पंचवर्षीय समीक्षा टीम प्रतिवेदन
Quinquennial Review Team Report
(2011-2016)

भारतीय मक्का अनुसंधान संस्थान
तथा
अखिल भारतीय समन्वित मक्का अनुसंधान परियोजना

Indian Institute of Maize Research
and
All India Coordinated Research Project on Maize

भाकृअनुप–भारतीय मक्का अनुसंधान संस्थान, लुधियाना

ICAR-Indian Institute of Maize Research
Ludhiana

पंचवर्षीय समीक्षा टीम प्रतिवेदन
Quinquennial Review Team Report
(2011-2016)

भारतीय मक्का अनुसंधान संस्थान
तथा
अखिल भारतीय समन्वित मक्का अनुसंधान परियोजना

Indian Institute of Maize Research
and
All India Coordinated Research Project on Maize

भाकृअनुप–भारतीय मक्का अनुसंधान संस्थान, लुधियाना

ICAR-Indian Institute of Maize Research
Ludhiana

Content

कार्यकारी सारांश

बहुमुखी फसल के रूप में मक्का भोजन, दाना, चारा और जैव ईंधन के स्रोत के रूप में उपयोग किया जाता है। इसकी विस्तृत वातावरण में अनुकूलता के कारण दुनिया भर में 170 से अधिक देशों में 188 मिलियन हेक्टेयर में मक्का की खेती की जा रही है। इसके साथ ही अनाजों में इसका उच्चतम उत्पादकता (5.64 टन/हेक्टेयर) और उत्पादन (1060 मिलियन टन) (एफएओस्टेट, 2018) है। भारत देश दुनिया में क्षेत्रफल के हिसाब से चौथे और उत्पादन में सातवे स्थान पर है। भारत में मक्का उष्ण–कटिबंधीय, वर्षा आधारित, छोटी अवधि की फसल होने के कारण, इसकी उत्पादकता (2.6 टन/हेक्टेयर) आदर्श स्थिति के तहत आश्वासित समशीतोष्ण फसल के साथ तुलनीय नहीं है। 2011-16 के दौरान, मक्का क्षेत्रफल और उत्पादकता में क्रमशः 9 लाख हेक्टेयर और 400 किलोग्राम/हेक्टेयर की वृद्धि हुई जिससे पिछली अवधि (2005-10) की तुलना में 55 लाख टन उत्पादन में वृद्धि हुई। इस अवधि में, क्षेत्रफल और उत्पादकता में रबी (5.2 लाख हेक्टेयर और 270 किलोग्राम/हेक्टेयर) और खरीफ (3.9 लाख हेक्टेयर और 330 किलोग्राम/हेक्टेयर) दोनों मौसमों में वृद्धि हुई। भारत में खरीफ (राजस्थान में 1.5 टन/हेक्टेयर से तमिलनाडु में 4.5 टन/हेक्टेयर) और रबी (महाराष्ट्र में 2.6 टन/हेक्टेयर से आंध्र प्रदेश में 7.9 टन/हेक्टेयर) मौसम में प्रमुख उत्पादक राज्यों के बीच विविध पारिस्थितिकी के कारण उत्पादकता में बहुत अंतर है। यह उल्लेखनीय है कि देश के कुछ जिलों में 10 टन/हेक्टेयर की औसत उत्पादकता है जो संयुक्त राज्य अमेरिका की उत्पादकता के साथ तुलनीय है।

अतीत में, मक्का को एक प्रमुख खाद्य फसल माना जाता था और वर्तमान में यह एक औद्योगिक फसल के रूप में बदल गयी है। कुक्कुट और पशुधन मक्का के प्रमुख उपभोक्ता हैं, जिसके बाद स्टार्च, खाद्य प्रसंस्करण और मूल्यवर्धन उद्योगों में उपयोग होता हैद्य भोजन के लिए केवल 14% मक्का का उपयोग किया जाता है। अलग–अलग क्षेत्रों में विभिन्न राज्यों की मक्का उत्पादकता को बेहतर प्रौद्योगिकी के विकास और उसे अपनाने से बढ़ाया जाना चाहिए। विभिन्न राज्यों में मक्का क्षेत्रफल का विस्तार किया जाना चाहिए जहां यह फसल विविधीकरण के लिए एक लाभकारी फसल के रूप में उभर रहा है।

क्यूआरटी टीम ने प्रत्येक क्षेत्र के प्रतिनिधित्व करने वाले प्रमुख एआईसीआरपी केंद्रों और आईआईएमआर स्टेशनों का दौरा किया जिनमें वाणिज्यिक बीज उत्पादन क्षेत्र भी शामिल हैं। प्रत्येक केंद्र के शोध कार्यक्रम की समीक्षा, उनकी प्रस्तुति और प्रक्षेत्रीय यात्रा के आधार पर की गई । किसान–वैज्ञानिक–उद्योग पारस्परिक गोष्ठियाँ, हितधारकों की जरूरतों को जानने और उनकी आवश्यकता के अनुसार शोध कार्यक्रम को विकसित करने के लिए आयोजित की गयी।

इस अवधि के दौरान, किसानों द्वारा लगाए जाने वाली मक्का की पुरानी किस्मों को वाणिज्यिक खेती से बदलने के लिए विभिन्न कृषि–जलवायु स्थितियों के अनुरूप 89 जैविक और अजैविक तनाव प्रतिरोधी संकर किस्में विकसित और अधिसूचित की गयी। खेती की लागत की कम करने के साथ उत्पादकता और लाभप्रदता बढ़ाने के लिए सर्वोत्तम फसल प्रबंध प्रणालियों को विकसित और प्रदर्शित किया गया। शोधकर्ताओं के संकर किस्मों के विकास की अभिव्यक्ति हितों की रक्षा के लिए, आईआईएमआर ने पीपीवीएफआरए के तहत 104 किस्मों के पंजीकरण की सुविधा प्रदान की। एकल संकर मक्का पर केंद्रित शोध अधिक फायदेमंद और संसाधन युक्त कुशल पाया गया है, जिसमे अंतर–संस्थागत संकर विकास कार्यक्रम को मजबूत करने के लिए एआईसीआरपी केंद्रों के बीच 6668 जनंद्रव्य नमूने के विकास, रखरखाव और साझाकरण द्वारा सदृढ़ किया गया। जनंद्रव्य किसी भी फसल सुधार कार्यक्रम की ताकत है। सत्रह नए जनंद्रव्य लाइनें विशिष्ट विशेषता (सूखा, गुणवत्ता और रोग प्रतिरोध) और आईएनजीआर संख्या के साथ एनबीपीजीआर में पंजीकृत की गयी। नई बीमारी प्रतिरोधी किस्मों के विकास के लिए केन्द्रों के साथ कई बीमारियों (77) के प्रतिरोध हेतु स्थिर स्रोतों की पहचान की गयी और साझा की गई।

पानी, खरपतवार, पोषक तत्व, फसल विविधीकरण और जलवायु परिवर्तन के मुद्दों को हल करने के लिएसंरक्षण कृषि प्रौद्योगिकियों (शून्य–जुताई, बेड रोपण) विकसित की गई है जिसमें खेती की लागत को कम करने के साथ–साथ कृषि लाभप्रदता और मृदा में कार्बनिक कार्बन में वृद्धि होने की संभावना है। लाभप्रदता बढ़ाने के लिए मक्का के साथ सोयाबीन, उर्द और मुंग का अन्तःशस्यन नियमित और जोड़ेदार पंक्ति विधियों के रूप में विकसित किये गये। व्यापक स्पेक्ट्रम खरपतवार प्रबंधन के लिए खडी फसल में एकप्रभावी शाकनाशी (टेम्बोट्रियोन) की सिफारिश की गई है। तना भेदक के प्रबंधन के लिए मक्का के साथ लोबिया अन्तःशस्यन के रूप में एक आवास प्रबंधन तकनीक की सिफारिश की गई।

आदिवासी किसानों के विभिन्न मुद्दों के हल हेतु प्रशिक्षण (6622 किसानों को 103 प्रशिक्षण), कृषि आगत (बीज, उर्वरक, शाकनाशी, हाथ से चलने वालास्प्रेयर इत्यादि), प्रदर्शन और साहित्य को टीएसपी कार्यक्रम के माध्यम से कृषि अर्थव्यवस्था और कृषक आजीविका सुरक्षा में सुधार के लिए प्रदान किये गये। 10608 हेक्टेयर अग्रिम पंक्ति प्रदर्शन में उत्पादकता में काफी वृद्धि हुई।

बीज उत्पादन श्रृंखला को लागु करने के बाद डीएसी के मांगपत्र के अनुसार संकर किस्मों के विभिन्न नर–मादा प्रजनको के पर्याप्त प्रजनक बीज का उत्पादन और आपूर्ति की गई थी। आईआईएमआर और एआईसीआरपी के वैज्ञानिकों ने 7344 शोध/समीक्षा पत्र प्रकाशित किए हैं, 48 पुरस्कार जीते हैं और दो पेटेंट भी दर्ज किए हैं। सम्मानित कुछ प्रतिष्ठित पुरस्कारों में एमएस स्वामीनाथन पुरस्कार और उत्कृष्ट डॉक्टरेट थीसिस अनुसन्धान हेतु जवाहरलाल नेहरू पुरस्कार थे। आईआईएमआर और एआईसीआरपी द्वारा समर्थित मक्का किसानों को उनकी सफलता की कहानी के आधार पर राज्य और राष्ट्रीय स्तर पर अधिकारिक रूप से प्रशंसा मिली थी।

परंपरागत प्रजनन कार्यक्रम के अलावा तेजी से अनुवांशिक लाभ के लिए जीनोमिक्स अनुप्रयोग, जेनेटिक इंजीनियरिंग, जीनोम संपादन, डबल हैप्लोइड (डीएच) तकनीक जैसे नए उपकरणों के उपयोग को अपनाने के द्वारा मक्का अनुसंधान को वैश्विक शोध कार्यक्रम के साथ प्रतिस्पर्धा करने के लिए मजबूती की आवश्यकता है। जलवायु परिदृश्य को बदलने के तहत जर्मप्लाज्म विविधीकरण की खोज की जानी चाहिए। विशेष मक्का (क्यूपीएम, स्वीट कॉर्न, पॉप कॉर्न, बेबी कॉर्न,हाई–स्टार्च) को पोषण सुरक्षा, रोजगार उत्पादन और आजीविका सुरक्षा के लिए प्रोत्साहित किया जाना चाहिए। ये कार्य एआईसीआरपी कार्यक्रम में चुनिन्दा केंद्रों पर किये जाने चाहिए। सार्वजनिक क्षेत्र के संगठन द्वारा संकर मक्का बीज उत्पादन कार्यक्रम का प्रदर्शन विविध स्थानों पर मजबूत किया जाना चाहिए ताकि समय पर किफायती गुणवत्ता वाले बीज की उपलब्धता आसानी से हो और बीज उत्पादन के लिए स्वदेशी निजी क्षेत्र के साथ साझेदारी को भी मजबूत करने के लिए प्रयास हो। संसाधनों के कुशल उपयोग के लिए अनुसंधान में पुनरावर्ती को रोकना और अंतर–संस्थागत प्रौद्योगिकी विकास को मजबूत किया जाना चाहिए। जलवायु परिवर्तन के तहत विभिन्न जैविक और अबाध तनावों के प्रतिरोध ६ सहिष्णुता के स्रोतों की पहचान को मजबूत करने की जरूरत है। अलग–अलग फसल प्रणालियों के तहत संरक्षण कृषि से लाभ का पता लगाने और विभिन्न पारिस्थितिकी में प्रदर्शित किया जाना चाहिए। पूर्ण मक्का मूल्य श्रृंखला के लिए समय–समय पर होने वाले आर्थिक प्रभाव पर अध्ययन की आवश्यकता है । सभी केंद्रों मेंकीट विज्ञान और पादप रोग विज्ञान जैसे विषय वस्तु विशेषज्ञ उपलब्ध नहीं हैं, इसलिए, विभिन्न क्षेत्रों और आईआईएमआर में काम कर रहे इन विषयों के वैज्ञानिक मानव संसाधनों के कुशल उपयोग के लिए उन्हें इस कार्यक्रम का हिस्सा बनना चाहिए।

मक्का में प्रगति वैश्विक शोध को प्रतिस्पर्धा को झूझने के लिए काफी बेहतर रहती जब पर्याप्त तकनीकी जनशक्ति, पर्याप्त धन और आधिकारिक कर्मचारियों को परेशानी मुक्त प्रशासन के लिए उपलब्ध कराया गया होता। वर्तमान में, आईआईएमआर में तकनीकी और सहायक कर्मचारियों की ताकत सभी प्रमुख प्रयोगशालाओं और कृषि संचालन के लिए वैज्ञानिक कर्मचारियों की स्थिति की तुलन में बेहद कम है। इस परिदृश्य में, पर्याप्त तकनीकी और सहायक कर्मचारियों की पर्याप्त संख्या प्रदान करने की अनुशंसा की जाती रही है। इसके अलावा, लुधियाना में अपनी नई स्थापना में पर्याप्त प्रगति करना ओर अधिक कठिन हो गया है जो अभी तक पूर्ण रूप से स्थापित और संचालन में नहीं है। शोध प्रगति की गति को बनाए रखने के लिए, स्वतंत्र कार्यालय भवन, प्रयोगशालाओं और प्रयोगात्मक खेतों का समर्थन करके संस्थान के साथ वर्तमान में उपलब्ध बुनियादी ढांचे और सुविधाओं का विस्तार करने की तत्काल आवश्यकता है। प्रजनन कार्यक्रम को जल्दी से आगे बढ़ाने के लिए हैदराबाद में शरद ऋतू नर्सरी केंद्र को जनशक्ति और आधारभूत संरचना के साथ मजबूत किया जाना चाहिए।

कुल मिलाकर, आईआईएमआर और एआईसीआरपी केंद्रों द्वारा इस अवधि के दौरान गया काम बहुत अच्छा है। हालांकि, भविष्य के कार्यक्रम को उपलब्ध संसाधनों और परिणाम उन्मुख कार्यक्रम के कुशल उपयोग के माध्यम से क्षेत्रीय और राष्ट्रीय आकांक्षाओं को पूरा करने के लिए ध्यान केंद्रित करने की आवश्यकता है। क्यूआरटी के इस अभ्यास से उभरी सिफारिशें देश के विभिन्न क्षेत्रों की बढ़ती मांग के मुताबिक टिकाऊ मक्का उत्पादन में मदद करेंगी।

(एस.के. दत्ता)	(साइं दास)	(ए. के. शर्मा)	(आई. पी. एस. अहलावत)
अध्यक्ष	सदस्य	सदस्य	सदस्य

(के. श्रीनिवास)	(शंकर लाल जाट)
सदस्य	सदस्य सचिव

EXECUTIVE SUMMARY

Maize as versatile crop used as food, feed, fodder and source of bio-fuel. It has a wide adaptability and worldwide being cultivated in over 170 countries on an area of 188 mha with the highest productivity (5.64 t/ha) and production (1060 mt) amongst cereals (FAOSTAT, 2018). The country stands 4th in area and 7th in production in the world. Being tropical rainfed short duration crop in India, its productivity (2.6 t/ha) is not comparable with assured irrigated temperate crop under an optimum condition. During 2011-16, maize area and productivity increased by 9 lakh ha and 400 kg/ha, respectively, and increased production by 55 lakh tonnes over past period (2005-10). In this period, area and productivity increased both in *rabi* (by 5.2 lakh ha and 270 kg/ha) and *kharif* season (by 3.9 lakh ha and 330 kg/ha). In India, there is a huge variation in productivity of *kharif* season (1.5 t/ha in Rajasthan to 4.5 t/ha in Tamil Nadu) and *rabi* season (2.6 t/ha in Maharashtra to 7.9 t/ha in Andhra Pradesh) due to varied ecologies amongst major producing states. It is significantly noted that some of the districts in the country have an average productivity of 10 t/ha which is comparable with the productivity of USA.

In the past, maize was considered as a major food crop and presently it turned as an industrial crop. The poultry and livestock are the major consumers of maize followed by starch, food processing and value addition industries with only 14% used for food. The productivity in the states in different zones needs to be enhanced with development and adoption of improved technology. The area in different states is to be expanded where the maize is emerging as a remunerative crop for crop diversification.

The QRT team visited major AICRP centres representing each zone and IIMR stations including commercial seed production areas. The research programme of each station was reviewed based on their presentation and field visit. The farmer-scientist-industry interface meetings were held to know the stakeholders' needs and develop better perceptions for fine tuning research programme as per their requirement.

During this period, 89 biotic and abiotic stress resistant hybrids were released and notified for different agro-climatic conditions for commercial cultivation by farmers to replace the old varieties. Best management practices to enhance productivity and profitability with reduced cost of cultivation were developed and demonstrated. To protect the interest of researchers and hybrid development efforts, IIMR facilitated the registration of 104 varieties under PPV & FRA. The focused research on single cross maize hybrids found to be more rewarding and resource use efficient, which was supported by development, maintenance, and sharing of 6668 germplasm samples among AICRP centres to strengthen inter-institutional hybrid development programme. Germplasm is the strength of any crop improvement programme. Seventeen new germplasm lines with the specific trait (drought, quality and disease resistance) and INGR number were registered at NBPGR. Stable sources of resistance for multiple diseases (77) were identified and shared with the centres for the development of new disease-resistant cultivars.

To address the issues of water, weeds, nutrient, crop diversification and climate change; the conservation agriculture technologies (zero-tillage, bed planting) developed which have the potential for reducing the

cost of cultivation, increasing farm profitability and organic carbon. Intercropping of maize with soybean, urdbean and mungbean were developed in a regular and paired row for increasing profitability. An effective post-emergence herbicide (Tembotrione) has been recommended for broad-spectrum weed management. Cowpea intercropping with maize, a habitat management technique for management of the stem borer was recommended.

To address the issues of tribal farmers, training (103 training imparted to 6622 farmers), farm input (seed, fertilizer, herbicide, hand sheller, sprayer etc.), demonstration and literature were given to improve economy and livelihood security in hinterland through TSP programme. In the 10608 ha FLDs, the productivity significantly increased.

Sufficient breeder seed of various parents of the hybrids was produced and supplied to DAC as per the indent following the seed production chain. The scientist of IIMR and AICRP have published 734 research/review papers, won 48 awards and filed two patents. Some of the prestigious awards conferred were M.S. Swaminathan award and Jawaharlal Nehru Award for Outstanding Doctoral Thesis Research. Maize farmers supported by IIMR and AICRP were recognized at the state and national level based on their success story.

Maize research needs strengthening to compete with global research programme by the adoption of the use of new tools like genomics application, genetic engineering, genome editing, double haploid (DH) technology for rapid genetic gains in addition to the conventional breeding programme. Germplasm diversification needs to be explored under changing climate scenario. Speciality corn (QPM, SC, PC, BC, hi-starch) needs to be promoted for nutritional security, employment generation and livelihood security. These work to be taken up by the identified selected centres in AICRP programme. Demonstration of hybrid maize seed production programme by public sector organization to be strengthened at diversified sites for timely affordable quality seed availability and partnerships with the indigenous private sector for seed production to be strengthened. Duplication of research to be discouraged and inter-institutional technology development should be strengthened for efficient use of resources. Identification of sources of resistance/tolerance to various biotic and abiotic stresses under climate change needs to be strengthened. The benefit from conservation agriculture under different cropping systems to be explored and demonstrated in different ecologies. Studies on the economic impact to be undertaken periodically for complete maize value chain. In all the centres, subject matter specialist like entomology and pathology are not available, therefore, the scientist of these disciplines working in different zone and IIMR should become part of the programme for the efficient use of scientific human resources.

The progress in maize would have been much better to compete the global research provided sufficient technical manpower, sufficient funds and official staff for hassle-free administration are in place. Presently, IIMR technical and supporting staff strength is extremely low against the scientific staff positions for all major laboratory and farm operations. In this scenario, it is recommended to provide the sufficient number of technical and supporting staff. In addition, it became more difficult to make adequate progress in its new establishment at Ludhiana that is not yet properly established and in operation. To sustain the pace of progress, there is an urgent need to expand the infrastructure and facilities presently available with the Institute by supporting independent office building, laboratories and experimental farms. The winter

nursery centre at the Hyderabad needs to be strengthened with manpower and infrastructure for advancing the material and fastening breeding programme.

Overall, work done during the period by IIMR and AICRP centres is rated very good. However, the future programme needs to be focused to meet the regional and national aspirations through efficient utilization of available resources and result oriented programme. The recommendations emerged from this exercise of QRT will help in sustainable maize production as per the growing demand by various sector in the country.

(S.K. Datta)
Chairman

(Sain Dass)
Member

(A.K. Sharma)
Member

(I.P.S. Ahlawat)
Member

(K. Srinivas)
Member

(S.L. Jat)
Member Secretary

1. INTRODUCTION

All India Coordinated Research Project (AICRP) on Maize was initiated in 1957 under the aegis of Indian Agricultural Research Institute, New Delhi. Subsequently, the AICRP on Maize was upgraded into the Directorate of Maize Research (DMR) in 1994. To cater the need of north Indian AICRP centers to grow their off-season nursery, Winter Nursery Center (WNC) of DMR was established at Amberpet, Hyderabad in 1962. Subsequently, the WNC was shifted to Rajendranagar in 2008. Similarly, keeping in view the importance of maize, particularly rabi maize in eastern India, Regional Maize Research and Seed Production Centre (RMRSPC) Kushmahaut, was established at Begusarai, Bihar on 4th May 1997 with a facility of 97.3 ac farm and office buildings. Realizing the importance of maize the erstwhile DMR was upgraded to Indian Institute of Maize Research (IIMR) in February 2015. In 2016, the headquarter of IIMR shifted to Ludhiana. Currently, IIMR has sanctioned manpower of 40 scientists, five technical, seven administrative and three supporting staffs. In addition to this, AICRP on Maize has 34 centers, two of which are ICAR institutes, and two under CAU, One at BHU, and remaining are functioning under SAUs with strength of 96 scientific positions.

1.1. Maize scenario in India vis-a-vis the world

Worldwide maize was grown over 188 mha acreage in 170 countries with highest production (1060 mt) and productivity (5.62 t/ha) amongst the cereals in 2016 (FAOSTAT, 2018). It is mostly grown in China (20.7%), USA (18.7%), Brazil (8.0%) and India (5.4%). The leading producers or maize are United States of America (36.3%), China (21.9%), Brazil (6.1%), Argentina (3.8%), and Mexico, Ukraine and India contributing ~ 2.5% each to global production. Amongst the top 10 producers, the highest productivity is of USA (11.0 t/ha) followed by in Canada (9.4 t/ha), Argentina (7.4 t/ha) and Ukraine (6.6 t/ha) and India has least primarily due to tropical rainfed short duration crop in India, its productivity (2.6 t/ha) is not comparable with assured irrigated temperate crop under optimum conditions. Due to this, India ranks 7th in production while 4th in acreage of the maize in the world. Maize is the important agri-commodity in the international market and exports by country totalled US$29.6 billion in 2017. The major importers of the maize are Japan (20%), Mexico (18%), Korea (12%), Vietnam (11%), Egypt and Spain (8% each) while the major importers were USA, Brazil, Argentina, Ukraine and France (USGC report, 2018).

