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वार्षिक प्रतिवेदन
Annual Report
2011 - 12

मक्का अनुसंधान निदेशालय
पूसा कैम्पस, नई दिल्ली-110012
Directorate of Maize Research
Pusa Campus, New Delhi 110 012

Annual Report

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Directorate of Maize Research
(Indian Council of Agricultural Research)
Pusa Campus, New Delhi 110 012 (India)

वार्षिक प्रतिवेदन
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Front Cover : Specialty Maize and Single Cross Hybrid

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PREFACE

Maize is considered a promising option for diversifying agriculture in various agro climatic zones and ranks as the third most important food crops in India. Maize together with rice and wheat provides at least 30% of the food calories 2 more than 4.5 billion people in 94 developing countries, where maize is the preferred staple. Maize is a major food, feed and fodder crop which contributes to food security in most of the developing countries. It is the most productive cereal characterized by a genetic diversity. India registered a growth rate of more than 7% in production and more than 6% in productivity in last five years. Maize production in India is 21.73 million tonnes with 8.55 million ha with productivity of 2.6 t/ha.

The Directorate of Maize Research has continued to focus its attention on increasing productivity and production of maize in a sustainable manner. Meeting the national challenge of achieving nutritional security for ever increasing population by increasing production and productivity as well as protection of the environment are the constant efforts and accelerating productivity and growth rate of maize in India is DMR's priority. The Directorate of Maize Research has shown the success in multi-location evaluation of agricultural technologies through effective inter-disciplinary approach. Our priorities include mobilization of germplasm resources and free exchange of research data among research workers, review of experimental data, advancing of breeding materials through use of Winter Nursery at Hyderabad, and effective monitoring of field trials besides conducting in house research on applied, strategic & basic research on improved production technologies including management of abiotic and biotic stresses. Emphasis on molecular tools are being employed for analyzing the genetic background as well as diversity of available germplasm. With a continued efforts of research on single cross hybrid across the country has helped in increasing production and productivity of maize. Due to focused research on single cross hybrids, the national average productivity is improving at the rate of >120 kg/ha per annum (2006-2010). Research on crop diversification, intercropping and resource conservation technologies are taken up to improve the farm profitability in maize based cropping systems. Maize AGRI*daksh*, an expert system of maize was developed by DMR in collaboration with Indian Agricultural Statistics Research Institute to disseminate recent advances in maize research to the farmers. We have promoted quality protein maize under nutritional security mission and there is a great response from farmers. The research on QPM is public strength and remarkable seed production and distribution is done in West Bengal covering North Eastern States and Rajasthan covering Northern and Western India. The cultivation of Baby corn, Sweet corn and pop corn under periurban agriculture showed an impact on the farmer's economy living adjacent to urban areas. This has been carried forward to all the farmers across the country.

(R. Sai Kumar)
Project Director
Directorate of Maize Research

विशिष्ट सारांश

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of'od Lrj ij Hkkjr dk eDdk dh [krh oky {k= rFkk mRiknu e Øe'k% pkFkk vkj lkrok LFkku gA Hkkjr e eDdk dh [krh okyk {k=] mRiknu vkj mRikndrk 2010&11 ¼;,lMh,½ e Øe'k% 8-6 fe-g-] 20-5 eh-V- vkj 2-4 V@g- FkA n'kHkj e bdgj ldj.k oky ldj ij dfUnr vul/kku l eDdk d mRiknu vkj mRikndrk dk c<ku e lgk;rk feyh gA

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lL;foKkuh ijh{k.kk e fofHkUu ifjiDork legk d thui:ik dk eY;kdu rhu mojrk Lrjk vFkkr N; P_2O_5: K_2O 100:50:50, 150:65:65, 200:80:80 fd-xk-@g- dh nj l e/;e] vxrh rFkk vfr vxrh ifjiDork dh fLFkfr;k e rFkk mojd Lrjk 150:65:65, 200:80:80 vkj 250:95:95 Lrjk ij iNrh ifjiDork dh fLFkfr e ikp vkpyk ¼tkUl½ e fd, x,A vfr vxrh] vxrh rFkk e/;e ifjiDork oky thui:ik u ik"kd rRok d mPp Lrj d ifr vufØ;k n'kkb] tcfd iNrh ifjiDork oky thii:ik e e/;e ik"kd rRok d Lrj d fo#) mYy[kuh; vufØ;k n'kkb tk fofHkUu vkpyk e dkQh fHkUu ikb xbA lokf/kd vufØ;k vkpy ¼tku½ I vkj ¼tku½ III e fjdkM dh xbA

dy 9 jkxfoKkuh ijh{k.kk e 266 eDdk thui:ik vkj 30 D;ih,e thui:ik dk eY;kdu eDdk d fofHkUu jkxk d fo#) eY;kdu d fy, fd;k x;kA ,bVh voLFkkvk e bue l dN vk'kktud o'kØe ,Q,p 3554] lh,e,p 08&287] , 7501] ,Dl 8ch 562] b,pD;&16] lh,e,p08&433] t,p 31404] ;ojkt xkYM td,e,p&7004] ,u,e,p&920] chihlh,p6 ¼iki dku½] ,Dl8ch691] ,e,e,p&09&4 FkA Vh,ych] ,e,ych] ch,y,lch vkj ,lMh,e d dkj.k mit e gku okyh {kfr dk eY;kdu vjHkkoh] fnYyh] iruxj vkj dk;EcVj e] tcfd ih,-Q,l-vkj- d fy, fnYyh vkj gnjkckn e fd, x,A ,lMh,e l dk;EcVj e lokf/kd mit {kfr ¼54-95 ifr'kr½ gbA

o"k 2011&12 d nkjku dhVfoKkuh ijh{k.kk d vUrxr Ñf=e lØe.k dh voLFkk e *dkbyk ikVyl* d fo#) ifrjk/k d fy, 132 ifof"V;k rFkk 202 vUrjitfur o'kØek dk eY;kdu fd;k x;kA dy 202 vUrjitfur o'kØek e l 10 lcl de lonh(191 e/;e nt d lonh rFkk 1 lonh ik, x,A 10 vkj 25

Mh, th ij er gV vkj iRrh {kfr lc/kh ifjo{k.kk l ;g inf'kr gvk fd chtk dk mipkj d 14 fnuk ckn ck fn;k tkuk pkfg, vkj fdlh Hkh gkyr e 21 fnuk dh vof/k e rk ck gh fn;k tkuk pkfg,A ;g Hkh n[kk x;k fd uk'kdthok dk iHkko 4 fnu rd jgrk g ftld i'pkr yko ik/kk dk {kfr igpku e l{ke gk tkr gA

vul/kku miyfC/k;k

ituu e ie[k vul/kku {k= bdgj ldj.k oky ldjk dk fodkl gA iNrh vkj e/;e ifjiDork leg e 100 vUrjitfur o'kØek dk eY;kdu fd;k x;k rFkk nk ijh{kd ch,e,y 6 vkj ch,e,y 7 dk mi;kx djd [kjhQ 2011 e 1846 ldj djku d i;kl fd, x,A vxrh eDdk e] 235 o'kØe vujf{kr fd, x, rFkk 129 bdgj ldj djk, x,A iorh; vxrh ihy ¼,pbokb½ iy l 40 o'kØe pu x, ftUg o'kØe foiFku d S1 pØ d :i e vkx c<k;k x;kA dku lc/kh fo'k"k igy d vUrxr D;ih,e vUrjitudk] uker¼ Mh,evkjD;ih,e 58] Mh,evkjD;ih,e 103] Mh,evkjD;ih,e 102 vkj Mh,evkjD;ih,e 58 u vc rd dh loJ"B fdLe ;k pd ¼,pdvkb 161½ dh ryuk e J"Brk inf'kr dhA jch 2011&12 d nkjku 117 D;ih,e bdgj ldj.k oky ldjk d lkFk ,d ikjfHkd mit ijh{k.k fd;k x;kA LohV dku rFkk iki dku d 767 tuun0;k dk eY;kdu fd;k x;k] puk x;k ¼204 LohV dku(121 iki dku½ vkj mUg vujf{kr fd;k x;kA tuun0; dk c<ku d fy, fgekpy in'k l iki dku d 10 tuun0;k dk ldyu fd;k x;kA rhl ¼30½ lokPp ldjk ¼eknk rFkk ijkxd d :i e mPp ry oky o'kØe d :i e J"B ldj½ dk vktek;k x;kA ; ldj bdgj ldj l;kxk dh ryuk e J"B FkA vok;oh; ifrcy ituu dh fn'kk e i;kl fd, tk jg gA jch 2011&12 e BM i;koj.k e vxrh fodkl l lcf/kr ijh{k.kk d fy, 85 ldjk rFkk 40 iFkDddkjd tul[;kvk dh NVkb dh xbA dN vUrjitud uker¼ ,pdvkb 1128] lh,e,y 169] lh,e,y 186 vkj ,y,e 5 ryuh; fdLe ¼,pdvkb 193&2½ dh vi{kk J"B ik, x,A l[kk dh nk uktd voLFkkvk ¼i"iu d io rFkk vfUre voLFkk e ifrcy½ e ikjfHkd tuun0; dh NVkb dh xbA

tuun0; vuj{k.k d vUrxr jk"Vh; ikni vkuof'kd llk/ku C;jk l ikIr 319 Hk&itkfr;k] 170 vUrjituu o'kØek lfgr 8362 tuun0;k vkj 1665 D;ih,e o 962 lkekU; o'kØek dk 'kjndkyhu uljh dUn] gnjkckn e fu;f=r ijkx.k d ek/;e l j[kk x;k@vkx c<k;k x;kA bld vfrfjDr vf[ky Hkkjrh; lefUor vul/kku ifj;ktuk@lkotfud vul/kku dUnk d lkFk 644 eDdk vUrjitfur ldjk rFkk 632 u, ldjk dh Hkkxhnkjh dh xbA vkj,evkj vkj ,lihlh] cxljk; e ,pD;ih,e&1 rFkk Mh,p,e 117 ldjk d iot o'kØe vx ifDr d in'kuk d fy, n'k d fofHkUu Hkkxk e vkir fd, x,A Ñf"k ,o lgdkfjrk foHkkx ¼Mh,lh] Ñf"k e=ky;½ d ek/;e l dy 193-20 fDoVy itud cht dh ekx ikIr gbA bl ekx dk n[kr g, 169-59 fDoVy cht mRiUu fd;k x;kA

nk ih,Q,lvkj ifrjk/kh o'kØek] nk xykch Nnd ifrjk/k] iR;d ,d iki dku d fy,] mPPk ry vkj pkj l[kk lfg".k lfgr eDdk d nl vUrjitud o'kØek dk jk"Vh; ikni vkuof'kd llk/ku C;jk e ithÑr fd;k x;kA ub J.kh d vUrxr rhu ldjk uker¼ ,pD;ih,e&5] ,p,e&9 vkj ekyoh; gkbfcM 2] ikp ldjk vkj lkr ldyk dk fo|eku J.kh d vUrxr ithÑr fd;k x;k gA bu thui:ik dk mPp mit] jkx vkj uk'kdtho ifrjk/k d fy, lkekU; rFkk fo'k"k dku ldjk d fodkl gr n'k d fofHkUu dUnk dk vkir fd;k tk,xkA [kjhQ 2011 d nkjku fnYyh vkj gnjkckn] nk LFkkuk e 21 ldjk rFkk 3 vUrjitudk ij Mh;,l ijh{k.k fd;k x;kA

o"k 2011&12 d nkjku fofHkUu lkrk l ikIr 2500 l vf/kd ueuk dk ikVhu] fVIVkQu] ykblhu] ry] 'kdjk] djkfVuk;Mk] β&djkVhu vkfn dk fo'y"k.k vk'kktud fdLek d p;u vkj igpku gr fd;k x;kA

lL;foKku d vUrxr lj{k.k trkb e [kr vul/kku i;kx fd, x, ftud vUrxr eDdk&xg&ex l lokPp vUu mit ikIr gb ftld i'pkr eDdk&lLcfu;k Qly i.kkyh dk LFkku FkkA Qyhnkj Qlyk dk

'kkfey dju l enk thon0; e ik"kd rRok dh vkifr o l{ethok dh fØ;k'khyrk iHkkfor gkrh g vkj bl idkj ioorh eDdk dh Qly dh nkuk mit e l/kkj gkrk gA flfpr fLFkfr;k d vUrxr Qly T;kfer vkj mojrk d Lrjk d vUrjfØ;k'khy iHkko d fy, i.k ekle d eDdk thui:ik d eY;kdu l ;g inf'kr gvk fd ifr gDVj 66]000 ik/kk d lkFk 250:90:90 d mojrk Lrjk d ifj.kkeLo:i eDdk dh lokPp nkuk mit gkrh gA lefdr [kjirokj ic/k ijh{k.k e vdj.k d io 1-0 fd-xk- l-r@g- ,Vkthu vkj vdj.k d io 0-25 fd-xk- l-r-@g- eVhC;tu d mi;kx l [kjirokjk d fu;=.k d mik;k d fcuk ikIr gku okyh mit dh ryuk e mYy[kuh; :i l mPp mit ikIr gkrh gA dkf;dh; mi;kxk e eDdk ij l[kk vkj mPp rkieku d iHkko dk v/;;u fd;k tk jgk gA o"k 2011 e mPp rkieku d vUrxr [kr fLFkfr;k e 20 vUrjitud o'kØek rFkk 5 F_1 dk eY;kdu fd;k x;kA Ng ¼6½ vUrjitud o'kØek ,y,e 17] ,pdvkb 577] ,pdvkb 1532] ,pdvkb 170 ¼1 $ 2½] ,pdvkb 325&17,,u rFkk lh,vkb 4514 u fuEu ,,lvkb d lkFk mPp rkieku d ifr lfg".krk d lkr dh if"V dh vkj bue oYyjk e de QVko gvk rFkk mPp nkuk mit ikIr gbA l[kk lc/kh i;kxk e 12 vUrjitud o'kØek ¼,pdvkb 209] ,pdvkb 325&17,,u] ,pdvkb 335] ,pdvkb 577] ,pdvkb 1532] lh,e 139] ,y,e 16] ,y,e 17] chtvkb,e 08&27] chtvkb,e 10&36] MhVhihokblh 9 ,Q 119 vkj lh, 14514½ u l[kk vudyu lc/kh x.k inf'kr fd,A

ikni c<okj dh fofHkUu voLFkkvk ¼vdj.k d 10] 15] 20] 25 fnu ckn½ eDdk d ruk o/kd ¼*dkbyk ikVyl*½ d fo#) ifrjk/k d fy, eDdk d 17 vUrjitudk dh NVkb dh xbA {kfr ikpyk d vk/kkj ij vUrjitudk ,pdvkb 577 vkj ,pdvkb 323 u ifrjkf/krk inf'kr dhA vUrjitudk d blh lV d fy, ,pih,ylh&ihMh, }kjk fQukfyd vEyk vFkkr Qjkfyd vkj ih&dkmefjd vEyk dk ek=kRed fu/kkj.k fd;k x;kA vUrjitudk e bu vEyk dk v'k *lh- ikVyl* dh iRrh {kfr nj l udkjkRed :i l lcf/kr ik;k x;kA jch 2011&12 ekle d nkjku MCY;,ulh] gnjkckn e *llfe;k bUQjl* d fo#) 202 vUrjitudk dk eY;kdu fd;k x;kA nk o'kØe uker¼ MCY;,utMihchVh,y 6 o b57ch xykch o/kd d ifr lonu'khy ik, x,A

jkxfoKku d vUrxr fofHkUu vkuof'kd i"BHkfe;k l ih,Q,lvkj d fy, 8 ifrjk/kh o'kØek dh pkj gkV LikV LFkyk e igpku dh xb] mUg fodflr fd;k x;k rFkk mudk eY;kdu fd;k x;kA Hkkjr d eDdk dh [krh oky fofHkUu {k=k l ,*e- Qfl;kfyuk* vkj ,*Q- oVhlhyk;Ml* d iFkDdjk ¼vkblkyVl½ d vkf.od y{k.ko.ku ij v/;;u fd, x,A ,QykVkfDlu ln"k.k d ifrjk/kh lkrk dk irk yxku d fy, eDdk d nku d eY;kdu gr Ñf=e lpj.k ¼bukDy'ku½ fLFkfr;k d vUrxr i;kx'kkyk e dy 45 dku thui:ik ¼27 vUrjitud o'kØek] 6 ldjk vkj 12 iyk½ dk ijh{k.k fd;k x;kA $AFB_1 < 20$ ppb, tk eu";k d fy, vueR; lhek g] d in'ku d dkj.k 15 vUrjitud o'kØek rFkk 3 iy dk vk'kktud ik;k x;kA [kjhQ 2011 d nkjku gkV LikV LFkyk ij Ñf=e bihQkbVkfVd fLFkfr;k d vUrxr ie[k jkxk d fo#) dy 224 J"B o'kØek dk eY;kdu fd;k x;kA bue l 2 o'kØe Vh,ych d fo#)] 31 ,e,ych d fo#)] 3 ch,y,lch ¼,evkj½ 56 ch,lMh,e d fo#)] 64 ih,Q,lvkj d fo#)] 2 ih- jrvk d fo#)] 57 vkjMh,e d fo#)] 25 b,lvkj d fo#) rFkk 35 lh,y,l d fo#) ifrjk/kh ik, x,A Mh;,l fn'kkfun'kk d vulkj 86 o'kØek d vkÑfrfoKkuh x.k fjdkM fd, x,A

eDdk lc/kh lpuk dk lcy cuku] ml ifj'kkf/kr dju rFkk mi;kxdrkvk rd igpku d fy, ,d vku&ykbu fo'k"kK i.kkyh Maize AGRI*daksh* vkjHk dh xb gA eDdk l lcf/kr lpuk] fdLek] [kjirokjk] jkxk rFkk ik"kf.kd xMcMh lc/kh fp=k dk i.kkyh d Kku vk/kkj e v|ru fd;k x;k gA eDdk mRiknu ik|kfxfd;k dk viuku e rth yku d fy, eDdk vul/kku fun'kky; u n'k d eDdk dh [krh dh ie[krk oky jkT;k e in'ku vk;kftr fd, gA eDdk vul/kku fun'kky; u Hkkjr d 10 l vf/kd jkT;k e yxHkx 8000 ,Q,yMh dk leUo;u fd;k gA vkfnoklh fdlkuk dk if'k{k.k ndj] in'ku vk;kftr djd o fuo'kk d forj.k }kjk jk"Vh; vkj {k=h; Lrj ij Hkk-Ñ-v-i- dh vkfnoklh mi ifj;ktuk dh 'k#vkr dh xb g rFkk bldh lQyrk d fy, li.k i;kl fd, tk jg gA

EXECUTIVE SUMMARY

Maize (*Zea mays* L.) is the most versatile crop with wider adaptability and highest genetic yield potential among the food grain crops. It is an important cereal crop in world after wheat and rice. The importance of maize lies in its wide industrial applications besides serving as human food and animal feed. As the demand for maize is growing globally due to its multiple uses for food, feed and industrial sectors there is need to produce more from same or even less resources. New production technologies offer great promise for increasing productivity to meet the growing demands of consumers. For decades, corn growers have worked for continuous improvement and greater efficiency.

At global level, India ranks 4th in area and 7th in production of maize. The area, production and productivity of maize in India are 8.6mha, 20.5mt and 2.4t/ha, respectively in 2010-11 (USDA). Focused research on single cross hybrid across the country has helped in increasing production and productivity of maize.

AICRP

Under co-ordinated research, six hybrids for different agro-climatic conditions of the country were released by Central Sub-Committee on Crop Standards, Notification and Release of Varieties. Among these, two late and two medium maturity hybrids were identified for *kharif* and two for *rabi*. These hybrids belong to private sectors developed with the active support of Directorate of Maize Research. In AICRP (*kharif* 2011-12), 238 entries were tested against 27 checks in 45 breeding trials. Of these, 122 entries were contributed by public sector and 116 entries by private sector. Five coordinating trials were constituted for testing yield superiority across 19 locations in *rabi* 2011-12.

In agronomy trials , the genotypes of different maturity groups were evaluated under three fertility levels *i.e.* N: P2O5: K2O 100:50:50, 150:65:65, 200:80:80 kg/ha, in medium, early and extra early maturity while in late maturity the fertility levels were 150:65:65, 200:80:80 and 250: 95: 95 in all the five zones. The extra early, early and medium maturity genotypes responded to high nutrient levels whereas late maturity genotypes significantly responded to medium nutrient levels which varied greatly between the zones. Maximum response was recorded in Zone I and III.

A total of 266 maize genotypes and 30 QPM genotypes in nine pathology trials were evaluated against different maize diseases. Out of them some promising lines in AET stages were FH 3554, CMH08-287, A 7501, X8B562, EHQ-16, CMH08-433, JH 31404, YUVRAJ GOLD JKMH-7004, NMH-920, BPCH6 (Popcorn), X8B691, MMH-09-4. Assessment of yield losses due to TLB, MLB, BLSB and SDM were conducted at Arabhavi, Delhi, Pantnagar and Coimbatore whereas for PFSR at Delhi and Hyderabad. SDM cause maximum yield loss (54.95%) at Coimbatore.

