APH2 (2.6) at North East Plain Zone and IIMRQPMH 1705 (2.15) at Central Western Zone was found resistant to resistant to *C. partellus*
- In rainfed trial, four entries RCRMH10 (CAH174) (2.9), ADH 1608 (2.8), AH 8178 (2.9), CMH 08292) (3.0) were found resistant at Central Western Zone. None of the entries were found resistant at Peninsular Zone (Hyderabad).
- In speciality corn none of the entries either in baby corn and popcorn were found resistant to C. partellus
- Among the 13 sweet corn entries evaluated against *C. partellus*, none of the entries were found resistant at North West Plain Zone, Peninsular Zone and Central Western Zone. Only one entry, DSCH-320 (2.60) was resistant at North East Plain Zone.
- The population of *Helicoverpa armigera* was monitored from pre-tasselling to harvesting stage in maize by installing pheromone traps @ 4 traps/ac during *Spring* and *Kharif* 2018 in Ludhiana and *Kharif* 2018 in locations, *viz.,* Delhi, Udaipur, Karnal, Hyderabad, Kolhapur, Coimbatore, Dholi and Imphal. Maximum catch of 33.25 moths/ trap was recorded during third week of September in *Delhi* followed by 28.17 moths/ trap during last week of April in Ludhiana and 23.25 moths/ trap during third week of August in Imphal.
- Chlorantraniliprole 18.5 SC (59.34 q/ha) followed by state recommended insecticide (52.32 q/ha) resulted in maximum yield return as compared to control in the management of *C. partellus* during *kharif*. *Bt* formulation followed by neem-based insecticide was found moderately effective with leaf injury rating of 3.66, 4.51 and maximum yield return of 46.57 q/ha, 45.02 q/ha, respectively.
- In Coimbatore, FAW was reported in the first week of September and highest infestation (33.33 %) observed in N 53 in crops established in first and second week of October. Maximum average number of larvae (2.25/per plant) was recorded in UMI 1230, where ~2larvae/ infested plant was recorded consistently throughout the cropping interval in Coimbatore. The maximum FAW infestation of 58.20%, 35.00% was observed in BML6 and CM 500, respectively during third week of August in Hyderabad. FAW was first observed during second week of July (12.67%) and the maximum infestation (100%) was observed during August in Kolhapur.
- Thirty late maturity, 11 medium maturity and seven QPM cultivars were screened under artificial infestation during *rabi* 2017-18 against *C. partellus* at PZ (Kolhapur) where, three late maturity cultivars, *viz*., ADV7037 (2.85) and BLH-113 (2.85) & PM16203L (2.86); and 2 QPM cultivars, *viz.*, HQPM4 (3.0) and MMHQPM-16-121 were found resistant to *C. partellus*. None of the medium maturity cultivars were found resistant to *C. partellus* at Kolhapur.
- Thirty late maturity, eleven medium maturity and seven QPM cultivars were screened under artificial infestation against *Sesamia inferens* Walker at PZ (Hyderabad) and NWPZ (Karnal) during *rabi* 2017-18 under artificial infestation, three medium maturity cultivars, *viz*.,100K-16 (2.87), Bio 9637 (2.89) and Bio 9544 (2.99) were found resistant in Karnal.
- Six inbred lines shortlisted earlier for *S. inferens* resistance were screened again under artificial infestation against *S. inferens* during *rabi* 2017-18 at Winter Nursery Centre, Hyderabad. Only two lines, *viz*., HEY Pool -2011-30-4-1-2-2-1 (2.20) and HEY Pool -2011-41-2-1-1-1-1 (2.23) were found resistant to *S. inferens*.
- The efficacy of new insecticides, viz., Chlorantraniliprole 20 SC, flubendiamide 480 SC and novaluron 10EC with the conventional state recommended insecticides, *viz.,* Deltamethrin 2.8 EC and Monocrotophos 36SL were evaluated at Hyderabad against *S. inferens* under artificial infestation. Flubendiamide 480 SC @ 0.2ml/l was found to be most effective in terms of leaf injury rating and grain yield.
- Sixty-five inbred lines were evaluated, against shoot fly, *Atherigona sp. during spring 2018 in Delhi under natural infestation and Atherigona naqvii* in Ludhiana under natural infestation with fish meal attractant. *In Delhi, no dead hearts were observed in two genotypes,* HEY Pool -2011-5SC-3-1-1 and

HEY Pool -2011-5SC-3-2-1, while *none of the genotypes were found to be resistant at Ludhiana.*

Crop production

The major agronomic research areas during *rabi* 2017-18 and *kharif* 2018 were

- Optimization of fertilizer dose and planting density for different maturity pre-released and notified maize hybrids,
- Precision nutrient management, site specific nutrient management (SSNM) for different tillage practices,
- Enhancing water-use efficiency in rainfed maize,
- Integrated nutrient management,
- Optimization of potassium fertilization for eastern India.
- Ecological intensification for climate resilient maize systems and
- Validation of Sensor based nitrogen management in maize.

Evaluation of pre-release genotypes under varying planting density and nutrient levels

The pre-released genotypes were tested at two densities (recommended and high) and two nutrient levels (RDF and 150% RDF). In *rabi* 2017-18, long duration hybrids responded to high density at and at high dose (250:80:100) of nutrient application where IM-8013 resulted significantly higher yields over best check in NWPZ. In NEPZ, the medium duration genotypes responded to high density and only BLH 109 was significantly superior over best checks.

In *kharif* season 2018, long duration genotype DKC 9178 responded to 150% RDF dose with high plant density (83,000) over best check (CMH-08-287, CMH-08-282) in North Western Plain Zone (NWPZ) and Peninsular Zone (PZ). In QPM genotypes, in NHZ, IMHQPM 1530 responded significantly at 150% RDF over best checks (HQPM5, Vivek QPM 9). While in NWPZ, none of the genotype responded significantly over best checks (HQPM 7, Pratap QPM). In popcorn genotypes, across the zones, *viz*., NHZ, NWPZ, NEPZ and PZ none of the genotypes responded significantly over best checks. In sweet corn, at NHZ, NEPZ, PZ and CWZ none of the genotype responded significantly over best checks. However, in NWPZ genotype ASKH1 resulted significantly over best checks (Priya, Madhurai and Win Orange) at higher plant density (83,000). Baby corn genotypes were tested in NEPZ and PZ but none of genotype responded significantly over best check (VL baby corn).

Nutrient management in maize based cropping system under different tillage practices

This long-term experiment conducted at 8 locations (Srinagar, Pantnagar, Dholi, Kalyanai Hyderabad, Banswara, Chhindwara and Udaipur) to find out effective precision nutrient management and tillage practices for achieving the higher yield and profitability with better soil health under intensified cropping system. At 4 locations zero tillage (ZT) and at one location each permanent bed (PB) and conventional tillage resulted in significantly highest yield and net returns of maize. The mixed response of nutrient management was observed and it was found that at some locations SSNM while at other 60% recommended dose of nitrogen + green seeker (GS) guided nutrient application significantly increased yield and net returns over RDF but the effect of nutrient management practices.

Long term trial on integrated nutrient management in maize- wheat cropping system

To explore the possibilities of integrated nutrient management by inclusion of organic sources in maize production, long-term experiment was initiated during *kharif* 2014 at Pantnagar. After completion of five years, significantly higher maize grain yield (5.26 t/ha) was obtained with 100% RDF + 5 t/ha FYM. On the contrary, economic analysis showed a new path for organic cultivation of maize and in third consecutive year it was found that, maize + cowpea as intercrop with FYM 10 t/ha + Azotobacter resulted in highest net returns and B: C ratio of maize (1.89). The same experiment also initiated in *kharif* 2018 and conducted at nine locations. The application of 100% RDF + 5 t/ha FYM gave significantly higher mean grain yield 7.2 t/ha (5.9 to 7.9 t/ha) across these nine locations with higher net returns in maize cultivation.

Enhancing water-use efficiency in rainfed maize

The experiments conducted at five locations to find out practices for enhancing water-use efficiency in rainfed maize in different agro-climatic conditions. The rainfed maize responded to mulching where mulching in CT increased maize yield by 4.8 to 26.5% over CT. However, the ZT+mulch increased maize yield significantly at three locations by 17.3 (Chhindwara) to 32.8 (Karimnagar) per cent over CT without residue. The hydrogel application significantly improved yield at two locations (Chitrakoot and Karimnagar) but the net returns were found lesser due to hydrogel application.

Optimization of potassium fertilization for eastern India

This experiment was initiated in *kharif* 2016 with the objective to work out economic optimum dose of potassium in maize for eastern India at four locations. After completion of three years results it was found that maize responded to higher potassium doses at Dholi (120 kg/ha) followed by at Kalyani (90 kg/ha) and to lower dose at Ranchi and Ambikapur (60 kg/ha). Hence, the recommended potassium doses of maize needs to be revised for bridging the yield gaps.

Ecological intensification for climate resilient maize systems

This experiment was initiated in *kharif* 2017 with the objective to develop the best crop management practices by enhancing the ecological processes and buffering the risk against the climatic aberrations for enhancing the resource use efficiency and soil health. The results revealed that by adoption of ecological intensification (EI) increased maize yield by 48.6% with the range of 5.1 (Ludhiana) to as high as 145.3% (Imphal) over the existing farmers' practices in various agro-ecologies. Nevertheless, the enhancement in the net returns were higher than the grain yield of maize and was 78.1% with a range of 7.6 (Ludhiana) to 187.0 (Imphal) percent.

Validation of Sensor based nitrogen management in maize

The validation experiments on the calibration curve developed at IIMR for optical sensor-based nitrogen application in maize were initiated in *kharif* 2017. The experiment was conducted at six locations (Bajaura, Ludhiana, Pantnagar, Ranchi, Hyderabad and Peddapuram) during *kharif* 2018. It was found that the application of N as 33% basal N + Green Seeker (GS) based N at knee high & tasseling stage at Bajuara and Ludhiana which was higher but statistically at par with RDF and nitrogen saving/optimization was observed at all locations and thus it can be inferred that GS based application curve developed is working.

Biochemistry

Under AICRP activities samples received under AICRP quality programme were also analysed for protein quality. Further, for protein quality analysis a total of 13 entries consisting of five newly developed QPM hybrids were grown at two locations, *viz.*, Ludhiana and Delhi. The data for protein, tryptophan and lysine are presented in Table 6.10. The entries namely IMHQPM1530, QPMMH27, IIMRQPMH1601, APQH5 and APQH 7 possessed the required concentration of protein quality and recommended for consideration as QPM hybrid.

Table 6.10: Protein, tryptophan and lysine content (%) of samples of coordinated QPM breeding programme

Sl. No	Name of entry	Protein (overall mean)	Tryptophan (Overall mean)	Lysine (overall mean)
1	IMHQPM 1530	8.96	0.79	3.53
2	QPM MH27	9.33	0.77	3.51
3	IIMRQPMH1601	8.9	0.66	3.04
4	APQH5	8.89	0.94	4.25
5	APQH7	8.34	0.93	4.19
6	APH27	8.59	0.38	1.87
7	Vivek QPM 9 (C)	9.29	0.85	3.84
8	HQPM 1 (C)	8.63	0.9	3.95
9	HQPM 5 (C)	8.45	0.84	3.84
10	HQPM 7 (C)	7.84	0.93	4.11
11	Vivek Hybrid 27 (C)	8.76	0.36	1.84
12	APQH 9 (C)	9.05	0.81	3.71
13	Pratap QPM Hybrid 1 (C)	8.17	0.91	3.58

Overall mean represent mean of data received from Ludhiana and Delhi of samples grown at Ludhiana and Delhi

Participants from IIMR and AICRP listening to a session during 61st Annual Maize Workshop

Release of Krishi Chetna during IIMR Foundation Day

7 SIGNIFICANT EVENTS

Institute Events

Annual Maize Workshop

The 61st Annual Maize Workshop of the All India Coordinated Maize Improvement Project was held at the CSK HPKV Hill Agricultural Research & Extension Centre, Bajaura from 7-9th April, 2018. Maize scientists working across India participated in the workshop. It was held in 12 sessions over three days. The workshop was inaugurated by Dr. R.L. Markanda, Minister of Agriculture, Tribal Welfare & Information Technology, Govt. of Himachal Pradesh. Dr. A.K. Sarial, Vice Chancellor, CSKHPKV, Palampur was the Chairman of Inaugural Session. Dr. I.S. Solanki, Assistant Director General (FFC), Indian Council of Agricultural Research and Dr. S.K. Malhotra, Agriculture Commissioner, Ministry of Agriculture, Govt. of India were the special guests. After three days of exhaustive sessions, the workshop emerged with some strong recommendations to improve maize production in India.

