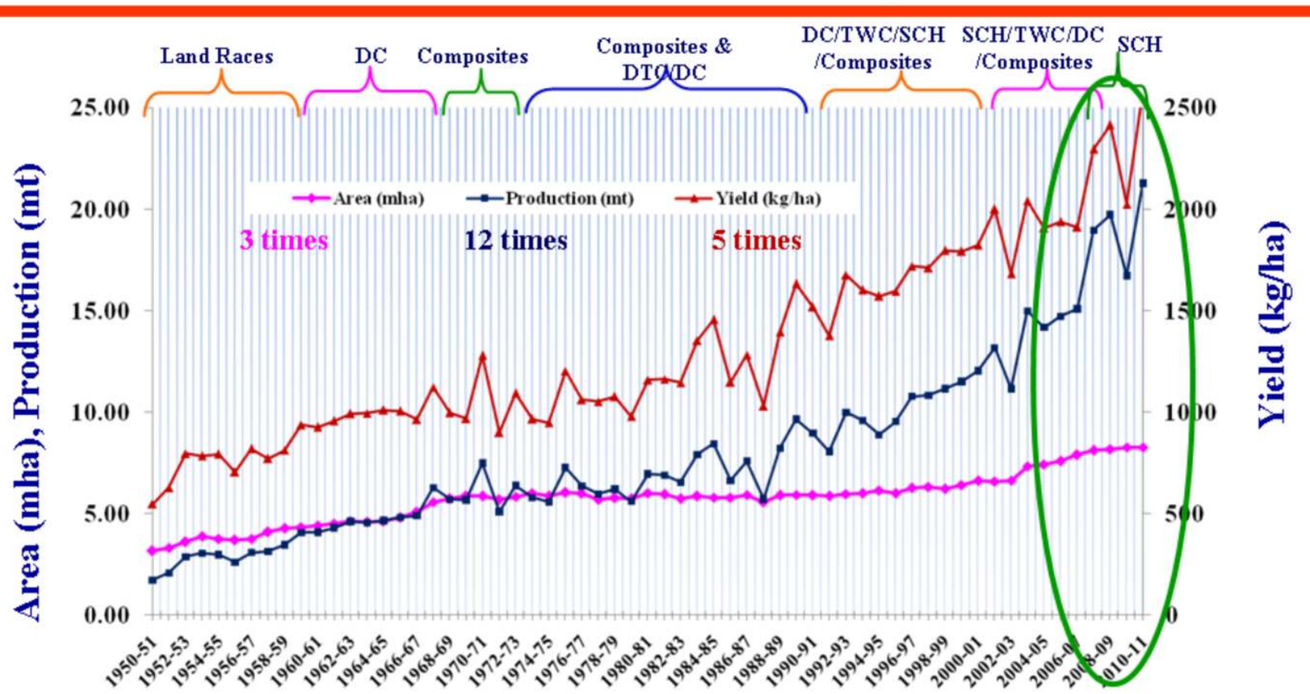
Maize Area, Production and Productivity Scenario - India



Year	Area (mha)	Production (mt)	Yield (kg/ha)
2006-07	7.89	15.09	1912.5
2007-08	8.11	18.96	2337.8
2008-09	8.17	19.73	2414.9
2009-10	8.26	16.72	2020.0
2010-11	8.26	21.23	2570.2

2006-2010

Quinquennial Review Team

Directorate of Maize Research

Report of the
Quinquennial Review Team
(2006-2010)
for

Directorate of Maize Research

and

All India Coordianted Research Project on Maize
Pusa Campus, New Delhi-110012

Dr. R. Hanchinal	Chairman
Dr. N. S. Malhi	Member
Dr. R. K. Malik	Member
Dr. K.T. Pandurangegowda	Member
Dr. S. J. Rehman	Member
Dr. M. C. Wali	Member
Dr. Pradyumn Kumar	Member Secretary

India Council of Agricultural Research

Preface

In the present Indian context, maize is gaining increasing importance because of its increasing area production, productivity and diversified uses. Directorate of Maize Research (DMR), New Delhi being a lead center shoulders the responsibilities of maize research and development in the country. The present Quinquennial Review Team is happy to review the progress made by the DMR in maize research and development during 2006-2010.

After interacting and discussing with maize research centres of the country through series of visits and meetings, the committee considers that the progress made by DMR is highly appreciable. DMR in collaboration with its AICRP centres succeeded in developing and releasing as high as 38 hybrids and composites of maize of different maturity groups, which can suit varied cropping systems in different agro-climatic conditions of the country. The policy initiative taken by DMR on shifting the focus on single cross hybrid development has been a real breakthrough in maize research in India. In continuation with this initiative, the hybrid programme was scaled up by sharing germplasm among AICRP centres. Since elite inbred lines are the basis of strong breeding programme, the Directorate itself and its AICRP centres have developed and registered 62 inbred lines with National Bureau of Plant Genetic Resources (NBPGR). During this period DMR has played a pivotal role in accelerating the single cross hybrid development programme. In this regard, elite inbreds have been distributed to different AICRP centres which have resulted in the development of promising single cross hybrids. To protect the interest of researchers, DMR has also facilitated the registration of extant and new cultivars under Protection of Plant Varieties & Farmers Right Act, 2001 (PPV & FRA, 2001). Recognizing its leading role in registration of hybrids/varieties among the ICAR institutes and SAUs, DMR has been conferred Best Institute Award by PPV & FRA in 2010-11.

Further, DMR has also developed several maize production and protection technologies. The excellent maize protection technologies developed is evident by the development of four patents and commercialization of more than half a dozen technologies. The admirable work in the area of conservation agriculture (zero tillage and permanent bed) has been demonstrated through long term experiments at DMR farm. In order to accelerate the adoption of new technologies, DMR through its AICRP centres have demonstrated Front Line Demonstrations (FLDs), Field Days, Kisan Vigyan Melas and exhibitions. The progress made by the Directorate during the period under report has been exemplary; to sustain the pace of progress, there is an urgent need to expand the infrastructure and facilities presently available with the Directorate by supporting independent office building, laboratories and experimental farms.

Since ICAR has created a centrally located facility, DMR has been able to appropriately harness the location advantage by giving tangible outcome which has significantly benefited the farming community across the length and breadth of the country.

The Chairman and members of QRT express their gratitude to Dr. S. Ayyappan, Secretary (DARE) and Director General (ICAR) for giving the opportunity for reviewing the work of Directorate of Maize Research and All India Coordinated Research Centres of Maize. The committee is also thankful to the Dr. R. Sai Kumar, Project Director (Maize) for providing facility and cooperation in reviewing the work of Directorate and its AICRP centres. The QRT expresses its gratitude for cooperation extended by CCS HAU, Regional Research Station, Karnal; MPUA&T, Udaipur; RAU, Samastipur; ANGRAU, Hyderabad and SKUAST (K), Srinagar.

®. R. Hanchinal)
Chairman

(N. S. Malhi)
Member

(R. K. Malik)
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(K.T.Pandurangegowda)
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Member Secretary

Contents

Executive Summary

Maize (Zea mays L.) is an important cereal crop grown in largest number of countries (170) in different agro-climatic conditions from sea level to more than 3000 m above mean sea level. The crop has the highest production and productivity among the cereals; hence it is referred as “The Cereal Queen”. The area, production and productivity of maize in the world is around 160 m ha, 817 m t and over 5 t/ha, respectively (2009-10). USA and China together account for nearly 40 per cent of total area and 60 per cent of total world production. The higher productivity in these countries is due to adoption of single cross hybrids, favourable climatic conditions, long crop duration and high input use. Presently, India ranks 4th in area and 6th in production of maize at world level. Among cereals, the graph for maize demand is continuously moving upward which calls for its sustained productivity growth rate.

As such, maize has registered the highest growth rate of 6.4% (2007-10), surpassing the growth rate of all other food crops and 4% growth rate for agriculture. It is further mentioned that this growth rate is against the target of 4.7% set by Planning Commission. This has been possible because of dedicated and concerted efforts of the scientists, other staff, private sector, farmers, extension functionaries, support from the Council and participating institutions. In view of its diversified use, the demand of maize is increasing and will continue to increase in future; hence we cannot afford to be complacent.

The success of single cross hybrids in United States of America is well known. The impact of single cross hybrid technology has also been realized in China, Brazil, Canada and several other countries. The success of maize programme in India too, has been largly the function of Single Cross Hybrids. The productivity of maize has increased from 1.7 t/ha in 2004-05 to 2.6 t/ha 2010-11, with the rise of 53% in the short span of 6 years. The area expansion during this period has been 0.6 m ha, with an increase of only 7.6 %. With the enhancement in productivity, efforts have been made to fulfill the demand of food and feed industry by producing more normal and Quality Protein Maize (QPM).

Of late, India has been able to export more than 3 mt maize to neighboring countries thus contributing to the national exchequer to the tune of `3000 crores. In order to improve the production and productivity and to serve the cause of tribal community, QRT recommends initiatives for infrastructure development.

Following new Regional Stations; Barapani, Haveri and Banswara are recommended to be established/strengthened, catering to the needs of North-East Hill regions, foot hills of the Western

Ghats and Western part of the country, respectively. Since, the area under rainfed conditions has considerably increased at northern parts of Karnataka (more than 0.4 mha.); a new center at Haveri is suggested to address the issues of rainfed maize cultivation.

DMR has also taken a futuristic and strategic initiative for public-private partnership and collaboration with CIMMYT in research and development of maize. It has also taken up a farmer's participatory approach for seed production related activities.

During the year 2010-11, 16 hybrids/composites were released by Central Sub-Committee on Crop Standard and Notification of varieties for different agro-climatic conditions of the country. Of these, eight hybrids and one composite belonged to public sector, which were developed with the active support of DMR. Recognizing the requirement of composites for the tribal population of north-east hills, the committee feels that the work on composites may be continued till the hybrid programme is appropriately strengthened and accepted.

DMR registered 20 inbred lines of maize including six normal and 14 specialty corn (QPM -2, sweet corn -8, popcorn -2, high oil -2) with NBPGR. These lines are being supplied among AICRP centers of the country for the development of high yielding and biotic and abiotic stress tolerant hybrids. Breeding efforts should be strengthened to develop hybrids for rainfed situation and under limited irrigation availability.

The QRT feels that the seed production potential of the parental lines should also be considered as one of the criteria for the release of hybrids. To further strengthen the seed production programme of hybrid maize, a position of Seed Technologist may be created at DMR and Regional Centres.

In some areas, fodder has become big constraint in improving the income of small farmers increasingly. To cater to the need of fodder, efforts should be made to evolve hybrids for their stay-green character so that they can be used for dual purpose. Special efforts should also be made to link fodder research of DMR with IGFRI and an additional post of scientist (maize breeder) for fodder maize may be created in DMR.

The climate change is increasingly impinging upon the agricultural productivity. Suitable maize hybrids need to be developed for climate resilient agriculture. The genetic manipulation and agronomic management should be given due importance to enhance the water and nutrient use efficiency.

During the period under report we observed that there has been significant yield enhancement. However, to sustain the yield levels and to address various biotic and abiotic stresses, there is need to develop strong linkage between molecular and conventional breeding.

DMR through its AICRP centres, evaluated different conservation agricultural (CA) practices and found larger acceptance of bed planting based inter-cropping of maize with vegetables and pulses. This has improved the income of small farmers who take more than one crop with same resources. Zero tillage maize has also shown promise in eastern and southern part of India. The committee feels that maize being grown by small farmers in the eastern Indo-Gangetic Plains (EIGPs), conservation agriculture work should be further encouraged. DMR has highlighted the requirement of higher doze of nutrients for maize. In order to improve the efficiency of nutrients, it is important to work on the time and application method of fertilizers. The nutrient management work of DMR should be tested at other AICRP centres as well.

A systematic germplasm collection, conservation, evaluation and utilization may be taken up at north-eastern hills and other hilly regions; and a special programme may be chalked out for promoting the maize hybrid development programme in these regions. Adequate man power requirement should include: (1) four entomologists one each for north-east hill Garhwal region, Kashmir Valley and Mandya, (2) one economist at DMR Delhi, (3) one plant breeder to link DMR with IGFRI, (4) three seed technologists at selected centers where seed production is strong, (5) five food technologists one for each zone, and one scientist in-charge (across discipline) at three proposed regional centers may be provided. All vacant positions at AICRP centers should be filled-up on priority basis or redeployed to the needy centers. Andaman and Nicobar being a tourist destination holds tremendous potentiality for specialty corn as is evident by the increasing area under maize cultivation, hence a voluntary centre is recommended at Central Agricultural Research Institute, Portblair.

Since, there are three crop seasons in maize, the present contingency of `1 lakh per scientist per year is insufficient, hence it may be raised to `1.5 lakhs and TA grant of `40,000 per annum against `25,000.

To enhance the pace of hybrid development, the inbred line production through the doubled haploid technology needs to be taken up. The infrastructure needed to develop this technology may be created. To further support the programme, the young scientists should be trained in the advanced laboratories of the world.

Directorate of Maize Research in collaboration with IASRI has developed 'Maize Agri Daksh', an expert system of maize crop to disseminate recent advances in maize research to the farmers. It is based on 'Agri Daksh' which is a tool for developing system online expert.

Some of our public sector hybrids could not cover larger areas in spite of their good potential because of unavailability of sufficient seeds. Efforts should be made to strengthen seed production programme in collaboration with the other public seed production agencies. The SAUs and ICAR Institutes should integrate the hybrid seed production programme with the mega seed project taken by ICAR. AICRP centers should also be provided with the revolving fund from ICAR to encourage the seed production activities of the hybrids released by respective centers.

The skill and knowledge development should be encouraged for training of trainers, extension agencies of public and private sector including dealers involving marketing of seeds. Farmers should be encouraged to take up hands - on training specially for seed production programme. Number of good hybrids released under specialty corn need to be linked with SAUs and food processing industries by conducting research on value addition.

These significant achievements could be made possible by the active support of ICAR, maize researchers and hard work and receptiveness of farmers to the advance technology. It was observed that Winter Nursery at Hyderabad and AICRP Centers at Ludhiana, Karnal, Almora, Hyderabad and Coimbatore have contributed significantly for the research and development of maize in the country. However, in the current reporting period, there has been a sharp contrast in the performance of some the AICRP centers namely, Faizabad, Kanpur, Ranchi, Dholi, Bhubaneshwar, Srinagar and Ambikapur due to lack of commitment towards the work. The QRT feels that the administration of these centers may be contacted to take corrective action.

1

Introduction

Maize crop has an important place in the food grain scenario of our country and is the third most important crop due to its importance in food, feed, specialty corn, starch, etc. for both domestic consumption as well as export. Being C_4 plant, it has more resilient to changing climate. Further, it has high range of adaptability to varied climatic and geographical situation.

All India Coordinated Maize Improvement Project (AICMIP) was the first in series of coordinated programmes of the country started in 1957. Keeping its increasing importance in the Indian socio-economic fabric it was upgraded as Directorate of Maize Research in January, 1994. High yielding single cross hybrid (SCH) seeds with improved package of practices boosted maize production. Consequently, it has registered highest growth rate among all other food crops, 6.4% (2007-2010), surpassing the 4% growth rate for agriculture and 4.7% for maize set by Planning Commission.