Last one and a half decade have seen exciting changes in maize production system in India. During 2011-16, maize area and productivity increased by 9 lakh ha and 400 kg/ha, respectively, and increased production by 55 lakh tonnes over past period (2005-10). In this period, area and productivity increased both in rabi (by 5.2 lakh ha and 270 kg/ha) and kharif season (by 3.9 lakh ha and 330 kg/ha). In India, there is a huge variation in productivity of kharif season (1.5 t/ha in Rajasthan to 4.5 t/ha in Tamil Nadu) and rabi season (2.6 t/ha in Maharashtra to 7.9 t/ha in Andhra Pradesh) due to varied ecologies amongst major producing states. Production doubled from about 11.6 million tonnes in TE 2000-01 to 23.3 million tonnes in TE 2015-16. The reasons can be attributed to raising awareness among the farmers by the public sector (field demonstrations by IIMR and its AICRP centres) and proactive efforts of private seed sector after the

introduction of 'New Policy on Seed Development, 1988'. Demand-side also has given an equal boost to maize production by showing a very positive growth in demand for the maize for different usages - different forms of food, livestock feed, poultry feed, beverages, starch, etc. The current utilization pattern of maize in the country indicates that it is mostly used for industrial purposes (85% in feed and starch) with very less for human consumption (Fig. 1.1). India exported 6.6 lakh tonnes of maize annually worth Rs 1140 Cr. during TE 2017-18 mainly to Nepal, Bangladesh, Sri Lanka, Philippines, Taiwan and Malaysia (APEDA, 2018). However, the export in TE 2017-18 decreased drastically compared to TE 2014-15 when the 51 lakh tonnes of maize worth Rs. 5718 Cr exported annually. The rising domestic demand and supply gap attributed to this, which underlines the need for increasing its production for earning forex.

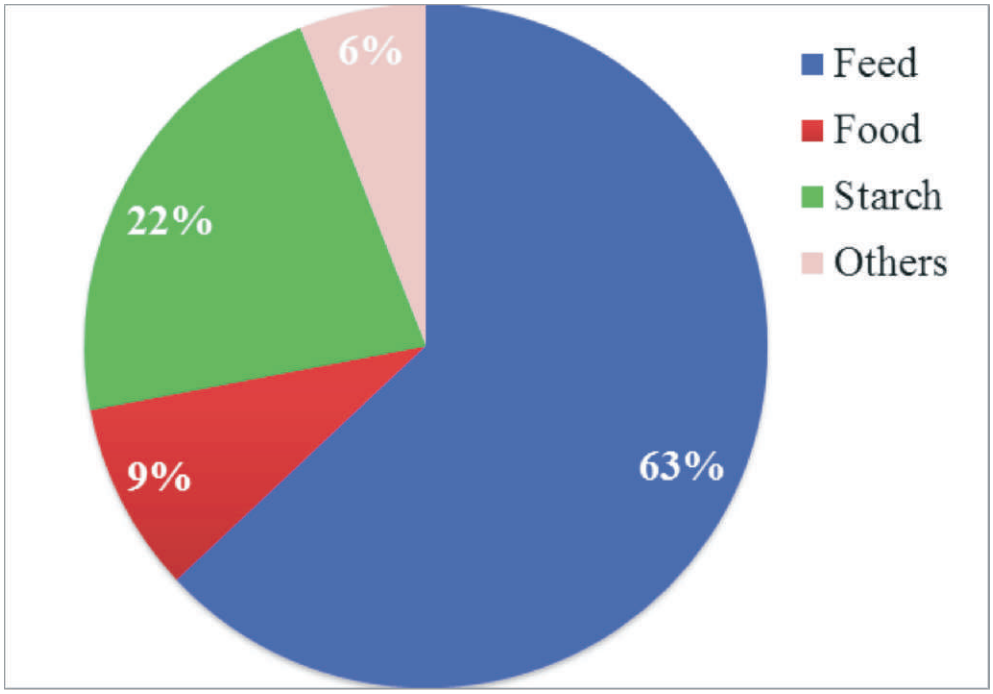


Fig. 1.1. Maize utilization pattern in India (FICCI Maize Summit, 2018).

This momentum is unmatched if compared with any other food grains, in the sense that the crop hardly gets any specific policy support from the government. Though there is a minimum support price (MSP) but no procurement by government agencies. Only private players are procuring the maize and they decide the price, which sometimes is more than the MSP and sometimes less than that.

The expansion in area and production has been accompanied also by a regional shift in cultivation since early 1990s, from the traditional maize growing belt of Indo-Gangetic Plain (IGP) region (Bihar, Madhya Pradesh, Rajasthan and Uttar Pradesh) to the central and southern plateau region (Combined state of Andhra Pradesh and Telangana, Karnataka and off late Maharashtra and Tamil Nadu). Currently, two states Andhra Pradesh including Telangana and Karnataka account for 25 per cent of total maize area of about 9 m ha and contributing roughly to 35 per cent of total maize production with an average yield of more than 3 t/ha. On

the other hand, more than 43 per cent of maize area spread over 340 districts in traditional region harvests less than 2 t/ha of maize against national average yield of about 2.5 t/ha during 2012-13 (Kumar et al., 2014).

Increasing maize productivity further depends on several factors, which are more than simply increasing the hybrids adoption. The slow and steady increase in profitability from maize cultivation has helped thousands of small and marginal farmers in ensuring the food security. This is one of the reasons that the marketed surplus of maize crop has increased in all the states, and slowly and slowly the crop becomes a cash crop. However, several challenges still pose threat to the crop, where urgent attention is needed to increase the profitability of all the stakeholders in the sector.

Improving the adoption of modern production as well as post-harvest technologies, reducing post-harvest losses, biomass management, dissemination of best production practices, improving access to a domestic and international market with an economy of scale, value creation and capturing, etc. are some of the areas where future investment is warranted from public and private sectors. Maize demand for bio fuels also can't be kept in abeyance for a long time, as many countries like China and Indonesia are importing maize to fulfil their feed as well as fuel demand. Any significant spurt in crude prices in the international market will also give pressure on this crop, for which the country needs to be ready.

On the downside, recently launched National Food Security Mission and National Food Security Act may work as the deterrent to this crop as fine cereals like rice and wheat are attracting lots of attention of the policymakers. However, the strong market demand will continue to support this crop growth in the country and the demand for maize will be 50 mt by 2025.

1.2 Quinquennial Review Team (QRT)

As per the ICAR office order F.No. CS/16/7/10-IA.IV dated 22 February 2017, Quinquennial Review Team (QRT) to review the work done by Indian Institute of Maize Research, New Delhi and AICRP on Maize during the five-year period from 2011 to 2016 has been constituted as follows.

S. No.	Name & address	Designation
1.	Dr. Swapan Kumar Datta, Vice Chancellor, Visva -Bharati, PO: Santiniketan, West Bengal-731235	Chairman
2.	Dr. Sain Dass, Former Director-Maize, C-141, 2nd Floor, Moti Nagar, Delhi-110015	Member
3.	Dr. A.K. Sharma, Ex-Director ICAR-NBIAM, House No. 1686, Urban Estate, Sector- 9, Karnal-131001(Haryana)	Member
4.	Dr. I.P.S. Ahlawat, Former Head, Division of Agronomy, IARI J-401, Green Valley Apartment, Plot No. 18, Sector. 22, Dwarka- Delhi-110077	Member
5.	Dr. K. Srinivas, Principal Scientist, Research System Management Division, NAARM, Rajendranagar, Hyderabad-500030 (Telangana)	Member
6.	Dr. Shankar Lal Jat, Scientist, IIMR Unit, New Delhi	Member Secretary

The committee reviewed the progress of the IIMR and AICRP on maize by conducting meetings and visits of various AICRP centres and institute stations as follows:

S. No.	Place	Date/s	Purpose
1.	Delhi	June 20, 2017	• Meeting with DG/DDG • Overview of project progress • Plan of QRT review
2.	Godhra	July 19-20, 2017	• Review of Central and Western Zone Centres (05) • Meeting with Starch & Distillery Industries
3.	Shantiniketan	August 8-9, 2017	• Review of North Eastern Plain Zone (NEPZ) and Northern Hill Zone (EH) centres (11)
4.	Hyderabad	August 21-22, 2017	• Review of Peninsular Zone centres (08); Visit to WNC and Hyderabad centre • Interaction meeting with Seed and Poultry Industry
5.	Ludhiana	October 15-17, 2017	• Review of North Western Plain Zone (NWPZ) and Northern Hill Zone (EH) centres (10) • Visit to IIMR Field & Lab
6.	Elleru and Hyderabad	March 05-06, 2018	• To visit *rabi* maize programme of Winter Nursery Centre, IIMR and PJTSAU at Hyderabad • To visit the hybrid maize seed production areas of Elleru district in Andhra Pradesh

Meeting with DG ICAR

DDG(CS) ICAR

QRT visit at Godhra station

Meeting with starch industries at Godhra

Meeting at Shantiniketan

Meeting with feed and seed sector at Hyderabad

QRT meeting at Hyderabad

Visits to Hyderabad centre and WNC IIMR

1.3 Vision, Mandates and Objectives

ICAR has two units for conducting maize research in India. One is the Indian Institute of Maize Research located at Ludhiana (IIMR), which deals mainly with basic and strategic research issues. The other is an All-India Coordinated Research Project on maize (AICRPM) with 32 centres in SAUs/CAU spread over 23 states to conduct applied research and pilot extension in a network mode. The AICRPM also has two centres at ICAR institutes.

A. 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.

B. Mandate of IIMR

- Basic and strategic research aimed at enhancement of productivity and production of maize, including speciality 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

C. Mandate of AICRP Maize

- Develop superior hybrids and varieties combining high yield and acceptable quality of grain and fodder, wider adaptability and resistance to major pests, diseases and abiotic stress factors for each zone
- Evolve appropriate crop management practices and formulate efficient maize-based cropping systems for sustainable maize production in each zone

- Conduct investigations on key or potential pests and diseases of maize and identify and evolve elite sources of resistance to develop suitable integrated plant protection strategies for increasing the stability of production
- Promote research and extension to meet local needs within each state through SAUs and other partners

D. *Objectives of IIMR*

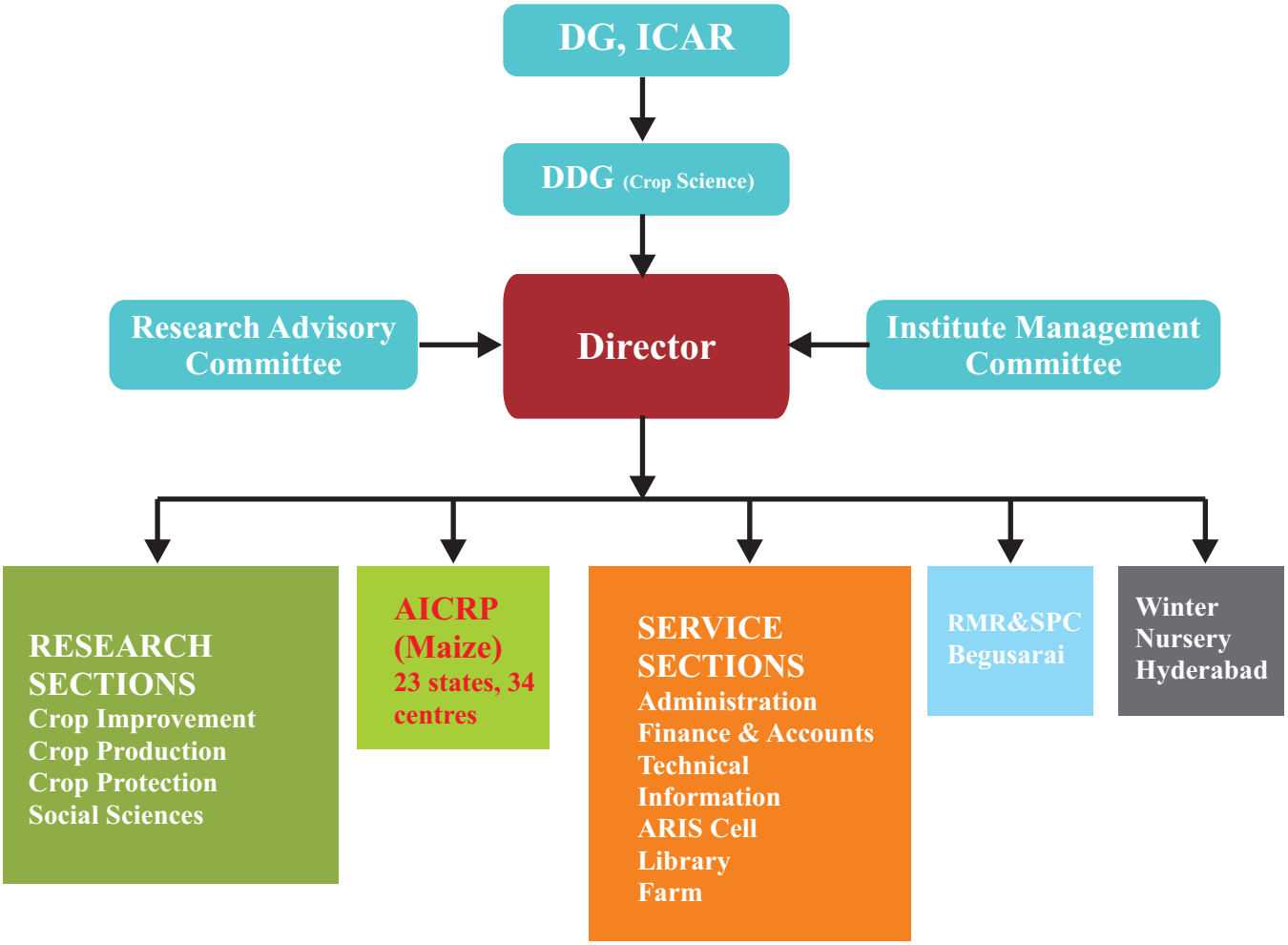
- To carry out basic, strategic and applied research aimed at enhancement of production and productivity of maize in the country.
- To conduct and coordinate multidisciplinary and multi-location research to identify appropriate technologies for varied agro-climatic conditions in different parts of India.
- Germplasm collection, evaluation, maintenance and its enhancement.
- To develop speciality corn cultivars such as Quality Protein Maize, baby corn, sweet corn, bio-fuel etc towards its diversified uses.
- To conduct training, frontline demonstrations and on-farm research to maximize and accelerate adoption of research findings and innovative technologies.
- To serve as core centre for the supply of maize research material and information.
- To develop linkages with the national, international and private sector for the collaborative research program.
- To provide consultancy services and undertake contractual research.
- Postharvest studies for value addition, quality control and storage
- To evaluate technologies and transfer it as per IP policies of ICAR

E. *Objectives of All-India Coordinated Research Project on maize (AICRPM)*

- Execution of strategic and applied research for genetic improvement in yield, quality and resistance to biotic and abiotic stresses.
- Development of varieties and hybrids with emphasis on single cross hybrids of different maturity durations to fit into *kharif*, *rabi* and spring cropping seasons and maize-based cropping systems for location-specific conditions in different parts of India.
- Development of efficient package of practices for increasing productivity
- Tailoring maize for diversified uses for industry and special purposes in other sectors such as Quality Protein Maize, Baby corn, Sweet corn, Bio-fuel, etc.
- Strategic research on post-harvest handling and value addition of maize.
- Maintenance, development and evaluation of germplasm for use in breeding.
- To organize breeder seed production programme for maize hybrids and cultivars.
- To organize on-farm research to reduce the yield gap between attainable and realized yield on farmers fields.

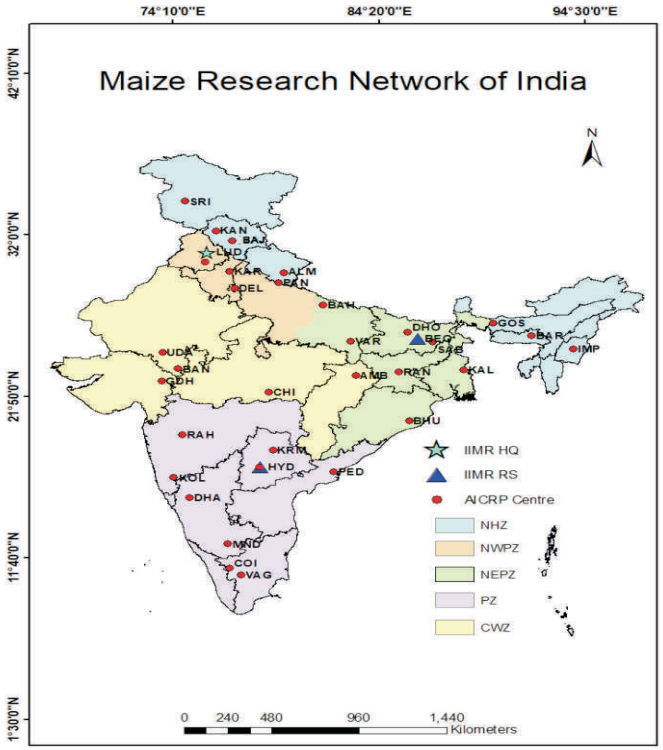
1.4 Organization

The organization works under the Crop Science division of ICAR and having two regional stations and 34 AICRP centres to cater the need of maize R4D in India. For the project prioritization, monitoring and evaluation the Institute has PME Cell. The PME Cell get technical output from the PME Committee and execute the decisions. Besides, there is Result Framework Document Cell and RFD Committee for taking into account the research output periodically. The ITMU Cell that is headed by the Project Director deals with the IPR issues. The Research Advisory Committee advises on the research activities of the institute. The Chairperson and Members of RAC are appointed by ICAR. Besides, it has an Institute Biosafety Committee having a DBT nominee as one of the members, which ensure the compliance of bio-safety measures in various research activities. The ARIS cell of the institute ensures the use of UICT in maize R4D along with the use of Institute personnel management system and financial management system developed by ICAR. Institute is having one Hindi Cell to promote the use of Hindi in the day-to-day official communication. The organogram is as follows:



1.5 Zone-wise AICRP Centres:

The distribution of AICRP centres in various zone of the country is given in map and Table, of the country that shows that it has pan India presence for maize R4D in the country.



Zone name	Centres
Northern Hill Zones (NHZ)	Srinagar, Udhampur, Kangra, Bajaura, Almora*, Barapani, Imphal (7)
North West Plain Zone (NWPZ)	Ludhiana, Karnal, Pantnagar, Delhi*, Kanpur (5)
North East Plain Zone (NEPZ)	Bahraich, Varanasi, Dholi, Sabour, Ranchi, Kalyani, Ambikapur, Bhubaneshwar, Gossaingaon (9)
Peninsular Zone (PZ)	Rahuri, Karimnagar, Hyderabad, Kolhapur, Dharwad, Mandya, Coimbatore, Vagarai (8)
Central Western Zone (CWZ)	Udaipur, Banswara, Jhabua, Godhra, Chhindwara (5)

* ICAR institute

1.6 Interaction and Linkage

The institute has strong collaboration and linkages with the sister organization, international organizations and SAUs for strengthening maize R4D in the country.

a. Local institutions in the area –Delhi and Ludhiana

- IARI, New Delhi
- NBPGR, New Delhi
- NRCPB, New Delhi
- IASRI, New Delhi
- PAU Ludhiana
- CIPHET, Ludhiana
- New Potential linkages can be NIFTEM, IIFT, CFTRI etc.

b. Other National Institutes and Agricultural Universities

National Institutes:

- DBT, New Delhi
- DST, New Delhi
- NASF, New Delhi
- NAIP, New Delhi
- IIFSR, Modipuram
- IGFRI, Jhansi
- PPV&FRA, New Delhi
- NIAB, Chandigarh

Agricultural Universities:

- Anand Agricultural University, Anand
- Assam Agricultural University, Jorhat
- Bihar Agricultural University, Sabour
- Maharana Pratap University of Agriculture & Technology, Udaipur
- MPKV, Rahuri

- Birsa Agricultural University, Ranchi
- CSAUAT, Kanpur
- CCS Haryana Agricultural University, Hisar
- Central Agricultural University, Imphal
- GB Pant University of Agri. & Technology, Pantnagar
- JNKVV, Jabalpur
- IGKVV, Raipur
- OUAT, Bhubaneshwar
- PJTSAU, Hyderabad
- RVSKV, Gwalior
- SKUAS&T, Jammu
- SKUAS&T, Kashmir
- Tamil Nadu Agricultural University, Coimbatore
- University of Agricultural Sciences, Bengaluru
- University of Agricultural Sciences, Dharwad

a. International institutions

- CIMMYT, Mexico

b. Extension and Development Agencies

- Department of Agriculture and Cooperation Ministry of Agriculture, Government of India
- Directorate of Millet Development (DMD), Department of Agriculture and Cooperation, MoA, Jaipur.

e. Private sector organizations:

Ankur Seeds Pvt. Ltd
Bhaskara Jyothi Agri Businesses Pvt Ltd
Bioseed Research India Pvt Ltd
Bisco Bio Sciences Pvt Ltd
Dayal Seeds Pvt Ltd
Namdhari Seeds Pvt Ltd
Pioneer Hibred Private Ltd
Rasi Seeds Pvt Ltd
Sayaji Groups
Shakti Vardhak Hybrid Seed Pvt Ltd
J.K. Agrigenetics
Kaveri Seed Company Pvt Ltd
Mahindra Agri Solutions Ltd
Metahelix Life Sciences
Siri Seeds(India) Pvt. Ltd.
SM Sehgal Foundation
Sungro Seeds Pvt ltd
Syngenta Foundation for Sustainable Agriculture
VNR Seeds Pvt Ltd
CP Seeds Pvt Ltd

2. MANAGEMENT

As per ICAR guidelines following meetings were conducted and the recommendations were incorporated in the programme to strengthen maize research. The recommendations of the RAC, IRC, IMC and the annual workshops were followed in strengthening the maize R4D in the country during 2011-16. The details of the meetings conducted are as follows:

2.1 Research Advisory Committee (RAC)

Chairman: Dr. J.B. Sharma (2011), Dr. B.S. Dhillon (2012-14), Dr S.K. Sharma (2015-17)

Member Secretary: Dr. K.S. Hooda and Dr. P. Kumar, Principal Scientist

Research Advisory Committee meetings were held during the period on the following dates:

Years	Dates	Year	Dates
2011	13th June	2014	13-14th June
2012	3rd June	2015	25-26th May
2013	2nd June	2016	27 -28th May

2.2 Institute Research Council (IRC)

Chairman: Director, IIMR

Member Secretary: Dr. K.S. Hooda and Dr. Ishwar Singh, Principal Scientist

Institute Research Council meetings were held during the period on the following dates:

Years	Dates	Years	Dates
2011	October 20-22nd	2014	May 2-3rd, August 14th
2012	June 18th	2015	May 28 -29th
2013	June 26 -27th	2016	May 4th , January 29th

2.3 Institute Management Committee (IMC)

The Institute Management Committee meetings were held on regular basis in chair of Director of the institute. Major recommendations were pertaining to monitoring of expenditure and they are complied with from time to time. All-important decisions implemented effectively. IMC meetings were held on the following dates:

2011	17th May	2012	11th July
2014	10th January, 30th August	2016	29th March

2.4 AICRP Annual Maize workshop

The institute held AICRP on maize workshop annually to review the progress and finalization of yearly

work plan and the recommendations emerged were followed for strengthening maize R&D in the country. The details of the workshop held were as follows:

Workshop	Place	Dates
54th	TANU, Coimbatore	April 02-04, 2011
55th	CCSHAU, Hisar	April 20-22, 2012
56th	ANGRAU, Hyderabad	April 06-08, 2013
57th	MPUAT, Udaipur	April 21-23, 2014
58th	PAU, Ludhiana	April 04-06, 2015
59th	UAS, Bangalore	April 10-12, 2016

3. MISCELLANEOUS INFORMATION

3.1 Awards and honours:

Year-wise Awards and Honours received by the IIMR and AICRP maize scientists were as follows:

Type of the award	Conferred By/occasion	Awarded to
2011-12		
MS Swaminathan award	For outstanding works in the field of agriculture.	Dr R Sai Kumar
Best Institution Award	For promoting Plant Variety Registration by PPVFRA.	Directorate of Maize Research
Young scientist award	Society of Extension Education, Agra during 6th National Extension Education Congress	Dr. VK Yadav
Academy for Advancement of Agricultural Sciences Senior Award-2011	Indian Society for Plant Physiology during 53rd National Conference of Plant Physiology (NCPP-2011)	Dr. Ishwar Singh
Young scientist award	Society for Recent Development in Agriculture during the International conference at SVPUA&T, Meerut	Dr. Dharam Paul Chaudhary
Jawaharlal Nehru Award for Outstanding Doctoral Thesis Research	Indian Council of Agricultural Research, New Delhi on the occasion of Foundation Day of the ICAR	Dr Chikkappa G. Karjagi
Best Poster Award	XI Asian Maize Conference, Nanning, P.R. China	Dr. Meena Shekhar
The Manthan Award	WEB-enabled access of agricultural information through pc and mobile devices	Dr. C. S. Singh
2012-13		
Best Scientist Award Fellow Members of Research Advisory Board	55th Annual Maize Workshop Indian Society of Agronomy Institute of Pesticides Formulation Technology, Gurgaon, Haryana	Dr. J. C. Sekhar Dr. Ashok Kumar Dr. Pradyumn Kumar
2013-14		
Jawaharlal Nehru Award for Outstanding Doctoral Thesis Research	Indian Council of Agricultural Research, New Delhi on the occasion of Foundation Day of the ICAR	Dr Ganapati Mukri
Shreeram Puruskar	Fertiliser Association of India for best popular article	Drs CM Parihar, SL Jat, AK Singh
2014-15		
Dr. R.K. Arora Best Paper Award	Indian Society of Plant Genetic Resources	Dr. O.P. Yadav
Distinguished Scientist Award	Society for Scientific Development in Agriculture & Technology during National Conference at DRR, Rajendranagar, Hyderabad	Dr. S.B. Singh

Type of the award	Conferred By/occasion	Awarded to
Best Poster Award	12th Asian Maize Conference at Thailand	Dr K.S. Hooda et al.
Best Poster Award	12th Asian Maize Conference at Thailand	Dr S.L. Jat et al.
Best AICRP centre award	Annual maize workshop 2014	PAU, Ludhiana
IInd position in the oral presentation	National Symposium on "Innovations in Horticulture: Production to Consumption	Dr. R.P. Singh
Faculty Excellence Award	G. B. Pant University of Agriculture & Technology, Pantnagar	Dr. N.K. Singh
P. S. Deshmukh Young Agronomist Award-2014	Indian Society of Agronomy, New Delhi.	Dr. C. M. Parihar
Jawahar Lal Nehru Award	Outstanding Doctoral Thesis Research in Agricultural and Allied Sciences–ICAR (2014)	Dr. Vignesh Muthusamy
N.R. Bhat Memorial Award	Research Paper published from PhD thesis–ISGPB (2014)	Dr. Vignesh Muthusamy
Best poster award	Genetic architecture and response of maize (*Zea mays* L.) hybrids under different nutrient (NPK) levels in late *kharif* condition	Dr. Vignesh Muthusamy
Skoth Order of Merit	WEB-enabled access of agricultural information	Dr. C. S. Singh
2015-16		
Innovative Scientist of the Year Award-2015	International Conference on Innovative Approaches in Applied Sciences and Technologies at Thailand	Dr. S.B. Singh
Outstanding Achievement Award	Society for Scientific Development in Agriculture & Technology during GRISAAS-2015	Dr. S.B. Singh
Young Scientist Award	ICAR-Indian Institute of Maize Research on 1st Foundation Day	Dr. C.M. Parihar
Outstanding Research Contribution Award	ICAR-Indian Institute of Maize Research on 1st Foundation Day	Dr. C.M. Parihar
Young Scientist Award	Society for Scientific Development in Agriculture & Technology	Dr. Bhupender Kumar
Appreciation certificate	ICAR-Indian Institute of Maize Research on 1st Foundation Day	Dr. Bhupender Kumar
Best Poster Award	National Conference on Global Research Initiatives for Sustainable Agriculture & Allied Sciences, RVSKVV, Gwalior	Dr. Nirupma Singh et al.
Best Poster Award	6th International Conference "Plant, Pathogens and People", New Delhi	Dr. Nirupma Singh et al.
Best Poster Award	National Seminar on Integrating Agri-Horticultural and Allied Research for Food and Nutritional Security in the Era of Global Climate Disruption, Imphal, Manipur	Dr. S.L. Jat et al.

Type of the award	Conferred By/occasion	Awarded to
Best AICRP centre award 2015	Annual maize workshop 2015	TNAU, Coimbatore
Best Paper Award	36th Annual Conference and National Symposium organized by Indian Society of Mycology and Plant Pathology with TNAU 2015	Dr. RP Singh
Best teaching practices award	Faculty of Agriculture, GBPUAT, Pantnagar	Dr. Amit Bhatnagar
Javahar Lal Nehru Best Ph.D. thesis award	Genetic Evaluation and characterization of maize (*Zea mays* L.) hybrids under rainfed and limited irrigation condition	Dr. Rameswar Prasad Sah
Best book Award for the Agronomy	Diploma Agriculture Students organized (2015)	Dr. P. Thukkaiyannan
2016-17		
Best Book Contribution Award	Second National Conference on *Agricultural Scientific Tamil* (2016)	Dr. P.Thukkaiyannan
Third Best Paper Award	Management of Stemphylium blight of onion by the use of bio-control agents" in National Symposium organized by Indian Phytopathological Society, 2016	Dr. R.P. Singh
Dr. Joginder Singh Memorial Award	Outstanding research contributions in maize genetics and breeding - ISGPB (2017)	Dr. Firoz Hossain
Best Teacher Award	37th Foundation Day of the Birsa Agricultural University (2017)	Dr. Vignesh Muthusamy
Best paper award	Identification of potassium responsive genotypes for yield and other traits in maize. Veena Kumari Tudu and Manigopa Chakraborty. *In* National Conference on Perspective of Challenges and Options in "Maize Production and Utilization" (2017)	Dr. Vignesh Muthusamy
Eminent scientist award	Outstanding contribution in the field of Agriculture conferred by Samagra Vikas Welfare Society and Bhartiya Cine Karmchari Sangh on World Environment (2017)	Dr. Vignesh Muthusamy
Scientist of the year Award	International Foundation of Environment and Ecology	Dr. Vignesh Muthusamy
International Plant Nutrition Institute Scholar Award	Genetics of drought tolerance in maize (*Zea mays* L.) under different potassium levels	Ms. Veena Kumari Tudu

Sri Ram Kewal Gupta Village Begampur, Baharcih received First prize on maize production in state year 2014.

Sri V. Venkateshwar Rao, Khanapur Village, Warangal received ICAR innovative farmer award from Union Agriculture Minister Sri Radha Mohan Singh, Govt. of India on 19th March 2016 in the reorganization of achieving highest yields in maize by adopting drip irrigation in paired row technology.

Sri R. Laxma Reddy, Desaipally (V), Boinpally (M), Karimnagar received ICAR innovative farmer award for the year 2012 in the reorganization of Zero-tillage maize.

3.2 Externally Funded Projects

S. No.	Funding agency	Title of the Project	Duration
1.	ICAR	Mega seed project.	2007-17
2.	PPV&FRA	Strengthening DUS test centres for effective implementation of PVP legislation.	2008-17
3.	ICAR-Network Project	Development of Maize Transgenic for Stem Borer Resistance.	2012-17
4.	ICAR-Network Project	Functional genomics of drought tolerance in maize.	2012-17
5.	ICAR -CRP	CRP on Maize Agro-biodiversity.	2014-17
6.	ICAR-CRP	National Initiative on Climate Resilient Agriculture (NICRA).	2015-17
7.	ICAR-EMF	Genetic Enhancement for low moisture stress tolerance in Maize.	2015-17
8.	ICAR-CRP	Incentivizing Research in Agriculture (BNF).	2015-17
9.	ICAR-CRP	Molecular breeding for improvement of tolerance to biotic and abiotic stresses, yield and quality traits in crops.	2015-17
10.	DST-WOSA	Study of host pathogen interactions as affected by extra chromosal factors dsRNA and DNA Plasmids in *Rhizoctonia* sp".	2014-17

S. No.	Funding agency	Title of the Project	Duration
11.	ICAR-NASF	Genetic Transformation and Development of Elite Transgenic Maize (*Zea mays* L.) for Biotic and Abiotic Stresses.	2015-18
12.	RKVY	RKVY project on "Development of QPM (quality protein maize) through biotechnological approaches"	2007-08
13.	ICAR CIMMYT	International Project (BMZ) entitled "Abiotic stress tolerant maize for increasing income and food Security among the poor in South and Southeast Asia	2011-14
14.	NAIP	Bio-prospecting and allele mining for abiotic stress tolerance.	2009-12
15.	RKVY	Organic farming base d integrated farming system-promotion, production & marketing of organic produce through self-help group.	2016-19
16.	CRP MAIZE, CIMMYT	Promotion of hybrid maize through evaluation, seed production and on-farm demonstration.	2013-16
17.	ICAR (Extra Mural Research)	Genetic enhancement of low moisture stress tolerance in maize.	2015-16
18.	Bayer Crop Science Ltd.	Evaluation of efficacy of Laudis 420 SC (Tembotrione 420 SC) in maize.	2016-18
19.	Novozymes South Asia Pvt. Ltd., Bangalore	Agronomic Bio-efficacy of Products for Seed Treatment in Corn.	2014-15
20.	DBT	Rapid conversion of normal maize inbreds to quality protein maize and further enhancement of limiting amino acids in elite inbreds through marker-assisted selection.	2009-14
21.	DBT	Development of micronutrient enriched maize through molecular breeding –Phase-II.	2012-17
22.	DBT	Enrichment of nutritional quality in maize through molecular breeding.	2015-20
23.	ICAR	Consortia Research Platform on 'Biofortification in selected crops for nutritional security-Maize component.	2014-20
24.	ICAR	Consortia Research Platform on 'Molecular breeding for improvement of tolerance to biotic and abiotic stresses, yield and quality traits in crops'.	2015-20
25.	DST/ SERB	Development and validation of gene-based markers for *sugary1* and *shrunken2* genes for improvement of sweet corn trait in maize (*Zea mays*) under SERB-Young Scientist Scheme awarded to Dr. Rashmi Chhabra	2015-18
26.	DST/ SERB	Development of low phytic acid (*lpa*)-based quality protein maize (QPM) genotypes through marker-assisted selection.	2016-19
27.	BRNS, BARC, Mumbai	To develop drought tolerant soybean mutants having good agronomic characteristics such as short stature, early maturing, high yielding and high oil percentage.	2014-Continue
28.	Ministry of electronic and communication technology	Web-enabled access of agricultural information through PC and mobile devices" collaborative project between BAU, Ranchi and C-DAC, Kolkata.	2010-13

S. No.	Funding agency	Title of the Project	Duration
29.	ICAR, New Delhi	Network Project on Organic Farming.	2011-Continue
30.	CIMMYT-India in collaboration of BAU	Sustainable Intensification of Smallholder Maize-Livestock Farming Systems in Hill Areas of South Asia.	2011-14
31.	Ministry of electronic and communication technology	DISC-Mission for Developing Digitally Inclusive and Smart Community" in collaborative project between BAU, Ranchi, C-DAC, Pune and C-DAC, Kolkata.	2015-18
32.	ICAR, New Delhi	Farmers First programme.	2016- Continue
33.	BRNS, BARC, Mumbai	To develop drought tolerant soybean mutants having good agronomic characteristics such as short stature. early maturing, high yielding and high oil percentage	2014- Continue
34.	ICAR, New Delhi	Network Project on Organic Farming	2011- Continue
35.	CIMMYT-India in collaboration of BAU	Sustainable Intensification of Smallholder Maize-Livestock Farming Systems in Hill Areas of South Asia	2011-14
36.	CMFRI, Bhavnagar, Gujarat	Efficacy of sea weed sap for enhancing the productivity and quality of *kharif* crops	2012-14
37.	Ministry of electronic and communication technology	DISC-Mission for Developing Digitally Inclusive and Smart Community" in collaborative project between BAU, Ranchi, C-DAC, Pune and C-DAC, Kolkata	2015-18
38.	ICAR, New Delhi	Farmers First programme	2016- Continue
39.	RKVY	Farmers participatory crop breeding for strengthening local seed systems	2013-17
40.	UGC	Diversity analysis of maize inbred lines for development of hybrids in temperate ecologies using morpho-molecular markers	2015-18
41.	PPVFRA	Collection, Characterization and Utilization and Registration of Farmers varieties of Maize Land Races from Kashmir Valley	2016-19
42.	RKVY	Enhancing Rural Livelihood Through Popularization of Sweet corn (*Zea mays saccharata* L.)	2016-19

3.3 Scientists engaged in teaching and student guidance

The scientist of IIMR and AICRP maize engaged in teaching and guidance of the students during 2011-16 were as follows:

Institution	Scientists engaged in teaching and student guidance
IARI, New Delhi	Drs. P. Kumar, Ishwar Singh, A.K. Singh, Dharam Paul, C.M. Parihar, S.L. Jat and Pranjal Yadava
PAU, Ludhiana	Drs JS Chawla, Gurjit Kaur Gill Ranmesh Kumar, Mukesh Chaudhary, Dharam Paul, Mahesh Kumar, Jawla Jindal and Harleen Kaur
SKUAST, Srinagar	Drs. Zahoor Ahmed Dar, Bashir Ahmad Alaie and Ajaz Ahmad Lone

Institution	Scientists engaged in teaching and student guidance
RMD College of Agriculture, Ambikapur	Drs. S.K. Sinha and A.K. Sinha
TNAU, Coimbatore	Drs.G. Nallathambi, R.Ravikesavan, Renukadevi, A.P.Sivamurugan
UAS, Dharwad	Drs. M.C. Wali, S.I. Harlapur, R.M. Kachapur, S.C. Talekar, S.R. Salakinkop
Tirhut College of Agriculture, Dholi	Drs. Mritunjay Kumar, Ajay Ku mar, Tanweer Alm, Usha Singh and Phoolchand
ANGRAU, Hyderabad	Drs. V. Narsimha Reddy, M. Lavakumar Reddy, D. Sreelatha, Shaik Ameer Basha
CAU, Imphal	Drs. Th. Renuka Devi and Amit Kumar Singh
CSAUAT, Kanpur	Dr. H.C. Singh
Maharashtra Shahu Agricultur e College, Kolhapur	Drs. S.R. Kulkarni, U.M. Borle, S.S. Majadol, S. Pilani and S.S. Patil
College of Agriculture, Mandya	Drs. Puttaramanaik, N. Mallikarjuna and D. Shobha
BCKVV, Kalyani	Drs. Srabani Debnath and Sonali Biswas
GBPUAT, Pantnagar	Drs. Pradeep Kumar, S.S. Verma, N.K. Singh, R.P. Singh, Amit Bhatnagar and Veer Singh
BAU, Kanke, Ranchi	Drs. M. Chakraborty and C.S. Singh
MPUAT, Udaipur	Dr. R.B. Dubey, Dilip Singh, Mukesh Vyas, B.L. Baheti, S.S. Sharma, M.K. Mahala and Amit Dadheech
Banaras Hindu University, Varanasi	Drs. J.P. Shahi and R.N. Singh

3.4 Budgetary support for the programme during 2011-16

A. AICRPM - Year-wise plan expenditure (Rs in lakhs)

Head	2011-12	2012-13	2013-14	2014-15	2015-16	Total
Salary	1297*	915	1102	1094	1642	6050
Contingency	151	141	150	60	229	731
TA	23.1	22.4	23	44	50	163
Other (TSP and NEH)	45	21.1	35	26	78	205
Total	1516	1099	1310	1224	1999	**7148**

**Include pay arrear*

B. IIMR- Year-wise expenditure (Rs in Lakhs)

Head	2011-12	2012-13	2013-14	2014-15	2015-16	Total
Capital	100	75	0	74	50	298
Revenue	225	375	316	376	400	1692
Total	325	450	316	450	450	**1990**

3.5 Research facilities and infrastructure developed

Equipment and vehicles purchased, major works undertaken during the 2011-16 by IIMR were as follows:

S. No.	Name of the equipment	Cost (Rs. in lakh)
1.	Root image analysis system	14.92
2.	Double beam digital spectrophotometer	7.10
3.	Digital penetrometer with accessories	6.41
4.	Automatic TOC	22.20
5.	A Set-up for blotting experiments, comprising of Mini-PAGE apparatus UV cross linkers Semidry electro blot transfer unit with Power packs	10.96
6.	Refrigerated storage facility:- 70°C Ultra Low Deep Freezer and -20°C Deep Freezer 4°C large cool cabinet	11.68
7.	Autoclave	4.80
8.	Electrophoresis Unit	2.94
9.	Tetrad PCR	21.42
10.	Retsch Mill	5.48
11.	Variable mode fluorescence imaging and documentation system	15.71
12.	Tractor	16.09
13.	SPAD Meter (Two)	5.00
14.	Infrared thermometer	3.39
15.	Atomic Absorption Spectrophotometer	10.00

In addition, to above, IIMR also has presently one rain shelter and greenhouse at Delhi unit. Presently functional laboratories of biotechnology (Delhi unit), plant pathology (Delhi unit and Ludhiana) entomology (Delhi unit and Hyderabad), agronomy (Delhi), biochemistry (Ludhiana). etc. It has only small sitting and laboratory space at WNC, Hyderabad. However, at Begusarai, laboratories and guest house is established.

Vehicle: A staff car was purchased during 2014 by IIMR. In addition to this, IIMR has two more gipsies of more than 10 years old.

Works Undertaken

S. No.	Description	Amount (Rs in lakhs)
1	Construction of threshing floor with shed at RMR& SPC, Begusarai	10.08
2	Boundary wall of the farm at RMR&SPC, Begusarai	17.63
3	Contour mapping and tube well at Ludhiana	2.79

However, in AICRP on maize no equipment, vehicle and works undertaken during 2011-16.

3.6 Manpower support for the programme

IIMR

Position	Approved	In-position
Scientific position		
Scientist	31	21
Senior Scientist	4	4
Principal Scientist	5	2
Technical position		
Technical assistant (T3)	6	3
Supporting Staff	3	3
AO	1	1
AF&AO	1	1
AAO	1	0
Assistant	4	2
UDC	1	1
LDC	2	0
Private Sec.	1	1
Personal Asst.	1	0
Stenographer	1	0

AICRP on maize

Total manpower approved during the reporting period was as follows :

S. No.	Type	Sanctioned positions
1	Scientific	96
2	Technical	149
3	Administrative	23
	Total	**268**

Centre-wise approved manpower during XII plan (2012-17) was as follows:

S. No.	AICRP Centre	Scientific				Technical	Administrative	Total
		PS	SS	S	Total			
1	SKUAST, Srinagar	0	1	2	3	5	1	9
2	HPKVV, Bajura	0	1	4	5	7	1	13
3	HPKVV, Kangra	0	0	2	2	4	0	6
4	AAU, Godhra	0	1	1	2	3	1	6
5	PAU, Ludhiana	1	2	3	6	11	1	18
6	CSA, Kanpur	0	1	1	2	4	0	6
7	GBPUAT, Pantnagar	1	1	2	4	6	1	11
8	NDUAT, Bah araich	0	1	2	3	6	1	10
9	RAU, Dholi	0	1	3	4	7	1	12
10	JNKVV, Chhindwara	0	1	1	2	4	0	6
11	MPUAT, Udaipur	0	3	3	6	8	2	16
12	MPUAT, Banswara	0	1	1	2	3	0	5
13	OUAT, Bhubaneswar	0	1	1	2	5	1	8
14	AAU, Godhra	0	1	1	2	4	0	6

S. No.	AICRP Centre	Scientific				Technical	Administrative	Total
		PS	SS	S	Total			
15	ANGRAU, Hyderabad	1	1	3	5	9	2	16
16	ANGRAU, Karimnagar	0	1	1	2	4	0	6
17	MPKV, Kolhapur	0	1	3	4	6	2	12
18	UAS, Dharawad	0	1	3	4	5	1	10
19	UAS, Mandya	0	1	3	4	6	2	12
20	TNAU, Coimbatore	**0**	1	2	3	5	1	9
21	CCSHAU, Karnal	0	1	3	4	7	1	12
22	IGKVV, Ambikapur	0	1	1	2	3	0	5
23	BHU, Varanasi	0	1	1	2	3	0	5
24	BAU, Ranchi	0	0	2	2	3	0	5
25	SKUAST, Udhampur	0	0	2	2	3	0	5
26	RVSKVV, Jhabua	0	0	2	2	3	0	5
27	TNAU, Vagarai	0	0	2	2	3	0	5
28	BCKV, Kalyani (WB)	0	1	2	3	3	1	7
29	BAU, Sabour, Bhagalpur (Bihar)	0	0	2	2	2	1	5
30	MPKV, Rahuri (Maharas htra)	0	0	2	2	2	1	5
31	CAU, Imphal (Manipur)	0	1	3	4	3	1	8
32	CAU, Barapani, Shillong (Meghalaya)	0	0	2	2	2	0	4
	Grand Total	**3**	**27**	**66**	**96**	**149**	**23**	**268**

4. PERFORMANCE OF IIMR

The research activities and their output during 2011-16 in respect of IIMR are being summarized in this chapter.

4.1 Crop improvement

Presently, ICAR-Indian Institute of Maize Research, Ludhiana is involved in several collaborative projects involving multi-institutions namely National Innovation on Climate Resilient Agriculture (NICRA), Consortia Research Platform on Agrobiodiversity (CRPAB), Consortia Research Platform on Biofortification, and Consortia Research Platform on Molecular Breeding (CRPMB). The main objectives of the above projects, funded by Indian Council of Agricultural Research (ICAR) are (i) identification climate resilient maize genotypes with tolerance to different moisture stresses, (ii) characterization of germplasm accessions conserved in gene bank at National Bureau of Plant Genetic Resources, (iii) development of new genetic or breeding material with enhanced nutritional value through marker assisted pedigree breeding method and also to explore for new alleles for different nutritional traits and (iv) conversion of elite inbred lines through marker assisted introgression of genes determining high nutritional value like high-lysine and tryptophan, low phytic acid, higher provitamin A. In addition, the institute is also involved in one collaborative project, Climate Resilient Maize for Asia (CRMA) with CIMMYT. The project focuses mainly identification of climate resilient hybrids through large scale phenotyping of new and high yielding hybrids under drought and water logging conditions. In addition, dedicated projects are running on various aspects like development of different of normal maize and quality protein maize hybrids for different ecologies with special focus on eastern India, to develop new and high-yielding hybrids, characterization and diversification of maize germplasm to identify sources of resistance to different biotic stresses and diversify genetic base of existing germplasm, strengthening and genetic enhancement of white maize, sweet corn, baby corn, high oil, fodder as well to meet the future requirement due to diversified uses of maize. Thus, the above projects are focuses on basic, applied and strategic research different areas.