Maize scientists felicitating Dr. I.S. Solanki, ADG (FFC) on attaining superannuation during AMW 2018

Dr. Sujay Rakshit discussing some important issues during the maize workshop

Institute Research Council (IRC) meeting

Institute Research Council meeting was held at Ludhiana from 20-21 June, 2018 under the chairmanship of Dr. Sujay Rakshit, Director, ICAR-IIMR to review the progress of on-going research projects and research proposals. Dr. G.S. Mangat, Head, Department of Plant

Dr. Sujay Rakshit chairing the IRC meeting

IIMR scientists during the IRC deliberations

Breeding and Genetics, PAU and Dr. J.S. Chawla, Sr. Maize Breeder from the Department of Plant Breeding and Genetics, PAU, Ludhiana were the external experts. Dr. Dharam Paul, Member-Secretary, IRC welcomed all and briefed the agenda of IRC meeting. In his opening remarks, Dr. G.S. Mangat highlighted the importance of maize crop for the country and for the Punjab state in particular. He stressed upon the need to produce seed of high yielding public sector hybrids. Dr. J.S. Chawla highlighted the importance of specialty maize and also informed that reduction in cost of cultivation could play an important role in increasing the farm income. The Director, Dr. Sujay Rakshit, in his remarks highlighted the targets achieved during the last year. He stressed upon the scientist to make quality research publications. It was followed by presentations by individual scientists for the in-house as well as externally funded projects. A total of 29 presentations including 22 for on-going in-house projects and 7 for externally funded projects were made during the meeting.

Research Advisory Committee (RAC) Meeting

The meeting of the Research Advisory Committee of the institute was held on December 5-16, 2018 under chairmanship of Prof. R.M. Singh, Former Professor Emeritus & Dean, Faculty of Agriculture, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi. Other members who attended the meeting included Dr. M.L. Lodha, Ex-Prof. & Head, Division of Biochemistry, ICAR-IARI, New Delhi; Dr. Srikant Kulkarni, Former Professor & Head (Plant Pathology), GKVK, Bengaluru; Dr. R.M. Prasad, Former Associate Director of Extension, KAU, Thrissur; Dr. A.R. Sharma, Director Research, RLB Central Agricultural University,

Dr. R.M. Singh, chairing the RAC meeting

Jhansi; Prof. S.R. Maloo, Former Dean & Incharge, Faculty of Agricultural Science, Pacific College of Agriculture, Pacific University, Udaipur; Dr. R.K. Singh, ADG (CC&FFC), ICAR, New Delhi and Dr. Sujay Rakshit, Director , ICAR-IIMR, Ludhiana. The committee appreciated the progress made during the last year. The Chairman, RAC emphasized on the development of hybrids and further research to be initiated for yield improvement of QPMs. He also endorsed that land races and exotic germplasm should be used in pre-breeding programs for their use in disease and insect pest management and comparison of conservation agriculture and traditional agriculture should be made on long term basis. The major recommendations of committee were: focused research on development of high density planting material, augmentation of heterotic grouping of maize germplasm with genomic data, strengthening of conservation agriculture-based research, identification of diversity among pathogen of TLB (*Setosphaeria turcica*), use of entomopathogens in the management of insect pests and strengthening of outreach programme of the institute. A presentation on, "Weather based forewarning system for diseases of maize" was made by Dr. Amrender Kumar, AKMU, IARI during the meeting. The Chairman, RAC launched the web based forecasting model for BSLB.

Institute Management Committee

The 10th meeting of Institute Management Committee was held on 11th Sept, 2018 at Ludhiana under the chairmanship of Dr. Sujay Rakshit, Director IIMR. The agenda for the meeting included proposed outlay of the SFC 2017-18, condemnation of old vehicle approved under SFC 2017-20, and extension of existing entomology laboratory, at WNC, Hyderabad. The 11th meeting of Institute Management Committee was held on 18th March, 2019 at Ludhiana under the chairmanship of Dr. Sujay Rakshit, Director IIMR. The agenda for the meeting included approval of institute building plan (laboratory-cum-office) at Ladhowal and purchase of equipment approved in SFC.

The IMC members discussing the agenda items

Institutional Biosafety Committee (IBSC)

The Institutional Biosafety Committee (IBSC) meeting was held on December 21, 2018. Dr. Sujay Rakshit (Chairman), Dr. Tanushri Kaul (DBT Nominee), Dr. Amrita Srivastava (Medical Officer), Dr. Monika Dalal (External Member), Dr. Bhupender Kumar (Member), Dr. Krishan Kumar (Member Secretary) and Dr. Alla Singh (Member) attended the meeting. The committee reviewed the biosafety aspects of ongoing projects involving GMO/LMO and found them to be satisfactory.

Independence Day Celebration

The 71st Independence Day was celebrated at all the centres of the institute with full zeal and fanfare. The day was marked with inspirational speeches, songs and recitation. On this occasion, the Director hoisted the national flag at Regional Maize Research and Seed Production Center, Begusarai.

National Flag hoisting on Independence day

Republic Day

The republic day was celebrated with joy, enthusiasm and patriotic fervor by all the scientific, administrative and technical staff of the institute. National Flag was hoisted by the Director at WNC, Hyderabad. It was followed by his speech emphasizing the great work done by the leaders and members of the constitutional committee to make this country an independent republic. The speech reflected upon a message for joint action by the citizens to make our republic stronger.

Celebration of Republic Day

IIMR Foundation Day

The fourth foundation day of ICAR-IIMR was celebrated on 9th February, 2019. Padma Shri Dr. B.S. Dhillon, Vice-Chancellor, Punjab Agricultural University (PAU) was the Chief Guest and Padma Shri Sh. Kanwal Singh Chauhan, Member Governing Body and General Body ICAR was the Guest of Honour of the function. The chief guest delivered the Foundation Day Lecture. He highlighted the importance of maize in the changing climatic scenario and stressed upon the scientists to develop high yielding climate resilient hybrids of Maize. S. Kanwal Singh Chauhan shared his journey with maize, particularly specialty corn, which not only gave him livelihoods but also social recognition.

Guest of Honour expressing his views on IIMR Foundation Day

Vigilance Awareness Week

The Vigilance Awareness Week was organized from October 29 to November 3, 2018. Integrity pledge was taken by staff members at all the centres of the institute. Events like debate, essay and quiz competitions were organized during this period. Institute integrity pledge was registered online and online integrity pledge at individual level was encouraged. Certificates were distributed to the winners of various competitions during the closing ceremony held on November 3, 2018.

IIMR staff undertaking the integrity pledge

Swachhta Hi Sewa and Swachhta Pakhwada

The institute organized "Swachhta Hi Sewa" campaign from September 15 to October 2, 2018. During this period one hour from 9.30 AM to 10.30 AM every day was devoted on cleanliness drives. Various events like debates, discussions, awareness programmes and poster competition were organized. A Swachhta Pakhwara was organized from December 16-31, 2018 at IIMR head office and at regional stations. During this period dry leaves, weeds and other biomass was conserved in biomass pit.

Cleaning of IIMR Ludhiana campus

Cleanliness drive by RMR & SPC Begusarai employees

Planting of a sapling by Director IIMR

Cleanliness drive by IIMR Delhi unit office staff

International Yoga Day

The international Yoga day was celebrated at the Institute on 21st June, 2018. On this occasion all the scientific, administrative and technical staff performed various yoga exercises under the guidance of an expert. The yoga class continued for a period of 2 hours from 6 to 8 A.M. This was followed by light refreshment.

IIMR staff doing yoga exercises

International Women's Day

International Women's Day was celebrated in the institute on March 8, 2019. Dr. Arvind Padhee (IAS) was the chief guest on this occasion. Dr. Sujay Rakshit, Director IIMR welcomed Dr. Padhee for his visit. All staffs of the institute, especially women were present to mark the occasion. Dr. Sujay thanked all the women employees, emphasizing the important role of women in society. Dr. Padhee, then graced the occasion and asserted that women must be respected for their contributions in all areas. He highlighted achievements of some Indian women, who have achieved laurels in their respective fields.

हिंदी प्रोत्साहन गतिविधियां

हिंदी पखवाड़ा

भारतीय मक्का अनुसंधान संस्थान में दिनांक 14-28 सितंबर, 2018 तक हिंदी पखवाड़े का आयोजन किया गया। पखवाड़े का शुभारंभ दिनांक 14 सितंबर को हिंदी दिवस मनाकर किया गया। पखवाड़े के दौरान कुल छः

राजभाषा पखवाड़ा समापन समारोह

प्रतियोगिताओं, निबंध लेखन, भाषा प्रवीणता, हिंदी भाषा में सर्वाधिक कार्य करना, शब्द-ज्ञान, आशु-भाषण और सामान्य ज्ञान प्रश्नोतरी को शामिल किया गया। संस्थान के सभी कर्मचारियों ने इन प्रतियोगिताओं में बढ़-चढ़ कर भाग लिया। हिंदी दिवस में निदेशक महोदय ने प्रशासनिक वर्ग के सभी अधिकारियों एवं कर्मचारियों से अपील की कि वे राजभाषा की धारा 3 (3) का अनिवार्य रूप से पालन करें एवं सर्वाधिक कार्य हिंदी में ही करें। कार्यालय में हिंदी में प्राप्त होने वाले पत्रों का उत्तर अनिवार्य रूप से हिंदी में ही देने का आदेश दिया गया। इस पखवाड़े का समापन समारोह दिनांक 28 सितंबर को मनाया गया जिसमें मुख्य अतिथि डॉ. सौरभ कुमार (प्राध्यापक, हिंदी विषय) और संस्थान राजभाषा कार्यान्वयन समिति के अध्यक्ष डॉ सुजय रक्षित (निदेशक, भारतीय मक्का अनुसंधान संस्थान) उपस्थित थे। प्रतियोगिताओं में निर्णायक मंडल द्वारा चुने गए विजेताओं को निदेशक महोदय और मुख्य अतिथि ने अपने कर-कमलों से प्रमाण-पत्र प्रदान किए गए। मुख्य अतिथि ने संस्थान के उपस्थित अधिकारियों से अपील की कि वो हिंदी भाषा को केवल संपर्क भाषा ही न समझें, अपितु राजभाषा को अपनी जीवन शैली में ढाल लें। निदेशक महोदय ने कहा कि 'ख' और 'ग' क्षेत्र से संबंध होने के बावजूद,

हिंदी कार्यशाला में श्रीमती किरण साहनी व्यत्तव्य प्रस्तुत करते हुए

संस्थान के अधिकारी और कर्मचारी हिंदी भाषा का प्रयोग करने की कोशिश करते हैं। यह अत्यंत ही प्रशंसनीय है।

हिंदी कार्यशाला

राजभाषा के प्रगामी प्रयोग को बढ़ावा देने के लिए 21 दिसम्बर 2018 को हिंदी कार्यशाला का आयोजन किया गया। कार्यशाला में सभी वैज्ञानिकों, प्रशासनिक अधिकारियों एवं कर्मचारियों ने भाग लिया। इस कार्यशाला में प्रशिक्षण देने हेतु नराकास, लुधियाना की सदस्य सचिव एवं सहायक निदेशक (राजभाषा) श्रीमती किरण साहनी जी को आमंत्रित किया गया। इस अवसर पर अतिथि सह–निदेशक (राजभाषा, आयकर विभाग) एवं निदेशक (भारतीय मक्का अनुसन्धान संस्थान) की गरिमामयी उपस्थिती प्रेरणादायी रही। इस प्रशिक्षण में कुल 08 वैज्ञानिकों और 03 प्रशासनिक अधिकारियों और कर्मचारियों ने भाग लिया।

भारत रत्न माननीय अटल बिहारी वाजपेयी जी की प्रथम मासिक पुण्य-तिथि पर श्रद्धांजलि

माननीय कृषि एवं किसान कल्याण मंत्री श्री राधा मोहन सिंह के दिशा निर्देश पर दिनांक 16 सितम्बर 2018 को सायंकाल में भारत रत्न स्वर्गीय श्री अटल बिहारी वाजपेयी जी की कविताओं का काव्यपाठ आयोजित किया गया। इस अवसर पर उपस्थित संस्थान के सभी वैज्ञानिक, अधिकारी एवं प्रशासनिक वर्ग के कर्मचारियों ने उन्हें नमन किया और भावपूर्ण श्रद्धांजलि अर्पित की। इसके उपरान्त कार्यकारी निदेशक महोदय ने उनकी जीवनी पर प्रकाश डालते हुए उनकी जीवन शैली और उनके व्यक्तित्व की प्रशंसा की। उपस्थित कर्मचारियों ने अटल जी के काव्य सागर से उन्ही को काव्यांजलि अर्पित कर श्रद्धांजलि दी। माननीय अटल जी का भारत निर्माण में अतुलनीय

भारत रत्न माननीय अटल बिहारी वाजपेयी जी की प्रथम मासिक पूण्य–तिथि पर श्रद्धांजलि

योगदान हम सबके लिए पथप्रदर्शक है। उनके व्यक्तित्व की महानता हमेशा हमेशा के लिए भारतीयों के ह्रदयों में गौरवशाली प्रेरणा के रूप में फलती फूलती रहेगी।

वर्ष 2018 के दौरान हिंदी भाषा में कार्यान्वन क्षेत्र में संसीन की प्रमुख उपलब्धियां

- वर्ष 2018 में हिंदी दिवस के उपलक्ष में नगर राजभाषा कार्यान्वन समिति (नराकास) द्वारा संयुक्त हिंदी प्रतियोगिताओं का आयोजन किया गया जिसमें डॉ प्रदीप कुमार (वैज्ञानिक) को प्रोत्साहन पुरस्कार मिला।

हिंदी पत्रिका 'कृषि चेतना' प्रकाशित करने पर नराकास द्वारा सम्मानित

"छोटे कार्यालय" की श्रेणी में वर्ष भर सर्वाधिक कार्य का निष्पादन हिंदी में करने पर तीसरा स्थान पुरस्कार प्राप्त

- हिंदी पत्रिका 'कृषि चेतना' के प्रकाशन करने पर संस्थान को वर्ष 2018 में नराकास द्वारा सम्मानित किया गया।
- नराकास द्वारा वर्ष 2018 में सर्वाधिक कार्य का निष्पादन हिंदी में करने पर संसीान को 'छोटे कार्यालय' की श्रेणी में तृतीय स्थान पुरस्कार प्रदान किया गया।
- संस्थान में हिंदी कार्य संबंधी औचक निरीक्षण राजभाषा अधिकारी, डेअर (भारत सरकार) द्वारा किया गया।

Workshops/ Meetings

Workshop on DUS Testing on Maize under Indo-German Bilateral Cooperation on Seed Sector Development

ICAR-IIMR and PJTSAU in collaboration with PPV&FRA organized a "DUS Workshop on Maize" from 25-26 September, 2018 at PJTSAU Hyderabad. The inaugural session was graced by Dr. K.V. Prabhu, Chairperson, PPVFRA as Chief Guest. Other dignitaries attended the program were Dr. V. Praveen Rao, Vice Chancellor, PJTSAU and Dr. Sabine Ulrike Elisabeth Lauer, German Expert on DUS testing. Dr. Sujay Rakshit, Director, IIMR was the Convener of the Workshop. Dr. K.V. Prabhu highlighted the significance of PPV&FRA in safeguarding the interest of plant breeders, farmers and researchers. Dr. Pravin Rao lauded the initiative to organize the workshop and expressed hope that the

The dignitaries felicitating a participant during DUS workshop on Maize

breeders will be proactive in protecting their rights as well as the rights of the farmers. Participants from public and private sector organizations attended the programmes.