At present the area, production and productivity of maize in India is 8.6 m.ha, 20.5 m.t and 2.4 t/ha respectively. This has been possible owing to the concerted efforts of the scientists of Directorate of Maize Research and its AICRP/SAUs/ICAR Institutes all over the country. DMR and/or AICRP/SAUs/ICAR Institutes are committed to development of Single Cross Hybrids (SCH) for sustained growth of this commodity through strategies mentioned in the document. DMR fulfils its mandate by integrating AICRP with institutional activities by way of effective planning and monitoring. There are 29 AICRP centres located at five zones of the country. Two regional research stations *viz.*, Winter Nursery Centre (WNC), Hyderabad and Regional Maize Research and Seed Production Centre (RMR & SPC), Begusarai caters requirements of DMR.

1.1 Quinquennial Review Team (QRT)

In consonance with the policy of the Indian Council of Agricultural Research of quinquennial review (achievement audit) of its institutes the QRT was constituted by Director General, ICAR vide letter no, F. No. 16-7/10-IA.IV dated 22 Nov. 2011 and given here under

Composition of QRT

Sl. No.	Name and Address	Designation
1	Dr. R.R. Hanchinal, Vice-Chancellor, UAS, Dharwad, KARNATAKA	Chairman
2	Dr. R. Sai Kumar, Project Director, Maize	Ex-officio Member
3	Dr. N.S. Malhi, Plant Breeder and Ex-Head PAU, Ludhiana, PUNJAB	Member
4	Dr. K.T. Pandurangegowda, Assoc. Dir. of Res., ZARS, Mandya, KARNATAKA	Member

5	Dr. R.K. Malik, Agronomist, HAU, Hisar, HARYANA	Member
6	Dr. S.J. Rehman, Principal Scientist, Entomology, ANGRAU, Hyderabad, ANDHRA PRADESH	Member
7	Dr. M.C .Wali, Sr. Maize Breeder & Head, AICMIP, ARS, Arabhavi, KARNATAKA	Member
8	Dr. P. Kumar, Principal Scientist, DMR, New Delhi	Member Secretary

The QRT team reviewed the overall research achievements for the tenure from 2006 – 2010 zone-wise. The first meeting of the QRT was held at Regional Research Station, CCS, Haryana Agricultural University, Uchani, Karnal on 9th Feb, 2012. Dr. R. Saikumar, Project Director presented overall achievements of the Directorate of Maize Research (DMR) from 2006-10. In charge scientists of 30 centres, besides principal Investigators of different faculties and other supporting disciplines of DMR participated and presented their achievements and also highlighted thrust areas. The Chairman and some members of the QRT visited field trials of Maize at Regional Research Station, CCS, Haryana Agricultural University, Uchani, Karnal, Agricultural Research Station and Winter Nursery Centre, Hyderabad, AICMIP, Udaipur and SKUAST&K, Srinagar.

QRT Visits and reviews.

S.No.	Date of Meeting	Place Meeting	Centres presented
1	9th Feb. 2012	CCS HAU, Uchani	Karnal, Pantnagar, Ludhiana
2	14th Feb. 2012	MPAT, Udaipur	Udaipur, Godhra, Banswara, Jhabua
3	25th Feb. 2012	DOR, Hyderabad	Hyderabad, Coimbatore, Arabhavi, Mandya, Karimnagar, Vagarai, Delhi, Kanpur
4	4-5th Mar. 2012	WALMI, Patna	Ranchi, Varanasi, Dholi, Bhubaneswar, Gossaigaon, Ambikapur, Chhindwara, Kolhapur
5	21-22nd Jul. 2012	SKUAST&K, Srinagar	Almora, Bajaura, Barapani, Bahraich, Kangra, Srinagar, Udhampur
6	7th Aug. 2012	DMR, New Delhi	PD (Maize) and Scientists of DMR

1.2 Vision, Mission, Mandates, Objectives and Activities

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.

Mission

Enhancing the productivity, profitability and competitiveness of maize and maize based farming system with economic and environmental sustainability.

Mandates

- To carry out basic, strategic and applied research aimed at enhancement of production and productivity of maize crop in the country.
- To serve as a core centre for maize research material and information.
- To conduct and coordinate multidisciplinary and multi-location research to identify appropriate varietal technologies for varied agro-climatic conditions in different parts of India.
- Germplasm collection, evaluation, maintenance and its enhancement.
- To develop specialty corn cultivars, and their associated technologies such as Quality Protein Maize, Baby corn, Sweet corn, Bio-fuel, etc for diverse uses.
- To conduct training, frontline demonstrations and on-farm research to maximize and accelerate adoption of research findings and innovative technologies.
- To produce adequate quantities of breeders' seeds of the parents of hybrids and composite or synthetic varieties to meet the maize seed requirements all over the country.
- To develop linkages with national, international and private organizations for collaborative research program.
- To provide consultancy services and undertake contractual research.

Objectives

- Enhancement of germplasm and development of improved cultivars for increasing productivity and nutritional value of maize crop with economic and environmental sustainability through basic, strategic and applied research.
- Development and identification of appropriate varietal technologies for varied agro-climatic zones through multi-disciplinary and multi-location coordinated research.
- Development and dissemination of maize production and protection technologies.

Activities

- **Research**

  The major research activity areas are germplasm development, enhancement and exchange. Inbreds are developed with host plant resistance to address both biotic and abiotic stresses. Investigations on biochemical basis of host plant resistance in maize germplasm are being undertaken. Development of single cross hybrids for different types of maize, normal and specialty corn is receiving increasing attention. Development of production and protection technology to reduce crop losses and enhancement of productivity and production. Application of biotechnological tools and techniques for maize improvement for production, protection and nutritional quality.

- **Education**

  The scientists of DMR constitute the important faculty of PG School, IARI, New Delhi and contribute in teaching in the discipline of Plant Breeding, Entomology, Pathology, Physiology, Agronomy, Biochemistry and Extension and guiding M.Sc and PhD students, thus, contributing significant academic output. DMR scientists are also engaged in imparting training in the above mentioned discipline to students and scientist from various organizations across the country.

- **Extension**

  The research findings are being disseminated to the end users through front line demonstrations, exhibitions, kisan melas, print media, films, trainings, mass media etc. Of late, DMR has developed one window user interactive maize information delivery system, AGRIdaksh.

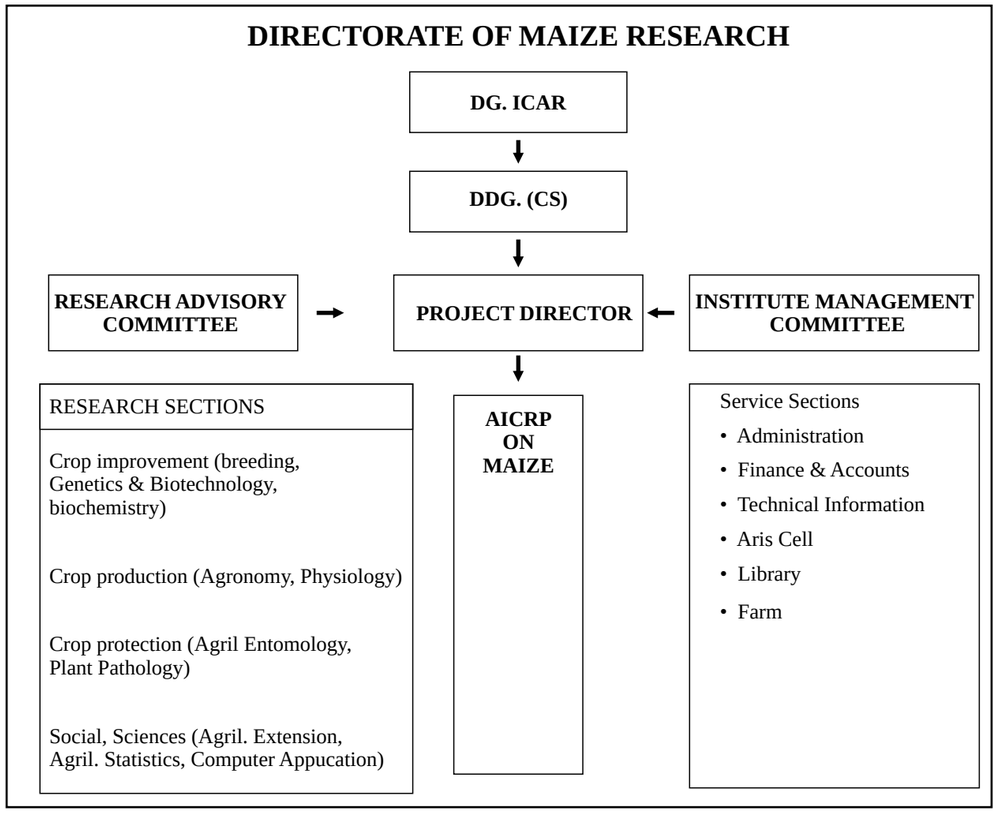
- **Information**

  DMR is having a well equipped ARIS cell which manages all information related to Directorate of Maize Research in the form of website https://www.maizeindia.org. The website also provides information on scientific, technical, administrative and financial information.

1.3 Organization

The highest policy making body of the Institute is its Institute Management Committee. The Institute Research Council is responsible for the formulation of research projects and monitoring of their progress.

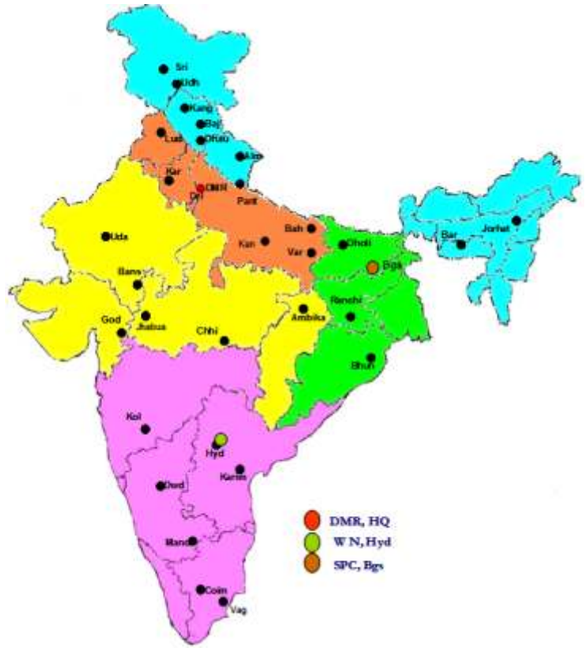
For the project prioritization, monitoring and evaluation the Directorate has PME Cell. The PME Cell get technical out put from the PME Committee and execute the decisions. Besides, there is Result Framework Document Cell and RFD Committee for taking into account the research output periodically. The IPR issues are dealt by the ITMU Cell which is headed by the Project Director. There is a provision of Research Advisory Committee which advises on the research activities of the Directorate. The Chair person and Members of RAC are appointed by ICAR. Besides, Directorate 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. Directorate is having one Hindi Cell to promote use of Hindi in day to day official communication.



1.4 Zone-wise AICRP Centers

Hill Region (Zone I)	Srinagar (SKUAST), Bajaura, Kangra, Dhaulauakuan (CSKHPKVV), Gossaingaon (AAU), Almora (VPKAS), Udhampur (SKUTJ) and Barapani (NEH)
North West Plain Region (Zone II) (CCSHAU) and Pantnagar (GBPUAT)	Delhi (IARI), Ludhiana (PAU), Kanpur (CSAUAT), Uchani
North East Plain Region (Zone III)	Dholi (RAU), Ranchi (BAU), Bahraich(NDUAT), Varanasi (BHU), Bhubaneswar (OUAT), Ambikapur (IGKVV)
Peninsular India (Zone IV)	Hyderabad, Karimnagar (ANGRAU), Arabhavi (UAS, Dharwad), Kolhapur (MPKVV), Coimbatore (TNAU) and Mandya (UAS, Bangalore)
Central India (Zone V)	Udaipur (MPUA&T), Godhra (AAU Anand), Chhindwara (JNKVV) and Banswara (MPUA&T)

1.4 Zone-wise AICRP Centers



1.5 Interaction and Linkages

National

DMR has collaboration with following institutes:

1. Indian Agricultural Research Institute (IARI)
2. Institute of Pesticide Formulation Technology, Gurgaon
3. Intra-institutional linkages with sister institutes of ICAR viz., NBPGR, NRCPB, IGFRI, CRIDA, NCIPM, CIAE, etc.
4. Linkages with ICMR, National Institute on Nutrition (NIN), Hyderabad
5. CIMMYT collaboration for research and development
6. Linkages with SAUs for strengthening AICRP programme and promotion of public research outcomes
7. Linkages with national and state seed corporations
8. Collaborations with state agriculture departments for transfer of technologies
9. Private industries linkages for research and development
10. Private linkages for seed production through PPP
11. Linkages with African countries for research and development in maize
12. Collaboration with seed companies for their hybrids evaluation.

2

Management

2.1 Institute Management Committee (IMC)

Chairman – Project Director (Maize)

Members:

- Joint Director (Agriculture), Development Department, Govt. of NCT, New Delhi
- Director (Agriculture), Govt. of Haryana, UT Chandigarh
- Dr. Vijayraghvan, Joint Director (Extn.), Indian Agricultural Research Institute, Pusa, New Delhi
- Dr. Pradyumn Kumar, Principal Scientist, Directorate of Maize Research, New Delhi
- Dr. Pratibha Sharma, Principal Scientist, Plant Pathology, IARI, New Delhi
- Dr. S. Vennila, Principal Scientist, NCIPM, New Delhi
- Dr. T. R. Sharma, Principal Scientist, NRCPB, New Delhi
- Assistant Director General (FFC), ICAR, New Delhi
- Shri Mohan Singh, F& AO, NRCPB, Pusa, New Delhi

Member Secretary: Administrative Officer, DMR, New Delhi

2.2 Research Advisory Committee (RAC)

Chairman: Dr. B.S. Dhillon, Vice-Chancellor, PAU, Ludhiana

Members:

- Dr. V.P. Ahuja, Principal Scientist (Breeding) Retd. New Delhi
- Dr. V. Satyanarayana, Professor (Agronomy) Retd., Hyderabad
- Prof. H.S. Shetty, Emeritus Scientist (Biotechnology), Mysore
- Dr. D.N. Yadav, Prof. Entomology, Retd., Anand (Gujarat)
- Prof. Amar Kumar, Prof. Botany, DU, New Delhi
- Dr. Sain Dass, President IMDA, Ex-Project Director (Maize), New Delhi
- Dr. R. Sai Kumar, Project Director (Maize), DMR, New Delhi

- Assistant Director General, (FFC), ICAR, New Delhi

Member Secretary: Dr. K. S. Hooda, Principal Scientist

The annual RAC meeting has held regularly. During 2010 and 2009, it was chaired by Dr. J.B. Chaudhary and during 2008 and 2007, it was chaired by Dr. S.K. Vasal. In the year 2006, the RAC was chaired by Dr. A. S. Khera. The advice of RAC was complied by Scientists of DMR during subsequent years.