1. In the last five years, a total of 6668 germplasm samples have been demonstrated and shared to various partners working across the country
2. 11 germplasm lines have been registered at NBPGR with INGR number for biotic stress tolerance and improved nutritional quality by IIMR. The list is as follows:

National identity	Donor identity	INGR No.	Year	Pedigree	Developers	Characteristics
IC0589137	DMRHO57	INGR11027	2011	Temp x Trop (H0)QPM-B-B-B-57-B-B	R Sai Kumar et al.	For high oil (6.34%)
IC0589141	DMR E-9	INGR11028	2011	WNZPBTL-3	JC Shekhar et al.	Tolerance to pink borer
IC0589142	DMR-E-57	INGR11029	2011	WNZPBTL-6	JC Shekhar et al.	Tolerance to pink borer

National identity	Donor identity	INGR No.	Year	Pedigree	Developers	Characteristics
IC0589143	DPcl10	INGR11030	2011	Winpop8	JC Shekhar et al.	For high popping
IC0590094	DMR-PFSR-1	INGR11041	2011	SW 93D-313-23-Pop-49-S4	Meena Shekhar et al.	Resistant to post flowering stalk rots caused by *Macrophomina phaseolina* and *Fusarium moniliforme*
IC0590095	DMR-PFSR-9	INGR11042	2011	JCY3-7-1-2-1	Meena Shekhar et al.	Resistant to post flowering stalk rots caused by *Macrophomina phaseolina* and *Fusarium moniliforme*, with stiff, strong and stay green character of stalk
IC0594370	DMR QPM 103	INGR13023	2013	CLQ-RCYQ 41-#-#-#-#-#-#DMR QPM 103	Jyoti Kaul et al.	An early maturing line with low ASI and tryptophan 0.67%.
IC0594369	DMR QPM 102	INGR13074	2013	CLQ-RCYQ 30-#-#-#-#-#-#DMR QPM 102	Jyoti Kaul et al.	Medium maturity, low ASI, high tryptophan, high protein.
IC0594368	DMR QPM 58	INGR14012	2014	Shakti 1-⊗-⊗-⊗-⊗-⊗#DMR QPM 58	Jyoti Kaul et al.	As early maturing QPM.
IC0594271	DMR QPM-03-124	INGR14013	2014	Shakti 1-⊗-⊗-⊗-⊗-⊗#DMR QPM-03-124	Jyoti Kaul et al.	As medium maturity QPM.
IC0594373	DMR E63 (WNZPBTL 9)	INGR14014	2014	WNZPBTL9 -⊗-⊗-⊗-⊗-⊗# #DMR E-63	JC Sekhar et al.	Source of resistance to pink borer.

3. 104 hybrids/varieties have been registered under PPV & FRA to protect the interest of the breeders were as follows:

S. No.	Hybrids	Name of centre	Date of filing	Acknowledgement no.	Period of protection (Years)
	New Hybrids				
1.	CoH(M)7	TNAU, Coimbatore	30.12.2015	REG/2015/2090	October 22, 2016 to October 21, 2031
2.	CoH(M)8	TNAU, Coimbatore	30.12.2015	REG/2015/2091	October 22, 2016 to October 21, 2031
3.	CoH(M)9	TNAU, Coimbatore	30.12.2015	REG/2015/2089	October 22, 2016 to October 21, 2031
4.	CoH(M)10	TNAU, Coimbatore	30.12.2015	REG/2015/2088	October 22, 2016 to October 21, 2031
5.	Pant Sankar Makka-1	GBPUA&T, Pantnagar	07.07.2014	REG/2014/1309	August 19, 2016 to August 18, 2031

S. No.	Hybrids	Name of centre	Date of filing	Acknowledgement no.	Period of protection (Years)
6.	PMH 6 (JH31292)	PAU, Ludhiana	07.07.2014	REG/2014/1310	August 26, 2016 to August 25, 2031
7.	Vivek Maize Hybrid 45	VPKAS, Almora	17.12.2013	REG/2013/1286	August 19, 2016 to August 18, 2031
8.	Pratap QPM Hybrid-1	MPUA&T Udaipur	18.11.2013	REG/2013/774	August 19, 2016 to August 18, 2031
9.	TNAU Maize Hybrid Co 6	TNAU Coimbatore	17.05.2013	REG/2013/302	August 26, 2016 to August 25, 2031
10.	HM-12	CCSHAU Karnal	03.08.2012	REG/2012/379	August 19, 2016 to August 18, 2031
11.	PMH 4 (JH 31153)	PAU Ludhiana	30.11.2010	REG/2010/340	April 27, 2015 to April 26, 2030
12.	PMH 5 (JH 31110)	PAU Ludhiana	30.11.2010	REG/2010/341	August 19, 2016 to August 18, 2031
13.	DHM 119 (BH 4062)	ANGRAU Hyderabad	15.11.2010	REG/2010/327	August 19, 2016 to August 18, 2031
14.	HQPM-4	CCSHAU Karnal	08.09.2010	REG/2010/263	August 26, 2016 to August 25, 2031
15.	Vivek Maize Hybrid 39 (FH 3356)	VPKAS Almora	26.07.2010	REG/2010/217	February 1, 2016 to January 31, 2031
16.	Vivek Maize Hybrid 43 (FH 3358)	VPKAS Almora	26.07.2010	REG/2010/216	February 1, 2016 to January 31, 2031
17.	DHM 117	ANGRAU Hyderabad	08.03.2010	REG/2010/75	April 8, 2015 to April 7, 2030
18.	DHM 111	ANGRAU Hyderabad	08.03.2010	REG/2010/76	August 19, 2016 to August 18, 2031
19.	DHM 113	ANGRAU Hyderabad	08.03.2010	REG/2010/77	August 26, 2016 to August 25, 2031
20.	HM-11	CCSHAU Karnal	07.09.2009	REG/2009/364	December 4, 2014 to December 3, 2029
21.	HM -10	CCSHAU Karnal	14.08.2008	REG/2008/438	April 30, 2013 to April 29, 2028
22.	HQPM- 7	CCSHAU Karnal	14.08.2008	REG/2008/437	February 5, 2013 to February 4, 2028
23.	Vivek Maize Hybrid-33	VPKAS Almora	14.08.2008	REG/2007/439	February 06, 2013 to February 05, 2028
24.	PAU-352	PAU Ludhiana	02.01.2008	REG/2008/44	February 12, 2013 to February 11, 2028
25.	Vivek QPM 9	VPKAS Almora	12.02.2008	REG/2008/198	January 17, 2013 to January 16, 2028
26.	HQPM-5	CCSHAU Karnal	15.11.2007	REG/2007/310	Dec. 07, 2011 to Dec. 06, 2026
27.	HM-8	CCSHAU Karnal	15.11.2007	REG/2007/317	May 16, 2013 to May 15, 2028
28.	HM-9	CCSHAU Karnal	15.11.2007	REG/2007/312	Dec. 07, 2011 to Dec. 06, 2026
29.	Malviya Hybrid Makka-2	BHU Varanasi	15.12.2007	REG/2007/398	Dec. 27, 2011 to Dec. 26, 2026

S. No.	Hybrids	Name of centre	Date of filing	Acknowledgement no.	Period of protection (Years)
	Extant hybrids				
30.	KMH-22168	MSASC, Kolhapur	23.05.2013	REG/2013/310	December 31, 2013 to August 30, 2025
31.	NAH-2049	ZARS, VC, Mandya	16.09.2009	REG/2009/370	August 02, 2012 to Feb., 10, 2024
32.	Shaktiman-3	RAU Dholi	02.01.2008	REG/2008/47	Oct. 20, 2010 to Sept. 19, 2021
33.	Shaktiman-4	RAU Dholi	02.01.2008	REG/2008/48	Oct. 20, 2010 to Sept. 19, 2021
34.	PMH 2	PAU Ludhiana	02.01.2008	REG/2008/42	Sept. 30, 2011 to April 24, 2021
35.	Prakash	PAU Ludhiana	02.01.2008	REG/2008/50	Sept. 30, 2011 to Sept. 8, 2012
36.	DHM-107	ANGRAU Hyderabad	02.01.2008	REG/2008/46	In Process
37.	PMH 1	PAU Ludhiana	02.01.2008	REG/2008/43	Dec. 21, 2009-Feb. 5, 2022
38.	COH (M) 5	TNAU Coimbatore	26.12.2007	REG/2007/411	Oct. 20, 2010 to July 19, 2022
39.	Vivek Maize Hybrid-23	VPKAS Almora	26.12.2007	REG/2007/410	Sept. 30, 2011 to Feb. 05, 2022
40.	HHM-1	CCSHAU Karnal	11.12.2007	REG/2007/399	January 31, 2013 to April 2, 2015
41.	HHMS-2	CCSHAU Karnal	26.12.2007	REG/2007/402	Oct. 20, 2010 to April 02, 2015
42.	HM-4	CCSHAU Karnal	15.11.2007	REG/2007/316	Oct. 20, 2010 to Aug. 24, 2020
43.	HM-5	CCSHAU Karnal	15.11.2007	REG/2007/311	Feb. 12, 2009-Aug. 24, 2020
44.	HQPM-1	CCSHAU Karnal	15.11.2007	REG/2007/319	Oct. 20, 2010 to Aug. 24, 2020
45.	Pusa Early Hybrid Makka-1	IARI New Delhi	06.12.2007	REG/2007/388	Feb. 12, 2009-Sept. 16, 2012
46.	Pusa Early Hybrid Makka-2	IARI New Delhi	26.12.2007	REG/2007/409	Oct. 20, 2010 to Sept. 16, 2012
47.	Pusa Early Hybrid Makka-3	IARI New Delhi	06.12.2007	REG/2007/385	Dec. 21, 2009-Feb. 1, 2016
48.	Pusa Extra Early Hybrid Makka-5	IARI New Delhi	06.12.2007	REG/2007/386	Dec. 21, 2009-Feb. 3, 2019
49.	Pratap Hybrid Maize-1	MPUA&T Udaipur	15.11.2007	REG/2007/315	Feb. 12, 2009-Feb. 3, 2019
50.	Buland	PAU Ludhiana	27.12.2007	REG/2007/432	Oct. 21, 2011 to Aug. 24, 2020
51.	Shaktiman-2	RAU Dholi	27.12.2007	REG/2007/420	Oct. 20, 2010 to Feb. 03, 2019
52.	Shaktiman-1	RAU Dholi	27.12.2007	REG/2007/428	Oct. 20, 2010 to Nov. 14, 2016
53.	COH 3	TNAU Coimbatore	26.12.2007	REG/2007/400	Feb. 12, 2009-Sept. 16, 2012
54.	COH (M) 4	TNAU Coimbatore	26.12.2007	REG/2007/405	Oct. 20, 2010 to Aug. 24, 2020
55.	Matungha (DMH-1)	UAS Dharwad	26.12.2007	REG/2007/417	January 2, 2012 to September 8, 2012

S. No.	Hybrids	Name of centre	Date of filing	Acknowledgement no.	Period of protection (Years)
56.	DMH-2	UAS Dharwad	26.12.2007	REG/2007/416	Oct. 20, 2010 to Sept. 03, 2017
57.	HIM-129	VPKAS Almora	26.12.2007	REG/2007/408	Oct. 20, 2010 to Sept. 08, 2012
58.	Vivek Hybrid-4	VPKAS Almora	26.11.2007	REG/2007/406	Oct. 20, 2010 to June 07, 2014
59.	Vivek Maize Hybrid-9	VPKAS Almora	26.12.2007	REG/2007/403	Oct. 20, 2010 to Feb. 01, 2016
60.	Vivek Hybrid-5	VPKAS Almora	26.12.2007	REG/2007/412	Oct. 20, 2010 to Feb. 01, 2016
61.	Vivek Maize Hybrid-15	VPKAS Almora	26.12.2007	REG/2007/407	Feb. 12, 2009-Feb. 1, 2020
62.	Vivek Maize Hybrid-21	VPKAS Almora	15.11.2007	REG/2007/309	March 07, 2011 to Feb. 05, 2022
63.	Vivek Maize Hybrid-27	VPKAS Almora	27.11.2007	REG/2007/344	Oct. 20, 2010 to Oct. 04, 2022
64.	Vivek Maize Hybrid-25	VPKAS Almora	27.11.2007	REG/2007/345	Oct. 20, 2010 to Oct. 04, 2022
65.	Vivek Maize Hybrid-17	VPKAS Almora	26.12.2007	REG/2007/413	Oct. 20, 2010 to Feb. 01, 2020
	New Composites				
66.	Bajaura Makka 1	CSK HPKV Bajaura	24.08.2009	REG/2009/341	January 22, 2015 to January 21, 2030
67.	Vivek Sankul Makka 35	VPKAS Almora	24.08.2009	REG/2009/342	December 4, 2014 to December 3, 2029
68.	Vivek Sankul Makka 37	VPKAS Almora	24.08.2009	REG/2009/343	April 7, 2015 to April 6, 2030
69.	Pant Sankul Makka-3	GBPAU&T Pantnagar	13.01.2009	REG/2009/10	August 19, 2016 to August 18, 2031
70.	Pratap Kanchan-2	MPUA&T, Udaipur	13.01.2009	REG/2009/9	November 9, 2016 to November 8, 2031
71.	Bajaura Makka	CSK HPKV Bajaura	14.08.2008	REG/2008/436	August 26, 2016 to August 25, 2031
72.	Vivek Sankul Makka 31	VPKAS Almora	12.02.2008	REG/2008/199	March 30, 2015 to March 29, 2030
73.	Jawahar Pop Corn-11	JNKVV Chhindwara	12.03.2008	REG/2008/202	October 26, 2015 to October 25, 2030
	Extant Composites				
74.	Pratap Makka Chari-6	MPUA&T Udaipur	23.05.2013	REG/2013/309	December 31, 2013 to February 10, 2024
75.	NAC-6004	UAS Nagenahalli	02.01.2008	REG/2008/40	March 07, 2011 to Feb. 01, 2016
76.	NAC-6002	UAS Nagenahalli	02.01.2008	REG/2008/41	March 07, 2011 to Sept. 03, 2017
77.	Shalimar KG Maize-2	SKUAST Srinagar	02.01.2008	REG/2008/49	Dec. 21, 2009-Aug. 24, 2020
78.	Gujarat Makai-6	AAU Godhara	20.11.2007	REG/2007/338	Dec. 21, 2009-March 11, 2018
79.	Gujarat Makai-2	AAU Godhara	20.11.2007	REG/2007/336	Feb. 12, 2009-May 3, 2010

S. No.	Hybrids	Name of centre	Date of filing	Acknowledgement no.	Period of protection (Years)
80.	Gujarat Makai-3	AAU Godhara	20.11.2007	REG/2007/337	Dec. 21, 2009-Sep. 3, 2017
81.	Gujarat Makai-4	AAU Godhara	20.11.2007	REG/2007/339	Dec. 21, 2009-Feb. 1, 2016
82.	Narmada Moti	AAU Godhara	20.11.2007	REG/2007/340	Oct. 20, 2010 to Sept. 03, 2017
83.	Priya Sweet Corn	ANGRAU Hyderabad	27.12.2007	REG/2007/422	Oct. 20, 2010 to Sept. 03, 2017
84.	Birsa Makai-1	BAU Ranchi	19.11.2007	REG/2007/332	July 20, 2009 to Dec. 31, 2011
85.	Birsa Vikas Makka-2	BAU Ranchi	19.11.2007	REG/2007/333	July 20, 2009 to August 24, 2020
86.	Azad Kamal	CSUA&T Kanpur	26.12.2007	REG/2007/415	Sept. 30, 2011 to Feb. 01, 2020
87.	Win Orange Sweet Corn	DMR	27.12.2007	REG/2007/421	Oct. 20, 2010 to Feb. 01, 2020
88.	D-994	GBPAU&T Pantnagar	27.11.2007	REG/2007/343	Dec. 21, 2009-May 30, 2019
89.	Gaurav	GBPAU&T Pantnagar	20.11.2007	REG/2007/341	Dec. 21, 2009-June 07, 2014
90.	Amar	GBPAU&T Pantnagar	27.11.2007	REG/2007/347	Dec. 21, 2009-June 07, 2014
91.	Pusa Composite-3	IARI New Delhi	06.12.2007	REG/2007/384	Dec. 21, 2009-Nov. 4, 2020
92.	Pusa Composite-4	IARI New Delhi	06.12.2007	REG/2007/387	Dec. 21, 2009-Nov. 4, 2020
93.	Jawahar Composite Makka-8	JNKVV Chhindwara	26.12.2007	REG/2007/404	January 2, 2012 to April 30, 2012
94.	Jawahar Composite Makka-12	JNKVV Chhindwara	27.12.2007	REG/2007/427	January 2, 2012 to June 07, 2014
95.	Jawahar Makka-216	JNKVV Chhindwara	27.12.2007	REG/2007/423	January 2, 2012 to February 03, 2019
96.	Pratap Makka-3	MPUA&T Udaipur	15.11.2007	REG/2007/318	March 07, 2011 to Feb. 01, 2020
97.	Pratap Makka-4	MPUA&T Udaipur	15.11.2007	REG/2007/314	March 07, 2011 to April 24, 2021
98.	Pratap Makka-5	MPUA&T Udaipur	15.11.2007	REG/2007/313	August 02, 2012 to April 24, 2021
99.	Aravali Makka-1	MPUA&T Udaipur	27.11.2007	REG/2007/346	January 2, 2012 to February 01, 2016
100.	Composite C-14	SKUAST Srinagar	27.12.2007	REG/2007/401	Dec. 21, 2009-Dec. 31, 2010
101.	Shalimar KG Maize-1	SKUAST Srinagar	27.12.2007	REG/2007/424	Oct. 20, 2010 to Aug. 24, 2020
102	COBC 1	TNAU Coimbatore	26.12.2007	REG/2007/418	Oct. 20, 2010 to June 07, 2014
103.	Vivek Sankul Makka-11	VPKAS Almora	26.12.2007	REG/2007/414	January 17, 2013 to January 16, 2028
104.	VL Baby Corn 1	VPKAS Almora	26.12.2007	REG/2007/419	Oct. 20, 2010 to Feb. 01, 2020

4. *In last five years, generated, coordinated and reported conduct of 275 AICRP trials at each location to generate location specific technology.*
5. *Developed RILs mapping population for MLB, popping and yield traits.*
6. *Developed and characterized a diverse association-mapping panel for TLB, charcoal rot, Fe and Zn.*
7. *Studied the genetics of Maydis leaf blight resistance in tropical maize germplasm.*
8. *Developed diverse sources of multiple diseases (TLB, Charcoal rot, MLB) tolerance.*

4.2 Agricultural Biotechnology

The IIMR initiated application of molecular tools and techniques in maize improvement. The major priority areas were development of protocols for in-vitro regeneration by using immature/mature embryo as explants. In addition, advance techniques like CRISPER Cas9 also explored for direct genetic manipulation, however, no major breakthrough was achieved yet by use of this technology. The important salient achievements of the biotechnology research were as follows:

1. *The standard protocol of in vitro regeneration of tropical maize germplasm using immature embryo as explants was developed.*
2. *The standard protocol for co-transformation of Type II embryogenic calli and transformation of immature embryos by particle bombardment was standardized in tropical maize germplasm.*
3. *In planta transformation (tissue culture independent) protocol using plumular meristem cells as explants was developed for HKI 163, where maize inbred line was transformed using Agrobacterium strain EHA105 containing vector pCAMBIA3301 carrying Cry1ab, gus and bar genes.*
4. *The role of plant growth regulators like Ascorbic acid, Salicylic acid and 24-epi-brassinolide in respect of adaptation to abiotic stress conditions elucidated.*
5. *Two transgenic events carrying Cry1Ab have been developed for stem borers with in-vitro expression of Cry1Ab protein @ 40 ng/mg of total soluble protein.*
6. *A hydroponic system for imposing quantifiable phosphorus and nitrogen stress was developed.*

4.3 Agronomy

Non-monetary input management

- ❖ Optimization of sowing dates in *kharif* maize and identified suitable hybrids for late planting.
- ❖ Optimized planting density in full season quality protein maize hybrid.

Weed management

- ❖ Developed eco-friendly weed management options of maize + cover crop (cowpea) intercropping.

Conservation agriculture in maize systems

- Identified atrazine +pendimethalin combination for weed management in maize.

Conservation agriculture(CA)

- Planting of maize in zero-tillage recommended for higher water and nutrient productivity along with enhancement in soils physical, chemical and biological health.
- Conservation agriculture based management practices developed for four intensified maize-based cropping system.
- Site Specific Nutrient Management (SSNM) based nutrient management along with conservation agriculture based tillage and crop establishment recommended for higher protein yield and net energy output in the maize-wheat-mungbean system.
- Long-term adoption of CA resulted in enhancement in yield, returns, input use efficiency and soil organic carbon status over conventional tillage practices.

Cropping system

- Maize-potato-mungbean followed by maize-baby corn- mungbean and maize-wheat-mungbean cropping sequence were identified as an alternative profitable cropping system in peri-urban interface.

Nutrient management

- NE–SSNM based nutrient management in maize followed by STCR guided nutrient management in wheat recommended for enhancing yield, returns and nutrient use efficiency.
- Crop residue incorporation of preceding crop with the application of fungal consortia (*Aspergillus awamori, Trichderma viride, Phanerochaete clirysosporium, Aspergillus nidulans*) in maize–wheat–mungbean cropping sequence recommended.
- Neem oil coated urea (NOCU) in 700 ppm concentration recommended for higher yield, returns and nitrogen use efficiency in *kharif* maize.

- Application of slow release neem/sulphur coated urea and the residue in the maize wheat/mustard–mungbean cropping systems recommended for improving crop health, soil properties and productivity.

4.4 Entomology

- **Germplasm Registration:** Registered three lines, DMR E9(INGR11028), DMR E 57(INGR11029) and DMRE 63 (INGR14014) for tolerant to *Sesamia inferens*.
- **Storage insect management by botanicals:** The pure compound extracted from leaves of dichloromethane extract of *Ixora coccinea L*. at a concentration of 0.0036 mg/cm^2 showed maximum per cent repellence against rice weevil, *Sitophilus oryzae* L. The extracted pure compound was identified and the structure of this sesquiterpene hydrocarbon was established as (2E, 6E, 10E)-2,6,11-trimethyl-dodeca-2,6,10-triene and was designated as Tanacetene**.**

  Maize treated with *Ageratum conyzoides* leaf powder at the rate of 2% w/w stored in High Density and Double layered polythene bags suffered minimum damage by storage pest *Sitophilus oryzae* L.

  The combination of sun drying of maize for 4 hours from 11.00 am to 3.00 pm for weekly intervals along with the application of leaf powder of *Erythrina indica* at the rate of 2% w/w provided the best protection against *S. oryzae* infestation.

Basic studies on key pests:

- The hydroxamic acid, 2,4-dihydroxy-7-methoxy- (2H)-1,4-benzoxazin-3- (4H)-one (DIMBOA) has resulted in highly significant negative correlation of -0.71 when infested with *C. partellus* and quantified for the compound in a week old plants, thus proving seedling resistance in maize.
- A modified, cost-effective method for extraction of DIMBOA was standardised. Two-day old maize seedlings were found to have the maximum amount of the DIMBOA, and the highest concentration quantified was 1.31 mg/g fresh weight of seedlings.
- Cell wall bound ferulic and p-coumaric acid content in maize inbred lines was negatively correlated with damage caused by *C. partellus* infested at different plant ages. Maximum correlation was observed at 20-day old plants, 0.709 and 0.609 respectively for leaf injury and tunnel length with ferulic acid 0.781 and 0.619 for the same with p-coumaric acid.
- In diet bioassays, highest mortality (41.5%) was observed in p-coumaric acid with the concentration of 2.5 mg/ml, whereas in ferulic acid, the highest (17.70%) was observed with 10mg/ ml.
- The potential of pink stem borer ovipositional preference/antixenosis in genotype screening were evaluated. As the plant age increases, the egg laying increases until 12-16 days and decreases thereafter. The genotypes E30, E 60(FC)O and HKI 164-7-4 ER-3 showed antixenotic response. The correlation coefficient of 0.59 between number of eggs per plant in multi-choice and no-choice test confirm the significant ovipositional preference exhibited among maize germplasm.

Insect rearing cage

Insect Handling Device

- The susceptibility index developed for shoot fly resistance screening is SI= Ax1*Ab/Ax2. Where, Ax1=No. of plants oviposited /Total no. of plants, Ax2= Total no. of eggs/No. of plants oviposited, Ab= No. of dead hearts formed/No. of plants oviposited. This is currently being used in AICRP for identifying shootfly resistant maize genotypes.

Identification of resistance sources

- Pink stem borer: based on three year testing under artificial infestation WNZEXOTICPOOLDC2 (2.6) AND WNZPBTL 6(3.0) were found resistant to Pink borer.
- Spotted stem borer: DMR E 63 and WNZEXOTICPOOL1A have been found moderately resistant to *Chilo partellus* (after three years of testing).
- Shoot fly : Based on the three year data ,no dead hearts were formed by shoot fly in the four lines, AEB(Y)1,AEB(Y)C534-1,G15QC7BBB6BBB,HKI1831 at Delhi when evaluated under fish meal technique.