Corn Festival

The first of its kind, a "Corn Festival" was organized by district administration of Chhindwara, Madhya Pradesh in collaboration with JNKVV, Jabalpur and ICAR-IIMR, Ludhiana from 29-30 September, 2018. The special guests in inaugural function were Dr. P. K. Bisen, Vice Chancellor, JNKVV; Dr. Sujay Rakshit, Director ICAR-IIMR; Dr. Sain Dass, Ex Director IIMR and Mr. Ved Prakash, District Collector, Chhindwara. ICAR-IIMR along with various public and private organizations exhibited improved production technology of hybrid maize and seed production of hybrid as

Some glimpses of the corn festival

well as specialty maize and value added products. More than 80,000 visitors visited the exhibition. The maize experts from IIMR shared their vision for enhanced production and better tillage practices. The festival acted as a platform of interaction between all stakeholders.

13th Asian Maize Conference

The 13th Asian Maize Conference and Expert Consultation on "Maize for Food, Feed, Nutrition and Environment Security" was held from October 8-10 at Ludhiana. The conference was inaugurated by Dr. Trilochan Mohapatra, Secretary, DARE and DG, ICAR. The three-day conference was jointly organised by Indian Council of Agricultural Research (ICAR), International Maize and Wheat Improvement Centre (CIMMYT), ICAR-Indian Institute of Maize Research (ICAR-

Some glimpses of Asian Maize Conference 2018

IIMR), Punjab Agricultural University (P AU), CGIAR-Research Program on Maize (MAIZE) and the Borlaug Institute for South Asia (BISA). The conference was attended by 215 participants belonging to fourteen maize-growing countries in Asia, besides experts from outside the continent, participated in this conference. Dr. Trilochan Mohapatra called upon the participants to work towards increasing maize productivity upto 5 t/ha in the kharif season. Citing example of Pakistan and China, Dr. Mohapatra dwelled on the need for public private partnership in India to deploy single cross hybrids to improve maize productivity . Dr. Martin Kropff, Director General CIMMYT, mentioned that maize in Asia has high productivity and demand. He stressed the need for continued funding for maize research keeping in mind the climate change problem. Dr. B.S. Dhillon, Vice Chancellor, P AU pointed out the challenges of climate vagaries under which the maize productivity is to be doubled. Dr. B.M. Prasanna, Director, Global Maize Programme, CIMMYT and CGIAR Research Programme on Maize highlighted the diverse range of topics to be covered in the conference, from breeding for climate resilience in maize-based systems and climate-smart agriculture to socio–economics for greater impact besides the importance of public private partnerships. Dr. B.S. Dhillon was awarded with MAIZE Champion Award on the occasion. A total of 9 technical sessions were held during the conference. A field visit for the delegates was arranged to the research farms of the BISA, PAU and IIMR on October 10, 2018 to highlight the performance of hybrids popular in India, conservation agriculture, mechanization and precision nutrition.

Launching of HTMA project

A USAID sponsored multi-organization project entitled "High temperature tolerant maize for Asia (HTMA)" was launched on October 11, 2018 at Ludhiana. The meeting was organized by CIMMYT India. A total of 20 participants from public and private sectors from different Asian countries including India, Pakistan, Bangladesh, Bhutan and Nepal, CIMMYT , USAID and Purdue University attended the launch programme.

The project team of HTMA

High level meeting on Fall Army Worm

A high level meeting on fall armyworm was held on August 20, 2018 under chairmanship of Secretary, DARE & DG, ICAR at Krishi Bhavan to discuss the course and action to tackle the meance of FAW. This was followed by another high level meeting at Krishi Bhavan on November 14 under chairmanship of Secretary, DAC & FW. In both the meetings Director, IIMR presented the status of FAW in India and response of IIMR.

Maize Germplasm Field Day organized at Winter Nursery Centre, ICAR-IIMR, Hyderabad

ICAR-IIMR and ICAR-NBPGR jointly organized maize germplasm field day at Winter Nursery Centre of ICAR-IIMR, Hyderabad on September 25, 2018. Two hundred ninety five maize accessions from the National Gene Bank (NGB) at NBPGR, New Delhi under the CRP-Agro biodiversity project were displayed. A total of 32 participants both from different organizations participated in the field day.

ICAR-IIMR organized Maize Germplasm Field Day cum Training Programme on Maize Breeding at Winter Nursery Centre of ICAR-IIMR, Hyderabad on March 1-2, 2019. A total of 48 participants from public sector *viz.,* from All India Co-ordinated Project on Maize, Indian Institute of Maize Research (IIMR), Ludhiana and its regional centres, CIMMYT-India, Hyderabad, National Bureau of Plant Genetic Resources (NBPGR), Hyderabad and MRC, PJTSAU Hyderabad participated in the field day. A total of 3187 maize lines (contributed by IIMR, AICRP and CIMMYT) were displayed for selections by the participants. The afternoon sessions were allotted for imparting training on AICMIP data recording and familiarization of AICMIP automation system to the participants in collaboration with ICAR-NAARM. Dr. A. Dandapani, Principal scientist, NAARM and Dr. N. Sunil from ICAR-IIMR involved in hands on training and automation programme.

Visits/Trainings

Visit of Dignitaries

Dr. S. K. Vasal, distinguished maize scientist and World Food Prize recipient visited the institute on August 11, 2018. Dr. B.M. Prasanna, Director, CGIAR Research programme on maize (MAIZE) program visited IIMR on August 11, 2019.

Maize Germplasm Field Day at WNC ICAR-IIMR, Hyderabad

Dr. S.K. Vasal at Ladhowal Farm

Maize Germplasm Field Day cum Training Programme on AICMIP data recording at Winter Nursery Centre, ICAR-IIMR, Hyderabad

Dr. B.M. Prasanna interacting with IIMR staff

DDG (CS) visit to WNC, ICAR-IIMR, Hyderabad

Dr. Anand Kumar Singh, Deputy Director General (Horticulture and Crop Science, ICAR) visited Winter Nursery Centre, ICAR-IIMR, Hyderabad on March 12, 2019. He was apprised of the activities being carried out by the WNC. He appreciated the activities taken up by the scientists particularly germplasm maintenance & distribution to various AICRP partners and fall armyworm experiments conducted in the centre. Dr. Singh stressed the need of sensor based drip irrigation systems for the maize fields at Winter Nursery Centre, to optimize the water usage for growing maize crop, at the earliest.

Visit of DDG (CS) at WNC, ICAR-IIMR, Hyderabad

Summer Training Conducted at IIMR, New Delhi for Graduate Students of Gautam Budda University (GBU), Greater Noida

A group of six graduate (integrated B. Tech-M. Tech in Biotechnology program) students (Ms. Divya Kumari, Ms. Gayatri Chaudhary, Ms. Uditi, Ms. Shristi Maurya, Ms. Pooja Singh and Ms. Kumari Priya) from Gautam Buddha University, Greater Noida successfully completed summer training at IIMR, New Delhi from May 21 to June 10, 2018 under bilateral MOU between IIMR and GBU. During the training, the students learned and performed various molecular biology techniques such as DNA extraction from maize and tobacco leaf tissue, quality control of isolated DNA, Agarose gel electrophoresis, PCR analysis, *etc*. On the last day of the training, the students presented their work.

Director, IIMR presenting certificates to the trainees

Students Visit at ICAR-IIMR, Delhi Unit Office

A batch of 152 B.Sc. (Ag.) first year students from G D Goenka University, Sohna Road, Gurugram (accompanied by 3 faculty members), visited ICAR-IIMR New Delhi Centre on Nov. 26 and 27, 2018 in as part of their educational tour. Dr. Chikkappa G Karjagi presented the students with an overview of maize production over the years and highlighted the importance of climate resilience in maize based cropping system

Visit of students of GD Goenka University at IIMR Delhi unit

Visit of students of Innocent Hearts Group of Institutions at IIMR Ludhiana

Visit of students of Mata Gujri College, Fatehgarh Sahib at IIMR Ludhiana

through novel breeding techniques.

Student visits at ICAR- IIMR, Ludhiana

Students of B.Sc. Agriculture of Innocent Hearts Group of Institutions visited ICAR-IIMR Ludhiana for knowledge of students on September 28, 2018. The students were briefed about the research mandate as well as facilities of the institute. Director, IIMR briefed the students about the importance of maize and upcoming research areas.

Students of B.Sc. (Biotechnology) Mata Gujri College, Fatehgarh Sahib visited ICAR-IIMR Ludhiana for study visit on March 27, 2019. The students were oriented with respect to different experimentation facilities in the laboratories of the institute. Director, IIMR presented an overview of maize in the country and highlighted the importance of research in improving Indian agriculture.

Glimpses of a session at 13th Asian Maize Conference

Exhibition of IIMR at 106th Indian Science Congress at Lovely Professional University, Jalandhar

8 AWARDS & RECOGNITIONS

- Dr. Alla Singh was awarded the Best Poster Award for the work, "Identification of *opaque2* Transcription Factor residues for gene editing towards maize nutrition by Singh A, Chaudhary DP, Kumar RP, Rakshit S" in Life Sciences Symposium, held at DAE Convention Centre, April 26-28 2018.
- Dr. Bhupender Kumar has been awarded with SERB-DST Early Career Research award on "*Genome-wide Association Mapping and Genetic Characterization of Turcicum Leaf Blight (Setosphaeria turcica) Resistance in Tropical maize Germplasm*" on May 8, 2018 for a duration of three years
- Drs. S.L. Jat, Bhupender Kumar and Mukesh Choudhary acted as organizing secretary, convener (member) and member of organizing committee for two days National Workshop cum Brainstorming Session on "Unleashing the hidden potential of maize technology in NEH region status, options and strategies" on July 30-31, 2018.
- Dr. S.L. Jat awarded with Certificate of Appreciation by Afghanistan National Agricultural Science and Technology University (ANASTU), Ministry of higher Education, Islamic Republic of Afghanistan on September 14, 2018.
- Dr. S.L. Jat awarded with best poster award (as co-author) on Long-term trend of conservation agriculture based maize systems; Yield, water productivity and environmental impacts" presented during 13th Asian Maize Conference and Expert Consultation on "Maize for Food, Feed, Nutrition and Environmental Security" held at Ludhiana, India, October 8-10, 2018.
- Dr. K.S. Hooda as co-author received best poster award for the abstract on "Identification of genomic regions for Fusarium stalk rot resistance in tropical maize (*Zea mays* L.) using Genome wide association study" presented during 13th Asian Maize Conference and Expert Consultation on "Maize for Food, Feed, Nutrition and Environmental Security" held at Ludhiana, India, October 8-10, 2018.
- Dr. K.S. Hooda as co-author received best poster award for the abstract on "Identification of stable sources of resistance against turcicum leaf blight of maize under temperate conditions" presented during 13th Asian Maize Conference and Expert Consultation on "Maize for Food, Feed, Nutrition and Environmental Security" held at Ludhiana, India, October 8-10, 2018.
- Dr. Ramesh Kumar as co-author received best poster award for abstract on "One-size doesn't fit all: Maize for various stress-prone agro ecologies in Asian tropics" presented during 13th Asian Maize Conference and Expert Consultation on "Maize for Food, Feed, Nutrition and Environmental Security" held at Ludhiana, India, October 8-10, 2018.
- Dr. Alla Singh awarded One Extra Mural Project awarded under DST Scheme for Young Scientists and Technologists on *"Rapid Detection of Quality Protein Maize for Increased Farmer Remuneration"* on October 23, 2018.
- Dr. A. K. Singh became ISA Fellow Indian Society of Agronomy 2015-16 by Indian Society of Agronomy during XXI Biennial National Symposium. Indian Society of Agronomy, MPUAT, Udaipur from 24-28 October, 2018.
- Dr. S. B. Singh awarded with "Excellence in Research Award" for Genetics and Plant Breeding, by Society for Scientific Development in Agriculture & Technology, Meerut in the International Conference on Global Research Initiatives for Sustainable Agriculture and Allied Sciences (GRISAAS) held at Rajasthan Agriculture Research Institute (RARI), Durgapura, Jaipur (Rajasthan) on October 28-30, 2018
- Dr. S.L. Jat was awarded with ICAR-NASF Project as Principal Investigator on "*Long-term conservation agriculture impact on microbiome and soil health indicators for resource efficiency and resilience in maize systems*" on November 1, 2018 for duration of three years.
- Dr. S.B. Singh honored as *Chairman in Technical Session-III and Poster Presentation session* in the International Conference on Global Research Initiatives for Sustainable Agriculture and Allied Sciences held at Rajasthan Agriculture Research Institute (RARI), Durgapura, Jaipur (Rajasthan) on October 28-30, 2018.
- Dr. S.B. Singh got recognition as organizing Convener of the International Conference on Global Research Initiatives for Sustainable Agriculture and

Allied Sciences held at Rajasthan Agriculture Research Institute (RARI) Durgapura, Jaipur (Rajasthan) on October 28-30, 2018.