2.3 Institute Research Council (IRC)

Chairman – Dr. R. Sai Kumar, Project Director

Invited Experts

All Scientists of the Directorate

The research output of the projects was reviewed and new project proposals were considered for approval.

2.4 Institute Grievance Cell for Women (IGCW)

The Directorate has Instituted Grievance Cell for Women which addresses the grievances of women staff at work place. The committee meets to redress the grievance of women staff as and when reported. The Institute Grievance Cell for Women constitute of the following members

1. Dr. (Mrs) Meena Shekhar, Sr. Scientist, DMR, New Delhi
2. Dr. (Ms) Ambika Rajendran, Scientist, DMR, New Delhi
3. Ms. Suby SB, Scientist, DMR, New Delhi

2.5 Public Information Officer

Dr. AK Singh, Sr. Scientist

The quarterly report had been sent regularly to the Council.

3

Miscellaneous Information of the Institute

3.1 Golden Jubilee workshop at Hyderabad

Directorate celebrated its 50th Workshop i.e. Golden Jubilee workshop at Acharya NG Ranga Agricultural University (ANGRAU), Hyderabad from April 13 to 15, 2007. Dr. S.K Vasal distinguished maize scientist and World Food prize laureate graced the workshop by his presence. In his concluding remarks, he appreciated the good work being carried out by DMR and its coordinating centers. A special session was conducted to review the 50 years of maize research: achievements and perspectives. It was realized that maize is poised to be the most important food, feed and industrial crop in future. It will also support food and nutritional security. Hence, requires strengthening in its research and development.

3.2 Awards

2006-2007:

Ms. Rafat Sultana, Senior Research Fellow, Physiology Lab, Directorate of Maize Research was awarded with the prestigious “ISPA fellowship” by International Society for Plant Anaerobiosis (ISPA), UK.

Dr. Meenu Agarwal selected as DST Women scientist under WOS-B scheme and awarded a project entitled “Development of Technology for the commercial production of Cotesia sp., a potential parasitoid of Lepidopteran pests” in Entomology unit of Directorate of Maize Research, New Delhi - 110012

2007-2008:

Dr. M.L. Jat, Senior Scientist received “NAAS Associate Fellow” of the National Academy of Agricultural Sciences w.e.f. 1st January 2008 for his outstanding contribution in the field of Conservation Agriculture and Precision farming.

2008-2009:

Dr. M.L. Jat, Sr. Scientist (Agronomy) and associates received best poster paper presentation award during National Symposium of Indian Society of Agronomy at Navsari Agricultural University, Navsari, Gujarat, November 19-21, 2008.

Dr. M.L.Jat invited as lead speaker in 10th Asian Regional maize Workshop, Makkasar, Indonesia, October 18-25, 2008.

Dr. M.L. Jat invited as lead speaker in 4th World Congress on Conservation Agriculture, New Delhi, India Feb 4-7, 2009

DMR stall was adjudged best for 'Prasansha Puraskar' in Pusa Kisan Mela, 2009

2009- 2010:

Dr. Dharam Paul was awarded Young Fellow Award by the Society for Scientific Development in Agricultural and Technology on the occasion of National Symposium on Achieveing Millenium Development Goals: Problems and Prospects during 25-26 Oct 2009, held at Bundelkhand University, Jhansi.

Dr. Ishwar Singh, Senior Scientist (Plant Physiology) awarded fellow of Indian Society for Plant Physiology (FISPP)

Dr. Ishwar Singh, Senior Scientist (Plant Physiology) has been nominated member of executive council of the Indian Society for Plant Physiology for the years 2010-12.

2010-2011:

Parihar C.M., Dass Sain, Jat S.L., Singh D.K., Hardevram and Malik, Shweta. Kharif mein makka ki unnat kheti. Khad Patrika (In Hindi) 47(6):33-34. This article was selected for Shri Ram Puruskar, second best article by the Fertilizer Association of India, New Delhi

Prof. K.P.V. Memon Best Poster Paper Award 2009 on "Cultural and morphological variability in the isolates of Exserohilum turcicum of maize" by Archana, Sangit Kumar and Meena Shekhar during International conference on Plant Pathology in global era.

3.3 Externally Funded Projects

Amount sanctioned (in lakhs) for externally funded projects operated at the Directorate.

Name of the Project	2006-07	2007-08	2008-09	2009-10	2010-11
AP-Cess Fund Scheme	33.09	16.42	4.56	1.40	--
FLD	287.92	260.05	236.05	236.31	302.91
DUS testing	8.90	6.99	7.50	4.10	10.84
Transgenic project	77.92	40.11	38.39	23.41	32.29
IPR	-	-	-	-	4.38
Total	407.83	323.57	286.5	265.22	350.42
Grand Total	**1633.55**				

3.4 DMR Scientists as Faculty Members in IARI

S.No.	Name Designation Discipline	Designation	Discipline
1.	Dr. Pradyumn Kumar	Principal Scientist	Entomology
2.	Dr. K. S. Hooda	Principal Scientist	Plant Pathology
3.	Dr. Aditya Kumar Singh	Senior Scientist	Agronomy
4.	Dr. M.L.Jat	Senior Scientist	Agronomy
5.	Dr. Ishwar Singh	Senior Scientist	Plant Physiology
6.	Dr. V.K.Yadav	Senior Scientist	Agriculture Extension
7.	Dr. Dharam Paul	Senior Scientist	Biochemistry
8.	Dr. Nirupma Singh	Scientist	Plant Breeding
9.	Dr. Avinash Singode	Scientist	Plant Breeding
10	Dr. C.M.Parihar	Scientist	Agronomy
11	Dr. Chikkappa G. Karjagi	Scientist	Plant Breeding
12	Dr. Shankar Lal Jat	Scientist	Agronomy

3.5 Intellectual Properties

Technologies developed and are ready for commercialization: This section includes the public-bred single cross hybrids of maize developed and released for cultivation in India during 2000-2011:

Public sector hybrids commercialized for seed production and marketing

Name of hybrids	Developing organization	Name of the private organization to which license issued
HQPM-1, HQPM-5, HQPM-7, HM-4, HM-5, HM-7 and HSC-1	CCSHAU, Hisar	M/s Green Gold Seeds Ltd. Aurangabad (Maharashtra)
HQPM-1, HPM-5, HM-4 and HM-5	CCSHAU, Hisar	M/s Kamboj Exports, Karnal (Haryana)
HQPM-1, HQPM-5, HM-4 and HM-10	CCSHAU, Hisar	M/s PI Industries, Gurgaon (Haryana)
HQPM-1 and HQPM-5	CCSHAU, Hisar	M/s Akash Seeds & Co. Ambikapur (Chhattisgarh)
HQPM-1 and HQPM-5	CCSHAU, Hisar	M/s Bhartiya Beej Nigam Ltd.,(Uttarakhand)
HM-8, HM-9 and HM-10	CCSHAU, Hisar	M/s Nuziveedu Seeds Pvt. Ltd., Ranga Reddy Distt. (Andhra Pradesh)
HQPM-1, HQPM-7, HM-4, HM-5 and HM-10	CCSHAU, Hisar	M/s Arpan Seeds Pvt. Ltd., Udaipur (Rajasthan)
HQPM-1 and HM-5	CCSHAU, Hisar	M/s Charoen Pokphand Seeds Pvt. Ltd. Bangalore (Karnataka)
HQPM-1	CCSHAU, Hisar	M/s Balaji Seeds, Karnool (Andhra Pradesh)
HQPM-1 and HQPM-5	CCSHAU, Hisar	M/s Sansar Agropol Pvt. Ltd., Bhubaneswar (Odisha)
HM-9 and HM-11	CCSHAU, Hisar	M/s Vibha Agrotech Ltd., Hyderabad (Andhra Pradesh)
DHM 117	ANGRAU, Hyderabad	M/s Vicky Seeds, Hyderabad (Andhra Pradesh)
DHM 117	ANGRAU, Hyderabad	M/s ABS Seeds, Hyderabad (Andhra Pradesh)
DHM 117	ANGRAU, Hyderabad	M/s Sampoorna Seeds, Emignur, Karnool (Andhra Pradesh)
Vivek QPM 9	VPKAS, Almora	M/s Bhartiya Beej Nigam Ltd., Rudrapur, Udham Singh Nagar (Uttarakhand)
Vivek QPM 9	VPKAS , Almora	M/s Ventura Crop Science Pvt. Ltd., Hyderabad (Andhra Pradesh)
Vivek QPM 9 and VL Baby Corn	VPKAS, Almora	M/s Keertiman Agro Genetics Pvt. Ltd., Aurangabad (Maharashtra)
Vivek QPM 9	VPKAS, Almora	M/s Sampoorna Seeds, Adhoni, Karnool (Andhra Pradesh)

Technologies developed and commercialized: MoU has been signed and a nonexclusive license for manufacturing and marketing has been issued to Amar Chand & Co., 56, Industrial Estate, Ambala Cantt-133 006. The details are given below:

S.No.	Name of Technology	Patent/Application No.
1.	Improved Aerial Insect Trap	Patent No. 226238
2.	Grain and Chaff Separator	-
3.	UV-C Sterilization Chamber	-
4.	Insect Handling Device	Patent No. 252363
5.	*Corcyra* rearing Cage	-
6.	*Helicoverpa* Oviposition Cage	-
7.	*Spodoptera* rearing cage	-
8.	An insect rearing cage	Application No. 0923/DEL/2011

3.6 Budget of the Institute (` In lakhs)

Head of Account	2006-07	2007-08	2008-09	2009-10	2010-11
Establishment	242.69	855.87	855.75	591.55	782.36
OTA	-	-	-	0.33	0.50
TA	35.35	97.00	14.00	37.91	40.82
Other Charges	362.38	427.95	411.20	539.01	504.90
Minor Works	132.11	19.24	14.00	6.28	18.62
Equipment	-	-	-	254.47	114.38
Other items/HRD	3.91	0.63	2.00	2.8	9.32
Total	773.44	1400.00	1313.90	1432.35	1470.90
Grand Total					**6390.59**

Resource Generation (` In lakhs)

Particulars	2006-07	2007-08	2008-09	2009-10	2010-11
Sale of farm produce	2.18	0.31	3.98	7.55	20.00
Sale of publication and tender forms	0.46	0.0	0.0	0.0	0.0
Rent/fee	-	-	2.40	-	-
Standard license fee	0.14	0.18	0.69	1.79	29.07
Interest earned on loans and advances/STD	0.37	0.38	3.11	1.74	7.09
Analytical testing charges	0.90	20.10	27.34	25.54	14.70
Receipts for services rendered	-	-	-	0.64	0.0
Income generated from IRG	-	-	-	3.42	0.97
Training, miscellaneous receipts	7.10	16.86	9.83	1.21	3.98
Total	11.15	37.83	47.35	41.89	75.81
Grand Total					**214.0**

4

Directorate of Maize Research

4.1 BREEDING

- A total of 14,839 germplasm was introduced and maintained, of which, 3,043 germplasm were supplied across the AICRP centres
- A total of 1163 entries was tested in the 127 breeding trials constituted at DMR for testing under AICRP across 29 locations in the country.

Hybrids/varieties released during the period

S. No.	Pedigree	Center (Source of Technology)	Year of release
1. DHM-111	BML 6 X BML 15	ANGRAU, Hyderabad	2010
2. DHM-113	BML 2 X BML 7	ANGRAU, Hyderabad	2010
3. HQPM-4	HKI 193-2 X HKI 161	CCS HAU, Karnal	2010
4. PMH-4	LM 5 X LM 16	PAU, Ludhiana	2010
5. PMH-5	LM 16 X LM 18	PAU, Ludhiana	2010
6. DHM-119	BML 2 X BML 15	ANGRAU, Hyderabad	2010
7. Vivek Hybrid 39	V 373 X CM 212	VPKAS, Almora	2010
8. HSC-1	HKI 1831 X HKI SCST - 1	CCS HAU, Karnal	2010
9. NAH-2049	SKV 50 X NAI 105	UAS, Naganahalli	2009
10. HM -11	HKI 1128 X HKI 163	CCS HAU, Karnal	2009
11 EH 434042	(CI 4 X CI 5) X KDMI 16	UAS, Arabhavi	2009
12. DHM-117	BML 6 X BML 7	ANGRAU, Hyderabad	2009
13. Vivek Sankul Makka-35	Composite	VPKAS, Almora	2009
14. Vivek Sankul Makka-37	Composite	VPKAS, Almora	2009
15. PMH-3	LM 17 X LM 14	PAU, Ludhiana	2008
16. HQPM-7	HKI 193- 1 X HKI 161	CCS HAU Karnal	2008
17. Vivek QPM-9	VQL 1 X VQL 2	VPKAS, Almora	2008
18. HM-8	HKI 1105 X HKI 161	CCS HAU Karnal	2008
19. HM-10	HKI 193 -2 X HKI 1128	CCS HAU Karnal	2008
20. Vivek Hybrid 33	V 372 X CM 212	VPKAS, Almora	2008

S. No.	Pedigree	Center Source of Technology	Year of release
21. Vivek Sankul 31	Composite	VPKAS, Almora	2008
22. Bajaura Makka	Composite	CSKHPKV, Bajaura	2008
23. Pant Sankul Makka-3	Composite	GBPUA&T Pantnagar	2008
24. Pratap Kanchan-2	Composite	Udaipur, Rajashtan	2008
25. Vivek 23	V 351 X V 341	VPKAS, Almora	2007
26. PAU 352	LM 15 X CML 32	PAU, Ludhiana	2007
27. Malviya Hybrid 2	HUZM 185 X HKI1105	BHU, Varanasi	2007
28. COH(M) 5	UMI 285 X UMI 61	TNAU, Coimbatore	2007
29. PMH-l	LM 13 X LM 14	PAU, Ludhiana	2007
30. Vivek 21	CM 212 X V 341	VPKAS, Almora	2007
31. Vivek 25	V 341 X V 346	VPKAS, Almora	2007
32. Vivek 27	V 335 X V 345	VPKAS, Almora	2007
33. HQPM 5	HKI 163 X HKI 161	CCS HAU, Karnal	2007
34. HM 9	HKI 1105 X HKI 161	CCS HAU, Karnal	2007
35. Jawahar vikas 421	Composite	JNKVV, Chhindwara	2007
36. Jawahar pop corn 11	Composite	JNKVV, Chhindwara	2007
37. PMH-2	LM 15 X LM 16	PAU, Ludhiana	2006
38. HQPM 1	HKI 193-1 X HKI 163	CCS HAU, Karnal	2006
39. Vivek Maize 21 (Fh3211)	CM 212 X V 341	VPKAS, Almora	2006
40. Shaktiman 3	CML 161 X CML 163	RAU, Dholi	2006
41. Shaktiman 4	CML 161 X CML 169	RAU, Dholi	2006

Inbred lines identified tolerant to water logging

Top ten preforming lines under waterlogging condition

S. No.	Cenotype	WL Score	Nodes with Brace Root	ASI	Grain Weight* (kg/plot)
1.	HKI-551-2	1	2	2	1.299
2.	JCY3-7-1-2-1-b-2-1-3-1	1	2	2	0.884
3.	HKI-335	1	1	1	0.367
4.	JCY3-7-1-2-1-b-2-1-3-1	1	1	3	0.337
5.	JCY3-7-1-2-1-b-6-1-2-1	1	2	5	0.304
6.	LM-13	1	2	2	0.303
7.	LM-9	1	1	3	0.222
8.	JCY3-7-1-2-1-b-2-1-2-1	1	2	1	0.178
9.	HKI-162	1	2	1	0.169
10.	HKI-3-4-8-6ER	1	1	0	0.159

Breeder Seed production

- During the period under report, a total of 62,142 kg of Breeder seed was produced.