Patents

- Patent granted for the technology ' An Insect Handling Device Patent no. 252363' Year 2012 and this technology was commercialized with a laboratory instrument manufacturing firm.

- ❖ Patent filed for the technology 'An insect rearing cage', patent application no. 0923/DEL/2011 and this technology was commercialized with a laboratory instrument manufacturing firm.
- ❖ Patents Filed for the technology 'Dynamic Volatile Collection System' Patent application No. 1235/DEL/2015. Maize volatiles emanated when infested with *C. partellus* were sampled using the system, analyzed and found a pest repelling compound D-Limonene.

4.5 Plant Pathology

1. Presence of PFSR pathogens (*Macrophomina phaseolina* and *Fusarium verticilloides*) in the asymptomatic host- plant identified.
2. Utilization of potential lines in breeding programme

   A. Mapping populations are being developed and screened against MLB

   - M-12 – 210 Genotypes – 154 genotypes resistant - NEPZ
   - M-13 - 207 genotypes – 26 genotypes resistant – NWPZ

   B. Association panel of 337 genotypes are being developed and screened

   - 10 genotypes were resistant for -TLB, C. rust & C. rot in NHZ, PZ and NWPZ

3. Based upon three years evaluation data, 77 lines were found resistant/moderately resistant against multiple diseases.

   - ❖ Maydis Leaf Blight (MLB) – 42 lines
   - ❖ Turcicum Leaf Blight (TLB) – 31 lines
   - ❖ Brown stripe downy mildew (BSDM) – 54 lines
   - ❖ Post-flowering stalk rots (PFSR) – 48 lines
   - ❖ Rajasthan downy mildew (RDM) – 6 lines
   - ❖ Polysora rust (P.RUST) – 2 lines
   - ❖ Curvularia leaf spot (CLS) – 2 lines
   - ❖ Erwinia stalk rots (ESR) – 2 lines

➢ Out of them following resistant germplasm were registered:

i. DML 339: Source of Charcoal rot resistance

ii. DML 1019: Source of Charcoal rot resistance with QPM background

iii. IML-PFSR3: Source of Charcoal rot; TLB; MLB resistance with QPM background

iv. DQL 2048: Source of MLB, TLB resistance (moderate) with QPM background

v. DQL 2105-1: Source of MLB, TLB resistance (moderate) with QPM background

4.6 Germplasm strengthening by WNC Hyderabad

Year	Accessions displayed	Packets of germplasm distributed	Centers benefitted	Accessions regenerated	Centers availed WNC
2011	1816	3687	23	451	11
2012	2721	3985	35	433	11
2013	1795	4050	22	1615	10
2014	1923	3672	29	755	10
2015	862	1816	23	791	10
2016	0	1080	16	739	10
Total	**9117**	**18290**	**148**	**4784**	**62**

4.7 Outreach programme

Online expert system: Developed and maintained the maize AgriDaksh in the English, Hindi and Telugu for technology dissemination through online expert system of maize in collaboration with IASRI**.**

Demonstration of technologies: Coordinated and prepared report for the conduct of >10000 ha FLDs under ISOPOM/NFSM at various AICRP centres. IIMR also conducted FLD in Bihar, Haryana and Telangana for a demonstration of improved technologies.

Trainings: Under TSP and other outreach activities, IIMR and its station have conducted 36 trainings at Delhi, Begusarai and Hyderabad benefitting 1729 farmers on various aspect of maize production, protection and value addition. The speciality corns were emphasized for enhancing the farm income and nutritional security in these training conducted under TSP programme by IIMR and its stations were as follows:

S. No.	Training title	Venue	Year	Farmers benefitted
1.	Seed prod uction cultivation and value addition of Maize	DMR, New Delhi	2011-12	416
2.	Maize Production	RMR & SPC Begusarai, Bihar	2012-13	311
3.	Seed production cultivation and value addition in Maize	DMR, New Delhi	2013-14	219
4.	Maize Production	RMR & SPC Begusarai, Bihar	2013-14	53
5.	Improved production and value addition technologies for specialty corn	IIMR, New Delhi	2014-15	49
6.	Production system and value addition in maize	IIMR, New Delhi	2014-15	47
7.	Maize production and value addition technologies increasing income of farmer	IIMR, New Delhi	2014-15	36
8.	Improved production and value addition for technologies specialty corn	IIMR, New Delhi	2014-15	44
9.	Maize production technologies	Begusarai, (Bihar)	2014-15	59
10.	विशिष्ट मक्का की उत्पादन एवं मूल्य संवर्धन	IIMR, New Delhi	2014-15	62
11.	विशिष्ट मक्का की उत्पादन एवं मूल्य संवर्धन की नवीनतम् प्रौद्योगिकियाँ	IIMR, New Delhi	2014-15	38
12.	आदिवासी किसानों के लिए मक्का अधिक उत्पादन एवं मूल्य संवर्धन नवीनतम् प्रौद्योगिकियाँ	IIMR, New Delhi	2015-16	224
13.	मक्का उत्पादन एवं मूल्य संवर्धन	IIMR, New Delhi	2015-16	137
14.	मक्का उत्पादन एवं सुरक्षा की उन्नत तकनीकयाँ	IIMR, New Delhi	2015-16	34
Total		**36 trainings**		**1729**

Officer/scientist training programmes: Model Training/short course conducted during 2011-16 for researchers and extension officials by IIMR and its stations benefitting/enriching knowledge of 235 researchers/extension officials in maize research and development. The detail of the training programmes is as follows:

S. No	Particulars	Venue	Dates	No. of Participants
1.	A 10 days ICAR sponsored Short Course on "*Precision Conservation Agriculture for climatic change adaptation and mitigation in cereal systems*"	ICAR-Indian Institute of Maize Research, New Delhi	08-17 August, 2016	17
2.	Yield enhancement in maize through breeding and testing of newly developed genotypes in all India coordinated research programme	ICAR-Indian Institute of Maize Research, New Delhi	1-3 June, 3016	22

S. No	Particulars	Venue	Dates	No. of Participants
3.	Farmers training (Inter-state) on *Integrated Crop Management in Maize* under ATMA, Ramanthpurum Districts , Tamil Nadu	ICAR-Indian Institute of Maize Research, New Delhi	February 9-11, 2016	60
4.	Farmer's training (Inter-state) on *Integrated Crop Management in Maize* under ATMA, Dindigul District Thoppampaty, Tamil Nadu	ICAR-Indian Institute of Maize Research, New Delhi	March 01, 2016	
5.	An 08 days training course on "*Production Protection and Value Addition for Maize base Production Systems*" sponsored by Directorate of Extension, Ministry of Agriculture , Governemntr of India	ICAR-Indian Institute of Maize Research, New Delhi	16-23 September, 2015	37
6.	An 08 days training course on "*Practices for conservation agriculture and climate resilient Maize system*" sponsored by Directorate of Extension, Ministry of Agriculture , Governemntr of India	ICAR-Indian Institute of Maize Research (erstwhile DMR), New Delhi	30 August - 06 September, 2014	29
7.	An 08 days training course on "*Maize Production systems for improving resource use efficiency and livelihood security*" sponsored by Directorate of Extension, Ministry of Agriculture, Governemntr of India	ICAR-Indian Institute of Maize Research (erstwhile DMR), New Delhi	02-09 September, 2013	34
8.	Organized National Workshop jointly by*DMR-IPNI-CIMMYT"Nutrient Expert based SSNM and data management for maize systems in India"*	DMR, New Delhi.	16 May, 2012	20
9.	Intensive Maize Training for Fresher's	DOR, Hyderabad (conducted by IIMR)	28-29 October, 2011	16
	Total	**09 trainings**		**235**

4.8 Publication

A total of 430 publications were brought out by Indian Institute of Research (IIMR) during the period 2011-2016. During the period 226 journal papers were published in different international and national journals. Different categories of publications year-wise are listed below:

Year	No. of publication (As per NAAS ratings 2017)				Journal type	
	0-5	5-8	8-10	Above 10	International Journal	National Journal
2011-2012	9	12	-	-	1	20
2012-2013	26	27		1	10	44
2013-2014	17	13	-	-	9	21
2014-2015	17	23	3	1	14	30
2015-2016	25	36	4	2	26	41
Total	**94**	**111**	**7**	**4**	**60**	**156**

5. PERFORMANCE OF AICRP ON MAIZE

All India Coordinated Maize Improvement Project has a network of 34 centres located in states having major maize area. Many centres are in existence for more than 25 years. Continuous efforts are being made for developing location/region specific technologies for the enhancement of maize productivity. The details of cultivars identified for release trials and FLD's conducted in addition to total breeder seed production and the centre wise achievements are concisely given below.

5.1 Crop improvement

a. A total of 89 cultivars were released under AICRP on maize for various agro-ecologies and the list is given in the Table below:

S. No.	Cultivar	Year	Nature	Centre	Area of adaptation	Average Yield (t/ha)	Season
1	Hema (NAH-1137)	2016	SCH	UAS, Mandya	Karnataka	5.60	*Kharif*
2	Pratap Hybrid Maize-3 (PH-1974)	2016	SCH	MPUAT, Udaipur	CWZ	5.59	*Kharif*
3	DKC 9126 (MCH 46)	2016	SCH	Monsanto India Ltd., Bangalore	NHZ, NWPZ, PZ and CWZ	8.96	*Kharif*
4	Palam Sankar Makka 2 (EHL 161708)	2016	SCH	CSK, HPKV, HAREC, Bajaura, Kullu	NHZ	9.88	*Kharif*
5	UDAY (DMR-248) Mahabeej-1114	2016	SCH	Mahabeej	Maharashtra	8.70	*Kharif*
6	Pratap Makka-9 (EC-3161)	2016	SCH	MPUAT, Udaipur	Rajasthan	4.80	*Kharif*
7	Karimnagar Makka-1 (KNMH401031)	2016	SCH	PJSTSAU, Karimangar	Telangana	9.50	*Kharif & Rabi*
8	PMH 7 (JH3956)	2016	SCH	PAU, Ludhiana	Punjab	7.50	Spring
9	D2244 (DAS-MH-501)	2016	SCH	DOW Agro Sciences India Pvt. Ltd., Mumbai	NHZ, PZ and CWZ	7.09	*Kharif*
10	Shalimar Maize Composite-5 (PS-98)	2016	OPV	SKUAST, Srinagar	Jammu and Kashmir	5.90	*Kharif*
11	Shalimar Maize Composite-6 (KDM-322)	2016	OPV	SKUAST, Srinagar	Jammu and Kashmir	5.50	*Kharif*
12	Shalimar Maize Composite-7 (KDM-72)	2016	OPV	SKUAST, Srinagar	Jammu and Kashmir	5.60	*Kharif*
13	LAXMI 3636 (LTH 22)	2016	SCH	Yaaganti Seeds Pvt. Ltd., Hyderabad	PZ	9.06	*Kharif*

S. No.	Cultivar	Year	Nature	Centre	Area of adaptation	Average Yield (t/ha)	Season
14	BIO 9782 (BIO 237)	2016	SCH	Bioseed Research India a Division of DCM Shriram Ltd., Hyderabad	NEPZ and CWZ	10.27	*Rabi*
15	Dragon (NMH-1247)	2016	SCH	Nuziveedu Seeds Limited, Hyderabad	NWPZ	9.97	*Rabi*
16	PMH 8 (JH 31244)	2016	SCH	PAU, Ludhiana	Punjab	8.30	Spring
17	CANDY (KSCH-333)	2015	SCH	Kaveri Seed Company Ltd., Secundrabad	NHZ, NWPZ, PZ and CWZ	11.88	*Kharif*
18	KMH-7148	2015	SCH	Kaveri Seed Company Ltd., Secundrabad	NWPZ	10.09	*Rabi*
19	Palam Sankar Makka 1 (EHL 162508)	2015	SCH	CSK, HPKV, HAREC, Bajaura	CWZ	5.30	*Kharif*
20	BPCH-6	2015	SCH	ANGRAU, Hyderabad	All zones	3.20	*Kharif*
21	RMH-4558 (PRO-379)	2015	SCH	Rasi Seeds (P) Ltd.,	NEPZ and PZ	-	*Kharif*
22	CP333 Hybrid	2015	SCH	Charoen Pokphand Seeds (India) Pvt. Ltd., Bangalore	CWZ	6.64	*Kharif*
23	Pratap Hybrid Maize-3	2015	SCH	MPUAT, Udaipur	CWZ	5.60	*Kharif*
24	PHM-12 (JPMH 4)	2015	SCH	SKUAST, Srinagar	Jammu and Kashmir	5.80	*Kharif*
25	P 3580 (X-35A180)	2015	SCH	Pioneer Overseas Corporation, Chikkaballapur	PZ	9.92	*Kharif*
26	CoH (M) 10 (CMH 08-433)	2015	TWC	TNAU, Coimbatore	PZ and CWZ	7.20	*Kharif*
27	HM-13 (HKH-317)	2015	SCH	CCSHAU, Karnal	NHZ	6.60	*Kharif*
28	PMH 6 (JH 31292)	2015	SCH	PAU, Ludhiana	NEPZ	6.30	*Kharif*
29	NMH-713	2015	SCH	Nuziveedu Seeds Ltd., Hyderabad	NEPZ and PZ	9.49	*Rabi*
30	NMH-731	2015	SCH	Nuziveedu Seeds Ltd., Hyderabad	PZ and CWZ	5.40	*Kharif*
31	KMH-25K45 (BUMPER)	2015	SCH	Kaveri Seed Company Ltd., Hyderabad	NWPZ, PZ and CWZ	9.00	*Rabi*
32	NMH-1242	2015	SCH	Nuziveedu Seeds Ltd., Hyderabad	NWPZ, PZ and CWZ	7.30	*Kharif*
33	CoH (M)7 (CMH 08-287)	2014	SCH	TNAU, Coimbatore	NEPZ and PZ	7.80	*Kharif*
34	CoH (M)8 (CMH 08-292)	2014	SCH	TNAU, Coimbatore	NWPZ, NEPZ, PZ and CWZ	7.10	*Kharif*
35	CoH (M) 9 (CMH 08-350)	2014	SCH	TNAU, Coimbatore	NEPZ and CWZ	6.40	*Kharif*

S. No.	Cultivar	Year	Nature	Centre	Area of adaptation	Average Yield (t/ha)	Season
36	DHM 121 (BH 41009)	2014	SCH	ANGRAU, Hyderabad	NEPZ and CWZ	5.40	*Kharif*
37	GH 0727 (Shrushti)	2014	SCH	ARS, Arabhavi	Karnataka	7.50	*Kharif*
38	Vivek Maize Hybrid 47 (FH 3513)	2014	SCH	VPKAS, Almora	NHZ	6.90	*Kharif*
39	Vivek Maize Hybrid 53 (FH 3556)	2014	SCH	VPKAS, Almora	NHZ	6.90	*Kharif*
40	Vivek Maize Hybrid 51 (FH 3554)	2014	SCH	VPKAS, Almora	CWZ	5.10	*Kharif*
41	KMH-25K45 (2700) (BUMPER)	2014	SCH	Kaveri Seed Company Ltd., Hyderabad	NWPZ, PZ and CWZ	9.00	*Rabi*
42	Bio 9544 (BIO151)	2014	SCH	Bioseed Research India a Division of DCM Shriram Ltd., Hyderabad	NHZ, NWPZ, NEPZ, PZ and CWZ	7.30	*Kharif*
43	P3522 (X35A019)	2014	SCH	Pioneer Overseas Corporation, Chikkaballapur	NWPZ, NEPZ, PZ and CWZ	9.10	*Rabi*
44	P 1864 (X8F984)	2014	SCH	Pioneer Overseas Corporation, Chikkaballapur	NWPZ	7.60	*Kharif*
45	Pratap QPM Hybrid-1 (EHQ-16)	2013	SCH	MPUA T, Udaipur	CWZ	5.90	*Kharif*
46	CMH 08-282	2013	SCH	TNAU, Coimbatore	CWZ	6.00	*Kharif*
47	Bisco 97 Gold (Bisco New 704)	2013	TWC	Bisco Bio Sciences Pvt. Ltd., Hyderabad	NHZ	8.00	*Kharif*
48	Shalimar Maize Composite-3	2013	OPV	SKUAST, Srinagar	Jammu & Kashmir	4.80	*Kharif*
49	KDM-438	2013	OPV	SKUAST, Srinagar	Jammu & Kashmir	6.00	*Kharif*
50	Pant Shankar Makka-1	2013	SCH	GBPUAT, Pantnagar	Uttarakhand	4.80	*Kharif*
51	KDMH-017	2013	SCH	Krishidhan	NWPZ and NEPZ	8.00	*Kharif*
52	Bio 9544 (BIO151)	2013	SCH	Bioseed Research India a Division of DCM Shriram Ltd., Hyderabad	NHZ and PZ	7.30	*Kharif*
53	NMH-1242	2013	SCH	Nuziveedu Seeds Ltd., Hyderabad	PZ	7.30	*Kharif*
54	S 6217	2013	SCH	Syngenta India Pvt. Ltd.	NWPZ, PZ and CWZ	7.60	*Kharif*

S. No.	Cultivar	Year	Nature	Centre	Area of adaptation	Average Yield (t/ha)	Season
55	LG 32-81 (Yuvraj Gold)	2013	SCH	Bisco Bio Sciences Pvt. Ltd., Hyderabad	NHZ and NEPZ	7.40	*Kharif*
56	Sun Vaaman	2013	SCH	Suncrop Sciences Pvt. Ltd.	NHZ and PZ	7.60	*Kharif*
57	NSCH-12 (Misthi)	2013	SCH	Nuziveedu Seeds Ltd., Hyderabad	NHZ, NWPZ and PZ	14944 (Green ear yield)	*Kharif*
58	BIO 605	2013	SCH	Bioseed Research India a Division of DCM Shriram Ltd., Hyderabad	NHZ and PZ	5.50	*Kharif*
59	Vivek Maize Hybrid 45 (FH 3483)	2013	SCH	VPKAS, Aimora	NHZ	5.40	*Kharif*
60	Hishell (MCH-42)	2012	TWC	Monsanto India Ltd., Banglore	CWZ	6.00	*Kharif*
61	KMH-218 Plus	2012	TWC	Kaveri Seed Company Ltd., Hyderabad	NEPZ	6.30	*Kharif*
62	KMH-3426	2012	TWC	Kaveri Seed Company Ltd., Hyderabad	NEPZ and CWZ	6.20	*Kharif*
63	NMH-731	2012	SCH	Nuziveedu Seeds Pvt. Ltd., Hyderabad	CWZ	5.40	*Kharif*
64	NMH-803	2012	TWC	Nuziveedu Seeds Pvt. Ltd., Hyderabad	NEPZ and CWZ	5.70	*Kharif*
65	HM-12 (HKH 313)	2012	SCH	CCSHAU, Uchani, Karnal	NEPZ	5.90	*Kharif*
66	KMH-25K60	2012	SCH	Kaveri Seed Company Ltd., Hyderabad	PZ	8 .30	*Kharif*
67	KMH 3712	2012	SCH	Kaveri Seed Company Ltd., Hyderabad	NWPZ, NEPZ and CWZ	7.00	*Kharif*
68	NMH-920	2012	SCH	Nuziveedu Seeds Pvt. Ltd., Hyderabad	NEPZ	7.70	*Kharif*
69	Bisco x 1 (Bisco 506)	2012	SCH	R &D unit of Bisco Bio Sciences Pvt. Ltd., Secunderabad	NEPZ and PZ	9.00	*Rabi*
70	P3441 (X8B691)	2012	SCH	Pioneer Overseas Corporation, Karnatka	NWPZ, NEPZ and CWZ	6.90	*Kharif*
71	P3502 (X8B562)	2012	SCH	Pioneer Overseas Corporation, Karnatka	CWZ	6.00	*Kharif*

S. No.	Cultivar	Year	Nature	Centre	Area of adaptation	Average Yield (t/ha)	Season
72	NK-30 (NECH-132)	2012	SCH	Syngenta India Pvt. Ltd.	NWPZ, NEPZ, PZ and CWZ	7.00	*Kharif*
73	NK 6240 (NECH-131)	2012	SCH	Syngenta India Pvt. Ltd.	NWPZ and PZ	7.00	*Kharif*
74	BIO-9682	2012	DCH	Bioseed Research India Ltd., Hyderabad	NWPZ and CWZ	5.10	*Kharif*
75	CO 6	2012	SCH	TNAU, Coimbatore	Tamil Nadu	6.00	*Kharif*
76	SMH-3904	2012	SCH	PHS Agritech Pvt. Ltd., Hyderabad	NEPZ and PZ	7.80	*Kharif*
77	Vivek Maize Hybrid 43 (FH 3358)	2012	SCH	VPKAS, Almora	CWZ	5.80	*Kharif*
78	Vivek Maize Hybrid 39 (FH 3356)	2012	SCH	VPKAS, Almora	NHZ	5.80	*Kharif*
79	P3501 (X7B401)	2012	SCH	Pioneer Overseas Corporation, Karnatka	NEPZ and CWZ	7.00	*Kharif*
80	DKC 9081 (MON 29)	2011	TWC	Monsanto India Ltd., Bangalore	NEPZ	9.10	*Rabi*
81	IG 8011 (MCH 37)	2011	TWC	Monsanto India Ltd., Bangalore	PZ	8.10	*Kharif*
82	IG 8237 (MCH 38)	2011	TWC	Monsanto India Limited, Bangalore	NEPZ and PZ	8.60	*Kharif*
83	Bisco 855 (Bisco Bhim)	2011	TWC	R &D unit of Bisco Bio Sciences Pvt. Ltd., Secunderabad	CWZ	7.40	*Kharif*
84	Bisco 555 (Bisco Ujala)	2011	TWC	R &D unit of Bisco Bio Sciences Pvt. Ltd., Secunderabad	NWPZ	8.40	*Kharif*
85	Bisco 111 (Bisco 840)	2011	TWC	R &D unit of Bisco Bio Sciences Pvt. Ltd., Secunderabad	PZ	8.30	*Kharif*
86	DHM 119 (BH 4062)	2011	SCH	ANGRAU, Hyderabad	PZ	8.60	*Kharif*
87	PMH 4 (JH 31153)	2011	SCH	PAU, Ludhiana	NWPZ	8.30	*Kharif*
88	PMH 5 (JH 31110)	2011	SCH	PAU, Ludhiana	CWZ	5.90	*Kharif*
89	YM-9905 (PKVM-SHATAK)	2011	OPV	Dr PDKV, Nagpur	Maharashtra	4.80	*Kharif & Rabi*

PMH-5 **Vivek hybrid 39**

Single cross hybrids developed by AICRP centres

b. The AICRP centres have registered 5 germplasm for abiotic stress tolerance and one germplasm was registered by NBPGR centre for prolificacy. Germplasm registered during the period was as follows:

National identity	Donor identity	INGR No.	Year	Pedigree	Developers	Developing Institution	Characteristics
IC0589129	KML-29	INGR11005	2011	KML-29	MV Nagesh Kumar et al.	ANGRAU, A|RS, Karimnagar, Andhra Pradesh	Drought tolerance and water logging
IC0589130	KDTML-3	INGR11006	2011	Tuxpeno Sequia	-do-	-do-	Drought tolerance
IC0589131	KDTML-19	INGR11007	2011	Tuxpeno Sequia	-do-	-do-	Drought tolerance