During the year 2011-12, 132 accessions and 202 inbred lines were evaluated for resistance against *Chilo partellus* under artificial infestation in entomology trials. Out of 202 inbred lines, 10 were least susceptible; 191 moderately susceptible and one completely susceptible. Plant infestation, dead heart and leaf injury observations at 10 and 25 days after germination showed that the seed must be sown

preferably within 14 days of treatment but certainly not later than 21 days. It was also observed that the impact of pesticide remains for 4 days after which the larvae causes damage to the plant.

Research Achievements

The major research area in breeding is single cross hybrid development in maize. In late and medium maturity group 100 inbred lines were evaluated and 1846 crosses were attempted in *kharif* 2011 using two testers BML 6 and BML 7. In early maize, 235 lines were maintained and 129 single crosses were made. From Hill Early Yellow (HEY) pool, 40 lines were selected for advancement as S1 cycle of lines derivation. Under specialty corn initiative, the QPM inbreds DMRQPM 58, DMRQPM 103, DMRQPM 102 and DMRQPM 58 showed superiority over best check (HKI 161). A preliminary yield trial was conducted with 117 QPM single cross hybrids in *rabi* 2011-12. 767 germplasm of sweet corn and pop corn were evaluated and selected (204 sweet corn; 121 pop corn) and maintained. Pop corn collection of 10 germplasm from Himachal Pradesh was done for germplasm enhancement. Thirty top crosses (elite hybrid as female and high oil line as pollinator) were attempted. These crosses were superior over single cross combinations. Efforts are also being made in abiotic stress breeding. In *rabi* 2011-12, 120 inbreds, 85 hybrids and 40 segregating populations were screened for traits related to early development in cold environment. Few inbreds *viz*., HKI 1128, CML 169, CML 186 and LM 5 were found to be superior over best check (HKI 193-2). Preliminary germpalsm screening in two critical stages (pre flowering and terminal stress) of drought was initiated.

During 2011-12, more than 2500 samples received from different sources were analyzed for protein, tryptophan, lysine, oil, sugar, carotenoids and β-carotene *etc* for selection and identification of promising lines.

Germplasm maintenance of 8362 genotypes including 319 land races, 170 inbred lines from NBPGR, 1665 QPM and 962 normal lines were maintained /advanced through controlled pollination at Winter Nursery Centre, Hyderabad. Also distribution and sharing of 644 maize inbreds and 632 introductions to AICRP/public research centres was carried. Parental lines of HQPM 1 and DHM 117 hybrids were produced at RMR&SPC, Begusarai to be supplied to various parts of the country for Front Line Demonstrations. A total of 193.20 quintals of breeder seed was indented through Department of Agriculture and Cooperation (Ministry of Agriculture). The indent was honoured and 169.59 quintals of seed was produced.

Ten inbred lines of maize including two PFSR resistant lines, two for pink borer resistance, one each for pop corn, high oil and four for drought tolerance were registered with NBPGR. Three hybrids under new category namely HQPM 5, HM 9 and Malviya Hybrid 2, five hybrids and seven composites under extant category have also been registered. These genotypes will be supplied to different centers of the country for the development of high yielding, disease and pest resistant, normal and specialty corn hybrids. During *kharif* 2011, DUS test was conducted on 21 hybrids and 3 inbreds at two locations Delhi and Hyderabad.

In agronomy, field research experiments were carried out in conservation tillage. Maximum grain yield was given by maize-wheat-mung bean closely followed by maize-sesbania cropping system. The inclusion of legumes influences nutrient supply, microbial activity and soil biomass thereby increasing

grain yield of preceeding maize crop. Under irrigated conditions evaluation of late maturing maize genotypes for interactive effect of plant geometry and fertility levels showed that the application of 250:90:90 with 66,000 plants per hectare resulted in highest grain yield. In Integrated Weed Management trial, the treatment of Atrazine 1.0kg a.i/ha pre-emergence and Metribuzen 0.25kg a.i./ha as pre-emergence gave significantly higher yield over weedy check. In Physiology experiments, the effect of drought and high temperature on maize was studied. Twenty inbred lines and five F1s were evaluated under field conditions in high temperature of 2011. Six inbred lines *viz*., LM 17, HKI 577, HKI 1532, HKI 170 (1+2), HKI 325-17AN and CA 14514 showed confirmed source of tolerance to high temperature with low ASI, less tassel blasting and comparatively higher grain yield. In drought experiments, 12 inbred lines (HKI 209, HKI 325-17AN, HKI 335, HKI 577, HKI 1532, CM 139, LM 16, LM 17, BJIM 08-27, BJIM 10-36, DTPY C9F119 and CA 14514) exhibited drought adaptive traits.

Seventeen maize inbreds were screened for resistance to maize stem borer (*Chilo partellus*) at different plant growth stages (10, 15, 20, 25 days after germination). Inbreds HKI 577 and HKI 323 showed resistance based on damage parameters. Also, phenolic acids *i.e.*, ferulic and p-coumaric acids were quantified by HPLC-PDA for same set of inbreds. The content of these acids in inbreds was negatively correlated with Leaf Injury Rating of *C. partellus*. During *rabi* 2011-12 season, 202 inbreds were evaluated against *Sesamia inferens* in WNC, Hyderabad. Two lines *viz*., WNZPBTL6, E57B were least susceptible to pink borer.

In pathology, 8 resistant lines for PFSR from diverse genetic background were identified, developed and evaluated at four hot spot location. Study of molecular characterization of isolates of *Macrophomina phaseolina* and *Fusarium verticilloides* obtained from different maize growing areas of India was done. A total of 45 corn genotypes (27 inbred lines, 6 hybrids and 12 pools) were tested in laboratory under artificial inoculated conditions for kernel assay to find out resistant sources to aflatoxin contamination. 15 inbred lines and 3 pools were found promising by showing AFB1 < 20 ppb which is permissible limit for human beings. A total of 224 elite lines were evaluated against major diseases under artificial epiphytotic conditions at hot spot locations during *kharif* 2011 *viz*., Out of them 2 lines were found resistant against TLB, 31 against MLB, 3 against BLSB (MR), 56 against BSDM, 64 against PFSR, 2 against *Polysora* rust, 57 against RDM, 25 against ESR, 35 against CLS. Morphological characters of 86 lines were recorded as per DUS guidelines.

For strengthening, refinement and dissemination of maize information to the users an online expert system Maize AGRI*daksh* has been launched. The information and images of varieties, weeds, diseases, and nutritional disorder of maize is updated in the knowledge base of the system. Inorder to accelerate adoption of maize production technologies, DMR conducted demonstrations in maize dominated states of the country. DMR co-ordinated nearly 8000 FLDs covering more than ten states of India. Initiation of Tribal Sub Plan of ICAR at National and Regional levels by conducting trainings, demonstrations and input distribution to tribal farmers with full effort.

The Directorate

THE DIRECTORATE

Maize is an important cereal crop in India owing to its varied utilization as feed, food and industrial products. In 1957, with the motive of intensifying maize research, All India Coordinated Research Project (AICRP) Maize was initiated. AICRP (Maize) is the oldest co-ordinated research system in India for varietal testing across different agro-climatic zones. It was upgraded to Directorate of Maize Research (DMR) in January 1994 located at New Delhi to increase the production and productivity of maize in the country. Mandate of DMR is to organize, conduct, coordinate and generate improved maize technology for continuous enhancement of maize productivity.

MISSION

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

VISION

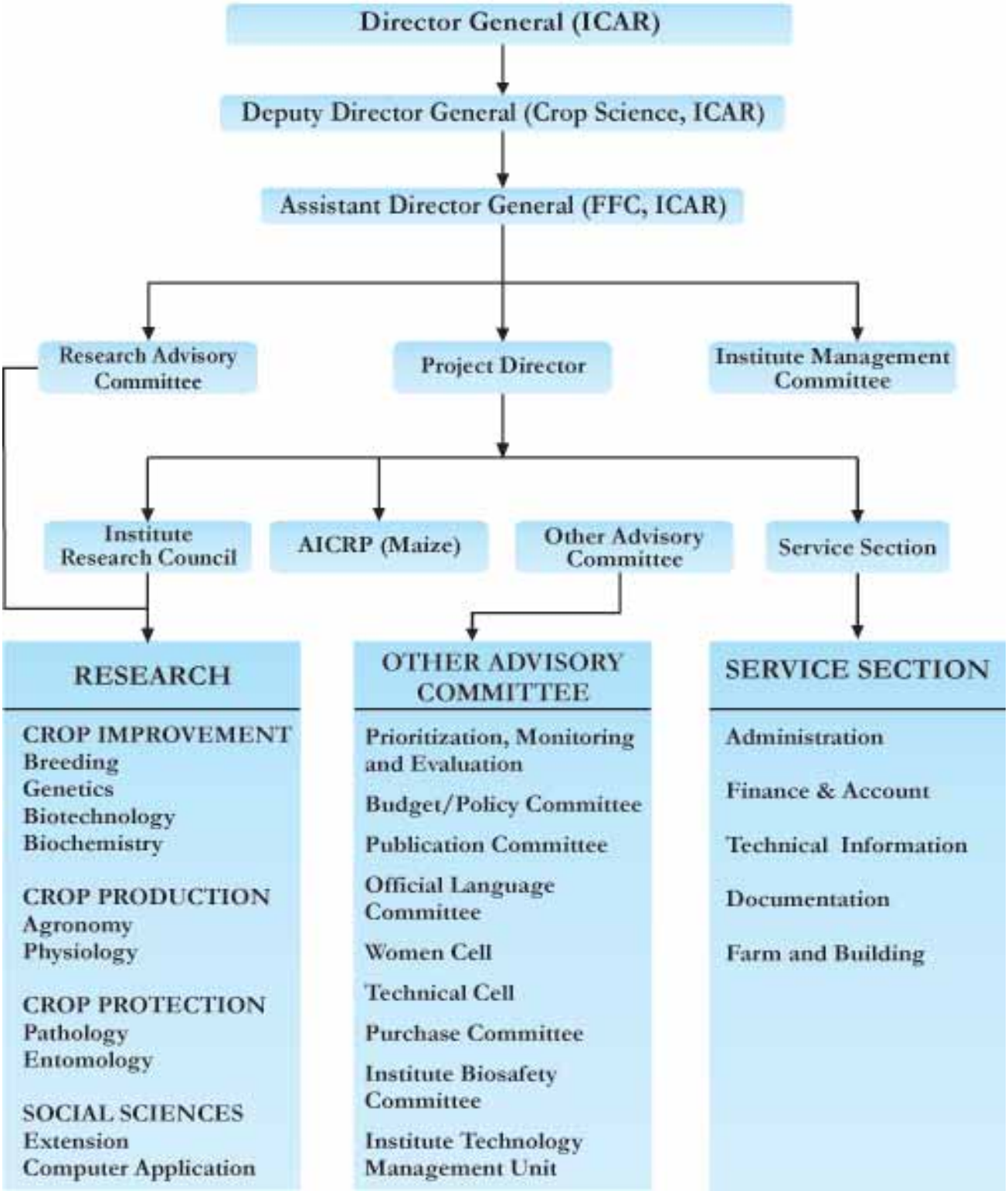
To bring about a rapid growth in the food, feed and industrial application of maize and maize based products, leading to generation of wealth, employment in farming and industrial sector, that would usher in prosperity for all those who are directly or indirectly associated with maize cultivation and utilization.

MANDATE

As food for man and feed for animals, maize is one of the most important crops in India and world agricultural economy. It has highest yield potential than any other food cereal. To meet the increasing demand several measures are to be taken with the following mandate:

- *To carry out basic, strategic, contractual and applied research aimed at enhancement of quality and productivity through collaborating with national and international research organizations.*
- *To serve as a core centre for making availability of germplasm and provide consultancy services.*
- *To conduct, coordinate multi-disciplinary and multi-location research to develop, identify and transfer ecologically sound and economically viable maize technologies for varied agro-ecosystem.*

ORGANOGRAM


Director General (ICAR)
Deputy Director General (Crop Science, ICAR)
Assistant Director General (FFC, ICAR)
Research Advisory Committee
Project Director
Institute Management Committee
Institute Research Council
AICRP (Maize)
Other Advisory Committee
Service Section
RESEARCH
CROP IMPROVEMENT
Breeding
Genetics
Biotechnology
Biochemistry
CROP PRODUCTION
Agronomy
Physiology
CROP PROTECTION
Pathology
Entomology
SOCIAL SCIENCES
Extension
Computer Application
OTHER ADVISORY COMMITTEE
Prioritization, Monitoring and Evaluation
Budget/Policy Committee
Publication Committee
Official Language Committee
Women Cell
Technical Cell
Purchase Committee
Institute Biosafety Committee
Institute Technology Management Unit
SERVICE SECTION
Administration
Finance & Account
Technical Information
Documentation
Farm and Building

Present Scenario

Maize has the highest genetic potential, production and productivity among the cereal crops. Presently, India ranks 4th in area and 7th in production of maize at world level. As per the latest reports by USDA; the area, production and productivity of maize in India is 8.6mha, 20.5mt and 2.4t/ha, respectively in 2010-11. The present growth rate in maize production (8.94%) is much more than its consumption of around 5%. The focused research on single cross hybrid across the country has helped in increasing production and productivity of maize. Cultivation of single cross hybrids has become relatively more remunerative leading to expansion in non-traditional areas. India has great potential to export grain, feed, seed and specialty corn due to low cost of production and less freight charges. Biotechnology and improved package of practices in different ecological regions of the country has contributed significantly in achieving higher production levels. Thus, India is now net exporter with annual export of 2.5-3.0 mt since 2008-09.

Organisational Structure

Directorate of Maize Research is primarily crop based institute working under the umbrella of the Indian Council of Agricultural Research The Directorate of Maize Research with its head quarter in New Delhi carries out its research under four divisions/sections *viz*., Crop Improvement, Crop Production, Crop Protection and Social Sciences. Directorate research activities are planned under the guidance of Research Advisory Committee and Institute Management Committee while the progress is critically evaluated by the Quinquiennial Review Team. 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 significantly the off-season and seed production requirements of DMR.

STAFF

Staff position of the Directorate as on March 31, 2012

S. No.	Type of Posts	Existing		Vacant*	Additional**	Total	
		Approved by D/o expenditure	In position			Sanctioned + Additional	Existing + Additional
1	Scientific	40	29	11	4	44	33
2	Technical	13	5	8	9	22	14
3	Administrative	13	4	9	3	16	7
4	Auxiliary			0			
5	Supporting	4	3	1	6	10	9
	Total	**70**	**41**	**29**	**22**	**92**	**63**

*The vacant posts are under process of recruitment

**The posts are approved in X and XI plan but not created

BUDGET

Financial Statement 2011-2012

Sanctioned Budget (Rs. in Lakhs)2011-2012					Expenditure (Rs. in Lakhs)			
Head of Account	**Plan**	**Non-Plan**	**AICRIP on Maize**	**Total**	**Plan**	**Non-Plan**	**AICRIP on Maize**	**Total**
Establishment	-	310.00	1326.00	1636.00	-	288.93	1329.00	1617.93
OTA	-	0.50	-	0.50	-	0.35	-	0.35
TA	8.80	3.50	25.00	37.30	8.80	3.49	23.00	35.29
Rec. Conti.	262.20	155.00	165.00	582.20	262.20	159.95	164.00	586.15
Minor Works	14.00	5.00	-	19.00	14.00	3.96	-	17.96
Equipment	86.00	15.00	-	101.00	86.00	15.38	-	101.38
Other Items/HRD	4.00	-	-	4.00	4.00	-	-	4.00
Total	**375.00**	**489.00**	**1516.00**	**2380.00**	**375.00**	**472.06**	**1516.00**	**2363.06**

Resource Generation

Particulars	Rs. (in Lakh)
Sale of farm produce	22.40
Sale of publications and tender form	-
Standard License Fee	1.66
Analytical and Testing Fee	15.17
Receipts form Services Rendered	-
Interest earned on short term deposits	5.60
Income generated from IRG	0.22
Training Miscellaneous receipts	4.43
Total	**52.86**

Funds Received for Externally Funded Projects

Particulars	Rs. (in Lakh)
AP Cess fund scheme	-
FLD	207.00
DUS Testing	8.84
Transgenic Project	5.83
IPR	5.24
Total	**226.91**

Research Achievements

I. AICRP

II. Research highlights

- Crop Improvement
- Crop Production
- Crop Protection
- Social Sciences

ALL INDIA COORDINATED RESEARCH PROJECT (Maize)

All India Coordinated Research Project (AICRP) on maize was launched in 1957 with the objective to develop and disseminate genetically superior cultivars and production/protection technologies. AICRP organizes interdisciplinary, inter-institutional, co-operative and systematic testing of newly developed cultivars of both public and private sectors for different agro-climatic zones of the country. The project resulted in refining efforts in varietal improvement. Since 1961, a total number of 187 cultivars including single cross hybrids, composites and multiple parent crosses have been released nationwide.

In India, maize is traditionally grown in monsoon (*Kharif*) season, which is accompanied by high temperature (<35° C) and rainfall. However, with the development of new cultivars and appropriate production technology, winter cultivation of maize has emerged as a viable alternative. Based on maize agroclimatic conditions, country has been demarcated into five zones (Fig. 1) constituting 29 centres (Table 1) for varietal testing in AICRP (Maize).

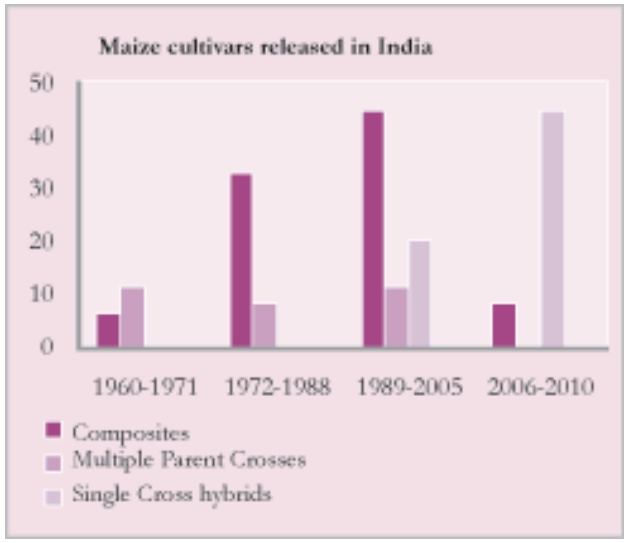


Table 1. Locations and soil characteristics of the various AICRIP Maize Research Centres at Directorate of Maize Research

Zone	States	Centres	Latitude (⁰N)	Longitude (⁰E)	Altitude (amsl)	Soil Type
Zone 1	Himachal Pradesh	CSK, HPKV - Bajaura	32.2	77.0	1090	Sandy loam
		CSK, HPKV - Kangra	32.6	76.16	2404	Light texture
	Jammu and Kashmir	SKUAST&T (J) Jammu - Udhampur	32.55	75.1	2480	Sandy loam
		SKUAST&T (K) Srinagar - Poonch	34.06	74.51	1652	Silty clay loam
	Uttarakhand	VPKAS - Almora	29.36	79.40	1250	Clay loam
	North eastern States	ICAR Research Complex for NEH region - Barapani	25.38	91.52	850	Sandy loam
		AAU, Assam - Gossaigaon	26.46	94.16	91	Sandy loam

Zone	States	Centres	Latitude (⁰N)	Longitude (⁰E)	Altitude (amsl)	Soil Type
Zone II	Punjab	PAU - Ludhiana	30.45	75.40	247	Sandy, clay loam
	Haryana	CCS, HAU - Karnal, Uchani	29.43	76.58	245	Clay loam
	Delhi	DMR, IARI - Delhi	28.38	77.12	228.1	Loam to sandy loam
	Uttar Pradesh	CSAU & T - Kanpur	26.28	80.40	125.9	Sandy loam
	Uttarakhand	Pantnagar	29.0	79.3	243.8	Clay loam
Zone III	Bihar	RAU - Dholi	25.59	85.75	51.8	Sandy loam
	Jharkhand	BAU - Ranchi	23.31	85.31	652	Sandy loam
	Orissa	OUAT - Bhubaneswar	21.15	85.15	45	Clay loam
	Eastern Uttar Pradesh	BHU - Varanasi	25.20	83.0	128.93	Sandy loam
		NDUA & T, Bahraich	27.34	81.36	130	Sandy loam
Zone IV	Karnataka	UAS, Bangalore - Mandya	12	76	695	Light red sandy loam
		UAS, Dharwad - Arbhavi	16.12	74.54	640	Medium black
	Andhra Pradesh	ANGRAU - Hyderabad	17.2	78.3	530	Black Clay loam
		ANGRAU - Karimnagar	18.25	79.9	869	Red sandy-loamy
	Tamil Nadu	TNAU - Coimbatore	11.0	77.0	411.5	Black
		TNAU - Vagarai	10.4	77.5	926	Black
	Maharashtra	Kolhapur	16.43	74.14	574	Light to medium black
Zone V	Rajasthan	MPUA&T - Banswara	23.5	73.58	218	Pleustertt
		MPUA&T - Udaipur	24.55	73.41	572	Loam to sandy loam
	Gujarat	AAU - Godhra	22.45	77.40	119.4	Sandy loam
	Madhya Pradesh	JNKVV - Chhindwara	21.28	78.10-79.24	682	Medium clay
		RVSKVV - Jhabua	22.7	74.6	318	Clayey to Sandy
	Chattisgarh	Ambikapur	23.7	83.12	1978	Sandy loam