	2006-07	2007-08	2008-09	2009-10	2010-11
Breeder Seed Produced (in kg)	5815	2260	12200	24251	17616

Registration of Inbred lines

- A total of 43 inbred lines were registered with NBPGR during 2006-10

S. No.	Donor/Other Identity	INGR No.	National Identity	Developing Institute	Novel Features
Normal Maize					
1.	DMR-7	10077	IC 0584583	DMR	Flint, productive, resistant to pink borer
2.	DMR-15	10078	IC 0584584	DMR	Flint, productive, good combiner, cold tolerant, attractive grain colour, temperate origin
3.	DMR-16	10079	IC 0584585	DMR	Flint, productive, good combiner, long cob, cold tolerant, attractive grain colour, temperate origin
4.	DMR-17	10080	IC 0584586	DMR	Flint, productive, good combiner, cold tolerant, attractive grain colour, temperate origin
5.	HKI C 322	10081	IC 0584587	Karnal	Medium, white, flint, productive, strong plant, dark green leaves
6.	HKI-MBR-139-2	10082	IC 0584588	Karnal	Medium, white, flint, good combiner, dark green leaves
7.	HKI-47	09057	IC 0563953	Karnal	Late, bright orange, flint, good combiner
8.	HKI-287L	09058	IC 0563954	Karnal	Late, yellow, flint, long cob, productive
19	HKI-327T	09059	IC 0563955	Karnal	Tall, late, yellow, flint
10	HKI-326	09060	IC 0563957	Karnal	Late, yellow, flint, productive
11.	HKI-1040-5	09061	IC 0563960	Karnal	Late, yellow, flint, good combiner, highly productive
12.	HKI-1341	09062	IC 0563962	Karnal	Late, white, flint, productive, resistant to rust
13.	HKI-1342	09063	IC 0563963	Karnal	Late, white, flint, long cob, resistant to rust, MLB
14.	HKI-288-2	08071	IC 0563956	Karnal	Late, Yellow and Flint and MLB resistant
15.	HKI-1126	08072	IC 0563958	Karnal	Late, Yellow and Flint and MLB resistant
16.	HKI-1040-4	08073	IC 0563959	Karnal	Medium, Orange and Flint and MLB resistant
17.	HKI-1015WG-8	08074	IC 0563961	Karnal	Medium, Orange and Flint and MLB resistant
18.	HKI-1347-4LT	08075	IC 0563964	Karnal	Late, White and Flint and MLB resistant

S. No.	Donar/Other Identity	INGR No.	National Identity	Developing Institute	Novel Features
19.	SC7-2-1-26-1	07025	IC 0549903	New Delhi	Resistant to MLB
Quality Protein Maize (QPM)					
20.	HKI 5072-2 – BT	10083	IC 0584589	DMR	Medium, yellow, flint, high tryptophan, attractive grain colour, dark green leaves
21.	DMRQ-107	10084	IC 0584590	DMR	Medium, yellow flint, high tryptophan, good combiner, thin cob
22.	HKI-170(1+2)	09064	IC 0563967	Karnal	Late, yellow, flint
23.	VQL-3	09012	IC 0568701	Almora	Early, orange, flint, high tryptophan (>0.83%)
24.	VQL-8	09013	IC 0568703	Almora	Medium, orange, flint, high tryptophan (>94%)
25.	VQL-12	09014	IC 0568706	Almora	Early, orange, flint, high tryptophan (>0.75%)
26.	VQL-16	09015	IC 0569174	Almora	Early, yellow, flint, high tryptophan (>0.73%)
27.	VQL-30	09016	IC 0569176	Almora	Early, orange, flint, high tryptophan (>0.71%)
28.	HKI-164D-4	08076	IC 0563965	Karnal	Late, Yellow and semi-dent grain and MLB resistant, QPM
29.	HKI-164-7-6	08077	IC 0563966	Karnal	Late, Orange and semi-dent grain and MLB resistant, QPM
30.	VQL-1	08011	IC 0542343	Almora	Medium, semi-flint, yellow with cap grains, high tryptophan (>0.6%)
31.	VQL- 2	08012	IC 0542344	Almora	Early, flint, orange grains, high tryptophan (>0.6%)
Sweet corn					
32.	Win Sweet Corn	10085	IC 0584591	DMR	Yellow, shrunken, high sugar
33.	DMSC-1	10086	IC 0584592	DMR	Yellow, shrunken, high sugar
34.	DMSC-6	10087	IC 0584593	DMR	Yellow, shrunken, high sugar
35.	DMS-201	10088	IC 0584594	DMR	Yellow, shrunken, high sugar
36.	DMS-203	10089	IC 0584595	DMR	Yellow, shrunken, high sugar
37.	DMS-206	10090	IC 0584596	DMR	Yellow, shrunken, high sugar
38.	DMS-207	10091	IC 0584597	DMR	Yellow, shrunken, high sugar
39.	DMS-208	10092	IC 0584598	DMR	Yellow, shrunken, high sugar
Popcorn					
40.	HKI PC-4B	10093	IC 0584599	Karnal	Medium, high popping, good pollinator
41.	HKI PCBT-3	10094	IC 0584600	Karnal	Medium, high popping, good pollinator
High Oil Corn					
42.	HKI-6	10095	IC 0584601	Karnal	Yellow, flint, high oil content
43.	HKI-1(T)	10096	IC 0584602	Karnal	Yellow, flint, high oil content

Protection of hybrids varieties under PPV & FR Act, 2001

Out of 58 hybrids filed under new and extant category, 26 have been granted certificates during the period. The detail is given below:

S. No.	Name	Centre	Period of production (Years)
Normal Hybrids			
1	HM-5	CCSHAU, Karnal	Feb. 12, 2009-Aug. 24, 2020
2	Pusa Early Hybrid Makka-1	IARI, Delhi	Feb. 12, 2009-Sept. 16, 2012
3	Pusa Early Hybrid Makka-3	IARI, Delhi	Dec. 21, 2009-Feb. 1, 2016
4	Pusa Extra Early Hybrid Makka-5	IARI, Delhi	Dec. 21, 2009-Feb. 3, 2019
5	Pratap Hybrid Maize-1	MPUA&T, Udaipur	Feb. 12, 2009-Feb. 3, 2019
6	PMH 1	PAU, Ludhiana	Dec. 21, 2009-Feb. 5, 2022
7	COH 3	TNAU, Coimbatore	Feb. 12, 2009-Sept. 16, 2012
8	Vivek Maize Hybrid-15	VPKAS, Almora	Feb. 12, 2009-Feb. 1, 2020
9	HHM-2 (HKH-1071)	CCSHAU, Karnal	Oct. 20, 2010 to April 02, 2015
10	Vivek Maize Hybrid-27 (FH 3288)	VPKAS, Almora	Oct. 20, 2010 to Oct. 04, 2022
11	Vivek Maize Hybrid-25 (FH 3248)	VPKAS, Almora	Oct. 20, 2010 to Oct. 04, 2022
12	Vivek Maize Hybrid-17 (FH 3186)	VPKAS, Almora	Oct. 20, 2010 to Feb. 01, 2020
13	Vivek Maize Hybrid-9 (FH 3077)	VPKAS, Almora	Oct. 20, 2010 to Feb. 01, 2016
14	Vivek Hybrid-5	VPKAS, Almora	Oct. 20, 2010 to Feb. 01, 2016
15	Vivek Hybrid-4 (FH 3049)	VPKAS, Almora	Oct. 20, 2010 to June 07, 2014
16	DMH-2	UAS, Dharwad	Oct. 20, 2010 to Sept. 03, 2017
17	Him 129 (EHF 1121)	VPKAS, Almora	Oct. 20, 2010 to Sept. 08, 2012
18	COM (M) 5	TNAU, Coimbatore	Oct. 20, 2010 to July 19, 2022
19	COH(M)-4	TNAU, Coimbatore	Oct. 20, 2010 to Aug. 24, 2020
20	Pusa Early Hybrid Makka-2 (EH 203492)	IARI, Delhi	Oct. 20, 2010 to Sept. 16, 2012
Quality Protein Maize Hybrid			
21	HQPM-1	CCSHAU, Karnal	Oct. 20, 2010 to Aug. 24, 2020
22	Shaktiman-1	RAU, Dholi	Oct. 20, 2010 to Nov. 14, 2016
23	Sakthiman-2	RAU, Dholi	Oct. 20, 2010 to Feb. 02, 2019
24	Shaktiman-3	RAU, Dholi	Oct. 20, 2010 to Sept. 19, 2021
25	Shaktiman-4	RAU, Dholi	Oct. 20, 2010 to Sept. 19, 2021
Baby Corn Hybrid			
26	HM-4	CCSHAU, Karnal	Oct. 20, 2010 to Aug. 24, 2020

35 extant composite varieties filed under PPV&FR Act 2001, 19 have been granted protection. Of these four are specialty corn i.e. two each of baby corn and sweet corn varieties , respectively.

S. No.	Name	Centre	Period of production (Years)
Composites			
1	Gujarat Makai-2	AAU Godhara	Feb. 12, 2009-May 3, 2010
2	Gujarat Makai-3	AAU Godhara	Dec. 21, 2009-Sep. 3, 2017
3	Gujarat Makai-4	AAU Godhara	Dec. 21, 2009-Feb. 1, 2016
4	Gujarat Makai-6	AAU Godhara	Dec. 21, 2009-March 11, 2018
5	D-994	GBPAU&T Pantnagar	Dec. 21, 2009-May 30, 2019
6	Gaurav	GBPAU&T Pantnagar	Dec. 21, 2009-June 07, 2014
7	Pusa Composite-3	IARI Delhi	Dec. 21, 2009-Nov. 4, 2020
8	Pusa Composite-4	IARI Delhi	Dec. 21, 2009-Nov. 4, 2020
9	Composite C-14	SKUAST Srinagar	Dec. 21, 2009-Dec. 31, 2010
10	Shalimar KG Maize-2	SKUAST Srinagar	Dec. 21, 2009-Aug. 24, 2020
11	Amar (D-941)	GBPAU&T Pantnagar	Oct. 20, 2010 to Feb. 01, 2016
12	Narmada Moti (IC-9001)	AAU Godhara	Oct. 20, 2010 to Sept. 03, 2017
13	Shalimar KG Maize -1	SKUAST Srinagar	Oct. 20, 2010 to Aug. 24, 2020
14	Birsa Makai-1	BAU Ranchi	July 20, 2009 to Dec. 31, 2011
15	Birsa Vikas Makka-2	BAU Ranchi	July 20, 2009 to August 24, 2020
Baby Corn			
16	VL Baby Corn-1 (VL-78)	VPKAS Almora	Oct. 20, 2010 to Feb. 01, 2020
17	COBC 1	TNAU Coimbatore	Oct. 20, 2010 to June 07, 2014
Sweet Corn			
18	Win Orange Sweet Corn	DMR, New Delhi	Oct. 20, 2010 to Feb. 01, 2020
19	Priya Sweet Corn	ANGRAU Hyderabad	Oct. 20, 2010 to Sept. 03, 2017

4.2 ENTOMOLOGY

Screening Maize Germplasm against Stem borers and identifying Resistant Sources

	2006-07	2007-08	2008-09	2009-10	2010-11	Total
Chilo partellus	154	10	--	14	31	209
Sesamia inferens	253	119	177	193	129	871

Sources of resistance identified against *Sesamia inferens*

Genotype	Mean leaf injury rating (S0)	Mean LIR (S5)	Mean leaf injury rating (S6)
WNZPINKL1	3.7	2.7	3.0
WNZPINKL2	3.3	2.4	2.8
WNZPINKL3	4.4	2.5	2.5
WNZPINKL4	3.3	3.1	3.0
WNZPINKL5	4.2	2.9	2.3
WNZPINKL6	5.4	3.0	3.0
WNZPINKL7	3.3	2.7	2.7
WNZPINKL8	3.7	2.7	2.3
WNZPINKL9	3.9	2.9	2.9

Management of Shootfly

- Seed treatment *@6ml/kg* imidacloprid gave protection against *Atherigona* sp.
- The residues of imidacloprid were BDL at 60 DAS even at *10ml/kg*.

Residue analysis of Imidacloprid used for seed treatment @ 6ml/kg seed in various maize germplasm and crop products

- HM 4 Baby corn
- Fodder
- Madhuri Sweet corn
- Fodder
- Green cob
- Fodder
- HQPM 1
- Grain
- Fodder

In all the crop products, the residue level was found below quantifiable limit

Impact of naturally occurring trichograma species in maize ecosystem

The percentage parasitization of *Chilo partellus* eggs were estimated at two locations. 34% eggs at Delhi and 30-51% eggs at Udaipur were found to be parasitized by *Trichograma chilonis*

IPM strategy was developed and validated for maize in 2006-07 and kharif 2007.

There have been consistent reduction in pest severity and consequently, increase in yield up to 24% at Ludhiana, 27.9% at Dholi, 44.8% at Udaipur and 5-6% at Hyderabad.

The role of Phenolic acids in imparting resistance in maize plant to *Chilo partellus.* The role of Ferulic Acid and p-Coumaric acid in imparting resistance against *C. partellus* was discovered. There was significant correlation between concentration of Phenolic acids in maize germplasm and leaf injury rating caused by *C. partellus*. The plants showed higher concentration up to 10 days after germination after which the concentration reduced and again increased after 20 days after germination suggesting that 10-20 DAG is most vulnerable stage for *C. partellus* and require intervention for its management.

Following technologies were developed in Entomology unit and patented:

AERIAL INSECT TRAP
Patent No. 226238 15.12.2008

EGG CLEANING DEVICE
Patent No. 213744 11.1.2008

INSECT HANDLING DEVICE
Patent no. : 252363 Year: 2012

A VERSATILE INSECT REARING CAGE
Patent Application no. : 923/DEL/2011

Eight technologies were commercialized.

1. Improved Aerial Insect Trap
2. Grain & Chaff separator
3. UV-C Sterilization Chambers
4. Insect Handling Device
5. *Corcyra* Rearing Cage
6. *Helicoverpa* Oviposition Cage
7. *Spodoptera* Rearing Cage
8. A versatile insect rearing cage.