- Dr. S.B. Singh selected as the Vice President of "Society for Scientific Development in Agriculture and Technology, Meerut (U.P.) India" for the term 2018-19.
- Drs. Sujay Rakshit and Ishwar Singh were elected as President and Vice-President, respectively of the Maize Technologists Association of India (MTAI) for the biennium 2018-20.
- Dr. Ishwar Singh was invited as lead speaker at 4th International Plant Physiology Congress (IPPC) held at NBRI, Lucknow during December 2-5, 2018.
- Dr. Ishwar Singh acted as Member National Organizing Committee of 4th International Plant Physiology Congress (IPPC) held at NBRI, Lucknow, during December 2-5, 2018.
- Dr. Ishwar Singh acted as Joint organizing secretary of International Conference on Climate Change, Biodiversity and Sustainable Agriculture (ICCBSA-2018) held at Assam Agricultural University, Jorhat, during December 13-16, 2018.
- Dr. Krishan Kumar awarded with Best Oral Presentation Award in technical session-9 in International Conference on Climate Change, Biodiversity and Sustainable Agriculture (ICCBSA-2018) held at Jorhat, Assam from December 13-16, 2018.
- Dr. Pardeep Kumar awarded with DST-SERB project on "*Pre-breeding of wild crosses for yield enhancement and climate resilience maize using wild species*" on January 1, 2019.
- Dr. Sujay Rakshit, Director, IIMR, Ludhiana acted as the president of the Agriculture and Forestry section of 106th Indian Science Congress held at Lovely Professional university, Jalandhar from January 3-7, 2019.
- Drs. Bhupender Kumar, S.L. Jat, Alla Singh and Pardeep Kumar awarded with ICAR-IIMR, Best scientist recognition" for outstanding contribution in research and institutional activities on occasion of ICAR-IIMR, Ludhiana foundation day celebration on February 9, 2019.
- Dr. Alla Singh recognized (acted) as Jury Member in 'Doaba SciFiesta-2019' on February 16, 2019
- Dr. Dharam Paul awarded fellowship by the Indian Society of Agricultural Biochemist during the National level Food and Nutritional Security Conclave held at MPKV Rahuri from February 25-27, 2019.
- Drs. Bharat Bhushan and Dharam Paul awarded third best poster award as author and co-author, respectively for presentation in the National level Food and Nutritional Security Conclave held at MPKV Rahuri from February 25-27, 2019.
- Dr. SL Jat and Mr. Mukesh Choudhary acted as organizing secretary and co-organizing secretary for one day National Workshop in collaboration with ICAR-NEH, Mizoram Centre on "Scientific maize cultivation in North East India" held at Sameti Hall, Aizawl, Mizoram on March 5, 2019
- Dr. Ishwar Singh acted as resource person at ICAR sponsored training program on "*Non-destructive High Throughput Phenotyping for Gene Discovery and Development of Climate Resilient Crops*" held at the Division of Plant Physiology, ICAR-IARI, New Delhi during March 14-23, 2019.
- Dr. P. Soujanya received "Best Young Scientist Award" for outstanding contribution in research during 6th Biopesticide International conference conducted by Amity University in collaboration with St. Xavier's College, Palayamkottai, Tamil Nadu during March 6-8, 2019 at Raipur, Chattisggarh.
- Dr. Alla Singh acted as Resource Person in One-day DST sponsored workshop on "*Hands-on Workshop on Protein Electrophoresis*" at BBK DAV College for Women, Amritsar in March 2019.


Islamic Republic of Afghanistan
Ministry of Higher Education
Afghanistan National Agricultural Sciences and Technology University
(ANASTU)

CERTIFICATE
OF APPRECIATION

THIS CERTIFICATE IS PROUDLY PRESENTED TO

Dr. S.L. Jat

Who has gone above and beyond the call of duty while teaching and guiding the second batch of M.Sc. Agronomy students of ANASTU. I am pleased to extend thanks and appreciate your valuable contributions made to the success of the second batch of M.Sc. Agronomy.

14/09/2018 — DATE
21-18 — REG NO
Dr.Khal Mohammad Ahmadzai
Chancellor, ANASTU

Dr. S.L. Jat awarded with Certificate of Appreciation by Afghanistan National Agricultural Science and Technology University (ANASTU), Ministry of higher Education, Islamic Republic of Afghanistan.

Dr. Sujay Rakshit, Director, IIMR, Ludhiana acted as the president of the Agriculture and Forestry section of 106th Indian Science Congress

Dr. A. K. Singh became ISA Fellow Indian Society of Agronomy 2015-16 by Indian Society of Agronomy

Dr. S. B. Singh awarded with "Excellence in Research Award" for Genetics and Plant Breeding, by Society for Scientific Development in Agriculture & Technology, Meerut

Dr Sujay interacting with participants at 106th Indian Science Congress

Maize crop at harvesting stage

Annexure I

List of Cultivars identified during 61st Annual Maize Workshop

Cultivar	AICRP Centre/Pvt. Company	Public/ Private	Average Yield (t/ha)	Zones	Area of adaptation States	Maturity of Type of Corn	Season
DKC 9165 (IM 8119)	Monsanto India Ltd., Bangalore	Private	11.77 (II), 10.66 (III), 9.16 (IV), 10.27 (V)	II, III, IV &V	Punjab, Haryana, Delhi , Planes of Uttarakhand & Uttar Pradesh, Eastern Uttar Pradesh, Bihar, Jharkhand, Odisha, West Bengal, Karnataka, Tamilnadu, Andhra Pradesh, Telangana, Maharashtra, Rajasthan, Gujarat, Chhattisgarh and Madhya Pradesh	Late	Rabi
ADV 7022	Advanta Limited, Hyderabad	Private	9.19	IV	Karnataka, Andhra Pradesh, Tamil Nadu, Telangana, Maharashtra	Late	Kharif
DKC (9164) IP9002	Monsanto India Ltd., Bangalore	Private	7.74	V	Rajasthan, Gujarat, Chhattisgarh and Madhya Pradesh	Late	Kharif
VaMH 12014	TNAU, Vagarai	Public	6.93	III	Eastern Uttar Pradesh, Bihar, Jharkhand, Odisha, West Bengal,	Medium	Kharif
JKMH 4103	Jk Agri- Genetics Ltd (JK Seeds), Hyderabad	Private	6.47	III	Eastern Uttar Pradesh, Bihar, Jharkhand, Odisha, West Bengal,	Medium	Kharif
JH 13347	Punjab Agriculture University, Ludhiana	Public	6.65 (III), 6.82 (V)	III &V	Eastern Uttar Pradesh, Bihar, Jharkhand, Odisha, West Bengal, Rajasthan, Gujarat, Chhattisgarh and Madhya Pradesh	Medium	Kharif
FH 3754	VPKAS, Almora	Public	6.76	I	Jammu &Kashmir, Himachal Pradesh	Early	Kharif
DMRH 1305	ICAR-Indian Institute of Maize Research, Ludhiana	Public	6.95	I	Jammu &Kashmir, Himachal Pradesh	Early	Kharif
JKMH 4222	Jk Agri- Genetics Ltd (JK Seeds), Hyderabad	Public	5.96	V	Rajasthan, Gujarat, Chhattisgarh and Madhya Pradesh	Early	Kharif
ASKH 4	Indian Agriculture Research Institute (IARI), New Delhi	Public	13.2 (Green ear) I, 14.12 (Green ear) II, 10.01 (Green ear) III, 14.56 (Green ear) IV,	I, II, III, IV	Jammu & Kashmir, Himachal Pradesh, Uttarakhand, Punjab , Haryana, Uttar Pradesh, Bihar, Odisha, Delhi, Jharkhand, West Bengal, Tamil Nadu, Karnataka, Andhra Pradesh, Telangana, Maharashtra, Assam, Manipur, Meghalaya, Mizoram, Arunachal Pradesh, Tripura and Nagaland	Medium	Kharif
FSCH 75	ICAR-VPKAS, Almora	Public	10.34 (cob yield)	I	Jammu& Kashmir, Himachal Pradesh, Karnataka, Andhra Pradesh, Tamil Nadu, Telangana, Maharashtra	Medium	Kharif

Cultivar	AICRP Centre/Pvt. Company	Public/ Private	Average Yield (t/ha)	Zones	Area of adaptation States	Maturity of Type of Corn	Season
IMHB 1532	ICAR-Indian Institute of Research, Ludhiana	Public	8.27 (II), 6.84 (V)	II &V	Punjab, Haryana, Delhi , Planes of Uttrakhand &Uttar Pradesh, Rajasthan, Gujarat, Chhattisgarh and Madhya Pradesh	Medium	Kharif
GAYMH -1	Anand Agricultural University, Gujarat	Public	1.22 (with-out husk) I,1.43 (with-out husk) IV,	I, IV	Jammu &Kashmir, Himachal Pradesh, West Bengal, Karnataka, Andhra Pradesh, Tamil Nadu, Telangana, Maharashtra	Medium	Kharif
IMHB 1539	ICAR-Indian Institute of Research, Ludhiana	Public	4.42	I	Jammu &Kashmir, Himachal Pradesh	Medium	Kharif

Annexure II

List of cultivars notified during 2018-19

S. No.	Cultivar	AICRP Centre/Pvt. Company	Public/ Private	Notification Date	Notification No.	Maturity	Area of Adaptation	Zone	Average Yield (t/ha)	Cropping season	Type
1	JKMH 4222	JK Agri Genetics Limited, Hyderabad (Telangana)	Public	26.12.2018	S.O. 6318 (E)	Early	Rajasthan, Madhya Pradesh, Chhattisgarh and Gujarat	V	5.96	Kharif	Normal
2	DMRH 1305	ICAR-Indian Institute of Maize Research, Ludhiana	Public	26.12.2018	S.O. 6318 (E)	Early	Jammu and Kashmir, Himachal Pradesh, Uttarakhand (Hill region), Meghalaya, Sikkim, Assam, Tripura, Nagaland, Manipur and Arunachal Pradesh	I	6.95	Kharif	Normal
3	IMHB 1532	ICAR-Indian Institute of Maize Research, Ludhiana	Public	26.12.2018	S.O. 6318 (E)	Medium	Punjab, Haryana, Delhi, Uttarakhand, Uttar Pradesh and Rajasthan, Gujarat, Madhya Pradesh & Chhattisgarh	II and V	8.27 (II), 6.84 (V)	Kharif	Baby corn
4	IMHB 1539	ICAR-Indian Institute of Maize Research, Ludhiana	Public	26.12.2018	S.O. 6318 (E)	Medium	Jammu and Kashmir, Himachal Pradesh, Uttarakhand (Hill region), Meghalaya, Sikkim, Assam, Tripura, Nagaland, Manipur and Arunachal Pradesh	I	4.42	Kharif	Baby corn
5	Pusa Super Sweet Corn 1 (ASKH4)	ICAR-Indian Agricultural Research Institute, New Delhi	Public	26.12.2018	S.O. 6318 (E)	Medium	Jammu and Kashmir, Himachal Pradesh, Uttarakhand (Hill region), Meghalaya, Sikkim, Assam, Tripura, Nagaland, Manipur, Arunachal Pradesh (North Eastern Hill Region), Punjab, Haryana, Delhi, Uttarakhand (Plain), Uttar Pradesh (Western region), Bihar, Jharkhand, Odisha, Uttar Pradesh (Eastern region), West Bengal and Maharashtra, Karnataka, Andhra Pradesh, Telangana and Tamil Nadu	I, II III & IV	13.2 (I), 14.12 (II), 10.01 (III) & 14.56 (IV) (Green ear yield)	Kharif	Sweet corn
6	MAH 14-5	University of Agricultural Sciences, Bengaluru.	Public	26.12.2018	S.O. 6318 (E)	Late	Karnataka	V	77.5	Kharif	Normal