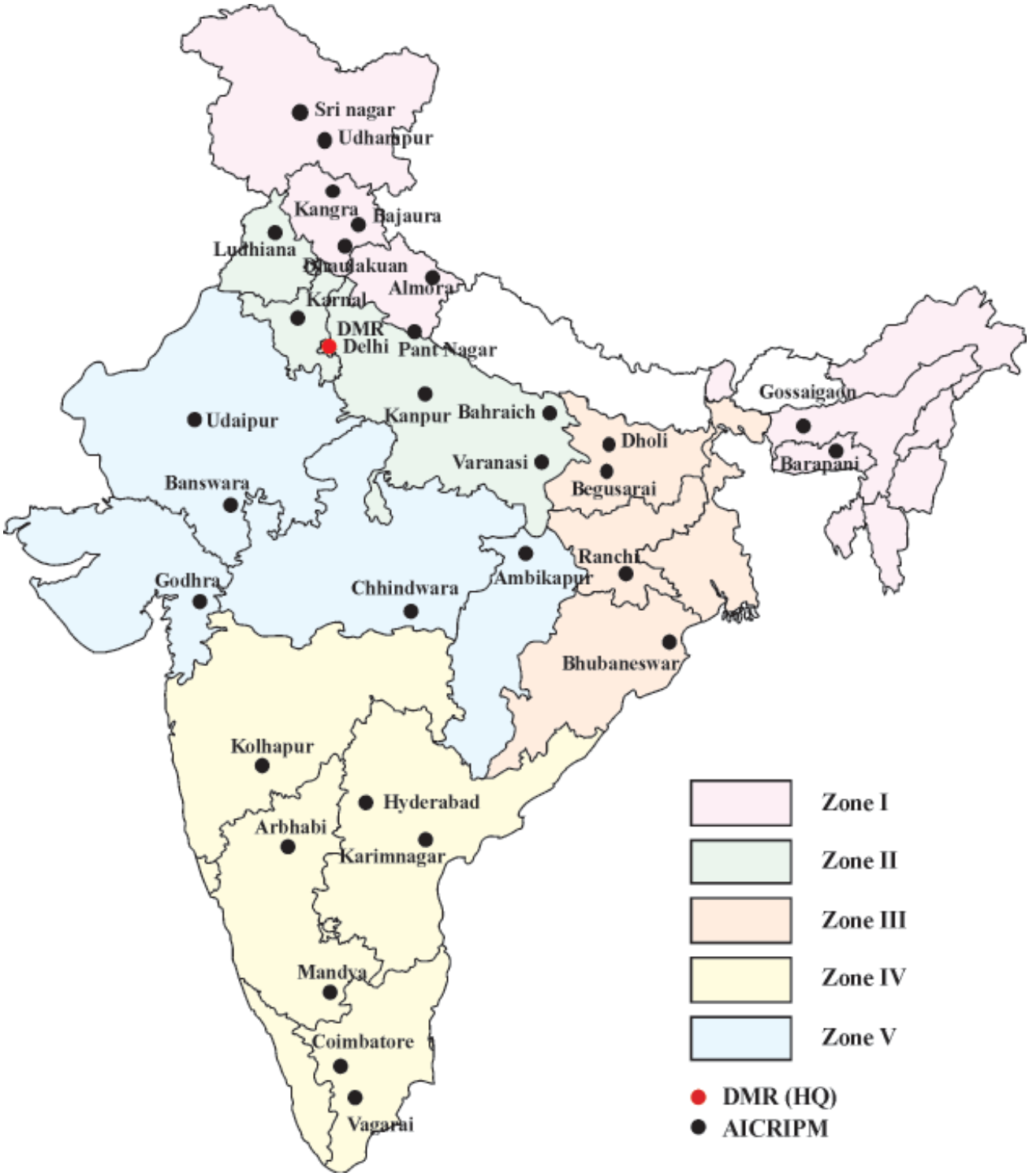


Fig. 3: Zones and centres of AICRP (maize) varietal testing

Breeding

In *kharif* 2011-12, 238 entries (Table 2) were tested against 27 checks in 45 trials. Among these, 122 entries were contributed by public sector and 116 entries were by private sector. The test entries are promoted from IET to AET-I based on the yield superiority of 5% (late maturity group) to 10% (medium, early and extra early maturity group) over the best performing check in atleast one or more than one zone. Superior entries should not exceed the critical difference (5%) value with respect to days to 50% silking and 75% dry husk over the best check. Similar criteria were followed for promoting test entries from AET-I to AET-II but promotion is at zonal level.

In *rabi* 2011-12, a total five coordinating trials were constituted for testing yield superiority, which included two IET (one of late; one of medium and early together), one each of AET-I (late and medium together), AET-II (late) and QPM-1 across 19 locations.

Table 2. Number of entries tested in 2011-12 breeding trials

***Kharif* 2011**

S.No.	Trial	Late Maturity	Medium Maturity	Early maturity	Extra-early Maturity
1	Initial Evaluation Trial	54	53	18	10
2	Advance Evaluation Trial-I	11	30	14	03
3	Advance Evaluation Trial-II	11	11	10	05
4	QPM1-2	12			
5	Popcorn	04			
6	Sweetcorn	05			

***Rabi* 2011-12**

S.No	Trials conducted	Maturity Groups	No. of entries evaluated
1	Initial Evaluation Trial	Late maturity	29
		Medium maturity	10
		Early maturity	02
2	Advance Evaluation Trial-I	Late maturity	24
		Medium maturity	02
		Early maturity	02
3	Advance Evaluation Trial-II	Late maturity	05
4	QPM-1		02

Hybrids notified during 2011-12

Given below is the list of hybrids of maize notified *vide* S.O. 456(E) dated March 16, 2012 during the period under report.

No.	Hybrids	Centre / Organization	Area of Adaptation / Zone	Characteristics
1	Vivek 43	VPKAS, Almora	Uttar Pradesh , Madhya Pradesh and Rajasthan	Early, orange, flint grains, average yield -5.0t/ha
2	Vivek 39	VPKAS, Almora	Uttrakhand, Himachal Pradesh	Early, orange, flint grains, average yield -5.0t/ha
3	P3501	Pioneer	Gujarat, Rajasthan, Madhya Pradesh, Chhattisgarh (Zone-5)	Medium, orange, flint grains, average yield-6.5 t/ha

Vivek -39

Vivek 43

Agronomy

The salient achievements of co-ordinated agronomic trials conducted in *kharif* 2011 and *rabi* 2010-11 are summarised below

Genotypic response to nutrients

In all five zones, the genotypes of different maturity groups were evaluated under three fertility levels *i.e.* N: P_2O_5: K_2O 100:50:50, 150:65:65, 200:80:80 kg/ha., in medium, early and extra early maturity while 150:65:65, 200:80:80 and 250:95:95 in late maturity group.

Tillage management in maize systems

Trials on tillage x weed control practices and tillage x genotype interactions on maize in different maize based farming systems were conducted at Udaipur, Dholi and Kashmir centres. Interactions between maize genotypes tillage; and crop establishment techniques was observed at Udaipur and Dholi. The yield performance of different genotypes was

found significantly higher in permanent beds over zero till and conventional till.

Nutrient management in maize systems

a. *Site-Specific nutrient management (SSNM):* At Bajaura, in maize-wheat cropping system SSNM (188 N + 79 P + 0 K + 25 $ZnSo_4$ kg/ha) was superior and statistically at par with improved nutrient management recommendations (150 N + 60 P + 40 K + 25 $ZnSo_4$ kg/ha).

b. *Nutrient management through exploring potential of biofertilizers:* Combined use of *Azotobactor*, Verbescular Arbuscular Mycorrhiza and Phosphobacteria, (bio-fertilizers) recorded the baby corn yield (1.32 and 8.55 t/ha) equal to recommended dose of NPK (1.46 and 8.95 t/ha).

c. *Nitrogen scheduling in maize:* In QPM, increasing N levels from 125 to 150 and 175 kg/ha enhanced grain yield by 10.07 and 28.44%, respectively.

d. *Realizing yield potential of single cross hybrids under irrigated condition:* Application of 240 N, 90 P_2O_5 and 80 K_2O kg/ha was the most productive nutrient at Bajaura. The highest planting density of 75,000 plants/ha (67x20 cm) proved better than lower levels of planting density (*i.e.* 66,000 and 60,000 plants/ha).

Weed management

Studies on weed management trials for diverse weed flora in maize based cropping systems were conducted in different agro-ecologies at various AICRP centres during *kharif* 2011 (Table 3).

Table 3. Recommendations under weed management trials

S.No	AICRP Centres	Recommendation
1	Kangra, Ludhiana and Arabhavi	Pre-emergence application of Oxyfluoran @ 0.15 kg a.i./ ha followed by one hoeing at 25 days stage
2	Udhampur, Pantnagar and Banswara	Metribuzin @ 0.25 kg a.i. (Pre-emergence) with one hand weeding at 25 and 30 days after sowing
3	Karnal, Ranchi and Udaipur	Pre-emergence application of Atrazine @ 1.0 kg a.i./ha followed by one hoeing at 25-30 days stage
4	Kashmir	Oxdiangyl @ 0.09 kg ai/ha (80% WB) followed by one hand having between 25-30 days stage

Performance of maize hybrids to adopt rainfall changes and climatic aberrations

The experiment on performance of popular maize hybrids to adopt rainfall changes and climatic aberrations was initiated during last year 2011 (Fig. 2-6).

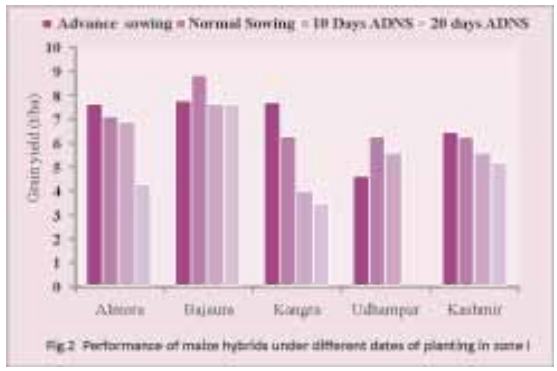


Fig.2 Performance of maize hybrids under different dates of planting in zone I

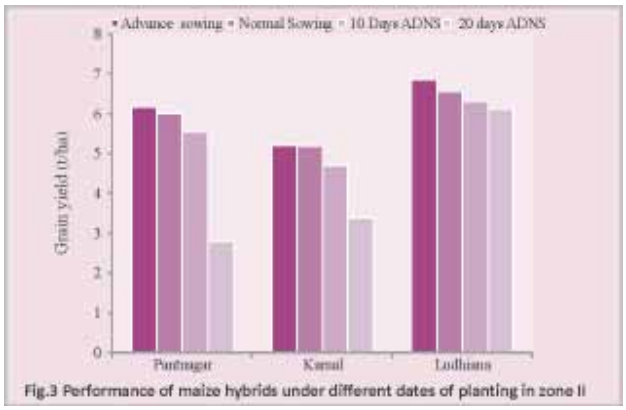


Fig.3 Performance of maize hybrids under different dates of planting in zone II

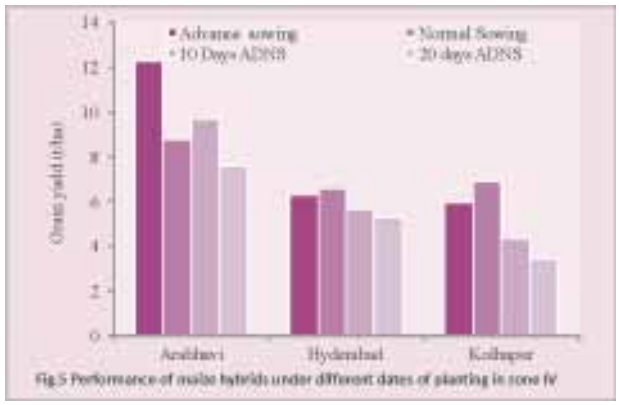


Fig.5 Performance of maize hybrids under different dates of planting in zone IV

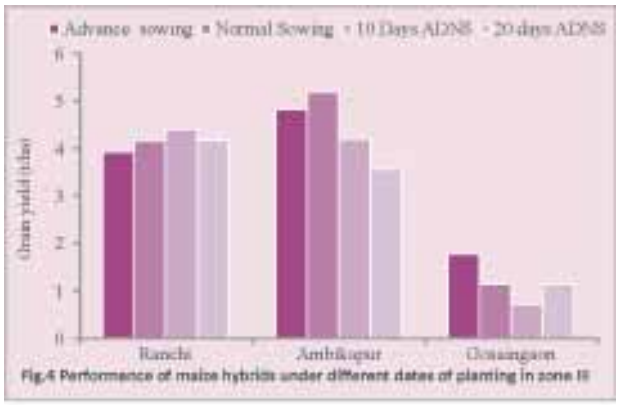
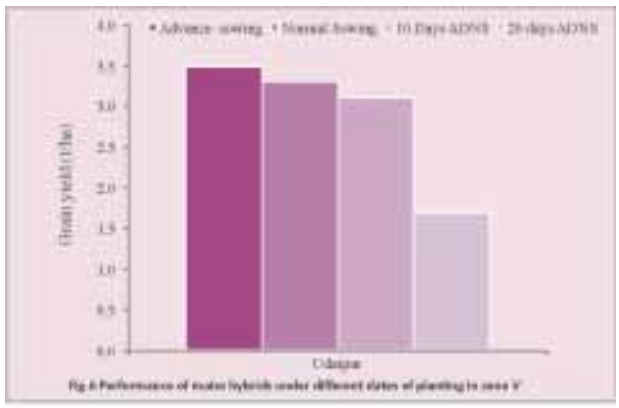


Fig.4 Performance of maize hybrids under different dates of planting in zone III



Entomology

Germplasm evaluation

During *kharif* 2011, 132 accessions of different maturity period evaluated for resistance against *Chilo partellus* under artificial infestation condition. Plants were rated on 1-9 scale based on Leaf injury rating (LIR) after 25 days of infestation. 202 inbred lines were also evaluated in which 10 were least susceptible; 191 moderately susceptible and one was susceptible.

Habitat management

In habitat management studies, maize intercropped with cowpea in the ratio of 2:1 was experimented at eight locations all over the country. Intercropping with cowpea was at par with maize pest control (Endosulfan @ 0.07 %) based on percent infested plants, LIR, dead hearts and yield at Kolhapur, Ludhiana, Hyderabad, Srinagar and Udaipur.

Ovipositional deterrent effect of Neem Seed Kernel Extract (NSKE) on maize stem borer

NSKE @12.5, 10, 7.5 and 5g/l was sprayed on maize plants covered with mosquito nets 10 days after germination. The observation on number of egg masses and eggs on the leaves showed complete ovipositional deterrence at Kolhapur and only partial deterrence at Udaipur centres.

Experimental field of ovipositional deterrence effect of NSKE

Efficacies of pre-treated seed with Gaucho (imidacloprid) 600 FS against shoot fly

Plant infestation, dead heart and leaf injury observations at 10 and 25 DAG showed that the seed must be sown preferably within 14 days of treatment but certainly not later than 21 days.

Effect of time of application of insecticide on damage of *Chilo partellus*

The data on LIR, plant height and tunnel length showed that the pesticide spray should be made within three days of hatching as the larvae enters the stem and becomes inaccessible. The pesticide spray after three days may harm natural enemies but certainly not the stem borers. The impact of pesticide remains for 4 days after which the larvae are able to cause damage to the plant.

Effect of plant age on damage of *Chilo partellus* and grain yield of maize

Effect of plant age on damage done by *C. partellus* was studied at Udaipur by artificial infesting the plants at 7, 9, 11, 13, 15, 17, 19 and 21 DAG. Infestation at different plant age was correlated with the damage parameters *i.e.* plant infestation, LIR, dead hearts and also with yield. The pest was able to cause damage and reduce yield even when the plants were infested 19 days after emergence.

Pathology

A total of 266 maize genotypes and 30 QPM genotypes (Tabel 4) in 09 different trials comprising of various maturity groups was evaluated against different maize diseases *viz.*, Maydis leaf blight (MLB), Turcicum leaf blight (TLB), Banded leaf and sheath blight (BLSB), Sorghum downy mildew (SDM), Brown stripe downy mildew (BSDM), Rajasthan downy mildew (RDM), Post-flowering stalk rots(PFSR), Common rust (C. Rust), Polysora rust (P. Rust) and Erwinia stalk rot (ESR). The screenings of these genotypes were carried out under artificially inoculated conditions in the various hot spots located in different agro climatic zones of the country. The most promising genotypes with combined resistance to various diseases are:

Table 4. Genotypes screened in Pathology trials

S. No	Diseases	No. of entries tested	Maturity groups	No. of entries identified	Promising entries identified with multiple diseases
1.	MLB, BSDM, PFSR MLB, BSDM MLB, BSDM, PFSR, C. Rust BSDM, ESR, C. Rust	60	IET Late Maturity	45	CMH08-381 CMH08-381(G) CMH09-464 BH-41015

	MLB, BSDM MLB, TLB, BSDM MLB, TLB, PFSR MLB, TLB, PFSR TLB, PFSR, ESR MLB, TLB, P. Rust, C. Rust MLB, TLB, BSDM				BH-41032 IISCHDMRWNC1 DMH 7705 S6668 P3303 P4546 MCH 45
	MLB, BSDM, PFSR RDM, BSDM RDM, BSDM MLB, RDM, BSDM, C. Rust MLB, RDM, BSDM, P. Rust, C. Rust MLB, RDM, P. Rust , C. Rust RDM, BSDM, PFSR MLB, BSDM, PFSR PFSR, ESR, C. Rust PFSR, P. Rust MLB, TLB, RDM, BSDM, PFSR, C. Rust MLB, BSDM, PFSR	57	IET Medium Maturity	39	CMH10-474 CMH10-480 CMH10-516 MM1108 X35A188 X35A189 Bisco x 4214 X 274 B 53 DAS-MH-301 KNMH 40112 BH-4062 (DHM 117)
	MLB, RDM MLB, PFSR RDM, BSDM, ESR RDM, BSDM	20	IET Early Maturity	15	CMH10-525 CMH10-526 Bisco 2238 K 21
	RDM, C. rust MLB, BSDM MLB, RDM, BSDM	12	IET Extra Early Maturity	8	FH 3554 FH 3555 FH 3556
	MLB, P.Rust MLB, RDM, BSDM, P.Rust, C.Rust MLB, BSDM RDM, BSDM, P.Rust, C.Rust, PFSR RDM, BSDM, P.Rust, C.Rust, ESR MLB, C.Rust, ESR	24	AET Late Maturity	13	CMH08-287 NMH-713 M 9977 P3540 A 7501 BIO-562

	MLB, P.Rust, C.Rust				JH12108
	MLB, P.Rust				NMH-920
	MLB, P.Rust, C.Rust, PFSR				X8B562
	RDM, PFSR, ESR, C.Rust				EHQ-16-
	PFSR, ESR, C.Rust				MHQPM-09-8
	MLB, PFSR	43	AET Medium	34	CMH08-292
	MLB, RDM, BSDM, PFSR		Maturity		CMH08-350
	MLB, TLB, RDM, BSDM				CMH08-433
	TLB, RDM				EC-3161
	MLB, TLB, RDM, BSDM, PFSR				JH 31404
	BSDM, PFSR				BH41001
	MLB, RDM, C.Rust				BH41009
	PFSR, C.Rust				MMH-09-4
	MLB, RDM, C.Rust				S6217
	MLB, RDM, C.Rust				S6217
	MLB, TLB, P. Rust				YUVRAJ GOLD
	TLB, PFSR				IMH-666
	RDM, BSDM, C. Rust				VMH 4106
	C. Rust, P. Rust				B 63
	C. Rust, PFSR				JKMH-7004
	MLB, C. Rust, PFSR				KNMH401061
	MLB, PFSR, P. Rust				X8B691
	RDM, BSDM, C. Rust	29	AET Early maturity	23	FH 3513
	PFSR, RDM				HKH-317
	MLB, PFSR, C. Rust, P. Rust				KMH-128
	MLB, PFSR, P. Rust				FH 3506
	MLB, PFSR, RDM				BIO 605
	PFSR, C. Rust				REH 2003
	PFSR				BPCH6 (POP CORN)
	ESR				BPCH27(POP CORN)
	MLB, BSDM, C. Rust	06	AET Extra Early maturity	03	FH 3510

Assessment of yield losses

Assessment of yield losses due to TLB, MLB, BLSB and SDM using paired plot technique, nine replications under artificial inoculation conditions was conducted at Arabhavi, Delhi, Pantnagar, Coimbatore; PFSR at Delhi and Hyderabad. The extent of losses is given below (Table 5).