4.3 PHYSIOLOGY

Germplasm were evaluated against different abiotic stresses. The findings during 2006-10 were presented in table below:

Abiotic Stress	Genotypes Tested	Parameter studied	Promising Genotypes Identified
Drought	Hybrids:19 Inbreds: 186	Plant height, root biomass, Leaf rolling, LAI, RWC, leaf chlorophyll, stomatal conductance, photosynthetic rate, transpiration rate, ASI, grain yield	Hybrids: 6 HQPM-1, HQPM-5, HM-5, Buland, HQPM-7 and Bio-9637 Inbreds: 6 HKI 209, HKI 335, HKI 577, HKI 1532, CM 139 and LM 16
Water-logging	Hybrids: 16 Inbreds: 87	Plant Height, Leaf firing, Leaf senescence, Leaf chlorophyll, photosynthetic rate, transpiration rate, ASI, Tassel blasting, grain yield	**Hybrids: 8** HM-5, Seed Tech-2324, HQPM-1, HQPM-5, HQPM-7, HM-10 and PMH-2 **Inbreds:19** **Medium maturity**: CML427, CML42,WL14-*-*-1-2, CML327, DL-15-2 ,Pant-1-3, DL-6-3, DT/LN/EM-46-3-1, PIO.301 1F2-3-5-3-B-B-6, CML327-3-2 and Pant -1-4 **Late maturity:** WL29-*-*-3, CML 226.WL7-*-*1, CM500-1.WL18-*-*-6, CM118, PIO. 301, AMATLCOHS44-1-1-2E-4-5 and WL10-x-x-2
High Temperature	Hybrids: 16 Inbreds: 87	Plant Height, Leaf firing, Leaf senescence, Leaf chlorophyll, photosynthetic rate, transpiration rate, ASI, Tassel blasting, grain yield	**Hybrids: 8** HQPM 1, HM7, HM 9, PMH1, PMH 2 PMH 3, Buland and Prakash **Inbreds: 6** HKI 170 (1+2), HKI 325-17AN, LM 17, CA 14514, G18SeqC5F68 and G18SeqC5F100
Low Temperature	Inbreds: 110	Plant Height, Leaf pigmentation, root development, leaf tip firing, Leaf chlorophyll, Tassel branching, ASI, grain filling duration, grain yield	**Inbreds: 6** P800 C5 R 13-1TL-1HT, HKI-209, BA92 31-1-7TL, B.P.V.C.344-1-1-2-4-2TL, P88C5 F154-20 and CA 14517

4.4 PLANT PATHOLOGY

- During the reporting period a total of 1168 hybrids of different maturity groups (full season, medium, early and extra early) were evaluated against 10 major diseases of maize under artificial inoculation condition at 12 hot spot locations of the country, out of them 454 hybrids were found resistant to major diseases like TLB, MLB, Common rust, Polysora rust, SDM and PFSR, and selected for further uses.
- A total of 975 inbred lines were evaluated for major diseases at various hot spot locations under artificial inoculation conditions and a total of 690 entries were selected based on diseases reaction were showing resistance to individual as well as multiple diseases.
- A total of 403 entries was evaluated against PFSR at 4 hot spot locations and out of them 96 entries were found resistant.
- In BLSB, the loss was from 29.02 to 36.23% in cv. Pant Sankul Makka -3 at Pant Nagar.
- In PFSR caused by Charcoal rot, the loss was from 19-42% at Hyderabad & Delhi and loss due to Fusarium rot was from 36.23-38.93% in Mahi Dhawal at Udaipur, in TLB the avoidable loss was 11.00-29.84% in different genotypes at Arabhavi.
- The extent of loss in TLB was from 10.58-14.03% in HM 8 and Bio 9681 at Delhi whereas the yield loss due to SDM was observed 54.95% in genotype COH (M) -5 at Coimbatore.
- Isolates of *R. solani*, the causal organism of BLSB, *viz.* Barapani, Delhi, Udaipur and Dholi were pathogenic at temperature range of 8.8^0C - 25^0C. None of the isolates produced sclerotia at low temperature.
- Udaipur and Dholi isolates were more aggressive with larger lesion size at low temperature.
- Biocontrol agents *viz. A. niger, T. harzianum and T. viride* strains isolated from maize grains were tested, all were effective in reducing the concentration of aflatoxin.
- New technology developed/validated for the first time in maize to identify the toxic and nontoxic strain of *A. flavus* through Ammonia vapour test
- Potassium carbonate @ 4 g/kg seed and Propionic acid @ 4 g/kg seed were effective in reducing concentration by 88.0 and 47.9 respectively as compared to other nontoxic chemicals tested.
- An integrated approach of MAS coupled with phenotypic selection in different generations was implemented for the first time in India for improving TLB and polysora rust resistance in maize.
- The integrated management module of post-flowering stalk rots was developed.
- The quality parameters; protein, sugar, starch and tryptophan decreased as compared to initial levels during 10 months storage period irrespective of treatments.
- Variability study was done under controlled conditions on a set of four inbred line & including seven isolates of *M. phaseolina*. Hyderabad isolate was more virulent than the rest isolates tested.
- Isolates of *F. moniliforme* causal organism of FSR from Udaipur, Kavita and Mannar areas were found more virulent than the ten isolates from different parts of the country.
- Eight resistant lines for PFSR from diverse genetic background were identified, developed and evaluated under epiphytotic condition at four hot spot locations.
- Out of eight resistant lines, two inbred lines resistant for PFSR were registered with NBPGR and rest is in pipeline.
- Twenty four promising lines with multiple disease resistance against three or more diseases were identified.
- Ammonium & Potassium Carbonate can be used @ 4 g/kg seed to reduce the aflatoxin production due to inhibition of growth of *Aspergillus flavus*
- PFSR integrated management module was developed through manipulation of cultural practices by avoiding water stress at flowering & balanced soil fertility.
- Seed treatment with fungicides metalaxyl Apron 35 SD Apron 35 FN etc @ 2.5 g/kg to control downy mildews.

4.5 BIOTECHNOLOGY

Among all crops, maize has highest number (65) of transgenic events approved worldwide and many more events for several traits are in pipeline. In India, insect resistance (Bt) and herbicide tolerant proprietary events of maize by four developers are already undergoing advanced field trials and are likely to be released in near future.

Being the apex and the only institute in the country exclusively mandated for maize research, there is a need to strengthen genetic engineering and biotechnology program at DMR.

4.6 AGRONOMY

Conservation agriculture in maize based cropping systems

In the initial years, permanent bed planting showed the superiority over zero tillage and conventional tillage, but after completion of two years cropping cycles, zero tillage out yielded all the tillage systems in maize-chickpea-*Sesbania*, maize-mustard-mungbean and maize-maize-*Sesbania* cropping sequences. However, in maize-wheat-mungbean permanent bed planting was the best method. Higher alkaline phosphatase, dehydrogenase activity and microbial carbon in soil were also found under zero tillage compared to permanent bed and conventional planting treatment and in general values of these parameters increased year after year. Among the different systems maize-wheat-mungbean had the highest productivity.

Site-Specific nutrient management (SSNM)
Site specific nutrient management practice in maize proved the best method of nutrient management in two major maize based cropping systems i.e. maize-wheat and rice-maize. The omission of either N or P from SSNM practice considerably reduced the maize yield.

Nitrogen scheduling in maize
Nitrogen application in 5 splits (10% basal, 20% at V4, 30% at V8, 30% at tasseling and 10% at grain filling) resulted in significantly higher grain yield over recommended N scheduling (33% basal, 33% at V8, 34% at flowering). The agronomic efficiency of N (AE_N) at different locations was 3-16% higher with 5 splits compared to 3 splits application.

Agronomic management of excessive soil moisture stress
Split application of recommended dose of N (120 kg/ha) in maize as 25% at 15 days after planting, 50% at knee high stage and 25% at tasseling stage was found the best treatment in reducing the stress injuries and losses due to excessive moisture at knee high stage.

Agronomic management of low temperature stress
The foliar spray of N (1% urea) +K (2% K_2PO_4) + Fe (200ppm) was the most effective treatment in improving cold tolerance in winter maize and 'Buland' was found as the tolerant cultivar.

Crop intensification/ Intercropping systems
To enhance the profitability of maize based cropping systems paired row intercropping of maize with different grain legumes resulted in significantly higher maize equivalent yield (MEY) compared to sole maize with maximum by maize + black gram in kharif season. In the peri-urban areas, intercropping of high value crops *viz*. beet root, peas and potato in baby corn planted on raised beds was found remunerative as compared to sole baby corn. The net returns varied from ` 1,52,841 under baby corn + beet root, ` 95,987 under baby corn + coriander, `86,704 under baby corn + knolkhol, `78,920 under Baby Corn + peas, and `65,010 under baby Corn + fenugreek intercropping systems. In crop intensification study on winter maize based cropping systems for peri urban areas; maize-cowpea-baby corn closely followed by maize-cowpea-okra was found as the best system and these systems recorded 25-30 % higher maize cobs equivalents as compared to maize-maize cropping system.

Agro techniques for inbred seed production
For producing higher seed yield from maize inbred, the planting of crop at higher density (60 cm x 20 cm) along with application of higher doses of N, P_2O_5 and K_2O (250:90:90) coupled with 15 t/ha FYM was found best combination.

Agro techniques for hybrid seed production
For seed production of maize hybrids (HQPM-1, HQPM-6, HQPM-7, HM-1602, HM-1604 and HM-4), the plant spacing of 60 cm x 15 cm combined with application of 250 kg N, 90 kg P_2O_5, 90 kg K2O and 15 t FYM per ha were found as the best practices. The ratio between female and male rows should be kept as either 3:1 or 4:1 for higher seed yield.

4.7 EXTENSION

Technologies transferred
All promising technologies (e.g. High yielding single cross hybrids, QPM, baby corn, sweet corn, pop corn, fodder maize, intercropping, RCT, plant protection etc) were demonstrated at farmers' field in different states of country. Number of demonstrations, field days, trainings and Kisan melas organized during 2006-07 to 2009-10 are mentioned below:

Year	FLDs				Trainings				Kisan Mela & Exhibitions
	Rabi	Spring	Kharif	Total	Field Days	Under ISOPOM	Others	Total	
2006-07	2434	188	9526	12148	>20	62	-	62	6
2007-08	2152	134	6751	9037	>25	29	2	31	9
2008-09	2122	355	5603	8080	>30	3	2	5	7
2009-10	3638	772	6390	10800	>40	15	5	20	8
2010-11	2450	481	5488	8419	>25	4	3	7	6

- Average yield of demonstrations and national average yield of maize are in increasing trend over the years. And average yield of demonstration are almost double than that of national average yield of maize.

Technologies developed
- Expert system of Maize i.e. Maize AGRIdaksh was developed in collaboration with IASRI, New Delhi.

Sustainability index
To assess the level of sustainability, maize cultivation practices were developed

4.8 BIOCHEMISTRY

The Biochemistry laboratory of DMR is the pioneer research centre which held a specific position in maize research in India with respect to the development of nutritionally improved maize genotypes. It played a major role in the development of quality protein maize in India. The laboratory functions as a central unit and caters to the needs of various maize centres of the coordinating unit of ICAR and State Agricultural University for biochemical analysis of maize germplasm. The laboratory is well equipped with modern instruments like Amino acid Analyzer, HPLC, Lyophiliser, Vacuum Concentrator, Geltech, automatic solvent extractor system, NIRT, spectrophotometer and many more. The laboratory facilitates the analysis of various parameters of maize quality such as protein

quality (protein, tryptophan and lysine), carbohydrate profile (starch, sugar, amylase and amylopectin), oil and carotenoids composition etc.

During the period from 2006-2010 around 4500 samples received from different sources were analyzed for various quality parameters viz. protein, tryptophan, lysine, oil, sugar, carotenoids, β-carotene etc. During 2006-07, around 500 samples were analyzed. During this year zein to non-zein ratio was analyzed in the milling products of QPM ('dalia', processed flour, maida, grits) including whole kernels as compared to their respective normal maize. Zein content was found less in all the milling products of QPM. During 2007-08 more than 1400 samples were analyzed. . A wide variability was observed in the protein and as well tryptophan content. A number of high protein lines were identified. In protein quality more than 70 lines were found to be having ≥9% protein and ≥ 0.6 tryptophan in their protein. Similarly a wide variability was observed in the oil and starch content. Some waxy maize lines (amylopectin content ≥90%) were also identified. During the year 2008-09, again around 1400 samples were analyzed for various parameters. More than 700 lines were evaluated alone for protein quality, 430 for oil, 436 for sugar and more than 400 lines were evaluated for starch content. During the period of 2009–2010 around 900 lines received from different sources were analyzed for various quality parameters. As many as 53 lines were found to posses more than 9% protein and more than 0.6% of tryptophan in their protein. 28 lines were identified having more than 25 µg/g carotenoid content and 11 lines were having 5 or more than 5 µg/g β carotene content. The range of sugar varied from 3.14 to 20.40 per cent.

4.9 COMPUTER APPLICATIONS

1. Development and Management of DMR Website
2. Developed an information retrieval system: The information on maize research can be retrieved from AGRIdaksh
3. Maintenance of LAN in DMR premises
4. Personal Management Information Network (PERMISNET): Information related to scientific, administrative and technical staff of DMR received from the administration and individuals were updated online and monthly throughout the year in online system PIMSNET.
5. Project Information and Management System-ICAR (PIMS-ICAR): Online submitted all ongoing projects and completed projects available with PME cell at DMR.
6. SAS software for data analysis has been installed in 20 computers of DMR.
7. AICRP on Maize: Data preparation, analysis and compilation of data generated through All India Coordinated Project on Maize were performed for identification of varieties/ hybrids from 2006 to 2010.
8. The electronic and transport properties of nanostructures like quantum dot and single wall carbon nanotube (SWCNT) based single electron transistor were investigated theoretically. The studies conducted on conductance of nanostructures provide useful inputs on SWCNTs as the base material for nano-devices.

5

Performance of AICRP Centres

Zone 1

1. NEH Region

Most of the maize growers of NEH region are not aware of hybrid maize. 'Private Seed Companies' are reluctant to supply seed to NEH region due to the higher cost of transportation and difficulty in accessibility. Under present situation, the public sector has more responsibility to disseminate the modern technology to NEH region. In view of the present situation, the following suggestions on research, development, administration, etc. are given below:

- The maize breeding program should concentrate on introgression of diverse genes in local germplasm.
- Maize program may be developed in collaboration with DMR.
- Maize program should be taken up at the following centres in NEH region: Basar (AP), Jharnapani (Nagaland), Gangtok (Sikkim) and Barapani (Meghalaya).
- Multi-location hybrid maize trials should be done in NEH.
- Regular training programs and supply of sample seeds to farmers may be taken up.
- Collaboration of public and private companies in bringing the superior hybrid maize seed to the farmers of NEH region.
- Separate budget including contingency and TA should be earmarked for NE region.

2. Srinagar

- Shalimar maize hybrid – 1 has been released in 2009.
- Shalimar maize composite - 3 and Shalimar maize composite – 4 have been released in 2009.
- Twenty two yellow and nine white maize inbred lines have been derived from popular varieties of SKUAST – K.
- A total of 3,672 kg breeder seed was produced.
- Soaking of seed with 0.1% thiourea for 6 hrs significantly enhance seed germination.
- Maize intercropped with *'rajmamash'* under mulch gave higher yield.