Annexure III

DUS Testing undertaken during 2018-19

Hybrid Entries

S. No.	Name of Entry	Testing Year	Category	SCH/MPH
1	DKC9145	Second	New	MP Hybrid
2	GK3172	Second	New	MP Hybrid
3	AFRICAN TALL	Reference OPV		OPV
4	NARMADA MOTI	Reference OPV		OPV
5	Winorange Sweet Corn	Reference O P V		OPV
6	DKC9141	Second	New	SCH
7	DKC8144	Second	New	SCH
8	KDMH 755	Second	New	SCH
9	MM 9333	Second	New	SCH
10	GK3200	Second	New	SCH
11	GK3176	Second	New	SCH
12	P 3550	Second	New	SCH
13	STAR X-14	Second	New	SCH
14	STAR X-12	Second	New	SCH
15	STAR X-20	Second	New	SCH
16	STAR X-18	Second	New	Hybrid
17	STAR X-16	Second	New	Hybrid
18	Palam Sankar Makka 1 (EHL 162508)	Second	New	Hybrid
19	P 3355	Second	New	Hybrid
20	P 1866	Second	New	Hybrid
21	P 3535	Second	New	Hybrid
22	P 3552	Second	New	Hybrid
23	PMH 10	Second	New	Hybrid
24	Palam Sankar Makka 2	Second	New	SCH
25	MM9168	First	New	SCH
26	MM9488	First	New	SCH
27	LG34.05	First	New	SCH
28	LG34.06	First	New	SCH
29	DS4142	First	New	SCH
30	PM16205L	First	New	SCH
31	PM16103L	First	New	SCH
32	PM16202L	First	New	SCH
33	P3592	First	New	SCH
34	PM16203L	First	New	SCH
35	RMHSx38	First	New	SCH

S. No.	Name of Entry	Testing Year	Category	SCH/MPH
36	TMMH 2840	First	New	SCH
37	TMMH 2838	First	New	SCH
38	MITHAS	First	New	SCH
39	KMH-4610	First	VCK	SCH
40	KMH-5010	First	VCK	SCH
41	DKC9162	First	VCK	SCH
42	DKC8164	First	VCK	SCH
43	DKC9164	First	VCK	SCH
44	DHM 117	Reference Hybrid		
45	HM 8	Reference Hybrid		
46	HQPM-1	Reference Hybrid		
47	HQPM4	Reference Hybrid		
48	HQPM5	Reference Hybrid		
49	PRAKASH	Reference Hybrid		
50	Shaktiman 1	Reference Hybrid		
51	Shaktiman 2	Reference Hybrid		
52	Shaktiman 3	Reference Hybrid		
53	Shaktiman 4	Reference Hybrid		
54	Vivek 27	Reference Hybrid		
55	Vivek 33	Reference Hybrid		
56	VIVEK 39	Reference Hybrid		
57	Vivek 43	Reference Hybrid		
58	VIVEK -9	Reference Hybrid		
59	VIVEK 25	Reference Hybrid		

SCH - Single Cross Hybrid
MPH - Multi-Parent Hybrid
OPV - Open Pollinated Variety
VCK - Variety Common Knowledge

Inbred Entries

S. No.	Name of Entry	Testing Year	Category	SCH/MPH
1	PH2A7S	Second	New	Inbred
2	PH1RA7	Second	New	Inbred
3	MZ14S028N	Second	New	Inbred
4	MZ14S022N	Second	New	Inbred
5	PH1DVA	Second	New	Inbred
6	PH2V73	Second	New	Inbred
7	PH1CHO	Second	New	Inbred
8	PH2A6G	Second	New	Inbred
9	PH2GP6	Second	New	Inbred
10	WCV01	Second	New	Inbred
11	PH2B00	Second	New	Typical
12	PH2NGW	Second	New	Typical
13	PH23FF	Second	New	Typical
14	SYN-CO-NP 5612	Second	New	Typical
15	SYN-CO-NP 5140	Second	New	Typical
16	SYN-CO-NP FX 7233	Second	New	Typical
17	SYN-CO-NP 5646	Second	New	Typical
18	SYN-CO-NP 5603	Second	New	Typical
19	SYN-CO-NP 5120	Second	New	Typical
20	SYN-CO-NP 5139	Second	New	Typical
21	SYN-CO-NP 5296	Second	New	Typical
22	SYN-CO-NP 5300	Second	New	Typical
23	BLI112	First	New	Typical
24	BLI113	First	New	Typical
25	PH219J	First	New	Typical
26	PH27AC	First	New	Typical
27	PH2RBC	First	New	Typical
28	PH2YNZ	First	New	Typical
29	PH2NFT	First	New	Typical
30	PH177S	First	New	Typical
31	CM152	Reference inbred		
32	CM 212	Reference inbred		
33	BML 5	Reference inbred		
34	BML 6	Reference inbred		
35	BML 7	Reference inbred		
36	HKI 1105	Reference inbred		
37	HKI 163	Reference inbred		

S. No.	Name of Entry	Testing Year	Category	SCH/MPH
38	HKI 193-2	Reference inbred		
39	HKI161	Reference inbred		
40	HKI193-1	Reference inbred		
41	HKI323	Reference inbred		
42	V 335	Reference inbred		
43	V 341	Reference inbred		
44	V 345	Reference inbred		
45	V 346	Reference inbred		
46	V 373	Reference inbred		
47	VQL 1	Reference inbred		
48	VQL 2	Reference inbred		

Hybrid / variety registered with PPVFRA during 2018-19

S. No.	Name	Centre	Period of protection (Years)
1	HM-13	CCSHAU Karnal	September 07, 2018 to January 27, 2030

Annexure IV

Breeder Seed Production 2018-19

S.No.	Variety	Year of Notification	Qty. in Qtls. Allocation BSP-I	Production	Surplus/Deficit over DAC Indent	Producing Institute
1	Shaktiman 2 (F) CML176	2004	0.04	0	-0.04	RAU Dholi
2	Shakhiman2 (M) CML186	2004	0.02	0	-0.02	
3	CM 150 (Female of Pusa Extra Early Hybrid Makka-5 (AH-421))	2004	0.040	0	-0.04	IARI New Delhi
4	CM 151 (Male of Pusa Extra Early Hybrid Makka-5 (AH-421))	2004	0.020	0	-0.02	
5	Pusa Composite 3 (Composite 85134)	2005	5.150	0	-5.15	
6	Pusa Composite 4 (Composite 8551)	2005	0.420	0	-0.42	
7	HKI 193-1 (Female of HQPM-1)	2007	0.60	0	-0.60	CCSHAU Karnal
8	HKI 163 (Male of HQPM-1)	2007	0.30	0.3		
9	HKI-193-2 (Female of HQPM-4)	2010	0.06	0.06		
10	HKI-161 (Male of HQPM-4)	2010	0.04	0.04		
11	HKI 161 (Male of HQPM-5)	2007	0.55	0.55		
12	HKI 163 (Female of HQPM-5)	2007	1.35	0	-1.35	
13	HK1-193-1 (Female of HQPM-7)	2008	0.05	0	-0.05	
14	HKI 161 (Male of HQPM-7)	2008	0.02	0.03	0.01	
15	Shalimar Pop Corn -1 (KDPC-2)	2017	1.00	1.45	0.45	SKUA&T, Srinagar
16	Birsa Vikas Makka-2	2005	1.76	1.2	-0.56	BAU Ranchi
17	Suwan-1	1985	0.88	0.9	0.02	
18	Jawahar Makka-216	2004	13.02	100	86.98	JNKVV, Chhindwara or RVSKVV Gwalior or JNKVV, Jabalpur
19	Jawahar Vikas Maize -421 (JVM-421)	2007	5.00	0	-5.00	

S.No.	Variety	Year of Notification	Qty. in Qtls. Allocation BSP-I	Production	Surplus/Deficit over DAC Inder	Producing Institute
20	Female of Phule Madhu (QMHSC-1182)		0.02	0	-0.02	Kolhapur
21	Male of Phule Madhu (QMHSC-1182)		0.05	0	-0.05	
22	Female of Phule Maharshi (QMH-1025)		0.02	0	-0.02	
23	Male of Phule Maharshi (QMH-1025)		0.05	0	-0.05	
24	GPM-456 (Female of Rajashree)	1989	0.10	0	-0.10	
25	GPM-342 (Male of Rajashree)	1989	0.05	0	-0.05	
26	BML 6 (Female of DMRH 1301)	2017	0.05	0.07	0.02	IIMR, Ludhiana
27	IML 418-1 (Male of DMRH-1301)	2017	0.03	0.05	0.02	
28	Vijay Composite Makka	1969	0.40	0	-0.40	PAU, Ludhiana
29	CM 139	1997	0.12	0.15	0.03	
30	CM 140	1997	0.20	0.2		
31	LM 20	2016	0.06	0.2	0.14	
32	LM 13	2015	4.00	4.2	0.20	
33	LM 19	2015	0.06	0.1	0.04	
34	LM 17	2008	0.06	0.55	0.49	
35	LM 14	2008	2.00	2		
36	LM 15	2006	0.12	1.2	1.08	
37	LM 16	2011	0.06	0.6	0.54	
38	LM 18	2011	0.12	0.2	0.08	
39	LM 23	2016	0.12	2.5	2.38	
40	LM 24	2016	0.06	0.2	0.14	
41	EI-586-2 (Female of Pratap Hybrid Maize-3 (PH-1974))	2015	6.30	12.6	6.30	Banswara and Udaipur
42	EI-670-2 (Male of Pratap Hybrid Maize-3 (PH-1974))	2015	3.10	6.2	3.10	
43	Praptap Makka-3 (EC-3108)	2005	0.50	8.89	8.39	
44	Pratap Makka-5		7.26	11	3.74	
45	Pratap Kanchan-2 WC-236 (Y)	2009	0.22	0.4	0.18	

S.No.	Variety	Year of Notification	Qty. in Qtls. Allocation BSP-I	Production	Surplus/Deficit over DAC Indent	Producing Institute
46	UMI 1205 (Female of CoH (M) 9 (CMH 08-350))	2014	0.04	0	-0.04	TNAU Coimbatore
47	UMI1201 (Female Parent of CoH(M)8)	2013	0.20	0	-0.20	
48	UMI 1230 (Male of CoH (M) 9 (CMH 08-350)*	2014	0.02	0	-0.02	
49	UMI1230 (Male Parent of CoH(M)8)*	2013	0.12	0	-0.12	
50	UMI1200 (Female Parent of CO-6)	2012	12.00	0	-12.00	
51	UMI1230 (Male Parent of CO-6)	2012	6.00	0	-6.00	
52	BML 6 (Female of DHM-117 (BH-40625))	2010	6.90	8	1.10	PJTSAU, MRC, Hyderabad
53	BML 7 (Male of DHM-117 (BH-40625))	2010	3.42	7	3.58	
54	BML 45 (Female of DHM-121 (BH 41009))	2014	4.39	6.91	2.52	
55	BML 6 (Male of DHM-121 (BH 41009))	2014	2.17	4	1.83	
56	Pant Sankul Makka-3 (D131)	2008	2.22	0	-2.22	GBPUAT Pantnagar
57	V 373 (Female of Vivek Hybrid Maize-45 (VMH-45)	2013	0.45	0.3	-0.15	VPKAS Almora
58	V 390 (Male of Vivek Hybrid Maize-45 (VMH-45)	2013	0.15	1.1	0.95	
59	Vivek Sankul Makka-31(VL-103)	2008	1.20	2.5	1.30	
60	Azad Kamal (R 9803)	2005	0.20	4.5	4.30	CSUAT Kanpur
61	HUZM 185 (Female of Malviya Hybrid Makka-2 (V-33)	2007	0.75	0	-0.75	BHU Varanasi
62	HKI 1105 (Male of Malviya Hybrid Makka-2 (V-33)	2007	0.25	0	-0.25	

Annexure V

Human Resource Development

A. Trainings attended

A1. Under approved HRD Annual Training Plan (ATP) 2018- 19:

A1.1: Scientific

Name	Name of the training program attended	Venue	Date
Dr. Bhupendra Kumar	ICAR-short course on "Phenomics, the next generation phenotyping (NGP)" for trait dissection and crop improvement	ICAR-IARI, New Delhi	October 22-31, 2018
Dr. P. Lakshmi Soujanya	Innovation in integrated management of insect-pest and diseases of field crops through endophytes and PGPRs	UAS, Dharwad	November 13-December 3, 2018
Dr. Chikkappa GK	Experimental Data Analysis through R	ICAR-NAARM, Hyderabad	February 21-26, 2018
Dr. MC Dagla	National Facilitators Development Programme (NFDP) on Agri-Marketing	Choudhary Charan Singh National Institute of Agricultural Marketing, Jaipur (Rajasthan)	November 26-December 5, 2018
Dr. KS Hooda	MDP on Priority setting, Monitoring and Evaluation of Agricultural Research Projects	ICAR-NAARM, Hyderabad	December 17-22, 2018

A1.2: Administrative

Name	Name of the training programme attended	Venue	Date
Sh. Ashwani Kumar	Establishment and Financial Matters for AOs/ JAO/ AF&AO/ F&AO and SO of ICAR dealing with the subject	ICAR-NAARM, Hyderabad Training at ICAR-CCARI, Goa	July 5-10, 2018
Sh. Permod Sharma	Establishment and Financial Matters for AOs/ JAO/ AF&AO/ F&AO and SO of ICAR dealing with the subject	ICAR-NAARM, Hyderabad Training at ICAR-CCARI, Goa	July 5-10, 2018
Sh. Prashant Kumar	Establishment and Financial Matters for Assistant/AAO/ AOs/ JAO/ AF&AO/ F&AO and SO of ICAR dealing with the subject	ICAR- NAARM, Hyderabad training at ICAR-CPRI, Shimla	November 15-20, 2018
Sh. Bhagesh Sharma	Organisation Specific Programme for Indian Council of Agricultural Research, New Delhi for Induction Training Courses for Newly Recruited Assistants	ISTM, New Delhi	June 11- July 6, 2018