Table 5. Assessment of yield losses

Genotype	Disease	Location	Yield loss (%)
Pant Sankul Makka	BLSB	Pant Nagar	29.02
30V92	PFSR	Hyderabad	20.74
HM 9	PFSR	Delhi	31.40
DHM – 2	TLB	Arabhavi	14.26
EH 434042(Arjun)	TLB	Arabhavi	11.97
Bio 9681	TLB	Arabhavi	29.84
COH(M)-5	SDM	Coimbatore	54.95
HM 8	MLB	Delhi	14.03

Evaluation of inbred lines against PFSR at Delhi, Hyderabad, Ludhiana and Udaipur

- A total of 51 entries were evaluated and out of them 22 were selected as a resistant to PFSR across the locations with disease score of <5.0 (1-9 rating scale).
- A total of 10 resistant pools for PFSR are being maintained and inbred lines from these pools are being extracted.

Rabi 2011-12

A total of 93 genotypes were screened out of them PRO 380, BP-001, BP-002, BP-003, BP-004, BP-005, KH-274 and Bio-151 for SDM: NMH-920 and X-915 for PFSR and RJMH-2 BY and NK 6607 were found resistant against TLB.

Stalks affected by PFSR

Nematology

Among 289 maize entries belonging to different maturity groups screened against cyst nematode, *Heterodera zeae* maize entries *viz*., P3303, B 161, CMH08-287, M 9977, JH 31467, EH 2116, CMH08-292, CMH10-518, EH-2184, KH-9560 and DH-229 exhibited moderately resistant reaction to *H. zeae*. Maximum occurrence (69.23%) and nematode population (14.22 cyst/ plant, 11.11 cyst/100 cc soil and 527.78 larvae/100 cc soil) was obtained in samples collected from Udaipur district while minimum occurrence (61.54 %) and nematode population (10.00 cyst/plant, 8.25 cyst/ 100 cc soil and 412.50 larvae/ 100 cc soil) was observed from Chittorgarh district of Rajasthan. Seven cyst and 310.00 larvae of maize cyst nematode per 100 cc soil was observed in sample received from Arbhavi (Karnataka) centre of AICRP (Maize). Occurrence of maize cyst nematode, *H. zeae* was observed 67.27 per cent in maize growing areas.

Crop Improvement

- **Breeding**
- **Biotechnology**
- **Biochemistry**

BREEDING

Maize production in the country had been increased significantly in the last two decades through adoption of high yielding hybrids. Further enhancement in maize production is needed to meet the increasing global demand for maize. Crop improvement activities at Directorate mainly focus on development of germplasm enhancement, high yielding hybrids, specialty corn and biotic and abiotic stresses.

Germplasm development, evaluation, maintenance and utilisation

Normal maize

Late and Medium Maturity

A total of 1000 inbred lines including several sister lines at different levels of phenotypic uniformity were evaluated as new source of germplasm *kharif* 2011. All lines were grouped into late (279), medium (495) and early based on one season data of days to 50% tasseling and days to 50 % anthesis. 1846 crosses have been attempted during the year 2011 using two testers (BML 6 and 7) and some of the highly uniform inbred lines. These crosses will be evaluated and some are under evaluation for their *per se* performance. More than 50 new inbred lines were derived from promising single cross hybrids like DHM 117, HQPM 1, HQPM 5 , HM 4, Seedtech 2324, HM 10 *etc*. are at S_3 stage and around 63 are at S_1 stage of development.

Early and Extra early Maturity

During *kharif* 2011, 235 lines were maintained and among them the promising inbred lines were selected for development of single cross hybrids. The criterion for selection was uniformity and productivity. The lines were first characterized as male and female parents. Based on synchronization the experimental crosses were made. 129 single crosses were attempted of which 90 crosses were successful. Initial evaluation trials were taken up during the *rabi* 2011-12 at two locations DMR, New Delhi and RMR&SPC, Begusarai farms. From HEY Pool (Hill Early Yellow), a total of 40 lines were also selected. The pool was maintained and 100 plants in this pool were selfed. Based on the cob characters, kernel characteristics like colour and dent/flint 40 cobs were selected for advancement which is regarded as S_1 cycle of line derivation. Further, these lines will be advanced in ear-to-row method.

Specialty Corn

Quality Protein Maize

During the year under report, a set of QPM lines (65) was evaluated for uniformity and other traits. Data were recorded on phenology, *per se* and yield related traits. Based on the superior performance, 47 lines were selected and 23 were found to be highly desirable. A preliminary yield trial was conducted with 117 single cross hybrids of QPM along with three checks, *viz*. HQPM 1, 5 and 7 and evaluated (*rabi* 2011-12) for phenology, yield, 1000 kernel weight and quality. List of most promising entries *per se* performance is given in Table 6.

Table 6. *Per se* performance of highly promising lines of QPM (*Kharif* 2011)

Inbred lines	Days to Anthesis (50%)	Days to silking (50%)	Anthesis Silking Interval	Ear placement ratio	Grain yield (t/ha)	1000-kernel weight (g)
DMR QPM 58	46	47	1	0.50	1.77	120
DMR QPM 03-104	47	50	3	0.37	1.10	130
DMR QPM 102	52	53	1	0.61	2.10	180
DMR QPM 103	49	50	1	0.50	1.95	190
DMR QPM 112	50	52	2	0.45	2.44	180
DMR QPM 03-124	51	52	1	0.60	0.66	160
DMR QPM 03-113	48	55	7	0.65	0.79	140
HKI193-2-2-4	50	56	6	0.39	1.46	180
CML 153 (check)	48	50	3	0.52	0.99	220
HKI 1105 (normal) (check)	51	53	3	0.45	3.10	240
HKI 161 (QPM) (check)	66	68	2	0.58	3.00	220
VQL 1 (check)	52	57	5	0.41	0.93	220
Mean	50.83	53.58	2.92	0.50	1.69	181.67
Range	46-66	47-68	1-7	0.37-0.65	0.66-3.10	120-240

Sweet corn and Popcorn

In *kharif* 2011 (Delhi), 767 germplasm of sweet corn and popcorn including sister lines were evaluated. From this, 204 sweet corn and 121 popcorn germplasm were selected for further advancement. 50 sweet corn and 5 popcorn cross combinations were evaluated and out of which one popcorn cross combination was found promising and none of the sweet corn cross combinations were found promising. At Hyderabad, selected germplasm was evaluated for uniformity. 300 and 20 cross combinations of sweet corn and popcorn were made respectively. A total of 19 populations, out of which 9 were of normal maize (HPOP1, HPOP2, HPOP3, HPOP4, HPOP5, HPOP6, HPOP7, HPOP8 and HPOP9) and 10 were of popcorn (HPPOP1, HPPOP2, HPPOP3, HPPOP4, HPPOP5, HPPOP6, HPPOP7, HPPOP8 and HPPOP9) were collected from Himachal Pradesh and are put for evaluation at WNC, Hyderabad.

High oil and Baby corn

In *kharif* 2011, thirty top cross (Elite hybrid as female x High oil corn inbred as pollinator) were attempted. These crosses surpassed single crosses of high oil corn. HM 4 X Indimyt 345, HQPM 5 X Indimyt 345, VH 4 X Temp. x Trop. (HO) QPM-B-B-B-60-B-B and VH 5 X Temp x Trop. (HO) QPM-B-B-B-60-B-B showed the best *per se* performance among top crosses. The female elite hybrids were chosen in accordance to the maturity of high oil pollinators. Top crosses were found to be better in terms of seed setting and seed production compared to single crosses (Fig. 7). Multiplication and selfing of elite seven identified lines with high oil (> six per cent oil) was done.

HM4 X Indimyt 345 B-B-60-B-B | HQPM5 X Indimyt 345 | VH5 X Temp xTrop(H0) QPM-B-B-B-60-B-B | VH4 X.Temp x Trop (H0)QPM-B-B-B-60-B-B

Fig.7 Mature cobs of top crosses

Baby corn traits were evaluated in ten popular early maturing single cross hybrids hybrids for high planting density (75x10cm). Detasseling was done by removing the tassel as soon as it emerged from the flag leaf. Picking was done daily until 2-3cm silk came out from top of the ear during morning hours. HM4 hybrid (check) was prolific and showed high total solid sugar content. Harvesting period was 10-12 days in this season. Three to four pickings were done during the harvest period. In *rabi* 2011-12, seed increase of 157 new inbreds was carried out for evaluation of useful traits.

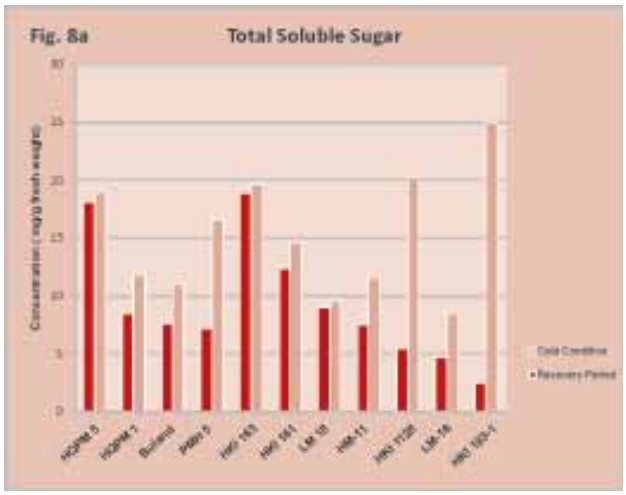
Abiotic stress

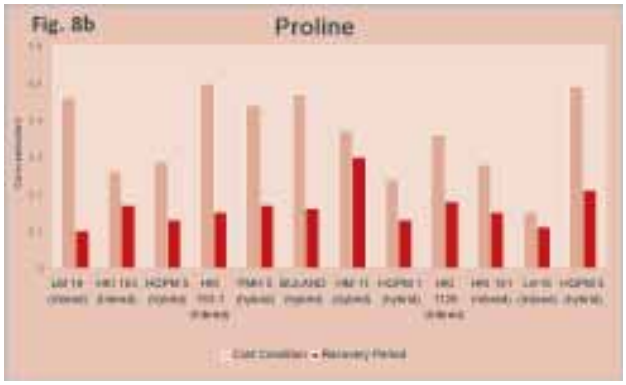
Cold tolerance

In *rabi* 2011-12, 120 inbred, 85 hybrids, 25 experimental hybrids and 40 F_2 Populations in cold

Table 7. Mean performance of inbreds for early establishment traits in cold conditions

Inbreds	Early vigor rating 1=weak9= vigorous	Leaf greenness (SPAD)	Days to 50% anthesis	Days to 50% silking	Ear placement	Cob weight(g)	1000 grain Weight
EC 655724	6	26.2	127	129	0.61	83	38.9
HKI 1128	3	23.4	131	133	0.44	58	33.4
CML 69	5.5	18.8	129	132	0.36	75	35.3
CML 186	3.5	23.2	128	131	0.43	73	31.8
LM 5	5	18.6	131	133	0.45	53	30.4
HKI 323	3.5	23.1	126	130	0.36	37	27.2
HKI 1105	4	19.4	126	129	0.42	43	26.4
CML 176	3	15.1	129	132	0.34	46	28.7
CM 140	3	23.8	127	129	0.6	56	26.8
HKI 193-2 (Check)	4	24.4	126	129	0.40	50	25.8





conditions of Delhi season was screened for traits related to early development in cold environment *viz*., leaf colour (1= yellow to 9= dark green), early vigour rating (1= weak to 9= vigorous), proportion of emergence (percentage of emerged plants), proportion of survival (percentage of plant survived) and SPAD values. The data of few superior entries is presented in Table 7.

Twelve genotypes of maize comprising of inbred and hybrids grown in field were evaluated for different physiological parameters *viz*., chlorophyll content, total soluble sugar, proline and glycine betaine. Samples were taken on first fortnight of January, 2012 in peak cold conditions and second sampling was in second fortnight of March 2012 to see the recovery of genotypes after getting favourable conditions (Fig. 8a, b & c).

Drought Tolerance

219 maize inbred lines belonging to different maturity group have been put for evaluation to drought tolerance at two locations (Hyderabad and New Delhi). Stress was given at two critical stages (pre-flowering and terminal stress).

Seed Production

Regional Maize Research and Seed Production Centre, Begusarai (Bihar)

Seed production of parental lines of hybrid HQPM 1 was done at RMR & SPC, Begusarai (Bihar). This seed was supplied to different part of the country for hybrid seed production (Table 8). Hybrid Seed Production of DHM 117 was also taken up and 2664 kg hybrid seed was produced during 2010-11. Seed produced was supplied to farmers under Front Line Demonstration in Bihar State and earned revenue of ₹ 2, 89,120.00. In addition to this wheat was grown during *Rabi* season in the area kept vacant under isolation distance. Seed production of maize inbreds and soybean in *Kharif* season earned a revenue of ₹ 12, 36,510.00.

Table 8. Institutions supplied with parental seeds of HQPM-1

S.No.	Name of the institution to which seed supplied	HKI 193-1(Female of HQPM-1) kg Quantity in	HKI 163(Male of HQPM-1) Quantity in kg
1.	KVK, Dhirang, Arunachal Pradesh	2.00	3.00
2	OUAT, Bhubaneswar	1.00	41.00
3	M/S Bala ji seeds, Kurnool, Andhra Pradesh	500.00	200.00
4	Sanjay Ghosh, Midnapur, West Bengal	135.00	50.00
5	Biswa Bharati Krishi Savambar Gosthi, Kulgachi, Nadia, West Bengal	2500.00	1200.00
6	Sri Laxmi Seeds, Kurnool, Andhra Pradesh	300.00	200.00
7	M.D.WBSSC Ltd, Kolkatta	900.	300.00
8	Regional Manager, NSC, Patna	500.00	200.00
9	Arpan seeds, Udaipur	—	500.00
10	Plant Manager, RSC Ltd, Banswara, Rajasthan	200.00	100.00
11	Kulgachi, SKUS Ltd, Nadia, West Bengal	488.00	72.00
12	Kamboj Export, Karnal	300.00	100.00
13	M.D.Satpathi, Sansar Agropol Pvt.Ltd., Bhubaneswar	15.00	5.00
14.	C.P. Seeds, Banglore	20.00	10.00

Breeder Seed Production

A total of 193.20 quintals of breeder seed was indented through Department of Agriculture and Cooperation (DAC, Ministry of Agriculture). The indent was honoured and 169.59 quintals of seed was produced (Table 9). The deficit in seed production will be met from the *rabi* and spring harvest.

Table 9. List of breeder seed producing centres and the quantity of seed indented and produced during production year 2011-12

S. No.	Hybrids / varieties	Centre	Breeder Seed allocated (qntls.)	Breeder Seed produced (qntls.)	Surplus (+) Deficit (-)
1	Pratap kanchan-2	Banswara	13.00	May, 2012*	
2	Pratap Makka Chari-6	Udaipur	5.00	6.00	1.00
3	HQPM-7(HKI-161)	Karnal	0.01	0.01	
4	HKI-193-1	Karnal	0.01	0.01	
5	Vivek Shankul Makka-31 (VL-103)	Almora	6.00	6.00	
6	HM-8 (HKI-1105)	Karnal	0.15	0.15	
7	Pratap Makka-5 (EC-3126)	Udaipur	10.00	0.00	-10.00
8	Azad kamal (R 9803)	Kanpur	0.20		

9	Pratap Makka-3	Udaipur	0.80	0.80	
10	Pratap Makka-3	Udaipur	4.00	4.00	
11	Pusa Composite-3	Delhi	3.27	3.50	0.23
12	Pusa Composite-4	Delhi	0.20	0.20	
13	Jawahar Makka-216	Chhindwara	36.40	46.00	9.60
14	Gujarat Makai-6	Godhra	0.50	0.50	
15	NAC-6002	Mandya	0.10	0.50	0.40
16	Narmada Moti	Godhra	0.20	6.60	6.40
17	Priya Sweetcorn	Hyderabad	0.18		
18	Amar	Pantnagar	0.70	2.00	1.30
19	Aravali Makka-1	Udaipur	6.00	6.00	
20	NAC-6004	Mandya	2.60	2.00	-0.60
21	Gaurav	Pantnagar	3.00	10.00	7.00
22	Jawahar Composite Makka-12	Chhindwara	1.00		
23	Dewaki Composite Makka	Dholi	0.30		
24	Mahi Dhawal	Banswara	0.08	Jun, 2012 *	
25	J-1006	Ludhiana	17.75	17.75	
26	Mahi Kanchan	Banswara	0.10	Jun, 2012*	
27	Azad Uttam	Kanpur	0.50		
28	Surya	Pantnagar	0.50	0.08	-0.42
29	Kanchan	Pantnagar	6.50	2.70	-3.80
30	African Tall	Kolhapur	52.12	25.26	-26.86
31	Navjot	Ludhiana	1.00	2.00	1.00
32	Navin	Pantnagar	0.05	Spring, 2012*	
33	Sonari (Shweta)	Pantnagar	0.50	Spring, 2012*	
34	C-6	Srinagar	3.00	0.50	-2.50
35	Composite-15	Srinagar	3.00	5.50	2.50
36	Vijay Composite Makka	Ludhiana	0.70	2.90	2.20
37	Early Composite	Bajaura	0.05	2.90	2.85
38	Ganga Safed-2 CM-600	Pantnagar	0.04	Spring, 2012*	
39	HM-8 Female	Karnal	0.08	0.08	
40	HM-8 Male	Karnal	0.15	0.15	
41	HQPM-1 (Female)	Karnal	0.05	0.05	
42	HQPM-1 (Male)	Karnal	0.15	0.15	
43	HQPM-5 (Female)	Karnal	0.05	0.05	
44	HQPM-5 (Male)	Karnal	0.15	0.15	
45	HQPM-1 (HKI-163R)	Karnal	0.01	3.50	3.49
46	PEHM-2 CM-137A	Delhi	2.00	2.00	
47	PEHM-2 CM-137B	Delhi	1.00	1.00	
48	PEHM-2 CM-138R	Delhi	1.00	1.00	

49	Pratap Hybrid Maize-1 Female	Udaipur	2.00	2.00	
50	Pratap Hybrid Maize-1 Male	Udaipur	1.00	1.00	
51	PEHM-2 Female	Delhi	2.40	2.40	
52	PEHM-2 Male	Delhi	1.50	1.50	
53	PEEHM-5 Female	Delhi	0.15	0.15	
54	PEEHM-5 Male	Delhi	0.05	0.05	
55	Shaktiman-2 CML-186R	Dholi	1.50		
56	Vivek Maize Hybrid-23 Female	Almora	0.05	0.45	0.40
57	Vivek Maize Hybrid-23 Male	Almora	0.10	0.10	
58	Vivek-9 CM-212A	Almora	0.10	0.45	0.35
59	Vivek-9 CM-212B	Almora	0.05	0.05	
60	Vivek-9 POP-31-C-4HSR	Almora	0.15		
	Total		**193.20**	**169.59**	**-23.61**

Registration of Germplasm

During the period 2011-12, ten most promising inbred lines were registered at NBPGR, New Delhi as unique germplasm (Table 10).

Table 10. Germplasm registered at NBPGR, New Delhi

S.No.	Inbred Line	INGR No. Identity	National	Centre	Unique trait/s
1	DMRE-9	11094	0589141	DMR	Source of resistance to pink borer, attractive orange colour kernels
2	DMRE-57	11095	0589142	DMR	Source of resistance to pink borer, attractive orange colour kernels
3	DMR-PFSR-1	11041	0590094	DMR	Source of resistance to PFSR
4	DMR-PFSR-9	11042	0590095	DMR	Source of resistance to PFSR, stiff, strong and stay green stalk
5	DPcl-10	11096	0589143	DMR	100% poppiness, good pollinator
6	DMRHO-57	11090	0589137	DMR	High oil content (6.34%), attractiveyellow flint kernels
7	KDTML-19	11082	0589131	Karimnagar	Drought tolerance, stay green and light orange flint kernels
8	KDTML-66	11083	0589132	Karimnagar	Drought tolerance, higher no. of kernel rows per cob and high test weight
9	KDTML-3	11081	0589130	Karimnagar	Drought tolerance, low ASI and orange flint kernels
10	KML-29	11080	0589129	Karimnagar	Drought tolerance and water logging tolerance, stay green foliage

Inbreds registered with NBPGR, New Delhi

Varietal protection under PPV&FR Act, 2001

Three hybrids under new category namely HQPM 5, HM 9 and Malviya Hybrid 2, five hybrids and seven composites under extant category has been registered. The detailed information is given in Table 11.