Shalimar Maize Composite - 3

- Farmers were given demonstration of single cross hybrid seed production technology.

Bajaura Makka

3. Bajaura

- One hundred twenty inbred lines for early and medium maturity have been developed.
- One composite variety 'Bajaura Makka' was released by CVRC.
- Bajaura sweet corn, Bajaura pop corn were released by SVRC.
- Eleven inbred lines were developed for different traits.
- Six thousand five hundred eighty - six kilogram breeder seed was produced from 2006 to 2010.

4. Almora

- Thirty-three inbred lines of normal maize have been developed and nine QPM and seven normal lines have been registered with NBPGR.
- Eight single cross hybrids and three composites have been released.
- Six hybrids and two composites were registered under PPV & FRA, 2001.
- MoU has been signed with three private seed companies for production and marketing of recently released single cross hybrid, Vivek QPM 9.
- The plant geometry of paired row provided better grain yield than normal equal row spacing.
- For Vivek QPM 9, the plant geometry of 60 X 16 was found most suitable to get optimal yield.
- Three thousand nine hundred twenty-six kilogram breeder seed and three thousand six hundred ninety-six kg of hybrid seed were produced.

5. Kangra

- At Kangra centre, 10 inbred lines were developed and thirty germplasm were registered with NBPGR.
- Twenty-two hybrids were promoted to higher evaluation level.
- Two thousand one hundred forty-two kilogram/variety/hybrid seeds were produced during the period under report.
- Ninety-four inbred lines resistant against ESR (5), BSDM (36), and BLSB (53) have been developed.

6. Barapani

- Three composites were developed and 125 germplasm collected from North Eastern Hill Region and maintained.

Zone 2

1. Karnal

- One hundred eighty-five inbred lines were developed, ninety inbred lines were characterized.
- Eight hybrids *viz.* HM 8, HM 9, HM 10, HM 11, HQPM 4, HQPM 5, HQPM 7 and HSC 1 have been released.
- Seven hybrids *viz.* HM 5, HHM 2, HM 9, HQPM 1, HQPM 5, and HM 4 were registered under PPV & FRA , 2001.
- Twenty-two inbred lines with various useful traits were registered with NBPGR.
- The centre produced 1602 kg hybrid seed and 1782 kg breeder seed.
- Karnal centre has the distinction of signing MoUs for commercial seed production of seeds of eleven hybrids with eleven seed companies.
- Babycorn planted 90 X 15 cm with two rows and single row at 60 X 15 cm gave higher yield.
- Application of nitrogen in five split doses i.e. 20, 25, 30, 20 and 5 % at basal, 4 leaf stage, 8-leaf stage, tassel emergence and early grain filling stage gave higher yield.

- Following inbred lines were developed:
  - Twenty-eight good combiner and productive lines.
  - Twenty-six rust resistant lines
  - Fifteen multiple resistant lines.
  - Fifteen lines resistant to *Chilo partellus*.

2. Kanpur

- Following inbred lines were developed:
  - Ten inbreds of QPM for early and medium maturity.
  - Twenty sweet corn inbreds of early maturity.
  - Ninety-eight inbred of normal maize for early, medium and late maturity.
  - One composite *'Chandramani'* for dual purpose released by CVRC for Zone 4 and 5.
  - Three thousand eight hundred eleven kg seed was produced.

3. Pantnagar

- Following inbred lines were developed:
  - Twenty-five QPM lines
  - One hundred sixteen excess soil moisture tolerant germplasm
  - One single cross hybrid, 'Pant Sankar Makka 1' was released for cultivation in the plains of Uttarakhand.
  - Eight thousand seven hundred thirty-three kilogram seed was produced.

4. Delhi

- Two maize composites PC 3 and PC 4 were released by CVRC.
- Twenty-six inbred lines were found resistant against MLB.

5. Ludhiana

- Six hybrids *viz.* PMH 1, PAU 352, PMH 3, PMH 4, PMH 5 and Punjab Sweet Corn have been released by CVRC.

PMH - 3

PMH - 4

PMH – 5

PMH – 1

- Eight hybrids *viz*. Parkash, Buland, PMH 1, PMH 2, PAU 352, PMH 3, PMH 4 and PMH 5 have been registered with PPV & FRA, 2001 and six inbred lines *viz*. LM 5, LM 13, LM 15, LM 16, LM 17 and LM 32 have been registered with NBPGR.
- Fifteen inbred and thirteen hybrids were found tolerant to charcoal rot disease.
- Eight inbred lines and fourteen hybrids were indentified resistant to Maydis Leaf Blight.
- A total of 1808 inbreds including sister lines have been developed and maintained at the centre.
- The artificial infestation dose of sixteen to twenty eggs per plant after eight to ten days of germination (DAG) for hybrids and twelve to fifteen DAG for inbred lines have been standardized for *Chilo partellus*.
- Single release of *Trichogramma chilonis* at the rate of 40,000 parasitized eggs per acre at 10-15 day old crop by keeping 40 release points have been recommended.
- Napier millet hybrids were preferred for oviposition over maize by *C. partellus*.
- Seed treatment with Imidacloprid 600FS at the rate of 6 ml/kg seed has been recommended for controlling shootfly.

Zone 3

1. *Dholi*

- Hybrids released:
  - Rajendra Makka Deepjwala by SVRC
- One thousand four hundred twenty-six inbred lines were screened for Maydis Leaf Blight among which 82 were found resistant.
- Production technologies for maize intercropping with pea, radish, *rajmash, arhar, urd* bean, groundnut, etc. have been developed for enhancing profitability.
- Nineteen thousand eight hundred fifty four kg breeder/parental seed were produced.
- The following value added products have been developed and entrepreneurs was encouraged to take them up at commercial level.

Entrepreneurship development

Suji,Dalia, Sattu Sewian, Flour, Grits, Bhujia	M/S K. M. Udyog, Khagaria
PUSA Shakti	M/S Om Shakti Foods, Sujawalpur, Dholi
Dilkhush	M/S Guru Kripa Foods, Ramdayalu Nagar Muzaffarpur
Proteino-H	M/S Pragati Swablami Sahakari Samiti, Sakra, Muzaffarpur

The processing centre is well equipped

2. Bhubaneswar

- A total of 227 inbred lines of maize was developed and maintained at the centre, among them 15 were found high in Lysine and Tryptophan content.

3. Varanasi

- One hybrid, 'Malviya Hybrid Makka 2' released and found tolerant to TLB and MLB
- A total of 142 inbred lines have been developed and maintained.
- Twelve new inbred lines have been developed for Quality Protein Maize.

Malviya Hybrid Makka 2

4. Ranchi

- Two varieties, Birsa makka – 1 and Birsa Vikas Makka – 2 have been registered as extant varieties.
- A total of 156 inbred line were developed and maintained, among them 26 were found high in Lysine and Tryptophan content.

5. Gossaingaon

- Hundred inbred lines were evaluated for yield and related traits among them, eight inbred lines were found promising by their *per se* performance.

6. Bahraich

- All India coordinated trials of breeding and agronomy were conducted and evaluated.

Zone 4

1. Hyderabad

- Four hybrids, DHM 111, DHM 113, DHM 117 and DHM 119 were released.

- Following lines were developed and maintained:
  - Normal yellow : 435
  - Normal white : 38
  - Lines resistant to PFSR: 47
  - Drought tolerant lines :128
  - Maize land races of Nagaland: 79
  - Lines isolated from Winter Nursery introductions: 35
  - QPM lines were developed from advanced material of QPM introductions: 40
  - QPM inbred lines were developed from new lines received from Winter Nursery: 145
  - Sweet corn lines developed from Madhuri, Priya, Sugar 75, Bright gene, Silver queen, Sunshine: 45
  - Popcorn lines were developed from Amber popcorn, other entries of pop corn trials and Winter Nursery introductions: 42

- Lines registered with NBPGR: 24
- Eleven thousand twenty-five quintals of seed for parental lines/hybrids produced.
- Three hybrids, DMH 107, DHM 109, DHM 117 and one composite, Priya, were granted protection by PPV & FRA, 2001.
- Technologies for zero-till maize production after rice was developed and standardized.
- Technologies for seed production of maize inbred and hybrid were developed.

2. Arabhavi

- Full season maturity hybrid, EH 434042 (Arjun) was released
- 124 lines were advanced to S4 stage from 8 exotic hybrids.
- Seventy-nine lines were advanced to S6 stage from National Yellow Pool from which 10 lines were selected based on *per se* performance.
- Based on phenotypic features, yield and test weight, seven lines have been selected.

- Twenty-seven inbreds and seventeen hybrids were identified for resistance to TLB.
- Nine inbreds and 15 hybrids were identified for resistance with Charcoal Stalk Rot.
- A planting geometry of 60 X 20 cm recorded higher yield in comparison to 75 X 20 or 60 X 30 cm.
- Inter cropping of two rows of soybean in between 90 cm rows of maize found profitable.
- A total of 194 kg nucleus seed, 33400 kg breeder seed and 216900 kg of certified/truthful label seeds were produced.

3. Mandya

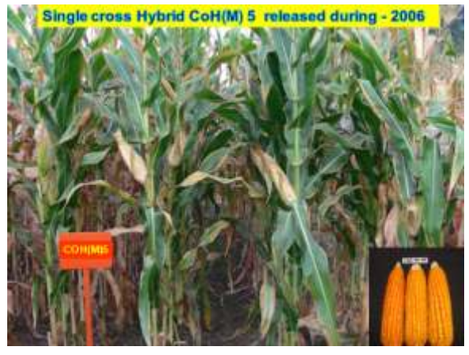
- Two full season hybrids, NAH 1137 (Hema) and NAH 2049 (Nithyashree) were developed and released.
- One early maturity composite NAC 6002 (resistant to TLB, P.rust and SDM) and one full season maturity composite NAC 6004 (resistant to TLB, P. rust and SDM) were developed and released.
- Following inbred lines resistant to TLB and P. rust were developed:
  - Ninety-five full season inbred lines.
  - Seventy medium maturity inbred lines.
  - Thirty-seven early maturity inbred lines.
  - Eighteen extra early maturity group inbred lines.
- One hundred twenty nine inbred lines developed were named as Naganhalli inbred lines NAI 1-129.
- Following inbred lines resistant to downy mildew were developed:
  - Fifty-four full season maturity
  - Seventeen medium maturity
  - Five early maturity
  - A total of 6145 kg breeder seed and 134000 kg of hybrid seeds was produced.
- Excellent work on value addition is being pursued at Mandya. Various value added products are depicted below.




Product prepared by Women Entrepreneurs

Photo	Product Name	Name of SHGs
	Papad	Sarasvathi
	Crunches	Lakshmi
	Vermicelli	Lakshmi
	Noodles	Sarasvathi
	Laddu	Sarasvathi
	Nippattu	Sarasvathi
	Nutri Mix	Lakshmi

4. Karimnagar



- A total of 612 inbred lines were maintained at the centre, among them 95 were developed at the station and remaining were selected from materials received by DMR Winter Nursery, Hyderabad.
- A total of 182 AICRP breeding trials were conducted and evaluated.
- A total of 35 inbred lines *viz.* DTML – 3, DTML-37, DTML-82, DTML-86 were found tolerant to drought.
- Four inbred lines *viz.* KDTML -3, KDTML – 19, KDTML – 66 and KML – 29 have been registered with NBPGR for Drought tolerance.
- Under agronomy programme, 79 trials were conducted.
- 0.2% spray of thiourea at pre-tasselling and 50% silking resulted in higher maize yield under rainfed condition.
- Nine hundred-seventy kg seed was produced.

5. Coimbatore

- One single cross hybrids CoH (M) 5 was developed which is resistant to SDM and stem borers.
- Twenty-seven inbred lines were developed for various traits of different grain types.
- Four hybrids *viz.* CoH 3, Co (Bc) 1, CoH (M) 4 and CoH (M) 5 were registered under PPV & FRA, 2001.

- Four inbred lines were registered with NBPGR.
- A total of 44090 kg of hybrid and 3100 kg of breeder seed were produced.

6. Vagarai

- The centre was established in March 2007 and research started in mid 2008, while AICRP started from April 2010.
- Thirty-one lines were utilized for synthesis of 73 hybrids.
- The application of 300-105-105 (NPK Kg/ha)+ FYM @ 15 ton/ha gave higher yield of male and female inbreds.
- Drip fertigation of 100% RDF (150: 75: 75 NPK kg/ha) gave highest grain yield in *kharif* and *rabi* season.
- Integrated disease management strategies against TLB, Charcoal Rot, BLSB, Polysora Rust were developed.
- Three hundred inbred lines of Vagarai were evaluated against *Chilo partellus* out of which 102 lines were found resistant.
- A total of 2,742 kg of seed was produced.

7. Kolhapur

- Single cross hybrid 'KMH-22168 (Rajarshi)' was released during 2009.
- Twenty-two promising hybrids developed/tested.
- Ten inbreds were developed.
- A total of 1094 genotypes were evaluated and 403 inbred lines were maintained and available at centre.
- A total of 145000 kg of seed was produced.
- Application of 120:60:40 kg of NPK per hectare with 75 X 20 cm spacing gave higher yield of Rajarshi.
- Intercropping of maize with spinach for vegetable purpose was found beneficial.
- A total of 90 genotypes against *Chilo Partellus*, 12 against *Sitophillus oryzae*, 2 against grass hopper and 4 were found resistant to *Heliothis*.
- Maize + cowpea + seed treatment resulted in higher grain yield of maize.
- IPM strategy on timely sowing, application of Captan @ 2 g/kg and *Trichoderma* @ 7g/kg, use of Atrataf @ 2 kg/ha at pre emergence, recommended dose of manures and fertilizers and release of *Trichogramma chilonis* @ 8 cards/ha on 8 and 13 DAG resulted in least deadhearts.

Zone 5

1. Udaipur

- Nine heterotic pools were developed.
- Pratap Makka Chari 6, a fodder variety and Pratap Hybrid Maize 2, an early hybrid were developed.
- Pratap Hybrid Maize 1 was registered under PPV & FRA, 2001.

- Four inbreds with special traits were registered with NBPGR.
- A total 10355 kg of breeder seed was produced.
- A total 49 trials were conducted under Agronomy programme.
- For Quality Protein Maize (HQPM 1), 115 kg N and 40 kg P_2O_5 was found optimum.
- For Baby corn 111 – 166 thousand plants per hectare at 60 X 10-15 cm recommended with 120 kg N and 40 kg P_2O_5 fertilization for higher yield.
- For pop corn, 90 kg N and 45 kg P_2O_5 found optimum with 66000 plant population and plant geometry of 60 X 25 cm.
- Highest reduction in maize cyst nematode population was observed in maize-mustard-fallow-cropping sequence.
- Neem and *aranj* seed kernel extract at 10% weight by weight as seed treatment effectively reduced infection of *Heterodera zeae* on maize.
- Release of *Trichogramma chilonis* @ 1.5 lakh per hectare at 10, 20 and 30 DAG successfully managed stem borer.
- Dusting of crop at 20 DAG with 5% Carbaryl followed by spray NSKE 5% is recommended for management of grass hopper.