A2. Others

A2.1: Scientific

Name of the scientist	Name of the training program attended	Venue	Date
Mr. Deep Mohan Mahala	Professional attachment training	ICAR- Indian Institute of Maize Research, Unit office, New	April 16-July 16,

Name	Name of the training programme attended	Venue	Date
		Delhi	2018
Mr. Abhjit Kumar Das	Statistical, biometrical and genomic methods applied to maize breeding training program	CIMMYT-Hyderabad, India	October 3-6, 2018
Dr.S.B. Singh	National Facilitators Development Programme (NFDP) on Agri-Marketing	ChoudharyCharan Singh National Institute of Agricultural Marketing, Jaipur (Rajasthan)	November 26-December 5, 2018
Dr. S.K. Aggarwal	Professional attachment training	ICAR-IARI, New Delhi	November 26, 2018 - February 25, 2019
Mr Mukesh Choudhary	Genomics assisted crop breeding techniques	PAU, Ludhiana	January 22-February 11, 2019
Mr. Abhjit Kumar Das	Modern statistical techniques in Genetics	ICAR-IASRI, New Delhi	February 1-21, 2019
Dr. N. Sunil	Science administration and research management	Administrative Staff College of India, Hyderabad	February 11-22, 2019

A2.2: Administrative

Name of the staff	Name of the training programme attended	Venue	Date
Ms. Chinkey Aggarwal	Training programme on “Reservation in services for SC/ST/OBC”	ISTM, New Delhi	September 17-20, 2018

B. Trainings conducted

Name of scientist /organizer	Name of the training programme conducted	Venue	Date
Drs Ishwar Singh, Coordinator, Chikkappa GK, Bhupendra Kumar, Krishan Kumar	Summer training of six undergraduate students of Gautam Buddha University, Greater Noida (UP) under bilateral MOU.	ICAR-IIMR, New Delhi	May 21-July 10, 2018
Dr. S.L. Jat (Organizing secretary)	National Workshop cum brainstorming session on “Unleashing the hidden potential of maize technology in NEH Region: status, options and strategies”	ICAR RC for NEH Region, Lamphelpat, Imphal, Manipur	July 31-August 1, 2018
Dr. S.L. Jat	Cornfest 2018 at in collaboration with JNKVV during	Chindwara, Madhya pradesh	September 29-30, 2018
Dr. S. B. Singh and Mr. Santosh Kumar	A training programmes under TSP were developed and organized on “Single cross maize hybrid technology and its seed production	Village Maira, Dist. Katihar (Bihar)	November 22, 2018
Dr. Bhupender Kumar	Conducted farmers trainings in collaboration with Scientists of CSKHPKV, Palampur, Himachal Pradesh under TSP Project	Chamba, Himachal Pradesh	January 17-18 and January 19-20, 2019
Dr. S. B. Singh and Mr. Santosh Kumar	A training programmes under TSP were conducted on “Single cross maize hybrid technology and its seed production”	Village Barhe, P.O. Lundri, District Ranchi (Jharkhand)	February 15, 2019

Name of scientist /organizer	Name of the training programme conducted	Venue	Date
Dr. S. B. Singh and Mr. Santosh Kumar	One farmer-training cum awareness programme on Fall Armyworm under Mega Seed project (101 beneficiaries)	RMR&SPC, Campus Vishnupur, Begusarai	January 22, 2019
Drs A.K. Singh, S.L. Jat and C.M. Parihar	One-day *seminar on "*Ecological intensification for climate resilient maize based cropping systems*"* onInstitute foundation day	ICAR-IIMR, Ludhiana	February 8, 2019
Dr. SL Jat (Organizing secretary) and Mr. Mukesh Choudhary (Co-organizing secretary)	National Workshop on "Scientific maize cultivation in North East India"	Aizawl, Mizoram	March 5, 2019
Dr. S. B. Singh and Mr. Santosh Kumar	Farmer-Scientist Interaction cum Field Day programme on "Maize hybrid technology, seed production and management of FAW in maize"	RMR&SPC, Kushmahaut, Begusarai	March 19, 2019

C. Participation in Conferences/ Seminars/ Workshops/ Important meetings

Name of the Scientist	Name of the Conference/ Seminars/Workshops/ Important meetings	Venue	Date
All scientists of ICAR-IIMR	13th Asian Maize Conference and expert consultation on "Maize for food, feed, nutrition and environment security for Asia"	Radisson Blu Hotel, Ludhiana	October 8-10, 2018
Dr. K.S. Hooda	106th Indian Science Congress	LPU, Jalandhar	January 3-7, 2019
Dr. A.K. Singh	Brain storming session on "Strategies for enhancing the productivity of Kharif cereals and pulses in the context of doubling farmer's income in U.P."	Lucknow	September 1, 2018
	Symposium on "Doubling farmers' income through agronomic inter-ventions under changing scenario"	MPUA&T, Udaipur	October 25, 2018
	IPNI Research Co-operators' Meet and International Symposium on "Advancements in Soil, Water and Plant Nutrition Research"	Nagpur	November 2, 2018
Dr. Ishwar Singh	International Conference on "Agricultural Education-Sharing Global Experiences"	NASC Complex, New Delhi	November 23-25, 2018
	4th International Plant Physiology Congress (IPPC-2018)	CSIR-National Botanical Research Institute, Lucknow, India	December 2-5, 2018
	Meeting under the chairmanship of the chairman, Commission for Agricultural Cost and Prices (CACP) to discuss Price Policy for *Kharif* maize 2019-20	Krishi Bhawan, New Delhi	February 13, 2019

Name of the Scientist	Name of the Conference/ Seminars/ Workshops/ Important meetings	Venue	Date
	National Conference on Agri-Nutrition	The Ashoka Hotel, New Delhi	March 15, 2019
Dr. Dharam Paul	National Symposium on "Biochemistry in Health and Diseases"	Panjab University, Chandigarh	December 22-23, 2018
Dr. S.B. Singh			
	Meeting on Technology Selection of Maize Hybrids for Kharif Season under Govt. Schemes	Director Agriculture (Govt. of Bihar) at Secretariat Office, Patna	May 05, 2018
	Meeting called by Hon'ble Union Minister of Agriculture and Farmer Welfare Sh. Radha Mohan Singh regarding progress report of the ICAR centres for last three years (2015-18)	State Guest House, Patna	June 02, 2018
	Scientific Advisory Committee Meeting of KVK, Begusarai	KVK, Khodawanpur, Begusarai	June 04, 2018
	Meeting of ATMA Management Committee Meeting organized by Project Director, ATMA, and Begusarai	District Agriculture Office, Begusarai	July 13, 2018
	Meeting on "Implementation of ATMA project under National Sub-Mission on Agricultural Extension and Technology (NMEAT)"	District Magistrate Office, Begusarai	July 24, 2018
	Meeting on "Issues Related to Cold Stress Tolerance in Winter Maize in Bihar" organized by ICAR-RCER, Patna under NICRA project	ICAR-RCER, Patna	August 14, 2018
	Conference on "Unleashing Maize Potential of Bihar" organized by FICCI under Maize Vision Programme	Hotel Maurya, Patna	August 21, 2018
	Scientific Advisory Committee Meeting	KVK Khagaria	August 18, 2018
	XXIV Meeting of the ICAR Regional Committee no. IV	Chanakya BNR Hotel, Station Road, Ranchi	September 14-15, 2018
	International Conference on Global Research Initiatives for Sustainable Agriculture and Allied Sciences (GRISAAS-2018)	Agriculture Research Institute (RARI) Durgapura, Jaipur (Rajasthan)	October 28-30, 2018
Dr. S.B. Singh and Dr. Ramesh Kumar	Annual review and planning meeting of CIMMYT project on "Climate Resilient Maize for Asia (CRMA)"	NakhonSawan Field Crop Research Centre (NSFCRC), TakFa, NakhonSawan, Thailand	June 11-12, 2018
Dr. S.L. Jat	National workshop and brainstorming session on "Unleashing the hidden potential of maize technology in NEH region: status, options and strategies"	Imphal, Manipur	July 30-31, 2018
	XIV Agricultural Science Congress	NASC complex, Pusa, New Delhi	February 20-23, 2019
	National Workshop on "Scientific Maize cultivation in North East India"	ICAR-NEH Region, Aizwal, Mizoram	March 5, 2019
Mr. Mukesh Choudhary	AICRP Forage Annual Workshop "National Group Meeting Rabi 2018-19	CCSHAU, Hisar, Haryana	September 07-09, 2018

Name of the Scientist	Name of the Conference/ Seminars/ Workshops/ Important meetings	Venue	Date
Mr. Mukesh Choudhary	Workshop on "Maize DUS Testing" under Indo- German bilateral programme	PJTSAU, Hyderabad	September 25-26, 2018
	CAFT Training programme on "Genomics assisted crop breeding techniques"	Dept. of Plant Breeding & Genetics, PAU, Ludhiana	January 22- February 11, 2019
	XIV Agricultural Science Congress	NASC complex, Pusa, New Delhi	February 20-23, 2019
	National Workshop on "Scientific Maize cultivation in North East India"	ICAR-NEH Region, Mizoram	March 5, 2019
Dr. Alla Singh	Life Sciences Symposium on "Frontiers in Sustainable Agriculture"	DAE Convention Centre, BARC, Mumbai	April 26-28, 2018
	4th Edition of International Conference on Plant Genetics and Genomics, "Next Gen Crops for Sustainable Agriculture	Chandigarh	July 19-20, 2018
Mr. Deep Mohan Mahala	28th National Conference on "Farmers' Friendly Soil and Water Conservation Technologies for Mitigating Climate Change Impact	Udhagamandalam, Tamil Nadu	January 31- February 02, 2019
	One day seminar on "Ecological intensification for climate resilient maize based cropping systems	Ludhiana, Punjab	February 8, 2019
Dr. Bhupender Kumar	80th meeting of Central Sub-committee on Crop Standards, Notification and Release of Varieties for Agricultural Crops	Krishi Bhawan, New Delhi	August 10, 2018
	Inception meeting of HTMA-II project (CIMMYT: ICAR-IIMR Collaborative project)	Ludhiana, Punjab	October 11-12, 2018
Dr. Krishan Kumar	International Conference on "Climate Change, Biodiversity and Sustainable Agriculture (ICCBS-2018)"	Jorhat, Assam	December 13-16, 2018
Dr. P. Lakshmi Soujanya	National symposium on "Entomology 2018: Advances and Challenges"	PJTSAU, Hyderabad, Telangana	December 10-12, 2018
	6th Biopesticide International Conference	Amity University, Raipur, Chhattisgarh	March 6-8, 2019
Dr. Bharat Bhushan	National Food and Nutritional Security conclave and XIX convention of Indian Society of Agricultural Biochemists	MPKV, Rahuri	February 25-27, 2019

D. Organization/participation of Kisan Mela/Kisan G osthi/Exhibition/Field Day

Name of Scientist	Programme	Venue	Date
Dr S.B. Singh	State Agriculture Fair (Kisan Kalyan Mela)	Zila High School Ground, Distt. Motihari	April 12-15, 2018
	Organized a Kisan Gosthi on "Maize	MelaParisar, Motihari	April 14, 2018

	Hybrid Technology		
	Krishi Kumbha-2019	Gandhi Maidan, Motihari	February 09-11, 2019
	A Farmer-Scientist Interaction cum Field Day programme on Maize hybrid technology, seed production and management of FAW in maize	RMR&SPC, Kushmahaut, Begusarai	March 19, 2019
Mr. Santosh Kumar	Krishi Kumbha-2019	Gandhi Maidan, Motihari	February 09-11, 2019
Dr. S.L. Jat	*KrishiKumbh* organized by Uttar Pradesh government	Lucknow, Uttar Pradesh	October 25-29, 2018
	XIV Agricultural Science Congress	New Delhi	February 24-28, 2019
	KrishiUnnatiMela	ICAR-IARI, New Delhi	March 5-7, 2019
Drs Bhupender Kumar and S.L. Jat	Meeting with Agrinnovate India Ltd, New Delhifor popularization of maize hybrids developed by ICAR-IIMR, Ludhiana (Proposals of five hybrids submitted and presented MoU with private partners)	New Delhi	March 20, 2019
Dr. S.L. Jat and Mr. Deep Mohan Mahala	Cornfest-2018	Chhindwara, Madhya Pradesh	September 29-30, 2018
Dr. A.K Singh, Mr. Mukesh Choudhary, Mr. Deep Mohan Mahala and Ms. MehakSethi	106th Indian Science Congress	Lovely Professional University, Jalandhar	January 3-7, 2019
Dr. A.K. Singh, Mr. Mukesh Choudhary, Mr. Deep Mohan Mahala and Miss Shanti Bamboriya	PAU *Kisan Mela*	Punjab Agriculture University, Ludhiana	March 15-16, 2019