Table 11. Hybrids and composites of Maize protected under PPV& FR act, 2001

S.No.	Name	Centre	Period of protection (Years)
	New category hybrids		
1.	HM 9	CCSHAU, Karnal	Dec. 07, 2011 to Dec. 06, 2026
2.	HQPM 5	CCSHAU, Karnal	Dec. 07, 2011 to Dec. 06, 2026
3.	Malviya Hybrid Makka 2	BHU, Varanasi	Dec. 27, 2011 to Dec. 12, 2026
	Extant category - Hybrids		
4.	Vivek Maize Hybrid 21	VPKAS, Almora	March 07, 2011 to Feb. 05, 2022
5.	Vivek Maize Hybrid 23	VPKAS, Almora	Sept. 30, 2011 to Feb. 05, 2022
6.	Parkash	PAU, Ludhiana	Sept. 30, 2011 to Sept. 8, 2012
7.	PMH 2	PAU, Ludhiana	Sept. 30, 2011 to April 24, 2021
8.	Buland	PAU, Ludhiana	Oct. 21, 2011 to Aug. 24, 2020
	Extant category - Composites		
9.	Pratap Makka 3	MPUA&T, Udaipur	March 07, 2011 to Feb. 01, 2020
10.	Pratap Makka 4	MPUA&T, Udaipur	March 07, 2011 to April 24, 2021
11.	NAC-6002	UAS, Nagenahalli	March 07, 2011 to Sept. 03, 2017
12.	NAC-6004	UAS, Nagenahalli	March 07, 2011 to Feb. 01, 2016
13.	Birsa Makai 1	BAU, Ranchi	July 20, 2009 to Dec. 31, 2011
14.	Birsa Vikas Makka 2	BAU, Ranchi	July 20, 2009 to August 24, 2020
15.	Azad Kamal	CSUA&T, Kanpur	Sept. 30, 2011 to Feb. 01, 2020

DUS testing

During the year 2011 *kharif*, DUS test was conducted at two locations, Delhi and Hyderabad, respectively. Of these, 21 were hybrids and three were inbreds. The list of candidate entries and references is given in Table 12. Data was recorded on traits as specified under DUS guidelines.

Inbreds DUS trial 2011

Number of entries	3 candidate and 5 reference
Number of rows	4 or 8
Row length	6 m
Row to row distance	75 cm
Plant to plant distance	20 cm
Number of replications	3

Hybrid DUS trial 2011

Number of entries	21 candidate and 6 reference
Number of rows	4 or 8
Row length	6 m
Row to row distance	75 cm
Plant to plant distance	20 cm
Number of replications	3

Table 12. Inbreds and hybrids in DUS trial 2011

Inbreds in DUS trial 2011

Sl. No.	Entry	
1	BIO 10107	Candidate inbred
2	NM 74A	Candidate inbred
3	NM 74B	Candidate inbred
4	HKI 161	Reference inbred
5	HKI 163	Reference inbred
6	HKI 193-1	Reference inbred
7	HKI 323	Reference inbred
8	CM 145	Reference inbred
Hybrids in DUS trial 2011		
1	EDEN	Candidate Hybrid
2	GK 3060	Candidate Hybrid
3	HM-10	Candidate Hybrid
4	HQPM-7	Candidate Hybrid
5	HT-CO-5101	Candidate Hybrid
6	PAU 352	Candidate Hybrid
7	SYN-CO 7313	Candidate Hybrid
8	SYN-CO-GS 5592	Candidate Hybrid
9	Vivek Maize Hybrid 33	Candidate Hybrid
10	Vivek QPM 9	Candidate Hybrid
11	NMH - 713	Candidate Hybrid
12	KMH-3426	Candidate Hybrid
13	HM 11	Candidate Hybrid
14	NMH - 731	Candidate Hybrid
15	Maharaja 999	Candidate Hybrid
16	30V92	Candidate Hybrid
17	MIM 001	Candidate Hybrid
18	JK Surabhi	Candidate Hybrid
19	**HM-4**	**Filler**
20	Bajaura Makka 1	Candidate Hybrid
21	V Sankul Makka 35	Candidate Hybrid
22	V Sankul Makka 11	Candidate Hybrid
23	HM 4	Reference Hybrid
24	HQPM 1	Reference Hybrid
25	ST 2324	Reference Hybrid
26	Prakash	Reference Hybrid
27	Vivek 9	Reference Hybrid
28	African tall	Reference Hybrid

Monitoring of DUS trials at Delhi (September 9, 2011)

Winter Nursery Centre, Hyderabad

Germplasm maintanence

A total of 8362 genotypes including 319 land races, 170 inbred lines from NBPGR, 1665 QPM and 962 normal lines were maintained /advanced through controlled pollination.

Germplasm Distribution

Major share of germplasm maintenance and distribution is carried out at Winter Nursery Centre, Hyderabad. In 2011-2012, 644 maize inbreds and 632 introductions were provided to AICRP/public research centres (Table 13 & 14).

Table 13. Maize inbred lines distributed to different centres in *rabi* 2010 - 11

S.No.	Name of the Centre	Number of inbred
1	Bhuvaneshwar, Odisha	82
2	Karimnagar, A.P.	30
3	TNAU, Coimbatore	113
4	Chindwara, M.P.	32
5	Arabhavi, Karnataka	7
6	Bahraich, U.P.	13
7	Almora ,U.K.	16
8	Pant Nagar, U.K.	9
9	Varanasi, BHU, U.P.	15
10	Vagarai, Tamil Nadu	8
11	DMR, New Delhi	48
12	Ranchi, Jharkhand	23
13	Srinagar, Jammu & Kashmir	21
14	Udhampur, Jammu & Kashmir	22
15	Dharwad, Karnataka	39
16	Kolhapur, Maharastra	16
17	Mandya, Karnataka	16
18	Dholi, Muzaffarpur, Bihar	77
19	Allahabad ,U.P.	11
20	Karnal	3
21	MRC, ARI, Rajendranagar, Hyderabad	43
	Total	**644**

Table 14. Maize introductions distributed to different centres in *rabi* 2010-11

S. No.	Name of the Centre	Number of introductions
1	Bhuvaneshwar, Odisha	54
2	Karimnagar, A.P.	60
3	TNAU, Coimbatore	89
4	Chindwara, M.P.	23
5	Arabhavi, Karnataka	2
6	Bahraich, U.P.	5
7	Almora ,U.K.	9
8	Pant Nagar, U.K.	1
9	Varanasi, BHU, U.P.	3
10	Vagarai, Tamil Nadu	3
11	CIMMYT,C/o ICRISAT, Hyderabad	12
12	DMR, New Delhi	83
13	Ranchi, Jharkhand	34
14	Srinagar, Jammu & Kashmir	5
15	Udhampur, Jammu & Kashmir	8
16	Dharwad, Karnataka	16
17	Kolhapur, Maharastra	6
18	Mandya, Karnataka	12
19	Dholi, Muzaffarpur, Bihar	16
20	Allahabad U.P.	4
21	Karnal	1
22	MRC, ARI, Rajendra nagar, Hyderabad	216
23	**Total**	**632**

Off-season facilities

Winter Nursery Centre at Hyderabad provides off season facility for DMR and AICRP centres. In *rabi* 2011-12 the following centres utilised this facility.

VPKAS, Almora
RRS, Bajaura
K.D. Research Station, Srinagar
AICMIP, G.B. Pant University of Agrl. Sci & Tech, Pantnagar
Maize Biotech Unit , IARI, New Delhi
Division of Genetics, IARI, New Delhi
AICMIP,PAU, Ludhiana
AICRP, Udhampur
NBPGR , New Delhi
DMR: i) Introduction, ii) Breeding, iii) Pathology, iv) Entomology, v) Genetics, vi) Physiology, vii) Agronomy and vii) Winter Nursery

Regional Maize Research and Seed Production Centre, Begusarai (Bihar)

Germplasm collection evaluation and development

Germplasm of normal and QPM collected from DMR were planted during *rabi* season for evaluation and desirable plants were selected for further improvement. For derivation of F_2 population best hybrids were selfed during *kharif* season. A set of segregating material was planted and 500 better performing lines were evaluated in *rabi* season.

Maize Fodder Experiment

A trial consisting of J 1006 (Fodder Maize), DHM 117 (Normal Maize), HQPM 5 (QPM), HSC 1 (Sweetcorn) and HM 4 (Baby corn) was planted at Begusarai during *kharif* season and was harvested at 50 days after flowering and chopped and then put in a pit for silage preparation (Fig. 9a, b, c). Similarly in case of baby corn also the crop was harvested. Baby corns were harvested and the stem was chopped and put in silage pit for silage preparation. In normal, sweet corn and QPM green cobs were harvested and then the chopped maize stalk was used for silage preparation. The silage pits will be opened in June so that nutritious fodder having quality in comparison to green fodder could be available to the livestock.

BMZ Experiment

Four trials in two replications each supplied by CIMMYT has been planted during *Rabi* season for evaluation under drought condition *viz*. Trial 1: CAAMTE114 - 132 entries, Trial 2: CAAMTD 114 - 140 entries, Trial 3 and 4: CAAMTC 114 and CAAMTB, 152 entries each. Artificial drought was created by stopping irrigation 15 days before flowering. Irrigation was resumed 15 days after flowering.

Fig. 9a Harvesting of maize for silage preparation at Begusarai

b. Chopping of maize

c. Compressing of Chopped fodder for better silage

BIOTECHNOLOGY

ICAR Network project on transgenic crops- Development of stem borer resistant transgenic maize

Putative transformants for *cry1Ab* have been confirmed by PCR and ELISA assay. T_1 seed were harvested from T_0 plants after selfing and T_1 seeds are under screening process to screen positive plants by PCR and southern.

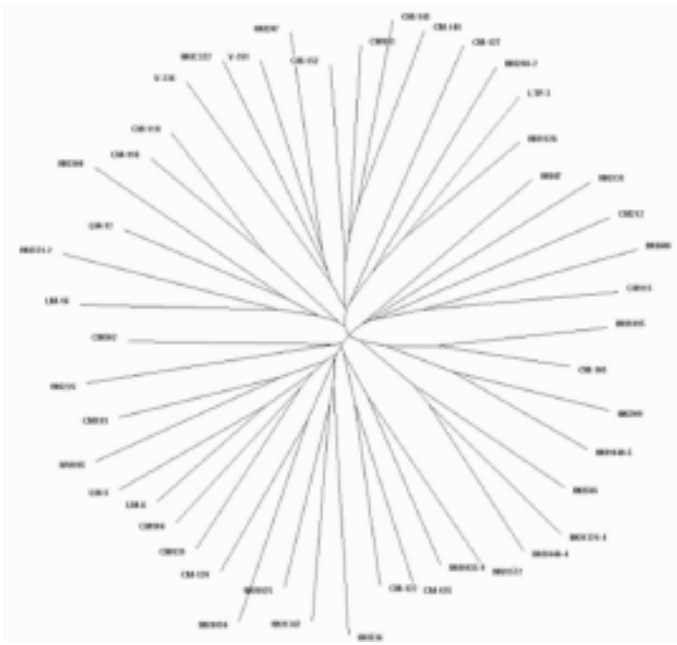
Molecular characterization of elite maize inbreds

In India, maize research is focused on development of single cross hybrids. Selection of diverse lines is the prerequisite for developing hybrids with high heterosis. Molecular markers are very useful and most efficient tools for diversity analysis.

SSR data revealed a total of 202 alleles detected in 46 microsatellite loci. The average alleles per locus were 4.39 and the alleles per locus ranged from 2-8. PIC value ranged from 0.33 to 0.78 and average PIC value was 0.62. Gene diversity at each locus ranged from 0.36 to 0.79. Major highest allele frequency was 0.78 for bnlg2238 which suggested that this allele is most commonly selected in maximum inbred lines. The unrooted tree distinctly grouped 48 inbred lines in four major clusters. The inbred lines have also shown a very high genetic distance. Maximum genetic distance of 0.92 was observed between HKI 488 and HKI 551-2. But, there was no pattern found between the inbred lines clustering together. The lines used in the present study are diverse and these lines can be used in hybrid breeding program.

Summary statistics of markers

Marker	Major Allele Frequency	H_E	H_O	PIC
bnlg2328	0.7778	0.3614	0.2889	0.3316
umc1551	0.6571	0.4377	0.0000	0.3491
umc1136	0.6489	0.4466	0.0638	0.3518
bnlg1129	0.6444	0.4693	0.0222	0.3924



BIOCHEMISTRY

Chemical and biological evaluation and nutritional quality of specialty corn

During 2011–12, more than 2500 samples received from different sources were analyzed for various quality parameters *viz*., protein, tryptophan, lysine, oil, sugar, carotenoids and β-carotene *etc* (Fig. 10).

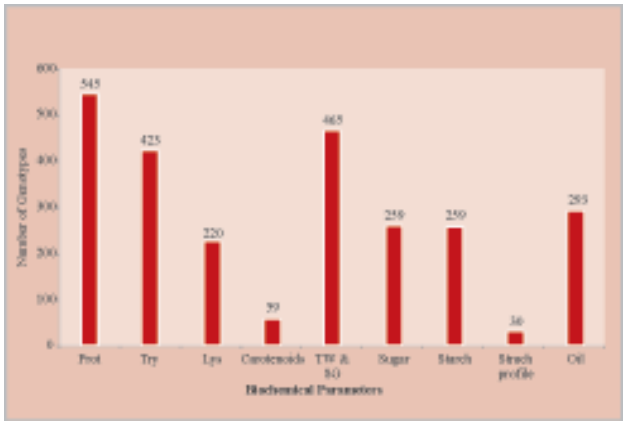


Fig. 10 Biochemical analysis of different types of maize germplasm

Protein, Tryptophan and Lysine estimation

Total protein, tryptophan and lysine contents were analyzed respectively in 545, 423 and 220 different inbred as well as hybrids received from various maize centers across India. The range of protein was 5.91 to 16.86 per cent with lowest and highest values being exhibited by the genotypes C-4 and Madhuri respectively. Tryptophan in protein varied from 0.30 to 0.98 (HKI-164-7-2) per cent. The range of lysine in protein was 1.22 (QPM-7-8) to 4.00 [HKI-170(1+2)] per cent. Around 67 lines showed less than 8 per cent of protein. A large number of lines (185 lines) showed between 8-10 percent protein, 120 lines exhibited 10 to 11 per cent and 93 lines showed protein in the range of 11-12 per cent. This year a significant number of lines (80) were found to have more than 12 per cent of protein. In case of tryptophan a large number of germplasm analyzed was found to be normal as tryptophan content was below 6 per cent. However, about 57 lines evaluated showed tryptophan in the range 0.6-0.7 % and as many as 45 were in the range of 07-08 per cent. A total of 41 lines showed tryptophan more than 0.8 per cent of their protein. As many as 27 promising line (Table 15) were found to be having more than 9% protein with ≥ 0.6% of tryptophan and ≥ 2.50% lysine in their protein.

Table 15. Most promising genotypes for tryptophan and lysine

S. No	Pedigree	Protein (%)	Tryptophan (%)	Lysine (%)
1.	HKI 191-1-2-5	9.56	0.97	3.92
2.	QPM 7-4	9.89	0.96	3.82
3.	QPM 9-2 X QPM-5-2	10.16	0.92	3.74
4.	HKI 170 (1+2)	9.28	0.86	4.00
5.	QPM 10-9 X QPM 5-2	9.29	0.84	3.34

Sugar estimation:

At maturity, maize kernel contain sugars other than starch in small amounts. A total of 259 samples were received from different sources and analyzed for sugar content. Sugar content varied from 3.00 to 8.35 per cent with lowest and highest values being observed in the genotypes HKI 164-7-7-ER-3 and Madhuri, respectively. Some most promising lines for higher sugar content are given in Table 16.

Table 16. Most promising genotypes with higher sugar content

S. No.	Pedigree	Sugar (%)
1.	CML 224	5.39
2.	HQPM 4	5.65
3.	HQPM 1	5.69
4.	HSC 1	6.89
5.	Madhuri	8.35

Starch estimation:

The starch in maize is made up of two glucose polymers: amylose, an essentially linear molecule, and amylopectin, a branched form. The composition of maize starch is genetically controlled. In normal maize, amylose makes up 25 to 30 percent of the starch and amylopectin makes up 70 to 75 percent. Waxy maize contains a starch that is 100 percent amylopectin. An endosperm mutant called amylose-extender (*ae*) induces an increase in the amylose proportion of the starch to 50 percent and higher.

A total of 259 different QPM and normal maize germplasm received from different sources were analyzed for starch content. The range of starch varied from 51.76 to 74.99 per cent with lowest and highest values being exhibited by the genotypes Madhuri and HKH 317, respectively. One hundred and forty five lines, out of 259 were found to be having more than 70 per cent starch content. Thirteen most promising lines are mentioned in Table 17.

Carbohydrate estimation:

In normal maize, the ratio of amylose to amylopectin is 25:75 percent. Waxy maize possess 100 percent amylopectin, whereas, corn having more than 60 amylose is called high amylose maize. A total of 71 different germplasm were analyzed for starch, amylose in starch and amylopectin in starch. The values of amylose in starch varied from 23.51 to 55.20 per cent with lowest and highest values being observed in the genotypes Vivek

Table 17. Most promising genotypes with higher starch content

S. No.	Pedigree	Starch (%)
1.	JM 8	74.10
2.	HKI 325-17AN	74.20
3.	HKI 325-17ANER-3	74.32
4.	1128*161	74.79
5.	HKH 317	74.99

Maize Hybrid 33 and VL Makka 54, respectively. Amylopectin content in starch ranges from 44.98 (VL Makka 54) to 76.49 (Vivek Maize Hybrid 33) per cent. Nine most promising lines selected for amylopectin in starch are mentioned in Table 18.

Table 18. Most promising genotypes with higher amylopectin in starch

S. No.	Pedigree	Amylopectin in starch (%)
1.	Pratap Hybrid Maize 1 (EH-50802)	71.05
2.	Vivek Maize Hybrid 43	71.21
3.	Pratap Makka 5 (EC-3116)	72.90
4.	Pratap Makka Chari 6 (EC-3135)	75.49
5.	Vivek Maize Hybrid 33	76.49

Oil estimation:

Maize oil is highly regarded because of its fatty acid distribution, mainly oleic and linoleic acids. Therefore, breeding for higher and better corn oil is an important specialty trait. A total of 293 samples of maize (QPM, sweet corn and normal maize germplasm) received from different sources, were analyzed for oil content. The oil varied from 1.94 (HKI 327D) to 11.55 (Madhuri) per cent. Twenty nine lines out of 306 were having more than 5 per cent oil content. Some most promising lines for higher oil content are given in Table 19.

Table 19. Most promising genotypes with higher oil content

S. No.	Pedigree	Oil [Dry wt. basis (%)]
1.	HKI 194-2ER-J	6.22
2.	HKI165	6.28
3.	HKI194-2 ER-4	6.89
4.	Madhuri (SC)	11.55

Test Weight and Specific gravity estimation

A total of 465 different QPM and normal maize germplasm received from different sources were evaluated for test weight and specific gravity. Out of the 465, 110 lines were selected for having more than 25 g/100 grain. The range of test weight was 5.62 to 44.00 g/100 grain with lowest and highest values being observed in the genotypes 328 x 329 and Seed Tech 2324, respectively. The range of specific gravity was 0.19 (Vivek Maize Hybrid 9) to 1.90 (CML 9). Some most promising lines for test weight are given in Table 20.

Table 20. Most promising genotypes with higher test weight

S. No	Pedigree	Test weight (g/100 grain)
1.	C 4	35.60
2.	KDMI 10	35.61
3.	QPM 7-4 X QPM 1-14	37.08
4.	QPM 7-4 X QPM 3-7	37.38
5.	C 8	37.60
6.	QPM 7-4 X QPM 3-10	38.55
7.	H 17	39.90
8.	CLQ RCYQ-40	42.33

Biochemical studies on shelf-life of carotenoids in maize

Carotenoids are widely distributed natural pigments responsible for the yellow, orange, and red colours of fruits, roots and flowers *etc*. They invariably occur in the chloroplasts of higher plants, although in this photosynthetic tissue their colour is masked by that of chlorophyll. Biological functions and actions have been increasingly attributed to these compounds.

A total of 59 samples of QPM and normal maize germplasm received from different sources were evaluated for carotenoids and β-carotene. Out of 59, 14 lines were found to possess more than 25 µg/g carotenoid content and only 7 lines were found to be having 2.0 or more than 2.0 µg/g â carotene content. The carotenoid content ranges from 3.47 (HKI-327 T) to 39.53 (DMH 117-2) µg/g whereas the range of β-carotene was 0.11 to 2.90 µg/g with lowest values being observed in HKI-170 (1+2) and highest in the genotype African tall. Some most promising lines for carotenoid content are presented in Table 21.

Table 21. Most promising lines with higher carotenoid content

S. No.	Pedigree	Carotenoid (µg/g)
1.	Panchaganga	30.44
2.	BMC 7	30.76
3.	GPM 342 (Male parent of hybrid KMH-22168)	30.78
4.	DMH 117-2	39.53

Crop Production

- **Agronomy**
- **Physiology**

AGRONOMY

Evaluating conservation tillage practices for improving resource use efficiency in maize based cropping systems

Conservation tillage experiment in different maize based cropping systems was initiated during monsoon season of 2008 consisting of three tillage and crop establishment methods *viz*., (i) Permanent bed (PB), (ii) No till/zero tillage (NT), (iii) Conventional till (CT) in four maize based cropping systems a) Maize-wheat-mungbean (MWM), b) Maize-mustard-mungbean (MMM), c) Maize-chickpea-*Sesbania* (MCS) and d) Maize-maize-*Sesbania* (MMS) with three replications. *Kharif* maize and *rabi* crops *viz*., maize, wheat, mustard and chickpea and summer crops mungbean and Sesbania were sown in sequence as per the treatments.