2. Godhra

- A total of 262 breeding trial were conducted under All India Coordinated Research Programme.
- A total of 29 of white and seven of yellow grain genotype have been tested and found tolerant to MLB under rainfed condition.
- Eight hundred ninety-four germplasm developed and maintained. Among them, 105 were of QPM and 130 were of high oil corn.
- The farmers of middle Gujarat were advised to make ridging at 2 m interval across the furrow after sowing of maize for securing higher yield.

3. Chhindwara

- A total of 1505 germplasm were maintained at the centre.
- Ninety inbred lines have been derived from the available germplasm. Among them, twenty-five were of specialty corn (Sweet corn and Pop corn)
- Four composite have been registered with PPV & FRA, 2001 (Jawahar pop corn, JM 8, JM 12, JM 216)
- A total of 30300 kg breeder seed and 10000 kg hybrid seed were produced during the period.

4. Ambikapur

- Forty-eight germplasm collected from Chhattisgarh state have been maintained.
- A total of 42 populations were developed up to S6 generation.
- Paired row planting of maize at 50/100cm in combination with three rows of groundnut, found profitable intercropping system for Northern Hills of Chhattisgarh.

5. Banswara

- Pratap Kanchan – 2, an early maturing composite was developed.

- Three composites were granted protection under PPV & FRA, 2001 during the period *viz.* Pratap Kanchan-2, Mahi Dhawal and Mahi Kanchan.
- A total of 78 trials in *kharif* and 118 trials in *rabi* were conducted in breeding programme.
- Under synthesis of new population/pool 103 lines were developed for rainfed population improvement programme.
- A total of 385 inbreds with special traits were developed using NP- 2 and Pool -28

- A total of 97 trials were conducted in the Agronomy programme.
- Maize intercropped with soybean in 2:2 row ratio (30/90cm) with Pendimethalin @1.0 kg a.i./ha followed by one hand weeding at 35 DAS was found to be most appropriated and economically viable for enhancing productivity of maize based cropping system.
- Paired row maize (50/100 x 20cm) + 3 rows of blackgram / soybean intercropping system was found more productive and economical for sustaining productivity of *kharif* maize under rainfed condition.
- Winter maize planted in paired rows with onion/garlic (2:4) at 50/110cm was found profitable intercropping system for maximizing productivity of *rabi* maize.
- Site-specific nutrient management practice was proved beneficial for enhancing productivity of rice-maize cropping system.
- A total of 3907 kg of parental line seeds, 25 kg of nucleus seed and 406000 kg of breeder seed were produced.

6. Jhabua

- A total of six breeding trials were conducted and evaluated.
- A total of 450 FLDs were conducted to demonstrate the performance of different hybrids and varieties.

6

Suggestions and Recommendations

The QRT conducted six visits at different places *viz*, Karnal, Udaipur, Hyderabad, Patna, Srinagar and Delhi. During their visit, the achievements of AICRP centres were thoroughly evaluated. Filed visits were also made at these places. QRT has came out with following recommendations to increase the efficiency and meet the national need of maize research.

BREEDING

1. Pyramiding of biotic and abiotic factors is necessary for crop improvement programme.
2. The research activities pertaining to specialty corns should be strengthened.
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.
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.
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.
6. As there is huge demand for fodder, research on fodder maize need to be strengthened.
7. Development of regional specific hybrids needs to be recommended; besides inter-institutional hybrids are to be tried in all the locations.
8. The doubled haploid programme may be strengthened with bio-technological facilities.
9. For advancing inbred - hybrid development programme haploid inducers may be acquired for accelerating the hybrid development programme.
10. Each centre was suggested to produce breeder seed for the parents of the hybrids released.
11. The importance of heterotic pools should be looked in to by different centres.
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.
13. Suggested to increase the seed production activities and compare the QPM genotypes with popular check.

14. It was suggested to focus the development of early maturing single cross hybrid.
15. Exchange of breeding material and inbreds between centres should be continued.
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.
17. Maintenance breeding and popularization of hybrids should be done on priority.
18. The period of testing of hybrids for release should be reduced.
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.
20. Participatory seed production should be thought off to increase the seed production activities.
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.
22. It is recommended to review the seed production programme at breeders level.
23. The inter-institutional or inter-zonal hybrids need to be developed and tested in different centres.
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.
25. The stay green type of hybrids should be tried to contain fodder problem.

AGRONOMY

1. The studies on residual effect especially the weedicides need to be undertaken.
2. Resource conservation technology is very important, hence technology needs to be developed in maize systems.
3. Organic inputs should be tried as substitute to inorganic fertilizers.
4. Chemicalization of agriculture is to be stopped with organic farming.
5. Intercropping research needs to be promoted as the majority of the farmers are either marginal or small.
6. Strengthening of site-specific agronomy development needs to be emphasized.

ENTOMOLOGY

1. It was suggested to check the effect of bio control agent (*Trichogramma*) as it is more efficient and effective.
2. The IPM package may be tried along with *Trichogramma* rather than *Trichogramma* alone.
3. As the stem borer incidence is very severe, needs entomologist attention.
4. The intercropping research needs to be strengthened, for insect management.
5. The plant protection technologies may be developed for tribal people, who do not practice plant protection measures.
6. The habitat management in maize using intercrop, the bio-agents data should be recorded.

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.

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.
2. The programme on research activities on disease need to be strengthened in zone II like previous years.
3. The survey and surveillance regarding Rajasthan downy mildew (RDM) should be under taken to know the status of disease incidence.
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.
5. The artificial inoculation should be properly tried for pathological screening of genotype.

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.
2. A short term training of the scientist at CIMMYT, Mexico to broaden the skills required for the development of Quality Protein Maize.
3. Training of the scientist at some appropriate laboratory abroad so as to equip the scientist for study the starch degradability.

BIOTECHNOLOGY

1. Bt corn programme needs to be strengthened besides work on bio agents.
2. The recommendations regarding transgenic maize should be from coordinated data rather than the private companies' data.
3. While conducting Bt trials all norms need to be followed. Bio-safety permission needs to be obtained before executing Bt trials.
4. Biotechnology techniques may be proposed for future research programmes.

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.

EXTENSION

1. It was suggested to execute more FLDs and field days.

COMPUTER APPLICATIONS

1. Nano technology may be tried with respect to seed treatment and to enhance photosynthetic efficiency.

GENERAL

1. Public private partnership (PPP) should be strengthened.
2. Coordination between public and public centres may be strengthened for improvement of research activities.
3. The technologies developed should be popularized by availing the support of KVKs.
4. The research areas to be prioritized in different states to work with.
5. The integration among Breeders, Pathologists, Entomologists and Agronomists need to be brought out for effective research work.
6. It has been recommended to enhance the recurring contingency (RC) to the tune of `2.5 to 3.0 lakhs and travelling allowance (TA) to the tune of `50,000 per Scientist.
7. Orientation programmes need to be organized to different centres to enhance the productivity at national level.
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.
9. The concept of KVK should be used for popularization of hybrids.
10. The promising hybrids released at state-level may be recommended for cultivation in other states also as per the demand of the farmers.
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.
12. A voluntary centre is recommended at Port Blair keeping in view of the demand of specialty corn.
13. Post harvest technology programmes, processing studies with value addition need to be looked in to for quality research activities.

ANNEXURE-I

INDIAN COUNCIL OF AGRICULTURAL RESEARCH KRISHI BHAVAN NEW DELHI-llOOOl.

F.No. 16-7/10-IA.IV Dated the 22, Nov., 2011

OFFICE ORDER

The Director General, ICAR has been pleased to constitute the Quinquennial Review Team (QRT) to review the work done by Directorate of Maize Research, New Delhi and AICRP on Maize during the five years period from 2006 to 2010. The composition of the QRT will be as under :

Sr. No.	Name & Address	Designation
1.	Dr. R.R. Hanchinal, Vice Chancellor, Dharwad UAS	Chairman
2.	Dr. N.S. Malhi, PI Breeder & Ex Head, PAU	Member
3.	Dr. Pandurangegowda, Associate Director (R), Mandya	Member
4.	Dr. R.K. Malik, Agronomist, HAU, Hisar	Member
5.	Dr. S.J. Rahman, Principal Scientist, EntonomologyANGRAU,	Member
6	Dr. M.C. Wali, Sr. Maize Breeder, ARS, Arabhavi, Karnataka	Member
7.	Dr. P. Kumar, Principal Scientist, DMR, New Delhi	Member Secretary

FUNCTIONS

The QRT shall conduct the review of the work of the DMR, 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 issue of this order for further submission to the General Body of ICAR. Terms and references for the QRT is enclosed in 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, DMR, 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 DMR, New Delhi in accordance with the relevant rules of the Council.

(Sujit K. Mitra)
Deputy Secretary(CS)

DISTRIBUTION

1. Chairman, QRT for DMR, New Delhi
2. All members of the QRT - as per list
3. Director, DMR, New Delhi. The T.A. of 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, DMR, 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 QR 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

Schedule of QRT Meetings and Visits

Date/Day	Zone	Venue/Centres
09/02/2012 (Thursday)	II	**Karnal**, Kanpur, Pantnagar, Delhi, Ludhiana
14/02/2012 (Tuesday)	V	**Udaipur**, Godhra, Chhindwara, Ambikapur, Banswara and Jhabua
25/02/2012 (Saturday)	IV	**Hyderabad,** Arbhavi, Mandya, Karimnagar, Coimbatore, Vagarai, Kolhapur
05/03/2012 (Monday)	III	**Dholi** , Bhubaneswar, Varanasi, Ranchi, Gosaigaon
July 21-22 (Saturday- Sunday)	I	**Srinagar**, Bajuara, Almora, Kangra
07/08/2012 (Tuesday)	Headquarters and Regional Stations	DMR, New Delhi

ANNEXURE-IV

Action Taken Report of QRT 1997-2005

S. No.	Recommendation	Action Taken
BREEDING		
1.	Listing of potential Germplasm	Potential Germplasm registered at NBPGR has been documented and a copy each provided to the AICRP (Maize) centres; notified hybrids (public- bred and proprietary) and composite varieties, too, have been documented. The bulletins (Registered Germplasm of Maize and Hybrids and composite varieties of maize released in India) are updated every year. These bulletins are released during Annual Maize Workshops.
2.	Inbred data-base	An attempt has been made to develop inbred data-base pertaining to parental lines giving vital information on 31 DUS-related traits. The information on kernel traits, maturity and other useful parameters in respect of established inbred lines belonging to different AICRP centres (including DMR) has been compiled and published as technical bulletins. Every year, these bulletins (A catalogue of maize inbred lines and Compendium of maize hybrids and composites under PPV&FRA) are released during Annual Maize Workshops and all the AICRP centres provided a copy each.
3.	Development of synthetics	Development of synthetics is under-way.
4.	Switching –over from multi-parent to 2-parent combinations	Since 2005-6, major emphasis has been laid on development and dissemination of single cross hybrids of maize. Consequently, 38 single cross hybrids have been released for cultivation since 2005. Of these 29 are of normal, seven QPM and one each of baby corn and sweet corn, respectively. A complete list is appended (Annexure1).

5. Field demonstration of hybrids and inviting private sector for PPP	DMR has been striving as a facilitator in forging PPP ties between AICRP centres and Private sector. DMR conducts demonstration trials of all public-bred hybrids during k*harif* season and private company personnel invited for on-spot assessment. An interface session between breeders from private sector and AICRP centres has been organized during Annual Maize workshops during which modalities of PPP discussed. Small, indigenous companies with no R&D have been tapped for initiating seed production of single cross hybrids. Seed production of single cross hybrids from Karnal and Almora has been taken up through PPP mode.
6. Procurement of new germplasm	Every year since 2005-6, introductions received from various institutions/organizations via NBPGR, New Delhi were evaluated mainly in *rabi* season at winter nursery Hyderabad.Since 2005-6, 9855 accessions received from CIMMYT, IITA, USA,Italy, Spain, Brazil, etc were evaluated for desirable traits under neutral climatic conditions of Hyderabad and the potential accessions selfed and carried forward. During the month of February/March, every year a field day is organized during which breeders from SAUs/ICAR Institutes and private companies select/indent the material and the same is supplied for use in augmenting Inbred /hybrid development programs .
7. Collaboration with NBPGR	An effective collaboration has been established with NBPGR for characterization/ evaluation of Germplasm in phased manner. A project on Multi-location evaluation of Germplasm of maize was initiated in 2009 involving Division of Evaluation (NBPGR), pantnagar, Coimbatore, Udaipur, Godhra and DMR, under which 200 accessions of indigenous Germplasm was evaluated every year during *kharif*. Efforts have been directed for characterization, evaluation and rejuvenation of Germplasm held under Long term Storage (LTS) under neutral climatic conditions of Hyderabad. As a consequence till date around 2500 exotic accessions (inbred lines/ populations/hybrids) were characterized and evaluated. The material was selfed and passport data generated and selfed seed (of inbreds) supplied to NBPGR.
8. Papers presented in Annual Maize workshops	A special session deals with the topical issues and the papers on them presented by concerned PIs and distinguished scientists.