E. Foreign visits

Name of Scientist	Programme	Venue	Date
Drs S.B. Singh, Ramesh Kumar and Bhupender Kumar	Annual Review and Planning Meeting of the project "Climate Resilient Maize for Asia (CRMA)"	Thailand	June 10-13, 2018

Annexure VI

Lectures/TV/Radio talks delivered

Scientist	Topic	Programme	Venue	Date
Dr. A.K. Singh	मक्का फसल की खेती	Hello Kisan	DD Kisan	June 27, 2018
	Ecological intensification for climate resilient maize based cropping systems in India	13^{th} Asian Maize Conference and expert consultation on "Maize for food, feed, nutrition and environment security for Asia"	Ludhiana	October 8-10, 2018
Dr. S. B. Singh	Quality seed production achievements by ICAR-IIMR under the project Seed Production in Agricultural Crops	Joint Annual Group Meeting of AICRP NSP (Crops) and ICAR Seed Project	PAJANCOA & RI, Karaikal, Puducherry	May 10, 2018
Dr. S. B. Singh	Raising Maize Productivity in Bihar-Challenges	Conference on "Unleashing Maize Potential of Bihar" organized by FICCI under Maize Vision Programme	Hotel Maurya, Patna	August 21, 2018
Dr. S. B. Singh	Status of corn cultivation in Bihar: opportunities and future challenges	International Conference on Global Research Initiatives for Sustainable Agriculture and Allied Sciences (GRISAAS-2018)	Rajasthan Agriculture Research Institute (RARI) Durgapura, Jaipur (Rajasthan)	October 29, 2018.
Dr. S. B. Singh	Scientific Crop management in maize for higher production	Farmer Scientist Interaction programme By DAO, Begusarai	District Agriculture Office Begusarai, Bihar	August 23, 2018
Dr. S. B. Singh	रबी मौसम की संकर मक्का में शीत प्रकोप से बचाव हेतु वैज्ञानिक तकनीकियाँ	Farmer Scientist Interaction programme By DAO, Begusarai	District Agriculture Office Begusarai, Bihar	August 24, 2018
Dr. S. B. Singh	Crop management for higher production of Soybean crop in Begusarai'	Farmer Scientist Interaction programme By DAO, Begusarai	District Agriculture Office Begusarai, Bihar	August 24, 2018
Dr. S. B. Singh	Field layout and data recording in AICRP Trials	Maize Germplasm Field day cum Training on Maize Breeding	Winter Nursery Centre, ICAR-IIMR, Rajendra Nagar Hyderabad	March 01-02-, 2019
Dr. S. B. Singh	मक्का एक परिचय एवं उच्च आय हेतु नए विकल्प	Farmer Training programmes	Katihar, RMR&SPC, Begusarai and Ranchi	November 22, 2018, January, 22-2019, February, 15,2019
Dr. S. B. Singh	एकल संकर मक्का के बीज उत्पादन की तकनीकी	Farmer Training programmes	Katihar, RMR&SPC, Begusarai and Ranchi	November 22, 2018, January, 22-2019, February, 15,2019
Dr. S. B. Singh	बिहार प्रदेश के लिए उपयुक्त संकर मक्का की किस्में	Farmer Training programmes	Katihar, RMR&SPC, Begusarai and Ranchi	November 22, 2018, January, 22-2019, February, 15,2019
Dr. S. B. Singh	मक्का की फसल में पोषण प्रबंधन एवं पौधा सरंक्षण	Farmer Training programmes	Katihar, RMR&SPC,	November 22, 2018, January,

Scientist	Topic	Programme	Venue	Date
			Begusarai and Ranchi	22-2019, February, 15,2019
Dr. S. B. Singh	बीज प्रसंस्करण, प्रमाणीकरण तकनीक	Farmer Training programmes	Katihar, RMR&SPC, Begusarai and Ranchi	November 22, 2018, January, 22-2019, February, 15,2019
Dr. S. B. Singh	मक्का की फसल में फाल आर्मी वर्म की पहचान व रासायनिक रोकथाम	Farmer Training programmes	Katihar, RMR&SPC, Begusarai and Ranchi	November 22, 2018, January, 22-2019, February, 15,2019
Dr. S. B. Singh	रबी संकर मक्का में शस्य क्रियाओं की वैज्ञानिक विधि	Farmer Training programmes	Katihar, RMR&SPC, Begusarai and Ranchi	November 22, 2018, January, 22, February, 15, 2019
Dr. Mukesh Choudhary	Development of drought and waterlogging stresses tolerance maize genotypes and identification of key regulatory elements playing role in their tolerance mechanism (presented on behalf of Dr. Bhupender Kumar)	106th Indian Science Congress	Lovely Professional University, Phagwara	(3rd-7th January, 2019)
Mr. Santosh Kumar	Integrated management of fall army worm and other important insect pests of maize	मक्का की संकर व बीज उत्पादन फसल में फॉल आर्मीवर्म के प्रकोप व रोकथाम विषय पर कृषक जागरूकता व प्रशिक्षण कार्यक्रम	RMR&SPC, Begusarai	January, 22-2019
Mr. Santosh Kumar	Hybrid seed production technique & importance of maize and integrated management of insect pests of maize	एकल संकर मक्का तकनिकी एवं बीज उत्पादन विषय पर एक दिवसीय आदिवासी कृषक प्रशिक्षण कार्यक्रम	Ranchi	February 15, 2019
Dr. Alla Singh	Molecular biology of ribozymes	Extension Lecture	BBK DAV College for Women, Amritsar	February 23, 2019
Dr. S.L. Jat	Post-Harvest Processing and Fodder from Maize	National Workshop on "Scientific Maize cultivation in North East India".	Aizawl, Mizoram	March 5, 2019
Dr. S.L. Jat	Babycorn and sweet corn production technologies for Mizoram	National Workshop on "Scientific Maize cultivation in North East India".	Aizawl, Mizoram	March 5, 2019
Mr. Mukesh Choudhary	Quality Seed Production of Maize in Mizoram	National Workshop on "Scientific Maize cultivation in North East India".	Aizawl, Mizoram	March 5, 2019
Dr. P.L. Soujanya	Management of storage pests of maize	SCSP training programme “Maize production technologies and Management of Fall Army Worm”	Maize Research Station, PJTSAU, Hyderabad	March 29, 2019
Dr. S.L. Jat	रबी मक्का की देखभाल	किसान की बात कार्यक्रम	ऍफ़ एम गोल्ड	25 जनवरी, 2019

Scientist	Topic	Programme	Venue	Date
Dr. S.L. Jat	रबी मक्का की देखभाल	हेल्लो किसान लाइव कार्यक्रम	डीडी किसान	15 जनवरी, 2019
Dr. S.L. Jat	रबी मक्का की बुवाई	हेल्लो किसान लाइव कार्यक्रम	डीडी किसान	30 अक्टूबर, 2018
Dr. S.L. Jat	रबी मक्का की खेती	किसान की बात कार्यक्रम	ऍफ़ एम गोल्ड	28 अक्टूबर, 2018
Dr. S.L. Jat	मक्का की देखभाल	हेल्लो किसान लाइव कार्यक्रम	डीडी किसान	06 सितम्बर, 2018
Dr. S.L. Jat	बेबी कॉर्न की खेती	किसान की बात कार्यक्रम	आल इंडिया रेडियो	23 अगस्त, 2018
Dr. S.L. Jat	दाने हेतु मक्का की खेती	हेल्लो किसान लाइव कार्यक्रम	डीडी किसान	23 मई, 2018
Dr. S.L. Jat	मक्का की खेती एवं देखभाल	हेल्लो किसान लाइव कार्यक्रम	डीडी किसान	11 अप्रैल, 2018

Annexure VII

Publications

Research Papers

1. Aggarwal SK, Mali BL, Trivedi A, Bunker RN, Rajput LS, Kumar S and Tripathi A (2019) Host Plant Resistance in Different Black Gram Cultivars against Anthracnose. Int J Curr Microbiol App Sci 8:571-75. http://krishi.icar.gov.in/jspui/handle/123456789/21353.
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9. Jat SL, Parihar CM, Singh AK, Kumar B, Choudhary M, Nayak HS, Parihar MD, Parihar N, Meena BR (2019) Energy auditing and carbon footprint under long-term conservation agriculture-based intensive maize systems with diverse inorganic nitrogen management options. Sci Total Environ 664: 659-668. http://krishi.icar.gov.in/jspui/handle/123456789/20132.
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Annexure VIII

On-going Projects

In-house Projects

Project Code	Title of the project	Principal Investigator	CoPIs/CCPIs	Project Duration
Agronomy				
AR:IIMR:17:09	Sensor guided nitrogen management in Maize base cropping system under conventional and conservation agriculture practices	Dr. SL Jat	Drs. AK Singh, CM Parihar, Meena Shekhar, Suby SB, Dilip Singh, D Sreelatha, CS Singh, Mahesh Kumar, Amit Bhatnagar, DR Thakur, PC Ghashal (Need based)	July 2017 to June 2022
AR:IIMR:17:10	Development of precision conservation agriculture practices in cereal based system in Indo-Gagatic Plains	Dr. AK Singh	Drs. Mahesh Kumar, SL Jat, PK Bagaria	July 2017 to June 2022
Biochemistry				
AR:IIMR:17:01	Analysis of Starch diversity and digestibility in Maize	Dr. Dharam Paul Chaudhary	Drs. Alla Singh, Abhijit Kumar Das	April 2017 to March 2022
Biotechnology				
AR:IIMR:16:02	Development of Banded Leaf and Sheath Blight resistant transgenic maize	Dr. Krishan Kumar	Drs. PK Bagaria, Deepak S Bisht, KS Hooda, Pranjal Yadava (Need based)	July 2016 to June 2021
AR:IIMR:16:04	Development of assay for testing protein quality in Maize	Dr. Alla Singh	Drs. Dharam Paul Chaudhary, Mrs Mamta Gupta	Sep. 2016 to Aug. 2019
Entomology				
AR:DMR:14:07	Development of management tools for maize pests	Dr. SB Suby	Drs. PL Soujanya, JC Shekhar, Amrender Kumar	Jan. 2016 to Dec. 2018
AR:IIMR:17:03	Management of Maize Stem Borers through Host plant resistance	Dr.P. Lakshami Soujanya	Drs. JC Shekhar, Chikkappa GK, Jawala Jindal, Swati Mehra, CVRratanavathi	July 2017 to June 2022
Plant Pathology				
AR:DMR:12:12	Studies of host-pathogen interaction between *M. phaseolina* & *F. moliniforme* (stalk rot pathogens) in maize and identification of source of resistance against Post Flowering Stalk Rots of maize.	Dr. Meena Shekhar		Jan 2013 to Dec 2018
AR:IIMR:16:01	Development of IDM strategy for major disease of maize with available effective tools	Dr. K.S. Hooda	Drs. Robin Gogoi, RP Singh, Harleen Kaur, Prasant Chauhan, Amrender Kumar	April 2016 to March 2021
Plant Breeding				
AR:IIMR:17:02	Genetic enhancement of QPM Germplasm	Dr. Ramesh Kumar	Drs. Abhijit Kumar Das, Dharam Paul, SB Singh, Sunil N, Sumit Kumar Agarwal, Suby SB	July 2017 June 2022
AR:IIMR:17:04	Genetic enhancement of White Maize for Food Purpose	Dr. Abhijit Kumar Das	Drs. SB Singh, Mukesh Vayas, SK Guleria, Savita Sharma, Baljinder Singh, Suby SB, Zahoor Ahmed, SS Sharma (Need based)	July 2017 June 2022
AR:IIMR:17:05	Breeding for High Yielding and better quality fodder cultivars in Maize	Mr. Mukesh Choudhary	Drs. MM Dass, Pradeep Kumar, AK Singh (Need Based), JS Lamba (25)	July 2017 June 2022
AR:IIMR:17:06	Breeding for development of baby corn hybrids	Dr.Pradeep Kumar	Drs. Sujay Rakshit, Mukesh Chaudhary, PK Bagaria (Need based), Menakshi Goyal,Bharat Bhushan	July 2017 June 2022

Project Code	Title of the project	Principal Investigator	CoPIs/CCPIs	Project Duration
AR:IIMR:17:07	Development of early maturing maize hybrid with enhanced yield and stress tolerance.	Dr. Manesh Chander Dagla	Drs. Mukesh Chaudhary, BS Jat, Meena Shekhar, JC Shekhar	July 2017 to June 2022
AR: IIMR :17:11	Diversification of sweet corn germplasm	Dr. Chikkappa GK	Drs. Sujay Rakshit, AK Das, Pardeep Kumar, KS Hooda	June 2017 to May 2022
AR:DMR:14:01	Characterization and diversification of maize germplasm.	Dr. Chikkappa GK	Drs. Jyoti Kaul, Vinay Mahajan, KS Hooda, SB Singh, Sunil N, Nirupma Singh, Bhupender Kumar, Ganapati Mukri, Vishal Singh, Yathish KR	June 2014 to May 2019
AR:IIMR:14:02	Genetic Enhancement of Maize for oil and methionine	Dr. Vishal Singh	Drs.Manesh Chander Dagla, Yathish KR	August 2014 to July 2019
AR:IIMR:16:03	Decision Support System of Maize Inbred Germplasm	Dr. N. Sunil	Drs. JC Shekhar, N Srinivas	April 2016 to April 2020
AR:DMR:14:03	Development of high yielding maize hybrids for different ecologies.	Dr. Bhupender Kumar	Drs.Vishal Singh, SB Singh, Chikkappa GK, Ramesh, KS Hooda, R Keshwan	June 2014 to May 2019
AR:DMR:14:04	Development of maize hybrids for eastern India	Dr. S B Singh	Drs. Krishan Kumar, PK Bagaria, BS Jat, Bhupender Kumar (Need based)	Oct. 2014 to Sep. 2019
AR:DMR:14:05	Breeding for tolerance to abiotic stresses in maize	Dr. B S Jat	Drs. Ishwar Singh, PK Bagaria Bhupender Kumar, Chikkappa GK, Ramesh Kumar	2014 to 2019
Physiology				
AR:IIMR:17:08	Physiological and Biochemical basis of nitrogen use efficiency in Maize	Dr. Ishwar Singh	Drs. SL Jat, Krishan Kumar	July 2017 to June 2020