Maize, chickpea and mustard grain/seed yield was maximum during *rabi* under zero tillage followed by bed planting and conventional till. However, the wheat grain yield was maximum under permanent beds compared to zero-till and conventional till (Fig. 11). In *kharif*, maximum grain yield was in Maize-wheat-mungbean which was closely followed by Maize-chickpea-*Sesbania* cropping system (Fig. 12). The higher grain yield of preceding maize crop in these cropping sequences was due to inclusion of mungbean, chickpea and Sesbania legume crops in these systems which may positively influence the nutrient supplying capacity, fertility, microbial activity and biomass of the soil. While in two other cropping sequences *i.e.* Maize-maize-*Sesbania* and Maize-mustard-mungbean the *kharif* maize grain yield was less because in these cropping systems two nutrient exhaustive crops *viz*., maize and mustard were included in succession leading to more uptake of nutrients from soil and under such cropping systems.

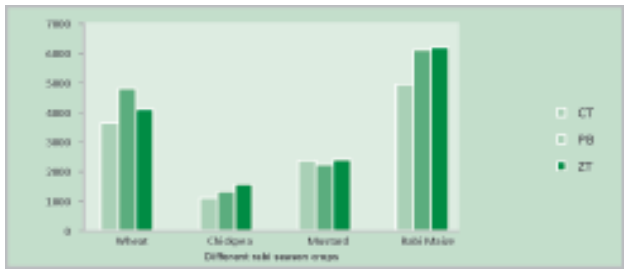


Fig. 11 Grain yield of *rabi* season crops influenced by different conservation tillage practices in various maize based cropping systems (2010-11)

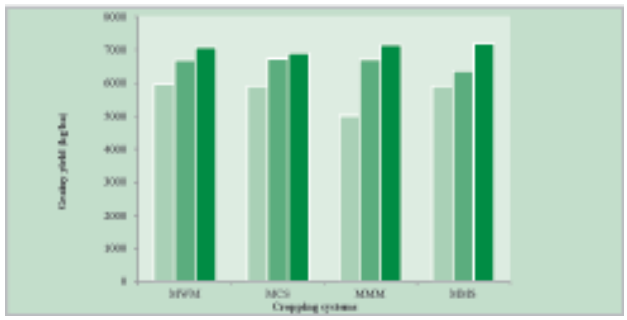


Fig. 12 Interaction effect of maize based cropping systems and conservation tillage practices on grain yield of *Kharif* maize (2011)

Adoption of conservation agriculture based resource conservation practices like zero till and permanent beds resulted in higher carbon based sustainability index (CSI) in various maize based cropping systems. Further it was also observed that among the maize based cropping systems the carbon sustainability index was maximum in maize-mustard-mungbean cropping system (Fig. 13).

Fig. 13 Carbon based sustainability index of different cereal based cropping systems under various conservation agriculture practices during 2010-11

Evaluating interactive effects of plant geometry and fertility levels on the productivity of late maturity maize genotypes under irrigated conditions

The field experiments were conducted during *kharif* (2010 & 2011) on the sandy loam soil having pH 7.8, organic carbon 0.33%, available phosphorus 16 kg/ha and potassium 120 kg/ha. The treatment consisting of plant geometry of 60,000 (67 x 25 cm), 66,000 (67 x 22.5 cm) and 75000 (67 x 20 cm) in three main plots and four fertility levels in the sub-plots comprising state recommendation [150: 60: 40 (N: P_2O_5 :K_2O kg/ha)], 200: 75: 75 (N: P_2O_5 :K_2O, kg/ha), 250: 90: 90 (N: P_2O_5 :K_2O, kg/ha) and 300: 105: 105 (N: P_2O_5 :K_2O, kg/ha). All the treatments were replicated thrice in split-plot design. The maize hybrid HQPM-1 was sown and the fertilizer N was applied in five-splits comprising 20% basal, 25% at V_4 stage, 30% at V_8 stage, 20% at V_T stage and 5% at grain filling stage.

The results indicated that the plant population of 66,000 plants/ha gave significantly higher grain yield over 60,000 plants/ha. Decrease in yield was observed with 75,000 plants/ha during both the years of investigation (Fig. 14). However, the yield of the late maturing genotypes increased with the increasing fertility levels upto 300: 105: 105 but it was statistically on par with 250: 90: 90 during both the years of field study (Fig. 15). The interactive effects of plant geometry and fertility levels showed that the application of 250: 90: 90 with 66,000 plants/ha resulted into highest maize grain yield *i.e.* 4,887 kg/ha as compared to other combinations (Fig. 16).

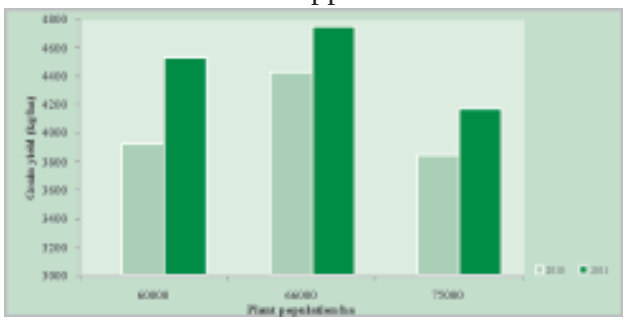


Fig. 14 Effect of plant population on the grain yield of late maturing maize genotype under irrigated conditions

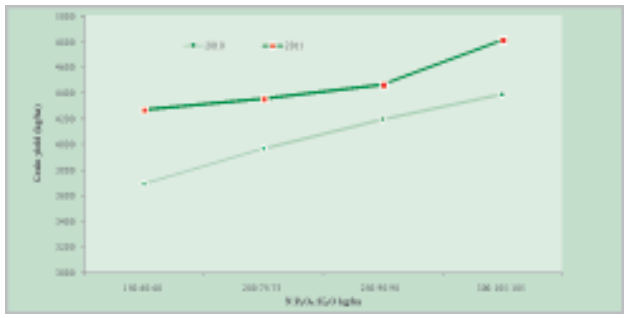


Fig. 15 Effect of fertility levels on the grain yield of full season maize genotype under irrigated conditions

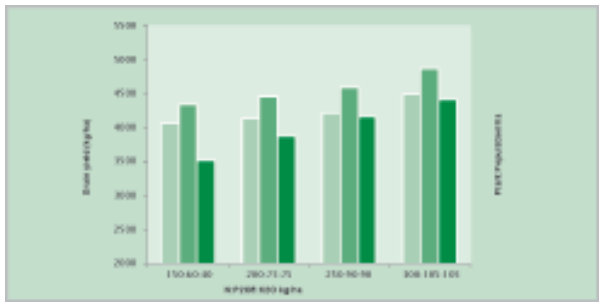


Fig. 16 Interactive effect of plant population and fertility levels on the grain yield of late maturing maize genotype under irrigated conditions (Mean of two years)

Weed management strategies against complex weed flora in maize based cropping systems

The trial on integrated weed management was conducted at IARI research farm during 2010-11 (HQPM 1) and 2011-12 (DHM 117). The treatment comprised of Atrazine 1.0 kg/ha as pre emergence (PE), Metribuzin 0.25 kg/ha as PE, Atrazine 1.0 kg/ha at 21 DAS, Atrazine 1.0 kg/ha as PE followed by one hand weeding (HW) at 21 Days of sowing (DAS), Metribuzin 0.25 kg/ha as PE followed by one HW at 21 DAS, Weedy check, Weed free (two HW) and Maize + Cowpea. During both the years Atrazine 1.0 kg a.i./ha pre emergence and Metribuzine 0.25 kg a.i./ha as pre emergence gave significantly higher yield over weedy check. However, non-herbicidal treatment

maize + cover crop (Cowpea) also suppressed weed and improved yield significantly over weedy check. The residual effect of all the weed management treatments was observed and it was found that the maximum yield of succeeding wheat crop was recorded in maize + cowpea (Fig. 17).

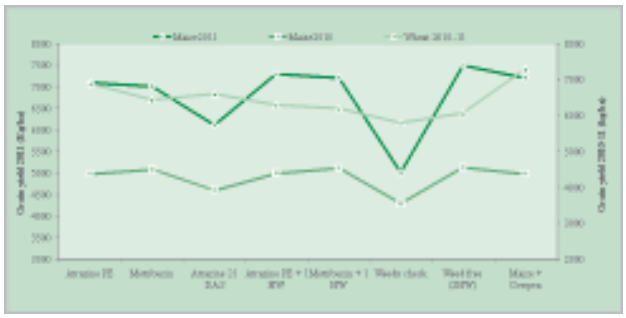


Fig. 17 Effect of different weed management strategies on the grain yield of the maize and their residual effects on wheat

Performance of maize hybrids to adopt rainfall changes and climatic aberrations

An field experiment was conducted during *kharif* 2011 with four main-plot treatments of time of planting *i.e.*, 10 days before Normal Date of sowing (NDS) (28 June), NDS (8 July), 10 days after NDS (18 July) and 20 days after NDS (28 July) alongwith four sub-plots having four maize hybrids *viz*. Vivek QPM 9, Parkash, DHM 117 and PMH 3 to evaluate performance of different maturity hybrids for climatic aberrations. The highest grain yield of 7.7 t/ha was observed when PMH 3 (full season maturity genotype) was sowed on 28 July as compared to other genotype x date of sowing interactions (Fig. 18). However early (Prakash) and medium maturity (DHM 117) genotypes gave significantly highest yield with 10 days after NDS.

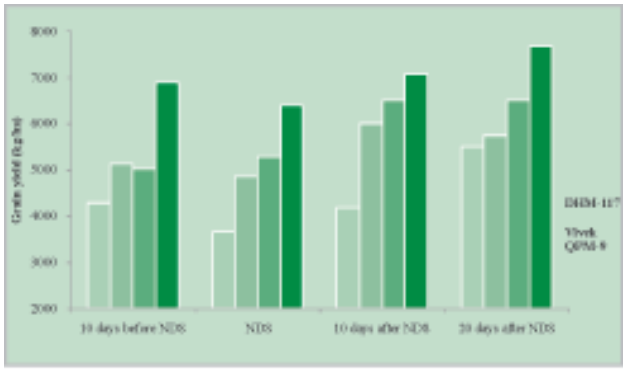


Fig. 18 Genotype x date of sowing interaction effect on the maize grain yield

Influence of different fertility levels on maize under different planting methods grown in various cropping sequences

The field experiment on maize with four fertility levels [Control, Half of Recommended dose of fertilizer (RDF) + FYM 5t/ha, RDF (150N: $60P_2O_5$:$60K_2O$ kg/ha) and RDF+ FYM 5t/ha) and two planting (Flat and Bed planting) was conducted in split plot design and replicated thrice. The highest grain yield and water productivity (grain yield/unit of water applied) were recorded with the application of recommended dose of NPK and FYM @ 5t/ha. The half RDF+ FYM 5 t/ha remained at par with RDF in respect of both yield and water productivity (Fig. 19). Among the planting methods, bed planting gave 7.4 % more yield than flat planting. Similarly, water productivity was also higher (79.0%) with bed planting. After harvest of maize, different *rabi* crops were grown as per the experimental planning. The results of those crops will be reported next year after completion of one crop cycle.

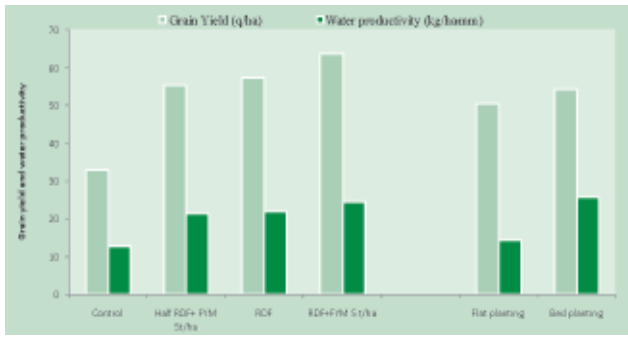


Fig. 19 Grain yield and water productivity of maize under different fertility levels and planting methods

MAIZE PHYSIOLOGY

High Temperature Stress

Twenty selected maize inbred lines including promising lines identified during summer 2010 and five F_1 hybrids (with one of the parent showing tolerance to high temperature), were evaluated under field conditions (Fig. 20) for their performance at high temperature during summer 2011. The crop was planted in randomized block design with three replications on March 18, 2011 and harvested during 2nd week of July 2011. The crop season (March-June) was hot and dry with maximum and minimum temperatures ranging between 30-42°C and 12-29°C, respectively, and total rain fall of 35.6 mm during the period. High temperature reduced plant height, inhibited synthesis of chlorophyll (induced leaf senescence) and negatively influenced photosynthetic efficiency of plant during vegetative growth. However, the flowering stage was most sensitive to high temperature and resulted in enhanced leaf firing, tassel blasting, increased anthesis-silking interval (ASI) and reduced pollen viability resulting in poor grain yield.

Six inbred lines *viz.*, LM 17, HKI 577, HKI 1532, HKI 170 (1+2), HKI 325-17AN and CA 14514 (Table 1) showed confirmed source of tolerance to high temperature with low ASI, less tassel blasting and comparatively higher grain yield. The F_1 hybrids having best heat tolerant inbred line (LM 17, CA14514) as one of the parent performed better as compared to F_1 hybrid having moderately heat tolerant inbred line (HKI 335) as one of the parent under high temperature conditions (Fig. 21).

Fig. 20 Evaluation of maize inbred lines for heat stress tolerance during summer 2011.

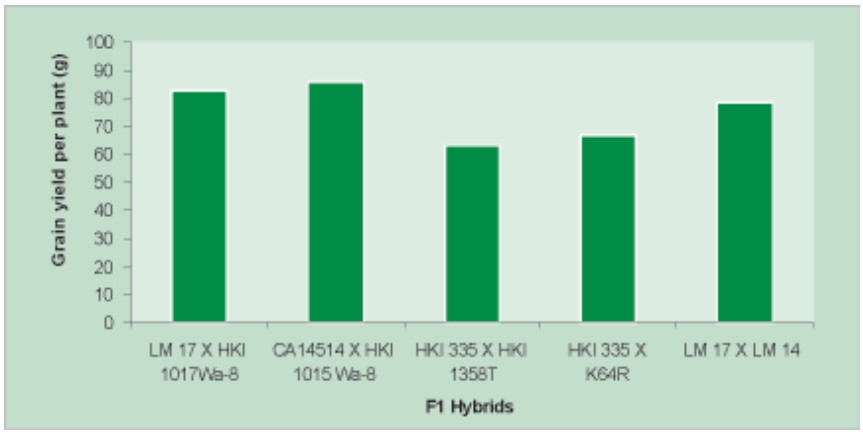


Fig. 21 Yield response of maize F_1 hybrids to heat-stress during summer 2011.

Drought

A set of 174 maize inbred lines were evaluated under drought stress (moisture deficit) during *kharif* 2011 under field conditions. The moisture deficit was created by withholding irrigation at the time of flowering. The moisture deficit resulted in increased ASI, induced leaf yellowing, decreased photosynthetic rate, increased root length and reduction in grain yield upto 80 % as compared to unstressed control. Based on their performance under moisture deficit, 58 inbred lines showed promising results and will be further evaluated under managed stress (rain-out-shelter) conditions for confirmation (Fig. 22).

Another set of selected promising 24 inbred lines was phenotyped for flowering stage drought tolerance during *kharif* 2011. Soil of the experimental plots was sandy loam with pH 7.8. Two sets of all inbred lines, *viz.*, unstressed control and drought (under rain-out shelter) were sown in the micro plots maintained specially for drought studies using randomized block design with two replications. Each entry was planted in single row, each 1.75 m long, with 0.20 m spacing within and 0.60 m between rows. All the entries were sown on 2nd July, 2011 and thinned to one plant per hill at the V_2 growth stage. The crop was raised following all recommended package of practices except with nitrogen applied in 5 split doses (basal, seedling, knee high, flowering and grain filling stages).

The target stage for imposing drought stress was whole reproductive phase, including flowering (both male and female), pollination, fertilization and early grain filling stage (lag phase, which is known to be completely dependent on current assimilate supply). The drought stress was imposed under managed stress (rain-out shelter) conditions by withdrawing irrigation and closing the top of rain-out shelter two weeks before 50% male flowering till two weeks after completion of 50% female flowering. After the completion of drought treatment the top was moved to its platform.

Out of 24 inbred lines tested, 12 lines exhibited drought adaptive traits like stay green character (measured by SPAD chlorophyll content and LCC score), increased root length, shorter ASI, lesser leaf senescence and non barrenness. These lines (HKI 209, HKI 325-17AN, HKI 335, HKI 577, HKI 1532, CM 139, LM 16, LM 17, BJIM08-27, BJIM10-36, DTPYC9F119 and CA 14514) showed confirmed source of tolerance to drought and could be used in developing hybrids suitable for cultivation under limited soil moisture/ rain-fed conditions. Results obtained are in Table 22 & 23.

Fig. 22 Phenotyping of maize inbred lines under managed stress conditions (Rain-out-shelter) at IARI, New Delhi during *kharif* 2011.

Table 22. Comparative performance of selected maize inbred lines and F_1 hybrids for high temperature stress summer 2011

Inbred line	Plant Height (cm)	Cob Position (cm)	No. of leaves / Plant $m^{-2}s^{-1}$)	Net Photosyn-thetic rate (µmol	Stomatal conductance (mol $m^{-2}s^{-1}$)	Leaf senescence score (1-10 scale)	Leaf firing s core (1-5 scale)	Tassel blasting score (1-5 scale)	Anthesis-silking Interval (ASI)	Grain yield /plant (g)
Inbred Lines										
LM 5	123.0	50.8	12.7	18.3	0.147	5.1	2.1	2.1	4.0	17.3
LM 6	136.6	90.0	14.6	12.7	0.182	6.7	2.1	3.3	7.0	14.0
LM11	137.8	86.4	14.4	19.3	0.165	3.7	2.8	1.8	4.0	13.5
LM 12	109.0	60.1	11.3	17.6	0.180	3.2	3.0	1.9	4.0	21.3
LM 13	163.2	81.2	13.9	12.2	0.181	4.4	2.0	1.4	3.7	18.0
LM 16	121.7	60.4	12.0	20.3	0.211	1.3	1.0	1.2	1.7	35.3
LM 17	169.6	98.6	13.7	27.9	0.240	1.4	1.0	0.3	2.3	46.7
HKI 170 (1+2)	143.1	72.4	14.7	25.5	0.246	1.4	1.0	0.0	2.0	42.7
HKI 325 17 AN	150.8	77.2	14.6	23.4	0.232	1.4	1.0	0.0	2.3	38.7
HKI 161T	112.4	48.0	11.4	18.1	0.165	3.2	2.1	0.1	2.3	12.3
HKI 577	142.3	70.3	13.1	23.5	0.241	1.3	1.1	0.4	1.0	48.7
HKI 1532	122.1	57.1	12.3	23.7	0.235	1.0	1.0	0.0	1.0	40.3
HKI 1105-6	78.9	41.0	12.1	19.8	0.152	3.4	1.9	2.3	4.7	3.0
HKI 1094WG	113.1	59.7	12.8	18.6	0.143	4.2	1.3	2.1	2.0	22.7
HKI 161	120.1	62.6	12.0	17.9	0.182	3.1	2.0	2.2	2.3	21.0
HKI 335	89.3	45.4	11.0	19.3	0.213	2.1	1.7	1.1	2.0	34.0
HKI 1015 Wa-8	104.3	48.3	9.6	16.0	0.171	5.7	2.4	2.0	3.7	13.7
CA 14514	85.8	37.4	11.1	21.6	0.300	1.3	1.9	0.7	2.3	36.0
G18SEQC5F100	92.2	29.4	9.7	19.6	0.148	4.1	2.0	3.1	2.3	10.3
G18SEQC5F68	99.6	43.0	8.8	7.4	0.044	3.7	2.2	3.3	2.3	12.3
F1 Hybrids										
LM 17 X HKI 1015 Wa-8	173.2	94.7	13.9	30.0	0.282	2.0	1.0	0.0	3.3	82.7
CA 14514 X HKI 1015 Wa-8	155.2	78.2	13.2	29.8	0.265	1.4	1.0	0.7	0.0	86.0
HKI 335 X HKI 1358 T	130.2	74.3	12.1	28.2	0.351	1.6	1.0	1.1	1.3	63.3
HKI 335 X K 64 R	146.4	74.0	13.0	29.5	0.312	1.3	1.0	0.8	0.0	66.7
LM 17 X LM 14	194.0	114.4	14.9	29.8	0.230	1.2	1.0	0.0	3.0	78.4

Table 23. Comparative performance of selected 24 maize inbred lines for flowering stage drought under managed stress conditions (Rain-out-Shelter) during *kharif* 2011