9. Intensifying of abiotic stress research	Drought, water logging and high temperature stresses were being studied in details. Different projects through International Collaborations with CIMMYT (BMZ and CSISA) have been undertaken to address these issues. A project on Abiotic stress tolerant maize for resource-poor in India, Bangladesh and Nepal was taken up during 2008 and successfully completed in May, 2011. Abiotic stress tolerant maize for Asia (ATMA) has been initiated for a period of three years since May 1, 2011.The released hybrids were evaluated under managed drought and water logging conditions and better performing hybrids *viz*. PMH1, 3, HM 8, HM 9, Pusa 5, DHM 119 selfed and segregating generations carried forward for the development of stress tolerant inbred lines.
10. Securing QPM lines from ` CIMMYT	Efforts are directed in developing source Germplasm for the extraction of lines. In this regard, material in various stages of development was procured from Dr. S.K. Vasal. This material (2205 lines) was thoroughly evaluated under Delhi as well as Hyderabad conditions and, desirable lines identified. Most of these lines under Delhi conditions showed late to very late flowering with reduced/no seed setting. However, 45 lines were found desirable and have been carried forward of these 35 were of normal and 10 QPM type. A complete set of CMLs (normal and QPM) was procured, evaluated and seed increased through hand pollinations. The desirable lines are being maintained and used as testers/checks for identifying potential in house inbred lines.
11. Augmenting pop corn and sweet corn research	As a part of sweet corn and popcorn research the project entitled “Development of Sweet Corn and Popcorn Hybrids in Maize” was initiated in 2007. Accordingly, 188 sweet corn and 78 popcorn germplasm lines were evaluated, out of which 38 sweet corn and 27 popcorn lines were analysed for sweetness and popping parameters and were found promising . The project has yielded in development of eight sweet corn and two popcorn productive inbred lines, their finger printing and registration as unique germplasm at NBPGR. However with respect to hybrid development three popcorn hybrids are under AICRP testing .
12. Sources of resistance	Efforts have been directed in developing and identifying inbred lines with gene/s for multiple disease resistance. A set of elite inbred lines (200) were evaluated under hot spot conditions/ artificial screening nurseries every year and resistant lines

	identified, seed increased and supplied to different AICRP (Centres) for utilization in single cross hybrid breeding program. Similarly, a common set of lines was evaluated for pod borer/pink borer resistance / tolerance. The information on resistance/ tolerance of lines for biotic stresses was compiled and unique lines registered at NBPGR.
13. Non-performing centres	Single cross hybrid breeding program is the mandate of all the AICRP centres . Accordingly, the breeders of these centres have been involved in the activities related with the development of inbred lines and single cross hybrids. However, only a few centres lag behind. The breeders from such centres take part in Germplasm field days organized annually at Hyderabad and indent for promising Germplasm (inbred lines and introductions). The breeders have also been re-oriented through refresher courses two times /year for 3-4 days at winter nursery (March) Hyderabad and Delhi (September). Moreover,The annual progress of these centres is reviewed during Annual Maize workshops through zone-wise presentations.
14. Specialty corn/processing industries	The villages Aterna and Mandauli in Haryana, have been adopted by DMR and the villagers have installed a Baby corn and Sweet corn processing industry as a small scale enterprise.
15. Work on post-harvest technology and value addition	Work on value addition is being pursued at Mandya and Pusa, Samastipur.
16. PPP mode for seed production and other activities	PPP mode is now being followed for seed production of single cross hybrids *viz*. HQPM 1, HM 8, HM 9, HSC 1, HM 5, Vivek QPM 9, Vivek 33,etc. This route has been followed for base line susceptibility studies as well.
17. High density planting of inbreds and hybrids	Public-bred Hybrids are evaluated under high density planting, selfed and segregating generations advanced for inbred line development. This method is also followed for identifying drought tolerant hybrids.A systematic study has been carried out under which 20-30 single cross hybrids are evaluated under high density. Such an approach has been found effective for identifying drought tolerant Germplasm. This approach has been followed at AICRP centres including DMR.
18. Use of molecular tools in breeding programs	The elite inbred lines(171) comprising normal (114) , Quality Protein Maize (45), 12 specialty corn including Sweet corn, Pop corn, high oil, waxy have

	been finger-printed using SSR markers. Apart from these using 120 SSR markers, additionally 46 inbred lines of which 21 are normal, 14 Quality Protein Maize, 7 Sweet corn, 2 Pop corn and 1 each high oil and waxy have been finger-printed.
19. Visit of DMR scientists to CIMMYT	Dr. Chikkappa G. Karjagi visited CIMMYT, El-Batan, Mexico during 5-16 April, 2010. In two weeks of training He has been exposed to both basic and applied aspects of recent maize improvement strategies viz., mapping of Provitamin A (ProA) trait through association analysis, marker assisted selection for ProA, Quality Protein Maize (QPM), Maize Streak Virus (MSV), integration of phenotypic and molecular information in regular breeding methods (Marker Assisted Recurrent Selection and Genome-wide selection) and genetic and molecular data analysis using different statistical packages/software.
20. Resource effectiveness : Planting of shorter rows , Advancing lines by selfed progeny bulked method	It is being done.
21. Publishing in research journals	DMR has actively worked and are poised for starting 'Maize Journal'
22. Research on maize testers	Testers in use include inbred lines from Karnal, CIMMYT (CMLs), Hyderabad and Ludhiana.CIMMYT QPM lines and Karnal QPM lines were also used in evaluation of inbred lines.
23 New hybrid combinations	Since 2005-6, hundreds of 2-parent combinations were developed and tested for yield and other important traits at DMR and Hyderabad, respectively. Inter-institutional single cross hybrid development program has been initiated under which inbreds contributed from different AICRP centres are involved in crossing program.
24. Basic information	In house projects on basic aspects of maize, *viz. in vitro* studies on anther culture, development of mapping populations, etc, have been initiated with the joining of new breeders/geneticists at DMR.
26. Development of pedigree populations	Efforts have been directed in developing pedigree populations for the extraction of inbred lines. With the joining of new breeders/ geneticists, this activity is expected to be hastened.

27 Superiority of newly developed hybrids	Every year DMR has been conducting trials based on hybrids developed. In such trials yield performance of newly developed hybrids (Public/proprietary) are compared with those released earlier. A comparative assessment of hybrids (20-30 hybrids per season) is undertaken both in *kharif* and *rabi* seasons and superior performing hybrids identified based on yield and other desirable parameters. The parental lines of the released hybrids are evaluated separately.
28 Inbred line development : options in methodology	This is being followed.
29 Line conversion for biotic, abiotic and nutritional traits	Efforts have been directed towards the development/ maintenance of basic infrastructure. hybrid-oriented germplasm (inbred lines) has been evaluated rigorously. Every year, a set of common elite lines (200) are evaluated for biotic and abiotic stress tolerance. The lines are also evaluated for protein, lysine, tryptophan, starch, oil, sugars,etc.
30 To cycle separately between seed parent and pollen parental lines	Being done. Material is in S2/S3 stages.
PHYSIOLOGY	
1. Research on abiotic stresses need to be intensified. More funds should be sought and allocated for this purpose. Stresses worth considering by the program are drought, water logging, nutrient use efficiency, and toxicity to different micro-elements. Breeding for such traits is difficult and demand good field conditions, management skills in handling stress regimes, precision in recording meaningful data, and doing work in season(s) when nature does not interfere with stress regimes. The QRT proposes that one or two sites be selected for each stress for proper screening. In addition, other facilities be developed that are needed to support this research. The QRT is also of the opinion that stress work can be readily accommodated as part of overall inbred hybrid strategy.	■ **Multi-location screening for abiotic stresses** Screening for various abiotic stresses *viz.* drought (Delhi, Hyderabad and Udaipur), Water-logging (Delhi, Dholi) and heat-stress (Delhi, Karnal, Ludhiana and Godhra) was done at 2 or more locations. The facility of rain-out-shelter at Delhi is being used for confirmation studies for identified source of tolerance to drought. ■ **Identification of source of tolerance to abiotic stresses** Based on the multi-location trials following sources of tolerance to various abiotic stresses have been identified **Drought** Hybrids: HQPM 1, HQPM 5, HM 5, Buland, HQPM 7 and Bio 9637 **Inbreds**: LM 14, LM 16, HKI 335, HKI 577, HKI 1532, CM 139, CML 69 **Water-logging** Hybrids: HM 5, Seed Tech 2324, HQPM 1, HQPM 5, HQPM 7, HM 10 and PMH 2

	Heat-stress Hybrids: HQPM 1, HM7, HM 9, PMH1, PMH 2 PMH 3, Buland and Prakash **Inbreds**: HKI 170 (1+2), HKI 325-17AN, LM 17, CA 14514, G18SeqC5F68, G18SeqC5F100
AGRONOMY	
1. Maize programme has enough agronomists at different centers across the country. In addition to routine agronomic experiments, additional responsibility can be assigned in so called related areas of their interest.	New experiments on various agronomic aspects viz. conservation agriculture and crop diversification in maize based cropping systems have been initiated at different centers across the country.
2. Collaboration could be in evaluating lines and hybrids under different densities and fertilizer regimes.	The ongoing trials on Nitrogen X Genotype interaction have been modified as Nutrient X Genotype interaction and experiments on evaluation of different planting densities have also been incorporated in the programme.
3. Their help could also be sought in drought and water logging screening work and perhaps in another pertinent area of addressing researchable issue in seed production of parental lines and hybrids.	Screening of germplasm under Abiotic stress study has been initiated. Experiments on agronomy of seed production of parental lines and hybrids were initiated and are going on.
SEED PRODUCTION	
1. Strengthening of seed production programme	The Centre for seed production (Begusarai) has been fully strengthened to meet rising demand of breeder seed. In this regard, two new scientists have been posted and one yet to join and breeder seed production of productive hybrid (HQPM 1, DHM 117, and HQPM 5) parents were produced as per the indent received.
PATHOLOGY AND NEMATOLOGY	
1. Studies on pathogenic variation in *Peronosclerospora sorghi* need to be initiated and those on *Exserohilum turcicum* intensified by collecting large number of isolates from different locations. Further, work on genetic variation in these pathogens using molecular markers may be	Information on pathogenic variability are available:- basically, *P. sorghi* is a sorghum patho type restricted to Southern India, a maize Patho type in Rajasthan *viz. P. heteropogon*i which infects maize & *Heteropogon contortus* but did not infect sorghum. However, Mandya centre of the AICRIP maize has been asked to undertake studies to revisit the present status of Sorghum Downy Mildew in Maize during the 12th plan. The work on the variability of *E. turcicum* has

undertaken in collaboration with National Research Centre on Plant Biotechnology, IARI, New Delhi.	already commenced at DMR and Maize,Genetics lab, IARI. The studies have revealed pathogenic & genetic variability within same region & also across locations indicating the need for introgressing polygenic resistance in the cultivars against *E. turcicum*.
2. Reliable and authentic information on genetics of resistance to important diseases of maize is very essential so as to give strength to the breeding programmes. In these studies, results can be interpreted with confidence only if the lines used in crosses are definitely resistant or susceptible. Further, availability of well defined isolates/races of the pathogen(s) is a prerequisite for such a study.	Information are already available for genetics of resistance on important diseases like Downy mildews, TLB and efforts are on to work out the mechanism of resistance for other important diseases. Isolates of important Pathogens are being collected and passport data are being generated for these isolates especially *M. phaseolina*, *Fusarium moniliformae*, *Rhizoctonia solani* , storage molds Aspergillus flavus etc.
3. Two diseases, viz. Banded Leaf and Sheath Blight and Post-flowering stalk rots need special attention. Every effort be made to uncover resistance to these diseases.	BLSB *R. solan*i a large no. of genotypes belonging to land races, inbreds etc. have been screened against this disease. No resistant line has been identified. However, recently a few lines *viz.* Gen6033, CML269, 42050-1-1-2-1-1-3 have been identified to be moderately resistant to BLSB. These lines were also found to possess resistance to maydis leaf blight. The screening for resistance to BLSB is a continuous programme to evaluate new genotypes. Besides, characterization of various isolates of *R. solani* on the basis of virulence on different hosts and molecular characterization of *R. solani* are proposed to be undertaken. **PFSR** ❍ Advance maize inbred line developed with resistance against PFSR (Post Flowering Stalk Rots) used to compare these lines with some established elite maize inbred lines to develop a reliable fingerprint for these lines. ❍ Eight resistant lines for Post Flowering Stalk Rots from diverse genetic background identified, developed and evaluated at four identified hot spot location (Hyderabad, Delhi, Udaipur & Ludhiana) during 2006 to 2010. Multiplication of seeds was done at winter nursery Hyderabad during 2011. ❍ Out of eight resistant lines two inbred lines resistant for PFSR were registered with NBPGR and rest is on pipeline.

4. Polysora rust is gaining importance in several pockets. There is a need to initiate work on epidemiological aspects of this rust.	The incidence Polysora rust *Puccinia polysora* is presently confined to Karnatka, Coastoal Andhra Pradesh and Tamilnadu. Resistant sources (inbred donors) have been identified at Nagenhalli & Mandya and resistant genes from these donors have been introgressed in 4 elite parental lines. About 10 promising experimental crosses are under evaluation. The Mandya centre is being asked to initiate the studies on epidemiology of this rust.
5. Effective Integrated Pest Management modules need to be developed against diseases and insect-pests.	Integrated diseases and insect management have been developed and validated for PFSR, MLB, BLSB and TLB. The yield increase over farmer's practice ranged from 11.18-44.2%
6. Work should be initiated on interaction of phytonematodes with soil-borne pathogens (involved in post flowering stalk rot),termites, borer etc.	This work could not be initiated as there is only one nematologist with AICRP(M) programme at MPUAT, Udaipur. The nematologist has been asked to submit a project proposal under Adhoc Scheme in the XII plan on these aspects.
ENTOMOLOGY	
1. Research on breeding for insect pest resistance needs strengthening as recommended by the previous QRT.	Experiment on inheritance of resistance of *Sesamia inferens* has been taken up and studies on *Chilo partellus* are in progress.
2. Studies on biotypes of *Chilo partellus, Atherigona spp.* and *Sesamia inferens* should be carried out on priority basis.	Bioassay of Cry proteins on multiple populations of *C. partellus* and *S. inferens* are in progress which may determine the difference in virulence among the populations.
3. Efforts should be made to correlate occurrence of insect – pests (based on Survey) with various abiotic and biotic factors.	Pest incidences in different zones are being studied.
4. Good work on IPM has been carried out and it should be continued in order to synthesize and develop highly effective IPM modules.	The IPM module developed for maize was validated in five states with up to 31% gain in yield.
5. Current cold room seed storage facilities are inadequate and perhaps in miserable condition at DMR and in other centres. Manpower and resources are wasted in frequent regeneration of	We could not purchase cold storage at any of the centres.

materials. There is always a risk of losing some useful breeding lines because of poor storage conditions. The QRT strongly recommends providing such facilities at least six at six centres in the country in the first phase where most of the research is being carried out. These centres are Delhi, Karnal, Ludhiana, Pantnagar, Hyderabad and Udaipur.	
6. At least one fully equipped functional biochemical laboratory should be established with enough manpower and resources to provide service to breeders. The laboratory should have sufficient capacity to analyze samples from all centres involved in QPM research. Assistance of some scientists who have expertise and experience in QPM research and are biochemists by training could be sought in developing such facility. Norms for type of samples to be analyzed should be agreed upon jointly by breeders and biochemists.	Biochemistry laboratory has been improved and two scientists in biochemistry have been recruited.
7. DMR requirements for additional space for the laboratories are considered favorably. More man power will also have to be hired to perform rapid timely analysis.	Four rooms have been spared by IARI in Cummings Lab. for DMR
8. Shift in winter breeding location from Amberpert to Rajendranagar is very much welcome. This change of course will require additional resources for fencing leveling and digging well for irrigation. The QRT strongly recommends providing funds for developing this facility rapidly so that breeders can get enough land in a timely fashion for planting.	The needful has been done.
9. The QRT feels that separate block of land be allotted to DMR at IARI	Five acre of land have been ear marked for DMR for

for germplasm development, enhancement and seed production. This will greatly facilitate DMR research and experimental work.	whole year and additional 15 acres have been committed during Kharif
OTHERS	
1. The present system of zoning for testing of maize genotypes needs reconsideration. Instead of five zones, there may be only three zones.	No change in zones was accepted by ICAR.
2. The system of promotion for entries and their zone wise testing need to be redesigned. The material promoted in one zone may be tested in other zones to establish superior performance across country.	Germplasm in IET and AET-1st year is being evaluated in all the zones whereas AET-2nd year evaluation is zone specific.
3. The system of coding of entries for testing in AICRP again needs rethinking. During field visits monitoring teams cannot ascertain the exact pedigree of good materials. The Intellectual Property Right (IPR) Act now covers the risk of misusing any breeders' material.	The issue was given second thought and it was considered that the present system of coding protects unbiasedness