Externally funded project

S. No.	Scheme/Project	Principal Investigator	CoPIs/CCPIs	Duration	Funding Agency
1	Long-term conservation agriculture impact on micro biome and soil health indicators for resource efficiency and resilience in maize systems- NASF	Dr SL Jat	Drs. Bhupender Kumar, Suby SB	2018-21	ICAR-NASF
2	Genome-wde association mapping and genetic characterization of turcicum leaf blight (*Setosphaeria turcica*) resistance in tropical maize germplasm	Dr. Bhupender Kumar		2018-21	DST (ECR), DST
3	Rapid detection of quality protein maize for increased farmer remuneration	Dr Alla Singh	Dr. Abhijit Kumar Das	2018-20	DST
4	ICAR-IP &TM (ITMU)	Dr KS Hooda	Drs. Dharm Paul, Suby SB, Alla Singh	2018-19	ICAR-NAIF
5	FLD Maize (NFSM)	Dr SL Jat		2018-19	ICAR
6	DUS project	Dr Chikkappa GK		2018-19	PPV&FR Authority
7	ICAR-Mega Seed Project	Dr SB Singh		2017-20	ICAR

S. No.	Project Code	Title of the project	Principal Investigator	CoPIs/CCPIs	Project Duration
8	ICAR-NICRA (Phase II)	Dr Bhupender Kumar	Drs. S B Singh, Chikkappa G Karjagi, SL Jat, BS Jat	2017-20	ICAR
9	ICAR-CRP on Biofortification	Dr Bhupender Kumar	Drs. S B Singh, Dharm Paul, Ramesh Kumar, Chikkappa G Karjagi, SL Jat, Vishal Singh, Mukesh Choudhary	2017-20	ICAR
10	Morphological, physiological and molecular characterization of diverse set of maize germplasm	Dr Chikkappa GK		2017-19	SERB-DST N-PDF
11	ICAR-CIMMYT: CRMA Project	Dr Ramesh Kumar	Drs. S B Singh, Bhupender Kumar	2016-19	CIMMYT

Annexure IX

Annual Financial Statement (2018-19)

Expenditure Statement (2018-19) **(INR in lakhs)**

	RE 2018-19			Actual Expenditure during 2018-19		
Head of Account	**Institute Govt. Grant**	**Govt. Schemes**	**AICRP on Maize**	**Institute Govt. Grant**	**Govt. Schemes**	**AICRP on Maize**
Grant in Capital	550.00	36.25	0	548.29	22.80	0
Grant in Salary	669.17	0	1510.00	668.96	0	1510.00
Grant in General	477.00	144.29	275.00	475.41	144.15	275.00
TSP	17.00	0	75.00	16.91	0	75.00
NEH	144.00	0	107.00	143.99	0	107.00
SCSP	1000.00	0	0	99.95	0	0
Total	**1957.17**	**180.54**	**1967.00**	**1953.51**	**166.95**	**1967.00**

Revenue Generation during the year 2018-19

Particulars	(INR in lakhs)
Sale of Farm produce	20.69
Sale of Seed	17.13
Sale of publications and tender documents	0
Licence fee	0.59
Analytical and testing fee	23.03
Receipts from Service rendered	0.020
Interest earned on Loan & Advances to Employees	0.92
Interest earned on short term deposits	58.91
Income generated from IRG	0.26
Application fee for candidates	1.80
Training miscellaneous receipts	5.57
Total	**128.92**

Funds received for externally funded projects during the year 2018-19

Particulars	(INR in lakhs)
DUS	19.00
CRMA	9.79
FLD	17.22
SERB	18.68
DST	27.98
Total	**92.67**

B. Financial targets and achievements (All employees)

(INR in lakhs)

S. No.	RE 2018-19 for HRD	Actual Expenditure up to 31st March, 2019 for HRD	% Utilization of RE 2018-19
1	4.00	3.92	97.96

Annexure X

Personnel, transfers, new joining, superannuation, promotions

Name	Designation	Discipline
Indian Institute Of Maize Research, P.A.U. Campus, Ludhiana		
Dr. Sujay Rakshit	Director	Plant Breeding
Dr. Karambir Singh Hooda	Principal Scientist	Plant Pathology
Dr. Aditya Kumar Singh	Principal Scientist	Agronomy
Dr. Dharam Paul	Principal Scientist	Biochemist
Dr. Ramesh Kumar	Principal Scientist	Plant Breeding
Mr. Vishal Singh	Scientist	Plant Breeding
Dr. Abhijit Kumar Dass	Scientist	Plant Breeding
Dr. Pardeep Kumar	Scientist	Crop Improvement
Dr. Alla Singh	Scientist	Agricultural Biotechnology
Mr. Mukesh Chaudhary	Scientist	Genetics & Plant Breeding
Dr. Manesh Chandra Dagla	Scientist	Plant Breeding
Dr. B.S. Jat	Scientist	Plant Breeding
Sh. Ashwani Kumar	AO	
Sh. Permod Sharma	AF&AO	
Mrs. Seema Khatter	PS to Director	
Mrs. Kamlesh Malik	AAO	
Ms. Chinkey Agarwal	Assistant	
Sh. Bhagesh Sharma	Assistant	
Sh. Prashant Garg	Assistant	
Mr. Dharambir Singh	UDC	
Mr. Samir Kumar Rai	T3	
Sh. Ram Kishan	SSS	
Indian Institute of Maize Research, Unit Office, Delhi		
Dr.Ishwar Singh	Principal Scientist	Plant Physiology
Dr. Chikkappa G. Karjagi	Scientist	Plant Breeding
Dr. Shankar Lal Jat	Scientist	Agronomy
Ms. Suby S.B	Scientist	Entomology
Dr. Bhupender Kumar	Scientist	Plant Breeding
Dr. PranjalYadav	Scientist	Agricultural Biotechnology
Dr. Krishan Kumar	Scientist	Agricultural Biotechnology
Sh. Anwar Ali	SSS	
Winter Nursery Centre, Hydearbad		
Dr. J.C. Shekar	Principal Scientist	Entomology
Dr. N. Sunil	Senior Scientist	Plant Breeding
Dr. P. Laxmi Soujanya	Scientist	Entomology
Dr. K. R. Yatish	Scientist	Plant Genetics
Sh. Amar Nath	SSS	
Regional Maize Research and Seed Production Centre, Begusarai, Bihar		
Dr. S.B. Singh	Principal Scientist	Plant Breeding
Mr. Rahul	T3	
Mr. Kamal Vats	T3	

Scientists on study Leave

Name	Time Period of Study Leave to pursue her study (Ph.D)	Institute Name
Ms. Mamta Gupta	12.03.2018 to 31.3.2020	IARI, New Delhi
Ms. Avni	12.06.2018 to11.06.2020	Guru Jambheshwar University of Science & Technology, Hisar
Sh. Praveen Kumar Bagaria	05.01.2019 to 04.01.2022	PAU, Ludhiana

Staff Positions of ICAR-IIMR as on 31st March, 2019

Type of Post	Approved by D/O expenditure	In Position	Vacant
Scientific	40	33	7
Technical	5	3	2
Administrative	13	7+1one post of Assistant on deputation	5
Supporting	3	3	0

New Joining

Name	Date	Place	From
Dr. Bharat Bhushan, Scientist	09.07.2018	ICAR-IIMR, Ludhiana	NBPGR, New Delhi
Sh. Deep Mohan Mahala	24.07.2018	ICAR-IIMR, Ludhiana	NAARM, Hyderabad
Ms. Shanti Devi Bamboriya, Scientist	08.10.2018	ICAR-IIMR, Ludhiana	NAARM, Hyderabad
Sh. Santosh Kumar, Scientist	09.10.2018	RMR&SPC, Begusarai	NAARM, Hyderabad
Dr. Sumit Kumar Aggarwal, Scientist	08.10.2018	ICAR-IIMR, Ludhiana	NAARM, Hyderabad


Dr. Bharat Bhushan (Biochemistry)


Sh. Deep Mohan (Soil Science)


Ms. Shanti Devi (Agronomy)


Sh. Santosh Kumar (Plant Breeding)


Dr. Sumit Kumar (Plant Pathology)

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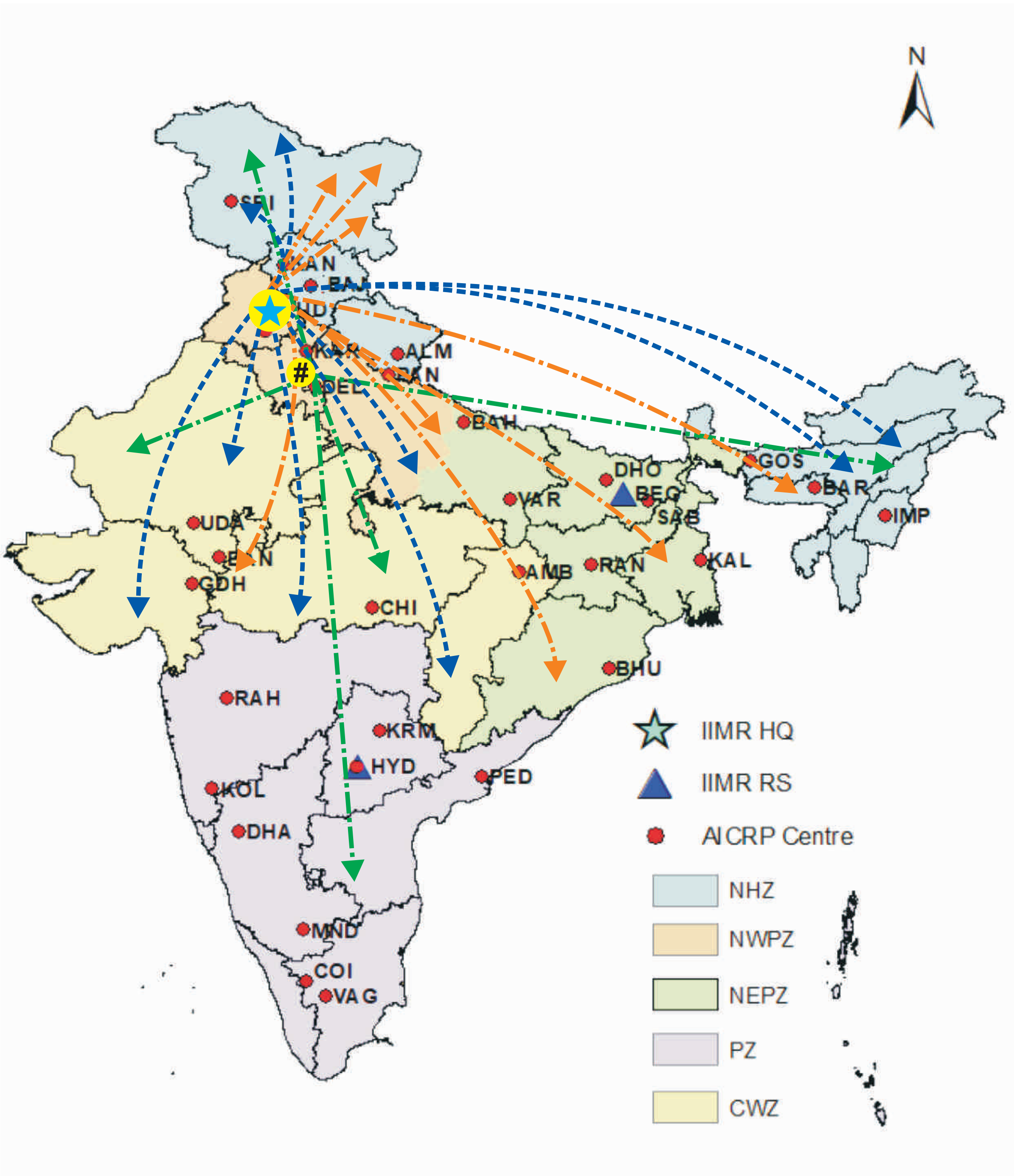
Technology Delivery Map of ICAR-IIMR



IIMR Hybrids

AICRP Centre Hybrids

IIMR Commercialized Technology Dissemination

Licencee of Commercialized Technology

IIMR Publication No. 2019/04

हर कदम, हर डगर
किसानों का हमसफर
भारतीय कृषि अनुसंधान परिषद

Agrisearch with a human touch