Genotype	Leaf area Index		Leaf Chlorophyll (SPAD value)		RWC (%)		Photosynt-hetic rate (µmol $m^{-2}s^{-1}$)		Transpiration rate(mmol $m^{-2}s^{-1}$)		Anthesis-silkimg Interval (ASI)		Grain yield/ plant (g)	
	C	D	C	D	C	D	C	D	C	D	C	D	C	D
HKI 170 (1+2)	3.41	2.06	45.4	32.3	87.2	56.6	34.6	24.2	8.8	6.1	2	5	55.0	23.3
HKI 209	3.86	2.47	40.1	34.9	82.6	68.4	40.2	32.8	6.5	3.8	0	1	68.0	30.6
HKI 295	3.22	2.16	45.0	29.1	83.0	48.6	34.9	19.3	7.6	3.8	3	5	43.0	13.0
HKI 325-17AN	3.31	2.68	47.7	41.1	84.7	68.6	43.1	39.8	8.5	4.9	1	3	60.0	40.3
HKI 335	3.60	2.31	44.6	38.8	88.8	69.3	37.8	31.1	8.6	5.5	2	3	55.5	34.7
HKI 577	3.48	2.83	48.2	41.3	80.3	63.9	39.1	34.4	7.4	4.7	0	2	54.7	45.9
HKI 1015-wg8	3.20	2.17	36.2	28.9	80.0	39.5	32.0	10.6	7.7	5.6	2	4	34.0	3.4
HKI 1025	4.14	2.76	39.2	28.1	86.0	47.9	39.9	20.4	7.9	5.8	5	7	26.3	2.0
HKI 1358T	3.08	1.71	43.9	27.1	84.7	49.2	35.4	22.6	7.7	4.1	1	3	36.5	6.0
HKI1532	3.29	2.88	42.6	36.5	85.8	63.3	45.1	34.9	8.9	5.0	1	1	67.5	48.2
CM139	3.27	2.46	41.1	38.3	85.0	60.4	40.7	36.1	8.1	5.4	2	4	55.5	39.3
CML 69	3.98	3.11	38.9	23.7	84.0	44.8	38.0	24.7	8.1	7.2	3	7	33.5	6.3
LM 12	4.23	3.51	40.4	27.4	87.9	48.7	43.5	23.6	9.0	7.6	2	5	46.0	9.8
LM 14	3.38	2.60	42.4	28.2	83.6	44.6	40.0	26.1	9.3	7.7	3	7	35.0	18.6
LM 16	3.71	2.72	46.4	32.4	89.2	57.4	38.2	31.4	7.3	3.5	2	5	53.6	36.5
LM 17	3.26	2.80	42.1	39.9	92.4	62.3	39.1	32.2	8.9	4.9	1	3	77.0	53.0
BLSBRIL 8	3.53	2.90	43.7	29.3	82.2	47.7	39.1	22.4	7.7	4.9	5	8	27.9	7.2
BJIM- 08-27	3.20	2.77	41.0	35.8	87.1	65.3	43.2	30.8	7.7	5.9	2	3	71.0	31.2
BJIM - 10- 36	3.41	2.78	48.6	36.7	87.0	61.9	38.7	26.6	9.7	6.5	2	4	68.0	38.0
BJIM - 10- 37	3.41	1.85	41.3	25.6	85.6	42.4	35.3	18.9	7.6	2.9	5	7	25.1	8.6
DTPYC9F119	3.24	2.57	45.7	42.8	88.1	65.6	38.4	30.3	7.4	3.2	2	3	57.5	26.6
DTPYC9F4	3.51	2.34	44.3	38.2	85.5	56.2	37.8	20.2	7.3	6.5	3	6	44.6	19.4
CA14514	3.63	2.44	49.5	38.6	83.7	49.6	40.6	28.9	7.7	4.4	1	3	56.4	37.5
POOL16 BNSEQC3F34	3.37	2.18	43.3	23.7	81.6	44.8	38.8	17.4	6.1	5.2	2	7	33.0	19.8
Mean	**3.49**	**2.54**	**43.4**	**33.3**	**85.3**	**55.3**	**38.9**	**26.7**	**8.0**	**5.2**	**2.2**	**4.5**	**49.4**	**25.0**

Crop Protection

- **Pathology**
- **Entomology**

PATHOLOGY

Studies on variability among the isolates of *Macrophomina. phaseolina* and *Fusarium verticilloides* in maize and Identification of sources of resistance against Post Flowering Stalk Rots of maize.

A total of 72 entries were tested in experiment field during 2011 *kharif* out of them following 29 promising entries were selected

1. SW-93D-313-23-Pop.49-S4-1-3-1-1-1-2-1-2-1-2-3-1-3-1-2
2. JCY3-7-1-2-1-'b-6-1-1-1-1-1-1
3. JCY3-7-1-2-1-'b-2-3-2-1-3-1-1
4. 42050-1-1-2-1-1-1
5. JCY3-7-1-2-2-1-3-1-1-2-7-1-2-5
6. CML 370-1
7. CM-117-3-2-1-1-1-2-1
8. CML 432 -2
9. CML 446
10. CML 248 -2
11. CML 389-4-1
12. CML 353-2
13. CML 269-1
14. TL02A-1184A-32-1
15. TL02A-1184A-32-4 -1
16. AF04B-5427 -93-3 - 3
17. AF03B-5402-15-2 - 1
18. AF -04-B-5779-22-3 - 3
19. AF-04-B-5796-A- 7-1-1-3
20. AF04B-5405-15-3-1
21. JCY2-2-4-1-1-1-3-1-3-1-1-1-2
22. LM 13-1 -3
23. CML 361-1
24. CML 434-1-1
25. CML 341-1-3
26. CML 446-2-1
27. CML 249-1-2
28. CML 321-1-2
29. CML 491-1-1

- Advance maize inbred line developed with resistance against PFSR (Post Flowering Stalk Rots) and were to compared to 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 were identified, developed and evaluated at four identified hot spot location, (Hyderabad, Delhi, Udaipur & Ludhiana) during 2006 to 2010. Multiplication of seed was done at WNC, Hyderabad during 2011.
- Out of eight resistant lines two inbred lines resistant for PFSR were registered with NBPGR and rest is in pipeline.

a. DMR- PFSR -1 (IC0590094/INGR11041)
b. DMR - PFSR-9 (IC0590095/INGR11042)

Study of molecular characterization of isolates of *Macrophomina phaseolina* and *Fusarium verticilloides* obtained from different maize growing areas of India

Twelve isolates of *F. verticilloides* and Eight isolates of *M. phaseolina* were collected from different agro climatic zones of India. 120 Operon primers from A, B, C, D, E and O series were tested for *Macrophomina* of which 24 from A, B, C, D and E series were selected for use in study of *M.phaseolina*. Total of 80 primers were tested for *F. verticilloides* of which 7 primers from B, C, and D series were selected for use in study of *F. verticilloides*.

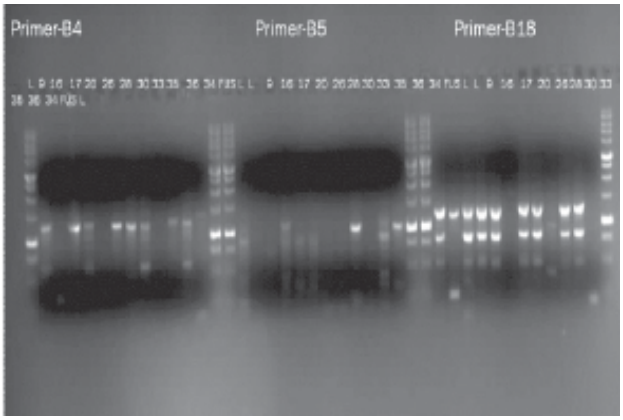


Fig. 23a DNA profiling of *F. verticilloides*

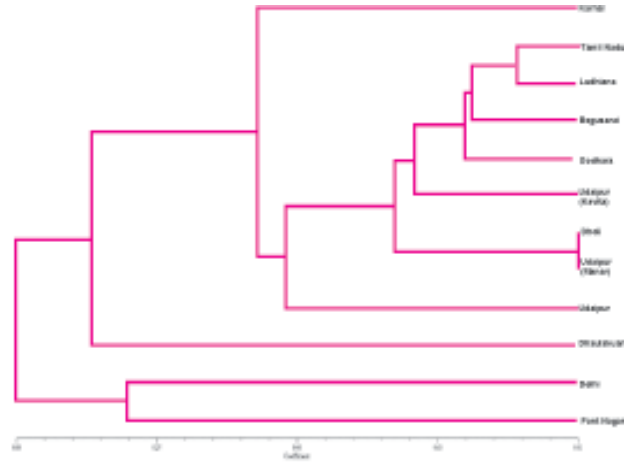


Fig. 23b Dendogram based on DNA characterization

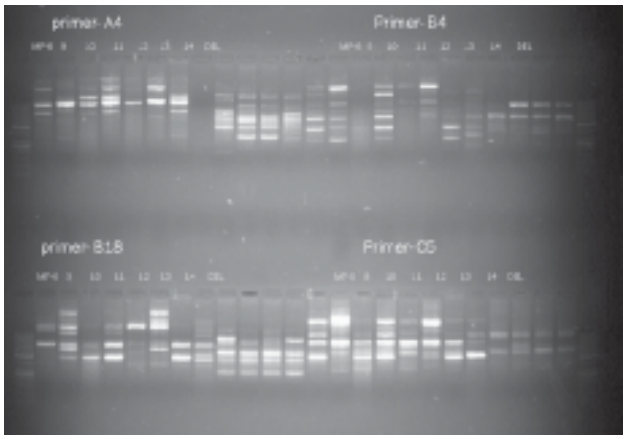


Fig. 24a DNA profiling of *M. phaseolina*

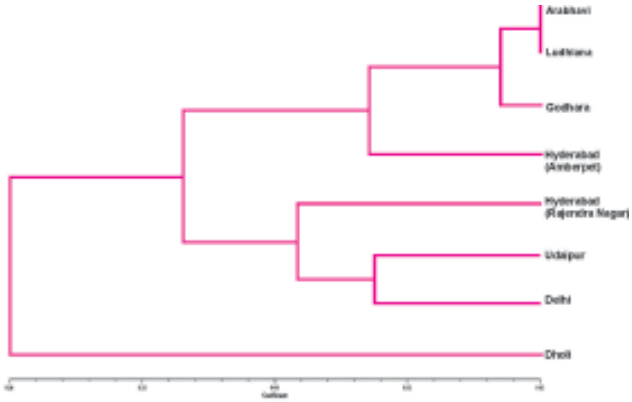


Fig. 24b. Dendogram developed based on DNA haracterization

Fusarium verticilloides

- Cluster analysis sub-divided the isolates into two major groups
- Group 1 contained isolates of Delhi and Pantnagar while, Group 2 contained isolates from Karnal to Dhaulakuan.
- Karnal isolate is out grouped with approximately 40 % similarity with rest of isolates (Fig. 23a & b).
- In group 2 again two groups formed in group 1 Dholi and Udaipur (Manar) with approximately 81% similarity.
- Tamil Nadu and Ludhiana formed another group with approximately 73 % similarity.

Macrophomina phaseolina

- Genetic analysis divided the *Macrophomina* isolates into two major groups, where one group consisted of only Dholi isolate (Fig. 24a & b).
- Another group (Group II) has seven isolates, in which Arbhavi and Ludhiana isolates are genetically similar at 0.61 coefficient of similarity.
- Group II is subdivided in two sub-clusters,

containing Delhi, Udaipur and Hyderabad (R) isolate in one subgroup and Arbhavi, Ludhiana, Godhra and Hyderabad (A) in another subgroup.

- Major finding is that Hyderabad (R) and Hyderabad (A) are in two different subgroups though being closely located.

Post harvest management of losses due to microbial colonization in stored maize grains

- Among 26 genotypes X1280, HQPM 1, Navjot and Prakash exhibited better storability during nine months storage as the germination percent is maximum (50-70%) as compared to other genotypes.

- These genotypes showed 5-10% increase in germination when treated with Potassium Carbonate @ (4gm/kg) & Propionic acid @ (4ml/ kg)

- Quality parameters *viz*; 100 kernel wt, Specific gravity, starch, oil, and sugar contents exhibited a decreasing trend while total protein increased during nine months storage.

Kernel Assay

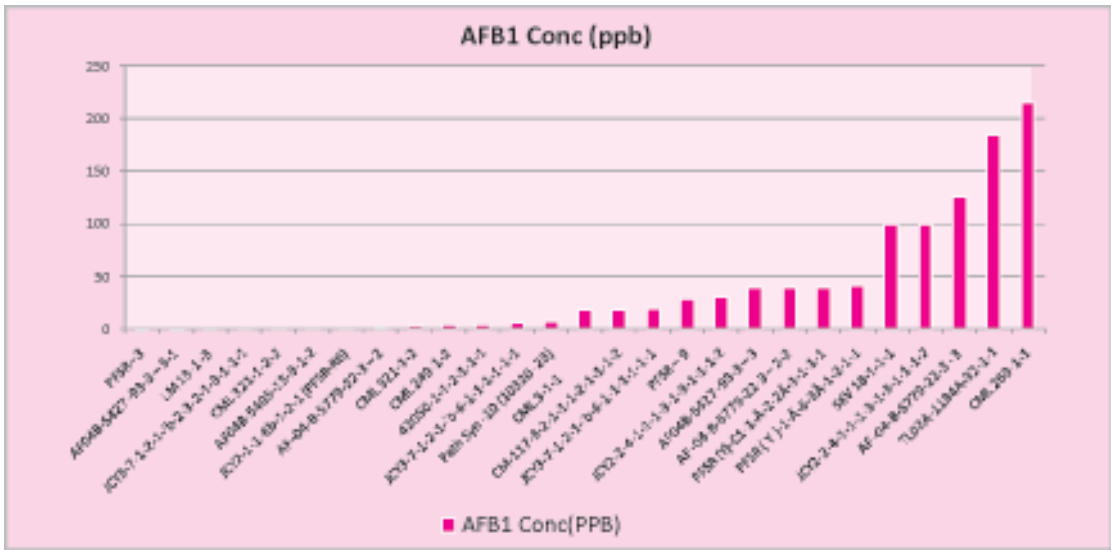
A total of 45 maize genotypes comprising 27 inbred lines, 6 hybrids and 12 pools were tested in laboratory for kernel assay experiment to find out resistant sources to aflatoxin contamination (Table 24a, b & c). Seeds were treated with highly toxic strain of *Aspergillus flavus*. The spore suspension was adjusted to concentration of 10^8 spores/ml and grains were dipped for 10 minutes in suspension for inoculation and for control. Same number of seeds were dipped in distilled water for 10 minutes and placed singly in each well in 24 well ELISA plates. Plates were incubated at temperature 26±2^{0}C and relative humidity of 95±2% for 15 days. Both the samples control and treated were analysed using ELISA method for Aflatoxin concentration. Out them 15 inbred lines some of them are, PFSR– 3, PFSR R -9, LM 13-1 -3, AF04B-5427 -93-3 – 3-1, CML 321-1-2-2, AF04B-5405-15-3-1-2 CML 321-1-2, CML 249-1-2, AF -04-B-5779-22-3 – 2, and Three pools *viz* PFSR (White), Indimyt-100, Indimyt-145, were found promising showing concentration of AFB_1 < 20 ppb which is permissible limit for human beings.

Table 24a. Estimation of AFB_1 in inbred lines

Inbred Line	AFB1 CONT-ROL	AFB1 TREA-TED
PFSR– 3	0.016	0.04
AF04B-5427 -93-3 – 3-1	0.136	0.398
LM 13-1 -3	2.094	0.671
JCY3-7-1-2-1-'b-2-3-2-1-3-1-1-1	0.014	1.166
CML 321-1-2-2	8.577	1.585
AF04B-5405-15-3-1-2	13.594	1.585
(PFSR-R6	0.042	1.626
AF -04-B-5779-22-3 – 2	0.054	2.326
CML 321-1-2	0.061	3.548
CML 249-1-2	7.356	4.642
42050-1-1-2-1-1-1	0.005	5.012
JCY3-7-1-2-1-'b-6-1-1-1-1—	0.398	6.31
Path Syn -10 (10320 -23)	0.918	7.451
CML 3-1-1	0.583	18.478
CM-117-3-2-1-1-1-2-1-1-1-2	1.359	18.478
JCY3-7-1-2-1-'b-6-1-1-1-1-1-1	0.19	20.261
PFSR – 9	1.166	29.286
JCY2-2-4-1-1-1-3-1-3-1-1-1-2	0.484	31.221
AF04B-5427 -93-3 – 3	0.394	39.811
AF -04-B-5779-22-3 – 2-2	0.631	39.811
PFSR (Y)-C1-1-?-2-2?-1-1-1-1	0.43	40.323
PFSR (Y)-1-?-6-3?-1-2-1-	4.262	42.332
SKV 18-1-1-1	0.858	100.0
JCY2-2-4-1-1-1-3-1-3-1-1-	0.1	100.0
AF -04-B-5779-22-3 - 3	0.025	125.89
TL02A-1184A-32-1-1	0.002	184.78
CML 269-1-1	3.981	215.44

PFSR –R 6

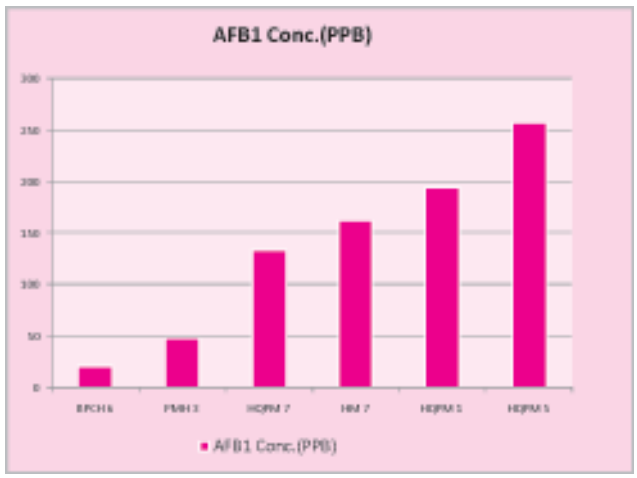
TL02A-1184A-32-1-1

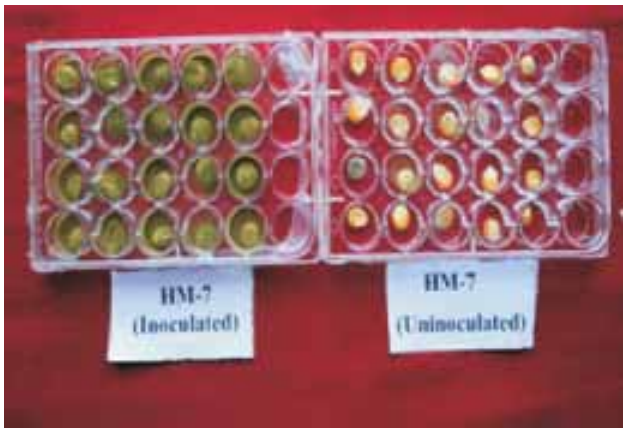


Graphic representation of *Aflatoxin* concentration observed in inbred line under artificial inoculation condition

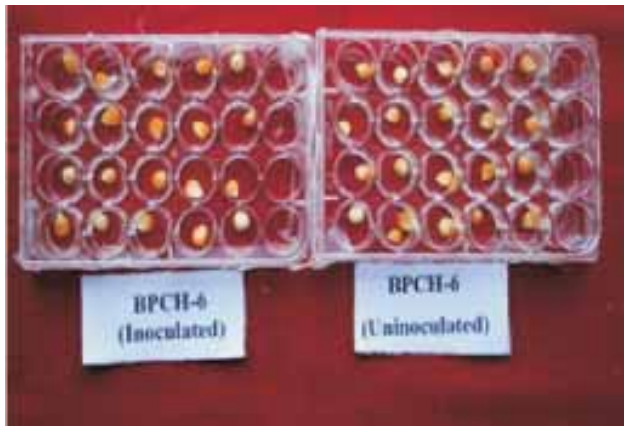
Table 24b. Estimation of AFB_1 in hybrids

Hybrids	AFB1 CONTROL SAMPLES	AFB1 TREATED SAMPLES
BPCH 6	6.943	21.544
PMH 3	0.005	48.603
HQPM 7	0.507	133.865
HM 7	18.69	162.596
HQPM 1	0.365	194.486
HQPM 5	49.835	257.698





HM-7



BPCH - 6

Estimation of AFB_1 for pools

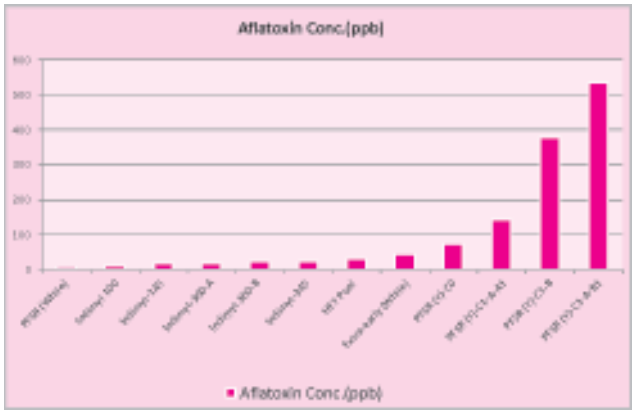


Table 24c. Estimation of AFB_1 in pools

PedigreePools	AFB ppb in Control	AFB ppb in Treated
PFSR (White)	0.001	6.58
Indimyt-100	0.000	10.00
Indimyt-145	0.022	16.88
PFSR (Y)-C1-A-A1	0.003	141.75
PFSR (Y)-C1-B	0.012	376.49
PFSR (Y)-C1-A-B1	0.060	533.67

PFSR (White)

PFSR (Y)-CO

Identification of stable sources of resistance to major diseases of maize

- Morphological characters of 86 lines were recorded as per DUS guidelines. Out of them, 10 lines *viz*.; Gen6033, CML269 and 42050-1-1-2-1-1-3, PFSR-R10, JCY2-7-2-1-1-B-1-2-1-1, JCY3-7-1-2-'B-1-1-4-1, JCY3-7-1-2-1-'B-1-1-2-3-1-1, CM117-3-4-1-2-5-2, LM13 and LTP 4 were found moderately resistant to BLSB. Based on diseases severity scores; lines with erect angle between blade and stem, straight and narrow attitude of blade, absence of anthocyaninn colour in leaf sheath, dense spikelet, narrow angle between main axis and lateral branches (in lower third of tassel) and straight attitude of lateral branches (in lower third of tassel) were found to confer resistance to the plant against BLSB.
- A total of 224 elite lines were evaluated against major diseases of maize under artificial epiphytotic conditions at various hot spot locations during *kharif* 2011 *viz*.; PFSR at Hyderabad, Udaipur, Delhi and Ludhiana, MLB at Ludhiana & Delhi, TLB at Almora, Bajaura & Mandya, P. rust & SDM at Mandya, BLSB at Delhi, Pantnagar & Dhaulakuan, ESR at Ludhiana & Dhaulakuan, BSDM at Dhaulakuan and RDM at Udaipur. Out of them 2 lines were found resistant against TLB, 31 against MLB, 3 against BLSB (MR), 56 against BSDM, 64 against PFSR, 2 against P. rust, 57 against RDM, 25 against ESR, 35 against Curvularia leaf spot. Some of the promising lines summarised in Table 25.