National identity	Donor identity	INGR No.	Year	Pedigree	Developers	Developing Institution	Characteristics
IC0589132	KDTML-66	INGR11008	2011	Tuxpeno Sequia	-do-	-do-	Drought tolerance; higher number of rows per cob and high test weight
IC0594467	KDTML-82	INGR13003	2013	KDTML-82	-do-	-do-	Drought tolerance
IC0524594	MCM-11/01	INGR13054	2013	Selection	AK Misra et al.	ICAR-NBPGR, RS, Umiam, Meghalaya	3-4 cobs per plant and early maturing.

c. A total of 606.96 q breeders seed has been multiplied.

d. Between 2011 to 2016, a total of 89 hybrids/varieties have been released by both public and private partners.

e. In the last five years, a total of 6668 germplasm samples have demonstrated and shared with various partners working across the country.

f. In the last five years, a total of 17 germplasm lines have been registered at NBPGR (Total: 103 till date).

g. In the last five years, 76 hybrids/varieties have been registered under PPV & FRA.

h. In last five years, 275 AICRP trials were conducted at each location.

i. MoU with private companies for seed production: To make the public sector bred hybrid seed available to the farmers, MoUs were signed with private companies for seed production and marketing by few centers. The details of the companies were as follows:

A. MoUs with Private Seed Companies for DHM 117 seed production & marketing by PJTSAU, Hyderabad.

S. No.	Name of the Company		Period of MoU (3 years)
1	Vikky Agri -sciences Pvt. Ltd, Hyderabad	On 5% royalty	2010-13
2	Sampoorna Seeds Yemiganur, Kurnool, A.P.		2010-13
3	ABC Seeds India Pvt. Ltd, Hyderabad		2010-13
4	Shakthi Seeds Pvt. Ltd., Hyderabad, Telangana		2014-17

S. No.	Name of the Company	Period of MoU (3 years)
5	Sonam Seed Technologies Pvt. Ltd., Karimnagar, Telangana	2014-17
6	Genesis Agro Seeds Pvt. Ltd., Hyderabad, Telangana	2014-17
7	Naveen Seeds, Adoni, Kurnool, A.P.	2015-18
8	Sri Laxmi Venkateswara Seeds, Peddapadu, Kurnool, A.P.	2016-19
9	Sayaji Seeds, Kathwada, Ahmedabad, Gujarat	2016-19
10	Chakra Seeds, Kurnool, A.P.	2016-19

B. MoUs with Private Seed Companies for DHM 121 seed production & marketing by PJTSAU, Hyderabad.

S.No.	Name of the Company	Period of MoU
1	Naveen Seeds, Adoni, Kurnool, A.P.	2015-18
2	Muralidhar Seeds Corporation, Kurnool, A.P.	2016-19
3	Sri Sai Laxmi Seeds, Kurnool, A.P.	2016-19

C. MoU by the Karnal centre during 2011-16 for various hybrids for seed production by indigenous seed companies.

S. No.	Name of the organization	Name of maize hybrids
1	Green Gold Seeds, Hyderabad	HQPM-1
2	Kamboj Export, Indri, Karnal	HQPM-1, HQPM-5, HM-4 & HM-5
3	M/s PI Industries Ltd., Gurgaon, Haryana	HQPM 1, HQPM 5, HM 4 & HM 10

S. No.	Name of the organization	Name of maize hybrids
4	Akash Seeds & Co., Ambikapur, Chhattisgarh	HQPM 1& HQPM 5
5	Bhartiya Beej Nigam Ltd., Uttarakhand	HQPM 1& HQPM 5
6	Nuziveedu Seeds Pvt. Ltd., Ranga Reddy, Telangana	HM 8, HM 9 & HM 10
7	Arpan Seeds Pvt. Ltd., Udaipur, Rajasthan	HQPM 1, 7, HM 4, HM 5 & HM 10
8	Charoen Pokphand Seeds Pvt Ltd., Bangalore, Karnataka	HQPM 1 & HM 5
9	Balaji Seeds, Kurnool, Andhra Pradesh	HQPM 1
10	Sansar Agropol Pvt. Ltd., Bhubaneswar, Odisha	HQPM 1 & HQPM 5
11	Vibha A grotech Ltd. Hyderabad, Telangana	HM 9 & HM 11
12	Nath Bio Genes India Ltd., Aurangabad, Maharashtra	HM 9, HM 10 & HM 11
13	Bhartiya Beej Nigam Ltd., Udham Singh Nagar, Uttarakhand	HM 8, HM 10 & HM 11
14	Siri Seeds (India) Pvt. Ltd., Hyderabad, Telangana	HQPM 1 & HQPM 5
15	Balaji Agri Biotech Pvt. Ltd., Bargarh, Odisha	HQPM 1 & HQPM 5
16	J.K. Agri Genetics Limited, Hyderabad, Telangana	HQPM 1 & HQPM 5
17	Bioseed Research India, Hyderabad, Telangana	HQPM 1
18	Sampoorna Seeds, Adoni, Kurnool, Andhra Pradesh	HQPM 1 & HQPM 5
19	Sri Sai Seeds, Kurnool, Andhra Pradesh	HQPM 1 , HQPM 5, & HQPM 7
20	Ganga Kaveri Seeds, Hyderabad, Telangana	HM 9 & HM 10

5.2 Crop production

State	Recommendation
Rajasthan	Maize intercropping with urdbean under rainfed condition with paired rows of maize: urdbean in 2:3 row ratio. A fertilizer dose of 120-60-40 kg N-P_2O_5-K_2O/ha for irrigated maize. Site-specific nutrient management in maize-based cropping system under zero tillage for profitability and nutrient use efficiency.
Tamil Nadu	Application of atrazine @ 1.5 kg /ha as pre-emergence followed by (fb) tembotrione @ 120 g/ha as post-emergence 25 DAS as the best weed control practice. Maize hybrid COH (M) 6 with 50 x 20 cm spacing and RDF (250:75:75 kg N-P_2O_5-K_2O /ha) is the best practice. Maize hybrid COH(M) 7 with 50 cm x 20 cm spacing and RDF (250:75:75 NPK kg/ha) is the best management practice for higher yield and returns.
Karnataka	Split application of recommended dose (150 -65-65 kg N-P_2O_5-K_2O/ha) with N in 5 splits proved better over N in 3-splits.
AP and Telangana	Application of 200-80-80 kg N-P_2O_5-K_2O /ha recorded significantly higher grain yield. Highest sweet corn yield was obtained in drip irrigation with a nitrogen dose of 240 kg/ha. For zero-tillage maize, glyphosate @ 1.0 kg/ha as pre–plant fb 2,4–D @ 0.4 kg/ha as post–emergence for higher grain yield and profitability. Late maturity hybrids (110 -120 days) responded up to the higher fertility level of 250-80-100 kg N-P_2O_5-K_2O /ha. Irrespective of maize hybrids, STCR treatment gave higher grain yield and is comparable with 150% RDF.

State	Recommendation
Punjab	Application of nitrogen by use of leaf colour chart (LCC) is recommended.
	Drip irrigation, fertigation and black mulch help in saving of 39.9% water, 20% of fertilizer and enhanced the yield of spring maize.
Chhattisgarh	Sowing of baby corn on 1st July with 125% RDF + 5 t/ha FYM is recommended.
	Paired row of maize at 84/50 cm alternated with 3 rows of soybean was very remunerative.
	Intercropping of sweet corn in paired row at 45/75 cm + 3 rows of coriander produced significantly higher system yield.
	For yield maximization of cv Bio 9637, plant density of 60 cm x 20 cm and site-specific nutrient management system is recommended.
Eastern UP	Fertilizer application @ 240 -60-60 kg N -P_2O_5-K_2O/ha with nitrogen at 5 different stages has been recommended in winter season maize.
	Hybrids fertilized with SSNM along with plant geometry of 60 cm x 20 cm proved most remunerative.
	Irrigation at critical stages i.e., 30 days, knee-high, tassel emergence and grain filling stage with 250:80:80 kg/ha NPK is recommended for winter maize.
	Maize hybrid PMH -3 recommended in *kharif* with SSNM based nutrient application for yield maximization.
	In *kharif* season, Hybrid DHM -117 should be fertilized with 200:60:60 kg N-P_2O_5-K_2O /ha along with 25 kg zinc sulphate /ha and plant geometry of 60 cm x 20 cm.
Uttrakhand	Hybrids PMH -1 gave the highest grain yield with application of 120-55-55 kg N-P_2O_5-K_2O /ha based on Nutrient Expert-SSNM.
	After completion of three years, significantly higher maize yield was obtained with 100% RDF + 5 t/ha FYM, however, it remained *at par* with 100% RDF+ 5 kg zinc sulphate.
	In *kharif* maize, atrazine @ 1.5 kg/ha as pre-emergence fb tembotrione 120 g/ha as post–emergence at 25 DAS recorded significantly higher grain yield.
Bihar	Nutrient management with 150-75-50 kg N-P_2O_5-K_2O and 25 kg zinc sulphate/ha for *rabi* hybrid maize for higher yield.
	Zero tillage and permanent bed planting for enhancing resource use efficiency in maize-based cropping system developed.
West Bengal	The popular hybrid responded to high -density planting (50 cm x 20 cm) and STCR based nutrient management.
	Best weed management practices are pre –emergence atrazine @ 1.5 kg/ha fb tembotrione @ 120 g/ha as post–emergence application.
J& K	Standardized sowing time and method in maize under rainfed areas
	Standardized integrated nutrient management for enhancing soil health and maize yields
	Standardization of speciality corn production technology and its popularization in urban and tourist areas for livelihood security
	Introduction of conservation agriculture (CA) in maize for enhancing yields with low production cost compared to conventional agriculture
	Identification and popularization of new herbicide molecule tembotrione for post–emergence weed management in maize
Haryana	Fertility dose of 200 -80-80 kg N -P_2O_5-K_2O /ha is recommended for *kharif* season maize hybrid.
	Zero-till sown maize produced significantly higher grain yield than conventional sowing on flatbeds.
	Grain yield and returns increased by up to 25 % by SSNM (187.5 -75-75 kg N -P_2O_5-K_2O /ha) over recommended dose of fertilizers in maize hybrids.
	Inbred grain yield (9.2 q/ha) can be maximized by planting at 60 cm x 20 cm.
	The spray of tembotrione 120 ml/ha in a spray volume of 500 litre water for control of complex weed flora in maize.

Paired row planting of maize + soybean

5.3 Entomology

Integrated management strategies of stem borers and shoot fly were developed as follows:

Chilo partellus

- Maize intercropped with cowpea in 2:1 ratio following by spraying of Neem Seed Kernel Extract (NSKE) @ 5% at 7 and 14 DAG was found to be effective for the management of *Chilo partellus.*
- A release of the biocontrol agent *Trichogramma chilonis* @ 1,25,000 parasitized eggs/ha at 10-12 and 20-22 DAG gave a significant reduction in plant infestation, dead heart formation by *C. partellus,* thus increase in average yield q/ ha as compared to control.
- Maize seed treated with imidacloprid 600FS @ 7 ml/ kg and intercropped with cowpea in 2:1 ratio was found to be effective for the management of *Chilo partellus.*
- Spraying Neem Seed Kernel Extract (NSKE) @ 5% at 7 and 14 days after germination was found effective for the management of *Chilo partellus.* Spraying of Neem Seed Kernel Extract (NSKE) @ 0.5% and above has oviposition deterrent effect on *C. partellus.*
- Sorghum was found to be the preferred host for *C. partellus* when grown along with Maize and pearl millet, hence sorghum can be used as a trap crop in maize. Sorghum as a trap crop in the form of four border rows is recommended for the management of stem borers in maize.
- Maize intercropped with sesame and marigold was found to be the best in terms of reduction in plant damage and percent dead hearts by *C. partellus*, among a group of habitat management technologies for pest management experimented.
- The new chemical pesticide, Flubendiamide 480SC @0.2 ml/l followed by Chlorantrianiliprole 20 SC @0.3 ml/l were found best for the management of *Chilo partellus.*
- Recommended spray of Chlorantraniliprole 18.5 SC @ 30 ml per acre on 2-3 week old crop for the management of maize stem borer in *kharif* maize for Punjab. The residues studies on Coragen 18.5 SC @ 30 and 60 ml/ acre revealed that insecticides were below determination limit after 20 days of insecticide application at both the doses.
- One insecticide spray should be done between 15 to 20 DAG for the management of *Chilo partellus.*
- A template for assessing crop loss was developed based on the crop loss assessment formula developed and validated. It was found that under field conditions the average crop loss amounts to 39.64%, in which the share of loss due to *C. partellus* is 16.73. The crop loss caused by *C. partellus* was calculated using crop loss assessment formula developed by ICAR-IIMR, Delhi centre. A loss of 9.87-22.88 per cent due to maize stem borer, *Chilo partellus* infestation was observed in different regions of Punjab.

Sesamia inferens

- The new molecule, Chlorantrianiliprole 18.5 SC @ 0.4 ml/l was found to be effective for the management of *Sesamia inferens.*

Atherigona spp

- The spring sowing of maize was recommended to be completed before February as the crop damage by Shoot fly, *Atherigona naqvii* was found to have increased with the delayed sowing of maize. It was estimated to cause 27.93 - 45.04 % grain yield losses when the crop was sown from the end of January to end February.
- Seed treated with imidacloprid 17.5 SL and followed by one spray of monocrotophos 36SL after 25 days of germination was found effective in controlling shoot fly.
- The maize seeds treated with imidacloprid 600 FS @ 6 ml/ kg was recommended to be sown preferably within 14 days of treatment but certainly not later than 21 days for the control of shoot fly in spring sown maize.
- Seed treatment with Thiamethoxam 70 WS @ 7 g/ kg seed and Clothianidin 50 WDG @ 2g/ kg seed one day and one month before sowing were found economical and effective in controlling the shoot fly.
- The susceptibility index developed for shoot fly resistance screening is SI= Ax1*Ab/Ax2. Where, Ax1= No. of plants oviposited /Total no. of plants, Ax2= Total no. of eggs/No. of plants oviposited, Ab= No. of dead hearts formed/No. of plants oviposited. This is currently being used in AICRP for identifying shoot fly resistant maize genotypes.

5.4 Plant Pathology

- 2536 genotypes of different maturity groups were evaluated against major diseases of maize at hotspot locations, of the 1307 were found promising with multiple disease resistance and data were used in promoting verities.
- About 2081 genotypes (hybrids) from different maturity groups were evaluated for exploring resistance against maize cyst nematode (*Heterodera zeae*) at Udaipur centre, of them 110 showed moderate resistance to cyst nematode.
- 3309 inbred lines were screened for MLB, TLB, BLSB, SDM , RDM, CLS, PFSR, C. rust, P. rust, BSR and Cyst nematode at hotspot locations.
- Yield losses were 13-50, 6-87, 13-36, 11-31, 36, 55-100, 56-80 and 37-72 per cent due to MLB, TLB, BLSB, PFSR, CLS, SDM, RDM and cyst nematode, respectively in paired plot technique under artificially created epiphytotics.
- The total phenolic compound, total soluble sugar and total flavonoides were recorded significantly higher in 24 PFSR resistant inbreds at knee high, flowering and at grain filling stage when challenged with *Fusarium verticilloides* and *Macrophomonia phaseolina* pathogens.
- *Trichoderma harzianum* (Local)-fortified FYM (1:50) @ 6 t/ha; *Trichoderma harzianum* (Delhi isolate)-fortified FYM (1:50) @ 6 t/ha, Propiconazole @ 0.1% and salicylic acid @ 50 mg/litre as seed priming and spray @ 150 mg/litre water are effective for control of charcoal rot.
- *Pseudomonas fluorescens @ 0.5%* as seed treatment + bioagent-fortified FYM (1:50) and spray@ 0.5%, *Trichoderma viride* @ 0.5% as seed treatment + bioagent-fortified FYM (1:50) and spray @ 0.5%, Propiconazole @ 0.1% spray at 40 DAS, Double dose of muriate of potash at 45 DAS are effective for FSR.
- *Pseudomonas fluorescens as* seed treatment (4 g/kg), FYM (100 kg/ha)- soil application + *Trichoderma harzianum* (2.5g/kg), Difenconazole @ 0.1%, Validamycin @ 0.1%, Tebuconazole @ 0.05%, Trifloxystrobin 25% + Tebuconazole 50% @ 0.05% were found effective for BLSB.

- *R. serpentina* leaves (Sarpgandaha) @ 10%, *TH-3* @ 0.5% as seed treatment bioagent fortified FYM (1:50) and spray @ 0.5%, *TV-3* @ 0.5% as seed treatment bioagent fortified FYM (1:50) and spray@ 0.5%, Propiconazole @ 0.1 %, Hexaconazole @ 0.1%, Carbendazim @ 0.1%, Mancozeb @ 0.2%, Carbendazim 12 WP + Mancozeb 63 WP @ 0.25% were effective in management of maydis leaf blight.
- Trifloxystrobin 25% + Tebuconazole 50% (0.05%) and Azoxystrobin (0.05%)as foliar spray were promising in controlling banded leaf and sheath blight (BLSB) giving > 65% disease control over check.
- Tebuconazole 250 EC (0.1%) as a foliar spray can control Turcicum Leaf Blight and Common Rust to the extent of >60% over check.
- *Trichoderma* spp. (0.5%) as seed treatment; bioagent-fortified FYM (1:50) and spray (0.5%) was effective in management of *Fusarium* stalk rot (>65% control) whereas Fosetyl-al (0.2%) seed treatment and spray (0.2%) provided >80% control of Rajasthan Downy Mildew. *Datura stramonium* (Datura), *Allium sativum* (garlic) cloves and *Azadirachta indica* leaves (10% aqueous Extracts) as foliar spray were effective in control of Maydis Leaf Blight and Turcicum Leaf Blight.
- Stripping of basal leaves was a good agricultural practice (GAP) checking the progress of banded leaf and sheath blight.

Integrated management of cyst nematode was developed by Udaipur centre as follows:

- Intercropping of maize with sesame, soybean or cluster bean (2:2 rows at 30 cm apart).
- Seed treatment with acephate 75 SP at 2%/ methomyl at 1% w/w. Carbofuran 3G/ phorate 10 G at 1-2 kg/ha as soil application.
- Application of neem/ karanj seed kernel at 10% w/w as seed treatment along with soil amendment with neem/ karanj cake at 2 q/ha.
- *Trichoderma viride* 10 g/kg seed along-with soil application of castor cake at 2 q/ha at the time of sowing.
- *Pochonia chlamydosporia* @ 2% w/w as ST + *Lantana camara* leaves @ 1q/ha as soil application or *Paecilomyces lilacinus* @ 2% w/w + Lantana leaves at 1q/ha or *Pochonia chlamydosporia* @ 2% w/w + Aak (*Calotropis procera*) at 1 q/ ha.
- Survey surveillance is a continuous activity under AICRP programme for studying the variation in intensities or emerging of any new disease. During the reporting period, extensive surveys were conducted in maize growing areas of Himachal Pradesh, Uttarakhand, Punjab, Haryana, Bihar, West Bengal, Rajasthan, Gujarat, Northern and Southern Karnataka, Telangana and Tamil Nadu. The most common observed diseases were MLB (L-H), TLB (L-M), BLSB (L-H), CLS (T-M), BS (T-M), BSR (L-H) in Himachal Pradesh; MLB (L-H), TLB (L), BLSB (H), CLS (T-L), BS (T-L), BSR (T-L), FSR (T), Cerco. LS (M), anthracnose (T) in Uttarakhand; MLB (L-M), BLSB (M-H), CLS (L, Ludhiana only), BS (L), BSDM (T, Gurdaspur only), BSR (L-M), PFSR (L-M) in Punjab; MLB (M-H), BLSB (M-H), CLS (L-M), C.Rust (L-M) in Haryana; MLB (M-H) in Bihar: MLB (L-M), TLB (L) in West Bengal; MLB (L-M), TLB (L), BLSB (L-M), RDM (L-M), BSDM (L), PFSR (T-H), CLS (M-H), BS (T-L), Flag smut (M), C.Rust (T) in Rajasthan; MLB (L-M), TLB (L-H), BLSB (L-H), CLS (L-H) in Gujarat; MLB (L-H), TLB (L-H), SDM (L-H), C. Rot (T-M), CLS (T-M), BS (T-M), C. Rust (H), P. Rust (L-H) in Northern and Southern Karnataka; DM (T), BLSB (T), wilt (T), ear rots (T), CLS (T), gray leaf spot (T) in Telangana; TLB (H), SDM (H), seedling blight (M) and C. Rot (M-H) in Tamil Nadu.
- Occurrence of maize cyst nematode was reported from maize growing areas of Dungarpur, Chittorgarh, Udaipur and Rajsamand districts of southern Rajasthan. Out of 51 samples collected from above districts, 33 samples were found to be infested with maize cyst nematode *i.e.* 64.71 - 67.27 per cent occurrence was estimated in Rajasthan. Besides this, root lesion nematode, *Pratylenchus zeae* was observed in most of the samples in high numbers (150-320 nemas/ 100 cc soil).

5.5 Outreach programme

Technology demonstrations: FLDs conducted during 2011-16 under ISOPOM /NFSM were as follows:

Year	FLD conducted (ha)			
	Kharif	*Rabi*	Spring	Total
2011	2781	-	244	3024
2012	1839	778	293	2910
2013	1366	762	261	2389
2014	301	1423	105	1829
2015	110	29	10	148
2016	197	71	40	308
Total	6593	3062	953	10608

In *kharif* season of 2016, the FLDs was conducted on 197 ha area focused on hybrid, weed management and intercropping where a yield advantage of 1.8 to 72 per cent was recorded in different states. On an average yield increase was 29 per cent as compared to the farmers' practices, which indicates a huge adoption gap of improved technologies in maize production at farmers field. In *rabi* season of 2015-16, the FLDs was conducted on 70.7 ha area focused on hybrid and quality protein maize where an yield advantage of 6.4 to 75.6 per cent was recorded in different states. On an average yield, increase was 27 per cent as compared to the farmers' practices. In spring season of 2016, the FLDs was conducted on 40.0 ha area focused on hybrid, baby corn, sweet corn and quality protein maize where an yield advantage of 10.2 to 29.3 per cent was recorded in different states. On an average yield increase was 16.5 per cent as compared to the farmers' practices that indicates a lesser adoption gap of improved technologies in maize production at farmers' field in spring season.

4623 farmers were trained in various training/field day programme of TSP and FLD programme by AICRP maize. The detail is as follows:

S. No.	Particulars	Venue	Year	No. of Participants
1.	Regional training programme on Maize	Amarwada, Chhindwara	4 December, 2011	206
2.	Regional training programme on Maize	Gossaingaon, Asom	15-17 February 2012	40
3.	Regional training programme on Maize	Barapani, Meghalaya	1 March, 2012	60
4.	Training programme cum field day	ARS, Banswara	16 March, 2012	250
5.	Regional training programme on Maize	Imphal, Manipur	20-21 March, 2012	50
6.	Regional training programme on Maize	State, Skkim	23 March, 2012	42
7.	Regional training programme on Maize	ICAR, Sikkim	22-23 March, 2012	60
8.	Maize conference	SKUAST-Kashmir	31 March, 2012	300
9.	Regional training programme on Maize	KVK Dimapur, Nagaland	10-11 July, 2012	52
10.	Training programme on Maize	Chhindwara	3 October, 2012	110

S. No.	Particulars	Venue	Year	No. of Participants
11.	Training programme	ARS, Banswara	19 October, 2012	700
12.	*Kharif* Maize Production	RMD CARS, Ambikapur Chhattisgrah	13September, 2013	100
13.	*Kharif* Maize Production	KVK Garwah, Jharkhand	27 June, 2013	182
14.	*Kharif* Maize Production	KVK Hazaribag, Jharkhand	26 September, 2013	78
15.	*Rabi* Maize Production	Ranidiha, Jamtara, Jharkhand	13 November, 2013	142
16.	*Rabi* Maize Production	Tamia, Chhindwara	30 March, 2013	118
17.	Maize Production	MSSRF, Jeypore, Koraput, Odisha	-	105
18.	*Rabi* Maize Production	Amarwada, Chhindwara	07 February, 2014	50
19.	Crop production	RVSKVV, Jhabua (M.P)	20 June, 2014	16
20.	Production technology and weed management	RVSKVV, Jhabua (M.P)	23-24 June, 2014	38
21.	Maize production technology	RVSKVV, Jhabua (M.P)	26 June, 2014	26
22.	Improved cultivation techniques of maize	MPUA&T, Banswara, (Rajasthan)	11 July, 2014	26
23.	Maize production technologies	Maize Research Station, Vagarai, (Tamil Nadu)	25 August, 2014	50
24.	Soil fertility Management	RVSKVV, Jhabua (M.P)	28 August, 2014	37
25.	In service training on irrigation, weeds, fertilizer management and post harvest management	RVSKVV, Jhabua (M.P)	10-11 September, 2014	20
26.	Maize production technologies	Maize Research Station, Vagarai, (Tamil Nadu)	11 September, 2014	50
27.	Maize cultivation	OUAT, Bhubaneswar, (Odisha)	22 September, 2014	35
28.	Maize production technologies	Begusarai, (Bihar)	17 October, 2014	59
29.	Improved maize production technology	RMD, CARS, Ambikapur (Chhattisgarh)	29 October, 2014	30
30.	Maize production technologies	Maize Research Station, Vagarai, (Tamil Nadu)	20 November, 2014	50
31.	Sweet corn cultivation	Nasik, (Maharashtra)	12 December, 2014	50
32.	Improved maize variety and hybrids, improved agro technologies, disease and pest management,	MPUA&T, Banswara, (Rajasthan)	25-26 March, 2015	61

S. No.	Particulars	Venue	Year	No. of Participants
33.	Weed Management and seed production technology	MPUA&T, Banswara, (Rajasthan)	27-28 March, 2015	29
34.	Maize cultivation	ZARS, V.C., Farm, Mandya (Karnataka)	March 2015	87
35.	Six training on Maize Cultivation	ICAR RC Centre Manipur	May 2015	276
36.	Maize Production Technology	RARS, AAU, Gossaingaon (Assam)	May 2015	52
37.	Improved Maize Production Technology	DEE, MPUAT, Udaipur (Rajasthan)	19 June, 2015	38
38.	Improved Maize Production Technology	DEE, MPUAT, Udaipur (Rajasthan)	23 June, 2015	52
39.	Maize Production Technology	ZARS, V.C Farm, Mandya (Karnataka)	15 July, 2015	100
40.	Production technology of Maize	KVK, Jhabua (Madhya Pradesh)	10 August, 2015	33
41.	Maize Production Technology	KVK, Jhabua (Madhya Pradesh)	12 August, 2015	21
42.	Integrated Crop Management *kharif* crops	KVK, Jhabua (Madhya Pradesh)	20-21 August, 2015	34
43.	Production Technology and Value Addition in Maize	OUAT, Bhubaneswar (Odisha)	3 September, 2015	25
44.	Production Technology and Value Addition in Maize	OUAT, Bhubaneswar (Odisha)	26 September, 2015	32
45.	Maize Production Technologies	MRS, TNAU, Vagarai (Tamil Nadu)	15 October, 2015	50
46.	Maize Improved Practices	AICMIP, ARI, Banswara (Rajasthan)	26-27 October, 2015	40
47.	Maize Improved Practices	AICMIP, ARI, Banswara (Rajasthan)	30-31 October, 2015	40
48.	Maize Production Technologies	BHU (Uttar Pradesh)	3-4 November, 2015	51
49.	Maize Production Technologies	MRS, TNAU, Vagarai (Tamil Nadu)	5 November, 2015	50
50.	Maize Production Technologies	MRS, TNAU, Vagarai (Tamil Nadu)	2 December, 2015	50

S. No.	Particulars	Venue	Year	No. of Participants
51.	Improved Maize Production Technology	RMD, CARS Ambikapur (Chhattisgarh)	11 December, 2015	30
52.	Maize Production Technologies	MRS, TNAU, Vagarai (Tamil Nadu)	29 December, 2015	50
53.	Production technology of Maize	KVK, Near Rajgarh Naka, Jhabua (M.P.)	15 June, 2016	56
54.	In service training on integrated crop production technology of *kharif* crops	KVK, Near Rajgarh Naka, Jhabua (M.P.)	05-06 July 2016	20
55.	Integrated crop management in *kharif* crops	KVK, Near Rajgarh Naka, Jhabua (M.P.)	19 July 2016	21
56.	Production Technology and Value Addition in Maize	OUAT, Bhubaneswar, (Odisha)	17 August, 2016	30
57.	Improved maize production technology	ZARS, V. C., Farm Mandya (Karnataka)	19 July, 2016	50
58.	Scientific Production Technology of *rabi* Maize	MPUA&T, Banswara, (Rajasthan)	23 November, 2016	63
59.	Maize Production technologies	TNAU, Vagarai, Tamil Nadu	20 September, 2016	50
60.	Maize Production technologies	TNAU, Vagarai, Tamil Nadu	23 November, 2016	50
61.	Maize Production technologies	TNAU, Vagarai, Tamil Nadu	5 December, 2016	50
Total		**61 trainings**		**4623**

5.6 Publication

Research/review papers were brought out by AICRP on Maize Scientists were 508 during the period 2011-2016. Different categories of publications year-wise are listed below:

Year	No. of publication (As per NAAS ratings 2017)				Journal type	
	0-5	5 to 8	8 to 10	Above 10	International Journal	National Journal
2011	20	14	1	-	1	34
2012	68	11	-	-	6	73
2013	71	19	2		6	86
2014	78	11	2		7	84
2015	85	26	1		5	107
2016	67	26	5	1	11	88
Total	**389**	**107**	**11**	**1**	**36**	**472**

6. RECOMMENDATIONS

6.1 IIMR

6.1.1 Crop improvement

- Strengthening of germplasm development, evaluation, characterization, and maintenance for:
  a) Sharing with ICAR/SAUs for germplasm diversification and encouraging the inter-institutional hybrid development programme.
  b) Promising lines to be used for hybrid combination and their evaluation for making small centres as a partner in various agro-ecologies and changing climate scenario.
  c) Development of speciality corn (QPM, sweet corn, baby corn, popcorn) hybrids and fodder maize cultivars by making small centres as a partner in various agro-ecologies.
  d) Registration of trait-specific germplasm with NBPGR and PPVFRA for IPR protection.
- Revolving funds to be created for meeting the demand of seed and new hybrid maize seed production sites to be identified.
- Use of new tools like genomic selection, genetic engineering, genome editing, bioinformatics and double haploid (DH) technology for rapid genetic gains is to be integrated with the breeding programme.

6.1.2 Crop physiology/biochemistry

- Physio-biochemical analysis of the genotypes under managed stress conditions to be done for the understanding the basis of abiotic stress tolerance.
- Growing degree days based classification of the maturity group (early, medium and long duration).
- The biochemistry laboratory needs to be strengthened to cater the need of a quality breeding programme of the country as a central facility wrt profiling of starch, amino acid, oil etc.

6.1.3 Crop production

- Need to develop practices to address the issues related to soil organic carbon management and carbon sequestration.
- Technology development for input-use efficiency especially nutrients (macro and micronutrients) and water for climate resilient agronomy.
- Identification of new effective molecules for pre and post-emergence weed control in maize-based cropping systems to avoid the problem of herbicide resistance.

6.1.4 Crop protection

- Development of forecasting models for major pests and diseases for the different regions for the benefit of the farmers using advanced techniques.

- Identification and evaluation of botanical/ biopesticides/insecticides against *field and storage pests of maize.*
- Identification of races/biotypes and host plant resistance for effective management of major diseases and pests.

6.1.5 Social sciences

- Economic impact analysis of maize production/consumption/value chain.
- Technology transfer and its impact on maize farmer.
- IT-based data management system in AICRP and IIMR needs to be developed.

6.1.6 General

- Existing technical and administrative manpower is extremely low in IIMR which needs serious attention.
- Sufficient funds need to be allocated for the establishment of IIMR at its new place in Ludhiana for development of farm and infrastructure.
- The Winter Nursery Centre, Hyderabad should be strengthened in terms of manpower and infrastructure. Keeping in mind the significance of maize in peninsular India, a Regional Maize Research Centre need to be established in Telangana or Andhra Pradesh. In long run, the Winter Nursery Centre may be merged with this Regional Maize Research Centre for peninsular India.
- Maize being a cross-pollinated multi-season crop, enough contingency shall be allocated to IIMR and AICRP in comparison to other crop for development of technology for three seasons.
- Until establishment of IIMR at Ludhiana, strategic research and continuing long-term experiments should be allowed in Delhi.

6.2 AICRP on maize

1. Development, evaluation and maintenance of inbred lines and their utilization in the breeding programme by all major centre Ludhiana, Karnal, Hyderabad, Coimbatore, Mandya, Almora, Delhi, Pantnagar, Dharwada, Dholi, Varanasi, Srinagar, Bajaura, Imphal and Udaipur.
2. Sharing of the germplasm amongst the centre should be emphasized.
3. The small centre should be a partner with the main centre for hybrid evaluation.
4. Sufficient breeder seed production of the parental line to be undertaken and MoU of released hybrid with the private and public sector (national/state seed corporations, NAFED, IFFCO, KRIBHCO, HIL) for seed production and their popularization by inviting them in annual maize workshop needs to be emphasized.
5. Technology for organic farming involving the use of microorganisms and other alternative means to be standardized through on farm trials to develop organic farming modules.

6. Location-specific need-based agro-technologies to be developed for normal and speciality maize-based inter and sequential cropping systems wherever post of the agronomist exists.
7. Identification of source of resistance for the major pests and diseases wherever plant protection scientists exists.
8. Wherever the specialist scientists are not available at any centre, the nearby centre scientist of the required discipline shall support in the evaluation. To support this additional fund to be provided by Director IIMR.
9. For efficient utilization of the resources and to avoid redundancy the centre specific focused programme recommended is as follows:

S. No.	AICRP Centre	Recommendations
1.	SKUAST, Srinagar	• Development of early maturity biotic and abiotic stress tolerant hybrids for rainfed ecology and evaluation of speciality corn hybrids.
2.	HPKVV, Bajaura	• Development of early to medium maturity normal hybrids and evaluation of speciality corn hybrids. • Development and refinement of eco-friendly production technologies.
3.	HPKVV, Kangra	• Development of early to medium maturity normal hybrids. • Bajaura, Dhaulakuan and Kangra should collaborate.
4.	AAU, Gosaingaon	• Evaluation and identification of suitable hybrids for *kharif* and *rabi* season for Asom region.
5.	CAU, Imphal (Manipur)	• Identification of suitable promising hybrids of normal and speciality maize by evaluating a set of released hybrids for NEH region.
6.	CAU, Barapani	• Evaluation of new hybrids for normal and speciality maize for NEH region.
7.	VPKAS, Almora	• Development of high yielding early duration normal and speciality maize hybrids.
8.	IARI, New Delhi	• All the coordinated trials should be conducted at Delhi. • Development of hybrid of normal and speciality corn.
9.	PAU, Ludhiana	• Development of long duration hybrids for *kharif* and medium duration for the spring season and speciality corn hybrids. • Studies on the racial differences for TLB pathogens.
10.	CCSHAU, Karnal	• Development of long duration hybrids for *kharif* and medium duration for the spring season and speciality corn hybrids. • Development of agro-techniques for spring season crop.
11.	GBPUAT, Pantnagar	• Development of medium to late duration hybrids for *kharif* and spring season. • Development of agro-techniques for high moisture stress and organic maize production.
12.	NDUAT, Bahraich	• Evaluation and identification of early to medium duration (in *kharif*), medium to late duration (in *rabi*) and medium duration (in spring) normal and speciality hybrids for UP. • Develop suitable package and of practices of maize cultivation in the spring season.
13.	BHU, Varanasi	• Development and evaluation of single cross hybrids for *kharif* and *rabi* season.
14.	DrRPCAU, Dholi	• Development of yellow and white hybrids of normal maize and QPM for *rabi* and spring season. • Development of value-added food products of QPM.
15.	BAU, Sabour, Bhagalpur (Bihar)	• The centre shall collaborate with Dholi wrt all activities. • Evaluation of yellow and white hybrids of normal maize and QPM for *rabi* and spring season.

S. No.	AICRP Centre	Recommendations
16.	BAU, Ranchi	• Development and evaluation of single cross hybrids for *kharif* and *rabi* season.
17.	BCKV, Kalyani (WB)	• Evaluation and identification of suitable hybrids for normal and speciality maize suitable for *rabi* season. • Development of package of practices for normal and speciality maize during *rabi* season.
18.	OUAT, Bhubaneswar	• Evaluation and identification of late and medium maturity stress resilient normal and speciality maize hybrids for Odisha.
19.	JNKVV, Chhindwara	• Development of package practices for *kharif* season maize and sweet corn. • Development of medium to long duration cultivars suitable for high rainfall areas and development of package practices.
20.	MPUAT, Udaipur	• Development of early to medium duration normal and QPM hybrids for *kharif* season. • Collaboration with Banswara to strengthen the maize programme in Rajasthan.
21.	MPUAT, Banswara	• Development of maize hybrids for *rabi* season.
22.	AAU, Godhara	• Early to medium maturity normal and speciality maize hybrid development and evaluation for inter and sole cropping systems in *kharif* and *rabi* season. • Development of package of practices for sweet corn in *rabi* season.
23.	IGKVV, Ambikapur	• Identification of early and medium duration single cross hybrid of normal and speciality maize. • Development of package of practices for *kharif* and *rabi* seasons.
24.	PJTSAU, Hyderabad	• Development of medium and long duration hybrids of normal and speciality maize for *kharif* and *rabi* season.
25.	PJTSAU, Karimnagar	• Development of drought tolerant hybrids for *kharif* season. • Effective collaboration with Hyderabad centre.
26.	ANGRAU, Peddapuram	• Development of single cross hybrids of medium to late maturity for *rabi* season. • Development of package of practices for planting densities, zero -tillage and PF SR management.
27.	MPKV, Kolhapur	• Development, evaluation and identification of medium to long duration hybrids for *kharif* and *rabi* season. • Development of package of practices for *rabi* season maize-based cropping system.
28.	MPKV, Rahuri (Maharashtra)	• Evaluation of normal and speciality maize hybrids for *kharif* and *rabi* season. • Collaboration with Kolhapur centre.
29.	UAS, Dharwad	• Development of medium and long duration hybrids suitable for rainfed and irrigated ecologies of *kharif* and *rabi* season. • Collaboration with Mandya centre.
30.	UAS, Mandya	• Development of early and medium duration single cross hybrids for the rainfed ecosystem in southern Karnataka. • Development of inbred lines for disease resistance to downy mildew disease. • Development of value -added products of speciality corn (popcorn, baby corn and QPM)
31.	TNAU, Coimbatore	• Development of high yielding medium and long duration normal maize hybrids for *kharif* and *rabi* season. • Evaluation of speciality corn hybrids and develop their package of practices.
32.	TNAU, Vagarai	• Development of high yielding maize hybrids under limited water conditions. • Collaboration with Coimbatore centre.

Annexure I. Office order for QRT constitution from ICAR

INDIAN COUNCIL OF AGRICULTURAL RESEARCH
Krishi Bhawan, Dr. Rajendra Prasad Road,
New Delhi 110 001

F.No. CS/16/7/10-IA.IV

Dated the 22nd Feb.,2017

OFFICE ORDER

The Director General, ICAR has been pleased to constitute the Quinquennial Review Team (QRT) to review the work done by Indian Institute of Maize Research, New Delhi and AICRP on Maize during the five years period from 2011 to 2016. The composition of the QRT will be as under :-

Sr. No.	Name & Address	Designation
1.	Dr. Swapan Kumar Datta, Vice Chancellor, Visva – Bharti, PO : Santiniketan, West Bengal – 731 235	Chairman
2.	Dr. Sain Dass, Former Director, IIMR, New Delhi.	Member
3.	Dr. I.P.S. Ahlawat, Former Head, Division of Agronomy, IARI J-401, Green Valley Apartment, Plot No. 18, Sector-22, Dwarka-77.	Member
4.	Dr. A.K. Sharma, Former Director, NBAIM, Mau, U.P.	Member
5.	Dr. K. Srinivas, Principal Scientist, Research System Management Division, NAARM, Hyderabad-500030, Telangana	Member
6.	Dr. Shankar Lal, Scientist, IIMR, New Delhi	Member-Secretary

FUNCTIONS :

The QRT shall conduct the review of the work of the IIMR, New Delhi, keeping in view the relevant guidelines thereon and submit its recommendations on future research thrusts through its report to the Council within 6 months from the date of issue of this order for further submission to the General Body of ICAR. Terms and references for the QRT are enclosed as per Annexure I.

PROCEDURE :

The Chairman of the Review Team will initiate action to convene the meeting of the Team as early as possible. The Chairman will also inform the Director, IIMR, New Delhi to provide the

information required by the Team in regard to the work done and other relevant information, as may be required for conducting the review.

The Director of the Institute will provide necessary stenographic, technical. logistic administrative assistance etc. to the QRT members for the efficient functioning of the Committee and preparation of the report.

The T.A. of the Non-official Members of the QRT for attending its meeting will be paid by the IIMR, New Delhi in accordance with the relevant rules of the Council.

(Rajeshwar Dayal)
Under Secretary(CS)

DISTRIBUTION :

1. Chairman, QRT for IIMR, New Delhi. Director, IIMR may communicate to the Chairman/Members please.
2. All Members of the QRT.
3. Director, IIMR, New Delhi. The T.A. for the non-official members of the QRT will be met by the Institute for which necessary budget provision in the Institute's budget may be made under other charges and not under T.A. which is meant for the staff of the Institute. The copy of Revised Guidelines for QRT is enclosed for reference and record. It is requested that the photocopy of same may be provided to Chairman for guidance.
4. DDG(CS), ICAR
5. ADG(FFC), ICAR
6. Director(Finance), ICAR
7. DD(F), ICAR
8. Accounts Officer, IIMR, New Delhi
9. Budget Section, ICAR
10. Guard file

Annexure II. Terms of Reference of Quinquennial Review Team

A. Institute/Unit

1. Research, Achievements and impact

To critically examine and identify research achievements of the Institute, regional stations and AICRP centers operated since the previous QRT and critically evaluate them. Commensurate with the objectives, mandates and resources, the socio-economic impact of results from farmers/beneficiaries through extension should be reviewed. The research and its impact should be brought out in quantifiable benchmarks wherever possible.

2. Research relevance and budget allocations

To examine objectives, scope and relevance of the research programs and budget of the Institute for the next five years in relation to overall state/regional/national plans, policies and long- and short- term priorities.

3. Relationships/collaboration with SAUs and other stake holders

To pinpoint whether the research program of the past and proposal of the future are in harmony with the vision of the ICAR and the program of the related centers of research and agricultural universities, state government and private sectors.

4. Linkages with clients

To examine the kind of linkages established with the clients and users of the results i.e. farmers and the extent of interest displayed in conducting " on- farm research" on farmers' fields and in organizing demonstrations/training courses for the transfer of technology to extension agencies and KVKs of ICAR.

5. Proposed changes in organization, programmes and budget

To examine whether any changes in the organizational setup are required for man power and fund allocation. The committee may also examine the resource generation efforts and implementation of project based budgeting.

6. Constraints

To examine constraints observed by the Institute in achieving its objectives and implementation of its program and to recommend ways and means of minimizing or eliminating them.

7. Looking forward

To look into any other point considered relevant by the committee or Institute Director or Management Committee in respect of future program development, research prioritization and management changes.

B. All India Coordinated Research Projects (AICRPs)

1. To analyze growth of man power, number of cooperative centers both in terms of funds as well as staff resources.

2. To critically examine and evaluate achievements of AICRPs in research with reference to (i) focus on national program (ii) multi- location testing (iii) evaluation of pests and diseases (iv) exchange of scientific information (v) inter-institutional and inter-disciplinary linkages (vi) off-season nursery facilities (vii) healthy competition in annual workshop (viii) quality of recommendation and follow-up action (ix) whether research is routine or breaking new grounds (x) whether there is individual initiative.

Budget

3. To examine sufficiency of big budget of the coordinated centers as the part of the total budget of the SAU and of the ICAR

Organization and Management

4. What is the monetary mechanism of the coordinated project to avoid distortion/duplication/over-lapping in program of AICRP?

Annual Workshops

5. How the annual workshop is organized? Is it surveying the focus of generation of new ideas? Do the senior officials from departments of agriculture and extension attend workshops? Do scientists from private sector participate?
6. Does the cooperating unit maintain an extensive database on the crop?
7. How is the HRD program organized for the young scientists working in the project and also other staff working in the project?

Annexure III: Action Taken Report on previous QRT recommendations

S. No.	Recommendations of QRT 2006-10	Action taken on the recommendations
	BREEDING	
1.	Pyramiding of biotic and abiotic factors is necessary for crop improvement programme.	Multi location screening for abiotic stress viz. drought (Delhi, Hyderabad and Udaipur), Waterlogging (Delhi, Dholi) and heat-stress (Delhi, Karnal, Ludhiana and Godhara) was done at 2 or more locations. The facility of rainout shelter at Delhi is being used for confirmation of studies for identified source of tolerance to drought. Institute working on moisture stress in project NICRA and institutional project. In addition to this, institute have established linkages with CIMMYT for work on abiotic stresses. In addition to rainout shelter at Delhi, institute also planned to establish one such facility at Ludhiana.77 multiple disease resistant lines were developed for utilization in stress resilient breeding programme. A database on maize inbred lines has been developed in 200-10 and updated in subsequent years. This consists of 1150 inbred lines of normal maize, QPM, sweet corn, pop corn, high oil, waxy, etc with information on their phenology and kernel traits. The RIL populations for MLB and drought also developed. IIMR also undertook a project on digitization of maize germplasm. IIMR shares elite maize germplasm developed by IIMR and AICRP centres every year with centres by conducting germplasm day and shared around 7000 germplasm to various centres for strengthening crop improvement programme.
2.	The research activities pertaining to specialty corns should be strengthened.	DMR is advising industries engaged in the processing of specialty corn particularly QPM, through Krishi Vigyan melas. Various products of specialty corn such as baby corn, pop corn are promoted through value addition training etc. A total of eight scientists from IIMR and five scientists from AICRP on maize visited to Thailand in 11th Asian Maize Conference to have exposure on specialty corn cultivation. In USA also, recently one scientist had undergone training of 3 months and two other attended international seminar to have exposure on latest maize improvement technologies. One each of baby corn (VMH 27), popcorn (BPCH 6) and sweet corn (FSCH 18) hybrids have been released and notified during 2017 and 2015 respectively. However, further strengthening of specialty corn is underway in the form of institutional projects on sweet corn and baby corn.
3.	The inbred lines developed by different centres are very less; hence more number of lines needs to be derived to contain the regional research activities.	The efforts are being made through supply of pre-breeding nurseries comprising early-generation segregating germplasm to facilitate centres to derive locally adopted new and promising inbred lines. In addition, efforts are on to tap the landraces (received under the CRP-Agrobiodiversity project) from the diverse agro-ecological regions of the country for strengthening and diversifying the inbred line genetic base. Further, we have

S. No.	Recommendations of QRT 2006-10	Action taken on the recommendations
		indented specific 50-temperate lines (received in 2016) and 75-tropical inbred lines (indented in 2016 and in the process) from USA and CIMMYT, Mexico respectively, which will be acclimatized and multiplied for use by the coordinated project centres. Efforts were made by channelizing the testing fee money for increasing contingency for AICRP centre to develop their own inbred development programme. Two trainings were also held by IIMR to the AICRP breeders for their capacity development in this field.
4.	It was suggested to focus on development of single cross hybrids, derive lines, pools and populations. More number of hybrids needs to be contributed for testing in the coordinated programmes.	The coordinated programme has been strengthened with supply of inbred line germplasm to develop suitable hybrids. Further, the process of deriving inbred lines from pools, populations was strengthened by capacity development of new researchers. 17 lines were developed for unique traits and registered with INGR number at NBPGR for strengthening the stress resilient maize breeding programme
5.	The breeder seed production programme of the hybrids released should be under taken and hybrids should be registered with PPV & FRA, 2001. It was suggested to conduct demonstrations of popular hybrids and credibility of the centre.	The breeder seed production of the inbred was taken up by all the centres as per DAC indent and efforts were made for hybrid seed production which was distributed under FLD and TSP programme. To protect the interest of researchers and hybrid development efforts, IIMR facilitated the registration of 104 hybrids/varieties under PPV & FRA during this period. All the centres planted their station cultivars in large plots at research station to display to stakeholders. National demonstration of all the hybrids (public and private sector) was also undertaken during 2013 and 2014 at Delhi where 106 and 131 hybrids/cultivars, respectively were displayed for popularization best hybrids. The demonstration were visited by officials of ICAR, NSC, SSC and private seed companies officials. Some of the better performing hybrids under national demonstrations were PMH 1, PMH 3, PMH 6, CMH 08-287, CMH 08-292, NK 6217, CP 828, FCH 184, DKC 9150, RMH 4726, DKC 9144, PAC 745, PAC 740 etc. in late and medium and Prakash, Vivek Hybrid 45, DMRH 1417, DH 1411, DMRH 1305, EHL 162508, Vivek Maize Hybrid 43, Vivek QPM 9 etc. in early and extra early maturity
6.	As there is huge demand for fodder, research on fodder maize need to be strengthened	The fodder types were developed and then tested in the AICRP on forage crops from *kharif* 2015 onwards where one cultivar reached in AVT-2 year having good fodder quality. An in-house project on fodder with IGFRI collaboration has been approved. In addition, selected lines from North East are being screened for fodder potential. The research on use of teosinte for fodder production potential has been started to cater the need of fodder production for livestock sector of the country.
7.	Development of regional specific hybrids needs to be recommended; besides inter-institutional hybrids are to be tried in all the locations.	The region specific hybrids were only identified for the various zone through VIC and the centres also an effort to release state specific hybrids. Inter-institutional hybrids were developed by Coimbatore, Udaipur and Varanasi centre during this period. The sharing of the germplasm amongst AICRP centre and with IIMR was emphasized in order to utilize the concept of the inter-institutional hybrid/cultivar development.

S. No.	Recommendations of QRT 2006-10	Action taken on the recommendations
8.	The doubled haploid programme may be strengthened with bio-technological facilities.	The fodder types were developed and then tested in the AICRP on forage crops from *kharif* 2015 onwards where one cultivar reached in AVT-2 year having good fodder quality. An in-house project on fodder with IGFRI collaboration has been approved. In addition, selected lines from North East are being screened for fodder potential. The research on use of teosinte for fodder production potential has been started to cater the need of fodder production for livestock sector of the country
9.	For advancing inbred-hybrid development programme haploid inducers may be acquired for accelerating the hybrid development programme.	Haploid inducer lines acquired and being maintained at PAU, Ludhiana and VPKAS, Almora centre. The efforts are being made to initiate use of haploids in regular breeding programme. A project for DH facility creation has been submitted for external funding which is under evaluation.
10.	Each centre was suggested to produce breeder seed for the parents of the hybrids released.	It is being practiced at present that all the centres are advised to undertake the breeder seed production of hybrids in seed chain. Instructions are being sent
11.	The importance of heterotic pools should be looked in to by different centres.	It was initiated in 2015 and identified LM13 and LM14 as the testers that were grouping the germplasm, better into heterotic pools.
12.	As the white maize is becoming more popular in some of the states, the research activities towards this direction should be strengthened by obtaining white maize germplasm.	White maize cultivar development was emphasized and 5 hybrids/ varieties viz. HM-12, SHIATS Makka 3, Bisco 555, Shalimar Maize Composite-5 and YM-9905were released during this period for various agro-ecologies.
13.	Suggested to increase the seed production activities and compare the QPM genotypes with popular check.	The seed production of the QPM was undertaken at farmers' field in collaboration with West Bengal and Rajasthan State Seed Corporations for popularization of QPM hybrids seed. The Chhindwara, Hyderabad and Ludhiana centres also undertook seed production for popularization of the hybrid. The public bred hybrid was also promoted through MoUs with private seed companies by CCSHAU, Hisar. The QPM was compared with the popular check and found that it has yield penalty
14.	It was suggested to focus the development of early maturing single cross hybrid	AICRP centres located in northern hill zone are exclusively working on early maturity hybrid development and 23 hybrids/varieties released during this period viz.HM-13, PMH-5, VMH4106, Vivek Hybrid maize 39, 45, 47, 51, 53, 55, P1864, Pant Sankar Makka-1, 4, Sun Vaaman, Bio 605, GAYMH-1, SHIATS Makka 3, D2244, KDM-438,Shalimar Maize Composite-3, 5, 6, 7 and BPCH-6 for various agro-ecologies in the country
15.	Exchange of breeding material and inbreds between centres should be continued.	The winter nursery centre of IIMR at Hyderabad is mandated for this activity and during the period germplasm were procured, maintained, displayed in field days and distributed to 25-25 centres annually by organizing Germplasm Day as a continues activity. In this way, 9117 accessions of contrasting characters were displayed and distributed as per the mandate and requirement of the centre
16.	Zone V needs more improvement. Ready material needs to be supplied for strengthening of all the centres. Released hybrids should be supplied for their immediate popularization.	The zone-V was given special emphasis on the development of early and medium duration hybrid for which germplasm were distributed and which rustled in release of 23 cultivars of early maturity resistant to biotic and abiotic stresses. The Gujarat State Seed Corporation has undertaken large-scale seed production of public bred hybrid Co-6 to cover is under hybrids

S. No.	Recommendations of QRT 2006-10	Action taken on the recommendations
17.	Maintenance breeding and popularization of hybrids should be done on priority.	A separate objective on the maintenance breeding was started at the institute projects to cater the need of pure genetic background germplasm in breeding and stress screening programme. The popularization of hybrids was done by organizing FLDs on1000 ha area and the training to more than 600 farmers.
18.	The period of testing of hybrids for release should be reduced.	The period of testing for the hybrid was discussed in the workshop but it was not materialized due to technical constraint of non-feasibility with standards of the CVRC and more fluctuations in the seasonal variability in maize ecologies. Hence, period of testing will remain same of 3 years for hybrid as well.
19.	Some of the centres are giving more importance to private and CIMMYT trials. This should be avoided and coordinated programme should be given priority.	The centres doing so were instructed and the ICAR-CIMMYT collaboration was streamlined and all the CIMMYT trial were reported in AICRP annual progress report and was monitored centrally by IIMR to ensure that sufficient time is given by the centre ion national programme.
20.	Participatory seed production should be thought off to increase the seed production activities.	State seed corporations did the participatory seed production at Rajasthan and West Bengal for hybrid maize to ensure quality seed production at diversified production site at affordable prices during 2011-16 at farmers field under technical guidance of maize scientist and support.
21.	The parents of the released hybrids may be obtained from the concerned breeder and kept in the stock, may be spared to needy centres.	The parent of the resealed hybrid sharing was discussed in the workshop and implemented in true spirit, which led to development of nutritionally quality rich hybrids by IARI and some inter-institutional hybrids. This was ensured that no centre would be denied to have released hybrid parental seed for maximum exploitation of the developed resources in maize R4D
22.	It is recommended to review the seed production programme at breeder's level.	This is being done regularly by monitoring the breeder seed production plots and it was ensured that quality breeder seed is produced as per DAC indent
23.	The inter-institutional or inter-zonal hybrids need to be developed and tested in different centres.	Several hybrids are developed by following such mechanism like Pratap QPM Hybrid-1 and hybrid by the Coimbatore centre and some of the advance stage hybrid of IIMR has parental line of the CCSHAU, Karnal
24.	As the major area is covered by composites, narrow based high yielding synthetics should be tried besides hybrid research programme to augment the productivity in zone I, for which diversity of germplasm is pre-requisite for crop improvement programme and DMR needs to spare the required germplasm	Work on composites is being carried out in zone I and promising germplasm being selected by the breeders for Zone I have been supplied by IIMR. It lead to development of four composites by Srinagar centre viz., Shalimar Maize Composite-3, 5, 6 and 7
25.	The stay green type of hybrids should be tried to contain fodder problem.	New hybrids are being developed and breeders are encouraged and sensitized to give due importance to stay green while developing new and high yielding hybrids. Some of the hybrid developed by IIMR like DMRH 1417 have typical stay green trait and it has been observed in the other hybrid as well. The farmers were also sensitized to take advantage of the stay green hybrid for increasing livestock productivity

S. No.	Recommendations of QRT 2006-10	Action taken on the recommendations
	AGRONOMY	
1.	The studies on residual effect especially the weedicides need to be undertaken.	The cropping system based experiments were conducted where residual effect of different herbicides and their combinations on the succeeding crop was evaluated. The treatment recording the maximum productivity in maize based cropping system was recommended.
2.	Resource conservation technology is very important; hence technology needs to be developed in maize systems.	The technologies on the site-specific nutrient management and conservation agriculture were developed in major maize based cropping system through AICRP and IIMR. It was observed that CA and precision nutrient management improves soil health and resource-use efficiency
3.	Organic inputs should be tried as substitute to inorganic fertilizers.	The integrated use of the organic and inorganic nutrient along with crop residue recycling and liquid NPK consortia and P biofertilizers were recommended in various agro-ecologies. Application of 5 t/ha crop residue was also recommended for moisture conservation and soil health in rainfed agriculture in NHZ and CWZ. A long-term manurial trial was initiated at Pantnagar in 2013 to develop agro-techniques for the organic maize production
4.	Chemicalization of agriculture is to be stopped with organic farming.	Considering the need of the organic farming 3-years research at Pantnagar for development of package and practices for organic maize, revealed that legume intercropping with maize and organic manure application could be the best method.
5.	Intercropping research needs to be promoted as the majority of the farmers are either marginal or small.	Intercropping of maize with pulses like mungbean, urdbean, pigeonpea and oilseed like groundnut was recommended during *kharif* season for various agro-ecologies
6.	Strengthening of site-specific agronomy development needs to be emphasized.	The experiment on the site specific nutrient management x tillage, SSNM x genotype, and use of hydrogel for water management and identification of suitable herbicides and IWM practices were carried out in order to generate site specific agronomy practices at 22 locations across India
	ENTOMOLOGY	
1.	It was suggested to check the effect of bio control agent (*Trichogramma*) as it is more efficient and effective	Release of the biocontrol agent *Trichogramma chilonis* @ 1,25,000 parasitized eggs/ha at 10-12 and 20-22 DAG recommended for the management of stem borer, *Chilo partellus*
2.	The IPM package may be tried along with Trichogramma rather than Trichogramma alone.	The IPM modules for stem borer includes the use of intercropping, botanicals, seed treatment and spray of newer low dose pesticides in addition to bio control agents, and is being implemented through AICRP
3.	As the stem borer incidence is very severe, needs entomologist attention.	It is being tackled though basic and applied research pertaining to host plant resistance, novel low dose pesticides, botanicals and bio-pesticides.
4.	The intercropping research needs to be strengthened for insect management.	Maize intercropped with marigold, sesame, cauliflower and cowpea has been found effective for various pests. Maize: cowpea intercropping in 2:1 is recommended for the IPM module
5.	The plant protection technologies may be developed for tribal people, who do not practice plant protection measures.	Use of pheromone traps, trap crops and botanicals are being worked out.

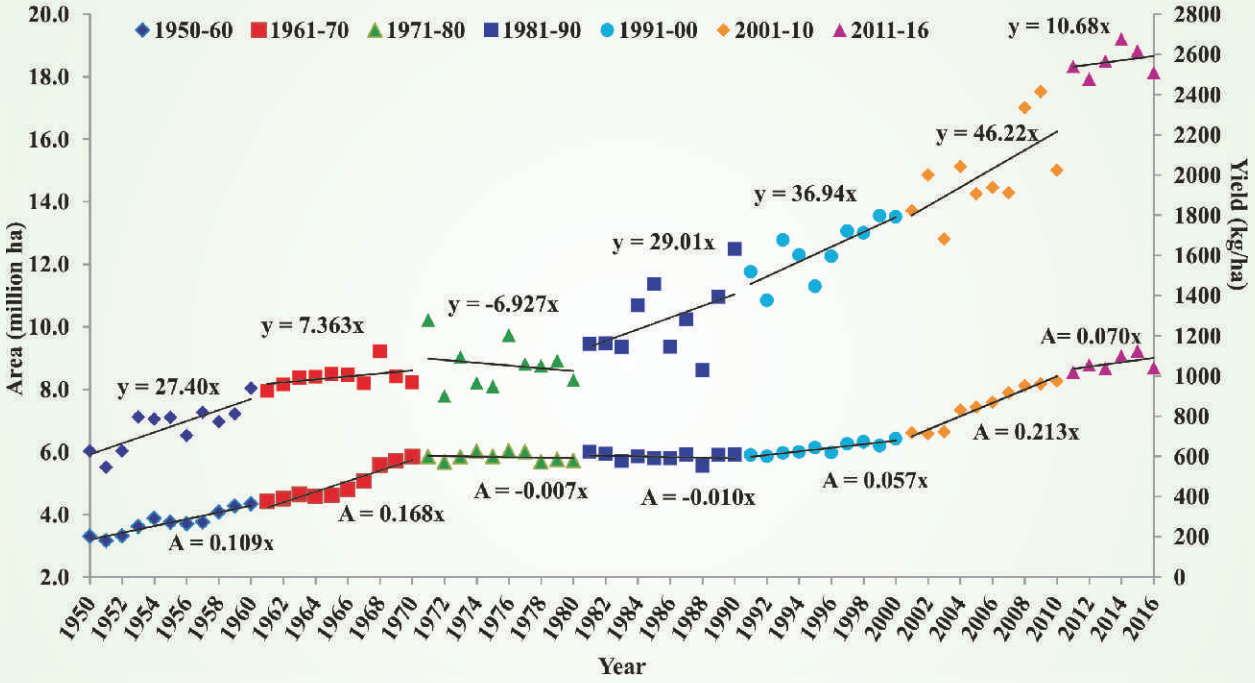
S. No.	Recommendations of QRT 2006-10	Action taken on the recommendations
6.	The habitat management in maize using intercrop, the bio-agents data should be recorded.	Habitat management using sorghum as trap crop, cowpea, marigold, and Sesame as intercrops has been worked out. Recommendations made for sorghum as a trap crop in the form of four border rows and cowpea as intercrop (Maize: cowpea, 2:1). Regular observations of bioagents/natural enemy populations are being taken.
7.	As there is lot of variation of the climate in zone I and the area stretch is very vast, from Arunachal Pradesh to J&K, there is need for three entomologists to address the entomological related problems.	One entomologist at Bajaura centre has already joined in AICRP programme, and one post at NEH at CAU, Imphal has already been sanctioned under IACRP maize in 12th plan
	PLANT PATHOLOGY	
1.	The survey and surveillance of brown stripe downy mildew (BSDM) need to be under taken as the disease is gaining importance in zone II.	During *kharif* 2011-12, extensive surveys were conducted under survey and surveillance programme in maize growing areas of Rajasthan, Himachal Pradesh, Andhra Pradesh, Karnataka, Tamil Nadu and Uttrakhand. In Rajasthan state, 327 fields from 47 places were visited. The major diseases, which were noticed viz., CLS, FSR, BLSB, RDM, MLB, TLB, BSDM, brown spot, head smut. The incidence of BSDM was recorded from moderate to severe from only three places i.e. Pepalwas, Pawa, Barwara whereas from traces to moderate from eight places which were Jhodal, Lila Dhar, Harzia Khera, Kavita, Kadiyan, Baghalo ka Guda, Bhagholon-Ka-Guda, Kuncholi. In *Kharif* 2013, severity of BSDM was noticed 20 to 25 per cent at Bheel Khera and Iswal of Rajasthan. During 2014-16, BSDM was noticed in low to moderate severity in Rajasthan whereas in Gurdaspur (Punjab), it was noticed in traces
2.	The programme on research activities on disease need to be strengthened in zone II like previous years.	Screening of germplasm/trap nursery trials/ yield loss assessment/ survey and surveillance for major diseases management of MLB, BLSB, C. rot and C. rust has been strengthened in Zone I
3.	The survey and surveillance regarding Rajasthan downy mildew (RDM) should be under taken to know the status of disease incidence.	Severe incidence of RDM was noticed only from four places – Kalaroi, Patia, Bijolia and Borkhera out of 327 fields from visited 47 places of Rajasthan state during extensive surveys conducted at Rajasthan, Himachal Pradesh, Andhra Pradesh, Karnataka, Tamil Nadu and Uttarakhand. In *Kharif* 2013, RDM was noticed from eight places of Rajasthan with 10 to 30 per cent incidence. During 2014-16, RDM was low to severe in Rajasthan whereas in Telangana, it was observed in trace form.
4.	Due to the introduction of private bred hybrids, many diseases observed. Hence, it has been recommended that the private bred material should also be screened thoroughly for all the pest and diseases.	Screening of private bred hybrids of all maturity groups has been initiated at hot spot locations in different zones.
5.	The artificial inoculation should be properly tried for pathological screening of genotype.	Revised guidelines with scales and severity charts for uniform method of disease assessment in maize under artificially/sick plot created epiphytotics has developed and data of NIVT hybrids (*Kharif* 2016 onwards) has been started to be recorded on 1-9 scale uniformly.

S. No.	Recommendations of QRT 2006-10	Action taken on the recommendations
		Some centres have initiated development of sick plot for screening against soil borne disease(s) on priority from *Kharif* 2016 onwards. Once developed, inoculums load in sick plot will be calculated while conducting trials. Director of Research/ Director of centres are ensuring this and will send compliance report to IIMR. All centres are directed to screen germplasm against diseases under artificially inoculated / sick plot conditions only and data from screening in natural/ low disease pressures was not considered.
	BIOCHEMISTRY	
1.	Addition of one post of scientist in the discipline of Food Science Technology/ Bio chemistry to conduct research on the development of value added products.	Efforts were made to include one post of Scientist Food Science and Technology. The proposal will again be sent to ICAR.
2.	A short term training of the scientist at CIMMYT, Mexico to broaden the skills required for the development of Quality Protein Maize.	Contacted Dr. Natalia Palacoius, Biochemist at CIMMYT in this regard. As per her response, She does not have any funds at present for this purpose. After receiving fund, the said training will be conducted.
3.	Training of the scientist at some appropriate laboratory abroad so as to equip the scientist for study the starch degradability.	Studied the starch digestibility characteristics of around 80 genotypes and identified promising genotypes having slow digestibility.
	BIOTECHNOLOGY	
1.	Bt corn programme needs to be strengthened besides work on bio agents	One externally funded project on Development of stem borer resistant transgenic maize was executed during the period. The Cry toxin expression achieved was 40 ng/mg of total soluble protein of maize leaf tissue.
2.	The recommendations regarding transgenic maize should be from coordinated data rather than the private + companies' data.	Issue will be discussed in Annual Maize Workshop to find out the possibility at centres and recommendations will be sent to ICAR.
3.	While conducting Bt trials all norms need to be followed. Bio-safety permission needs to be obtained before executing Bt trials.	Every Institute, SAU has IBSC and it is obligatory on the part of institute to comply the protocol.
4.	Biotechnology techniques may be proposed for future research programmes	Three externally funded projects and 1 in-house project initiated during the period.
	PLANT PHYSIOLOGY	
1.	The research activities pertaining to biotic and abiotic stresses, forage crops and climate change are the important faculties which need extra attention.	➢ We are regularly extensively screening the available maize germplasm under different biotic (insect-pest and diseases) and abiotic stresses (drought, waterlogging and high temperature). ➢ We have initiated work of breeding for better forage quality maize ➢ We are partner in the ongoing ICAR CRP project on "*National Initiative for Climate Resilient Agriculture*"

S. No.	Recommendations of QRT 2006-10	Action taken on the recommendations
	EXTENSION	
1.	It was suggested to execute more FLDs and field days.	10608ha FLDs were conducted during 2011-16 and more number of trainings and field days were emphasized in TSP programme.
	COMPUTER APPLICATIONS	
1.	Nano technology may be tried with respect to seed treatment and to enhance photosynthetic efficiency.	Scientist was trained in USA for 3 months under NAIP project for the nanotechnology but in absence of funding research could not be taken up in 12th plan.
	GENERAL	
1.	Public private partnership (PPP) should be strengthened.	Efforts made to strengthen PPP for seed production of hybrid maize
2.	Coordination between public and public centres may be strengthened for improvement of research activities.	The public and private coordination was strengthened by increasing partnership in basic research like baseline susceptibility to *Chilo* and the decision on involvement of private centre as test location was taken which is to be implemented from *kharif* 2017.
3.	The technologies developed should be popularized by availing the support of KVKs	The technologies developed are being sent to the office of the ATARI in respective places in order to their popularization amongst farmers. These technologies were also sent to the SMD Agricultural Extension/Agricultural Engineering for overall coordination and compilation at the ICAR level.
4.	The research areas to be prioritized in different states to work with.	The research areas in maize were prioritized according to current and future maize demand wherein the research projects were also framed accordingly as well.
5.	The integration among Breeders, Pathologists, Entomologists and Agronomists need to be brought out for effective research work.	Interdisciplinary projects on stress tolerance breeding and disease and insect tolerance germplasm development were emphasized for effective research work.
6.	It has been recommended to enhance the recurring contingency (RC) to the tune of Rs 2.5 to 3.0 lakhs and travelling allowance (TA) to the tune of Rs 50,000 per Scientist.	To enhance the contingency the testing fee was distribute amongst the centres, which made equal to or more than Rs 2.5 to 3.0 lakh. However, the TA grant could not be raised to Rs 5000 due to less allocation of fund from ICAR for the AICRP as the expenditure on salary was also not met satisfactorily.
7.	Orientation programmes need to be organized to different centres to enhance the productivity at national level.	A total of three refresher training program were organized at Delhi and Hyderabad centres in order to strengthen the research and development ion maize at different centres during 2011-16.
8.	The lead centres may be created and zonal coordinators may be nominated to monitor the research activities at zonal level. The regional centres may also be identified. Hence, it has been recommended to create separate budget for such activities.	A zonal coordinator for each of the programme on crop improvement and crop production were identified to coordinate research activities of the particular zone.
9.	The concept of KVK should be used for popularization of hybrids.	The technologies developed are being sent to the office of the ATARI in respective places in order to their popularization amongst farmers. These technologies were also sent to the SMD Agricultural Extension for overall coordination at the ICAR level.

S. No.	Recommendations of QRT 2006-10	Action taken on the recommendations
10.	The promising hybrids released at state-level may be recommended for cultivation in other states also as per the demand of the farmers.	The effort were made in direction and a hybrid DHM 117 was recommended for Bihar and Rajasthan which was earlier recommend for Peninsular region.
11.	The promising hybrids released at state-level may be allowed to enter in AET II year directly to save on time for its promotion for other regions.	All the hybrids released at the state level in maize are being tested in AICRP at all India level as well in Initial Varietal trials.
12.	A voluntary centre is recommended at Port Blair keeping in view of the demand of specialty corn.	Voluntary centres created that have done excellent work on maize popularization specially QPM and sweet corn in collaboration with ICAR-Central Island Agricultural Research Institute, Port Blair. However, after 2014 it was stopped due to non-technical support and not showing interest by CARI.
13.	Post harvest technology programmes, processing studies with value addition need to be looked in to for quality research activities.	The processing studies have been carried out at the Mandya and Dholi centre where a good amount of product developed in maize.

Maize scenario in India



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

Agrisearch with a human touch