Table 25. Promising lines for multiple disease resistance

TLB	PFSR - R10, PFSR - S2
MLB	HKI-MBR-139-2, CML 117-3-4-1, KML 3-3, PFSR R3-4, CML 44, KML 3-1, DMSC16-1, HIGH OIL POPULATION II-, PFSR-R9, PFSR-S2, PFSR-S3, SW-930-313-23-PO-49-54, PFSR R3-1, KML 3-3, PFSR R3-4, CML 44, KML 3-1, DMSC16-1, HIGH OIL POPULATION II-, PFSR-R9, PFSR-S2, PFSR-S3, JCY2-1-2-1-1B-1-2-3-1-1, CML33, SW933D-313-23-POP.49-S4-1, JCY3-7, LM13
BLSB (MR)	BML 7, JCY 3-7, JCY2-2-4
BSDM	Win sweet corn, 951-7 , CUBA 380, DMSC16-1, DMSC-37-3, HKI PC 4B, HKI-PC-5-1, HKI-PC-7, WINPOP-1, WINPOP-4, WINPOP-21, ESM-11-3, PFSR/51016-1, Hyd05r/2-1, Hyd05R/13-2, LM15, LM16, CM114, CM144, HKI C 78, HKI 141-2, HKI C 323, Pool 16 BNSEQ.C3F6x38-1, CML 269, CML 384, HKI 164-7-4 ER-3, HKI 191-1-2-5, HKI 193-2-2-4, HKI-MBR-139-2, DMR QPM-03-104, DMR QPM-58-26, CLQ-RCYQ30, CLQ-RCYQ36, CLQ-RCYQ41, CML 451Q, 02POOL 33 C24, PFSR-R2, PFSR-R3, PFSR-R9, PFSR-R10, PFSR-R10, PFSR-S2, PFSR-S3, JCY2-1, JCY2-7, CM 117-3-4, SW-93D-313-23-POP.49-S4-1, JCY3-7, CM117-3-4, JCY3-7, CML44, LTP4

PFSR	SCM PINK, KML 29, CML 269, Hyd05R/2-1, HKI C 323, CML 269, HKI 191-1, HKI 193-1, CML 165, CLQ-RCYQ36, HKI 193-2, PFSR - S2, JCY2-1, JCY2-7, CM 117-3-4, CML 3, CM 117-3-4, SW-93D-313-23-POP.49-S4-1, PFSR – R9, PFSR – R10, PFSR – S3, JCY2-2, JCY3-7, LTP 4, 42050-1-1-2-1-3, DMSC-37-3, Gen6033, LM16, CM121, HKI-141, HKI193-2, DMHOC4, PFSR-R3, PFSR-R10, PFSR-S2, LM13
Polysora rust	HKI 141-2, HKI 193-1, KML 3-3
RDM	EC 646012, HKI 1040-11-7, HKI 141, G18Seq C5 F74-2-1-1-2-1-B-B-B, CML 384, HKI 34(1+2)-1, PFSR – R10, PFSR - S3, JCY2-1, CM 117-3-4, LM 13, PFSR-R9, PFSR-R10, PFSR-S2, PFSR-S3, SW-930-313-23-PO-49-54, JCY3-7, PFSR R3-1, SW-93D-313-23-POP.49-S4, HKI-PC-5-1, 42050-1-1-2-1-3, 10601, KML 3-3, JCY 3-7, KML 3-5, JCY 2-2, PFSR R3-5, HKI193-2, DMRQPM-03-104, PFSR-R9, JCY2-1, 42050-1-1-2-1-1-3, LM13
ESR	951-7, WSC Shrunken X MUS MADHU, WINPOP-3, KML 29, HKI PC 4B, WINPOP-16, WINPOP-21, WINPOP-1, P390Am/CML c4 F230-B-2-1-2-2-B-B-B, WS KHOTHAI-1-WAXY-1-1, HKI 1040-11-7, HKI 141, ESM-11-3, DMR QPM-03-104, DMR QPM-58-26, DMRQPM 58, SW-930-313-23-PO-49-54, JCY2-1, CM 117-3-, PFSR – S3, CM 117-3-4, JCY3-7, HKI 1128, 10608, LM12
CLS	WSC Shrunken X MUS MADHU, P390Am/CML c4 F230-B-2-1-2-2-B-B-B, T2str-1107 EC596653, BML 6, EC 646012, ESM-11-3, SW-930-313-23-PO-49-54, JCY3-7, DTPWC9-F75-3-2, CML446, DMSC-37-3, LM15, HKI164-3(2-1)-1, CML167, HKI-MBR-139-2, SC24- (C12)-3-2-1-1, HKI 323, HKI-PC-5-1, DTPWC9-F31-1-1Tempx Trop (H0)QPM-B-B-B-57-B-B, PFSR – S2, CM 117-3-4, CLQRCYQ-47-B, HKI 1040C2, HKI-1040-11-7, HKI 1040-5, HKI C 322, WINPOP-1, SCF, SCM PINK, Mas madu (sh2sh2), LM12.

ENTOMOLOGY

Role of phenolic acids in maize resistance to the spotted stem borer, *Chilo partellus*

Seventeen maize inbreds were screened for their resistance to maize stem borer (*C. partellus)* at different phenological stages of plant growth (10, 15, 20 and 25 DAG). Among them HKI-577 and HKI-323 are grouped as resistant inbreds based on damage parameters *viz*., leaf injury rating (LIR), stem tunneling and percent dead hearts. Higher damage was observed on HKI-488, HKI-1035-10, HKI-3-4-8-6ER, HKI-1332 and HKI-295 and were identified as susceptible inbreds. Phenolic acids *i.e*., ferulic acid and p-coumaric acids were quantified from seventeen inbreds by HPLC-PDA. The *p*-coumaric acid was more prevalent than the ferulic acid in all the inbreds at different phenological stages of plant growth. There was significant difference in the content of ferulic acid and p-coumaric acids among the inbreds, ranging from 1.41 to 5.58 mg/g and 0.72 to 4.90 mg/g of fresh weight of leaf samples respectively. The content of these acids in inbreds was found to be negatively correlated with the leaf injury rating of *C. partellus* at different phenological stages of the plant growth. Bioassay conducted by diet impregnated with these acids affected growth and development of *C. partellus*. The mortality was higher in *p*-coumaric acid than ferulic acid. The *p*-coumaric acid reduced the larval and pupal weight significantly, whereas ferulic acid showed no affect on larval and pupal weight. Both the phenolic acids prolonged the development period, reduced pupation and delayed adult emergence, thus affecting growth and development of *C. partellus.*

Inbred lines registered with NBPGR

Three promising lines, resistant to pink borer *Sesamia inferens* were registered at NBPGR

a. DMRE-7 (INGR10077),

b. 201DMRE-9 (INGR11028)

c. DMRE-57 (INGR 11029)

Identifying the sources of resistance to *Sesamia inferens*:

During *rabi* 2011-12, 202 inbred lines along with one susceptible and resistant checks from Indian maize program were evaluated against *S. inferens* in WNC, Hyderabad by releasing 12-15 neonate larvae on 15 day old plants. Leaf injury rating (LIR) was recorded 30 days after infestation. Only two lines, WNZPBTL6 and E57B were found to be least susceptible to Pink borer (Table 26).

Table 26. Screening of maize inbred lines against *Sesamia inferens* during *Rabi* 2011-12

S.No.	Pedigree	Mean leaf injury rating (on 1-9 Scale)
1	WNZPBTL 1	2.45
2	WNZPBTL 2	2.48
3	WNZPBTL 3	2.81
4	WNZPBTL 4	3.50
5	WNZPBTL 5	3.23
6	WNZPBTL 6	2.95
7	WNZPBTL 7	3.43
8	WNZPBTL 8	2.19
9	WNZPBTL 9	1.95
10	CM 202	7.70
11	CML 287	7.95
12	CML 451	8.06
13	BASI LOCAL	8.55
14	CM 500	3.30
	CD 5%	0.48

Social Sciences

- **Extension**
- **Computer Application**

EXTENSION

Strengthening and Refinement of Maize AGRI*daksh*

Maize AGRI*daksh*, is an expert system of maize to disseminate recent advances in maize to the users. It is based on **AGRI*daksh*** which is a tool for developing online expert system.

The information and images of varieties, weeds, diseases and nutritional disorder of maize is updated in the knowledge base of the system. The maize varieties were validated and duplicated/ unwanted varieties were deleted from Maize Expert System. Decision Tree module was re-examined and modified by adding more questions for variety selection. Database designing for the development of Multilingual System was completed.

Accelerating adoption of maize production technologies in India

DMR conducted demonstrations in 25 acres of land in Punjab, Haryana, Uttar Pradesh and Rajasthan using DHM 117 and HQPM 1 hybrids in *kharif* 2011. Average yield of DHM 117 and HQPM 1 in demonstration were 78.34 and 68.0 q/ha respectively.

Monitoring of FLD at Garhshankar in Punjab

Frontline Demonstrations (FLDs)

DMR coordinated approximately 8000 FLDs during *rabi / spring* 2010-11 and *kharif* 2011 in more than ten states of India through public and private sectors. Seed production technology of QPM, baby corn, green cobs, single cross hybrids and intercropping *etc*. were demonstrated in FLDs at farmer field.

FLDs - Regional Maize Research and Seed Production Centre, Begusarai

FLDs were also conducted in Bihar State to promote different technologies. The details of the FLD's allotted and conducted during *kharif* and *rabi* 2010-11 are given below:

Front line Demonstrations during 2010-11

Allotted	Conducted
kharif	
100	**100**
rabi	
400	**400**

BMZ Project – Abiotic stress tolerant maize for increasing income and food security among the resource poor in South and South-east Asia

This project is running in DMR with the objective of system analysis for enhanced maize product targeting. The ranking of production constraints was done in Morva and Santrampur districts

Ranking of production constraints in Maize

Production constraints	Morva	Santranpur
Soil type (*e.g.* undulating and rocky)	-	2
Water scarcity/lack of irrigation water	1	1
Access to quality seed	4	4
Access to fertilizer	2	3
Land availability	3	-
Feed/Fodder	-	3

Farmer's expectations in future

- Drought tolerant maize varieties
- Irrigation facilities
- Availability of fertilizer in time
- Access to crop knowledge/information, land leveler (Santrampur Block)

Other infrastructures like hospitals, colleges, banks and co-operative societies.

Field Day at seed production plot in Sarayranjan, Samastipur (Bihar)

COMPUTER APPLICATION

- For strengthening statistical computing high end statistical package 'SAS' provided by IASRI is installed and maintained on computers of DMR staff.

- PERMISNET -II - Personnel Management Information System Network (PERMIS*net*-II) for ICAR is next version of PERMIS*net*. The information related to personal, professional and referential attributes of staff of DMR is managed and updated by ARIS CELL on regular basis.

- PIMS-ICAR - Project Information and Management System of ICAR

  Ongoing and new approved projects were uploaded and project Id and password were issued to PI of the all the projects. Technical support for data entry is provided by Nodal officer at ARIS CELL.

- HYPM- Half Yearly Progress Monitoring System of scientists

  This online software developed at IASRI was started to enter proposed targets for the coming half-year and achievements of the completed half-year with respect to research, teaching, training, extension and other prioritized activities of each scientist. A unique user Id & password has been issued to all scientists of the DMR for submission of their half yearly progress.

- The website of the institute *www.maizeindia.org* is regularly updated and developed by ARIS Cell of the DMR. The Maize Expert System is regularly updated through the Maize Agri*Daksh* developed with IASRI collaboration.

Institutional activities

- Technology Assessed & transferred
- Linkages & Collaborations
- Awards & Recognitions
- Significant Events
- Distinguished Visitors / Foreign delegates
- Human Resource Development
- Participation in Trainings / Conferences / Symposium / Seminar / Workshop / Meetings- (International and National)
- Lectures Delivered
- T.V / Radio Talks
- On-going Projects
- Publications
- Appointments / Promotions / Transfers / Retirements
- Important Committees
- Personnel

Technology assessed and transferred

Trainings conducted

Officers' Training

DMR coordinated more than twelve Officers' Training Programmes under ISOPOM in different parts of the country. Progressive farmers (men and women) attended these trainings. They gained knowledge and skill about cultivation of *kharif* and *rabi* maize, QPM, baby corn, sweet corn, pop corn, intercropping, seed production, value addition and industrial utilization *etc*. These trained officials will impart training to the farmers in their respective states and regions to benefit the farming community.

Director (DMR) addressing participants in Officers' Training Programme

Intensive Maize Training for Freshers

A two days training programme was organized from October 28-29, 2011 at Directorate of Oilseeds Research, Hyderabad. Sixteen scientists and maize workers from different SAUs/ICAR Institutes across the country attended the training programme. The participants were exposed to newer techniques in maize improvement.

Trainings conducted under PPV&FRA

- One day Awareness-cum-training programme on PPV&FRA was organized at Winter Nursery Centre, Hyderabad on October 30, 2011

Organizers and participants of Awareness cum training program, WNC, Hyderabad

- One day Awareness-cum-training programme on PPV&FRA was organized at Aterna village, Haryana on February 29, 2012

Organizers and participants of Awareness cum training program, Aterna village, Haryana

Kisan Melas and Exhibitions

Directorate of Maize Research actively participated by putting up stalls in the following Kisan Melas and Exhibitions/occasions:

Delegates of 54th Annual Maize Workshop visiting maize exhibition in TNAU, Coimbatore (April 02-04, 2011)

6th National Conference on KVKs held at JNKVV, Jabalpur, Madhya Pradesh (3-5 December 2011)

DDG (Crop Science), ICAR and Vice Chancellor (CCSHAU, Hisar) along with other delegates visiting maize stall

Pusa Krishi Vigyan Mela - IARI, New Delhi (March 01-03, 2012)

Secretary, DARE and DG, ICAR - India International Trade Fair (IITF) held in Pragati Maidan, New Delhi (November 14-27, 2011)

Global Conference on Women in Agriculture - IARI, New Delhi (March 13-15 2012)

IARI Regional Station, Pusa (Bihar) on 17-03-2012 and Sh. Giri Raj Singh, Minister for Animal Husbandry and Fisheries was Chief Guest on this occasion

Maize Field days

- Field day was conducted on February 26, 2011 at WNC, Hyderabad. Forty scientists from public sector visited and selected the introductions and inbred lines for utilization in the respective breeding programs. In this field day a total of 2768 genotypes of different categories were planted for selection.

- At RMR & SPC Begausarai three Field days were conducted during the year under report. One field day cum training programme was organised during October, 2011 and seed of parental lines was distributed to farmers for hybrid seed production.

Patents filed

A multipurpose folding type of insect rearing cage has been developed. The technology has been filed for patenting *vide* Patent Application no. 0923/DEL/2011.

Insect rearing cage

Commercialization of technology

A non-exclusive license has been given to Amar Chand & Company, 56, Ambala Cantt.133006 to produce insect rearing cage.

Tribal Sub Plan (TSP) of ICAR

- Demonstrations

  During *rabi*/spring 2011-12, complete package of practices of single cross hybrid, quality protein maize, baby corn, seed production, resource conservation technologies and Integrated Pest Management *etc*. were being demonstrated at tribal farmers' field. Cost of cultivation in the form of inputs is being provided to the demonstrating farmers. Besides this, sprayers, weeders and shellers were also distributed to farmers. DMR allotted 12 demonstrations of maize to tribal farmers in Jharkhand and 15 demonstrations in Odisha.

- National level training programmes

  Five national level training programmes were conducted at DMR, New Delhi during 2011-

Ex-Vice chancellor, BAU, Ranchi addressing tribal farmers in training programme

Ms Ritu Singh imparting training on value addition of Maize

Trainings held under TSP

Three days training programme on ''मक्का का बीज उत्पादन, उत्पादन तकनीक एवं मूल्य संवर्धन'' at DMR, Pusa, New Delhi	22 to 24 March, 2012
National level training programmes on "Seed Production, Cultivation and Value Addition of Maize" at DMR, Pusa Campus, New Delhi	17-19 March, 2012
	22-24 March, 2012
	29-31 March, 2012
	26-28 March, 2012
	12-14 October, 2011

12. Approximately, 50 tribal farmers from more than ten states participated in each programmes. Farmers were trained about seed production, production technology and value addition of maize. These trained farmers will impart training to the other farmers in their respective states and regions and farming community will be benefited.

♦ Regional training programmes

During 2011-12, regional trainings were imparted in tribal dominated states such as North eastern states (Assam, Meghalaya, Manipur, Sikkim *etc*.) Andhra Pradesh, Rajasthan and Madhya Pradesh *etc*. Women tribal farmers also participated in these programmes. They gained knowledge and skill about cultivation of *kharif* and *rabi* maize,

Single cross hybrid DHM117 at tribal farmers' field in Medak in Andhra Pradesh

quality protein maize, baby corn, sweet corn, pop corn, intercropping, seed production, value addition and industrial utilization *etc.*

One day training programme on promotion of maize production in tribal areas of East Godavari district was conducted at Pandirimamidi, Rampachodavaram under TSP (2012) organised by KVK, Pandirimamidi on 20.3.12. About 350 tribal farmers attended the programme along with Agricultural officers from Rampachodavaram of seven tribal mandals of East Godavari district.

Training Conducted (Title)	Duration
Improved Hybrids of Maize, Seed Production and Production Technology for NEH Region	February 15-17, 2012
	March 1st, 2012
	March 20-21, 2012
	March 22-23, 2012
	March 23rd, 2012

Regional training in East Godavari district of Andhra Pradesh

Farmers of Odisha with input provided by DMR under TSP

Regional training in Chhindwara district of Madhya Pradesh

Training for farmers at Begusarai

Seed distributed to tribal farmers under TSP in Jharkhand

Farmers in Maize Field at RAU, Pusa

Linkages and collaborations

Launch of new ICAR-CIMMYT Collaborative Project

ICAR-CIMMYT collaborative project "Abiotic stress tolerant maize for increasing income and food security among the poor in South and Southeast Asia" (ATMA) was launched in Project Launch Workshop at University of Hohenheim, Stuttgart, Germany on May 30-June 1, 2011. The participants included Dr. R. Sai Kumar (Director), Dr. Jyoti Kaul, Dr. V. K. Yadav and Mr. Manavannan A. of DMR, Dr. P.H. Zaidi of CIMMYT-India, Dr. Gary Atlin, Dr. Raman Babu and Dr. Kai Sonder of CIMMYT-Mexico, Dr. Le Quy Kha of Hanoi, Vietnam, Dr. Art Salazar from Philippines, Prof. Dr. A.E. Melchinger, Prof. Dr. H.P. Piepho and Dr. H.K. Parzies of Stuttgart. During the presentations, Dr. R. Sai Kumar, Director, DMR highlighted the role of development of a comprehensive package (for the countries) to address pertinent issues of development and dissemination of abiotic stress tolerant maize Single Cross Hybrids with improved agronomic practices.

Organizers and Participants of ICAR-CIMMYT Project Launch Workshop at University of Hohenheim, Stuttgart, Germany

Awards and Recognition

Dr R Sai Kumar (Director, DMR) - jointly shared with Dr N Shobha Rani the prestigious **MS Swaminathan award** for their outstanding works in the field of agriculture. Dr R Sai Kumar was nominated for outstanding work done by him as a maize breeder in the development and release of 14 maize hybrids and varieties.

Directorate of Maize Research - **Best Institution Award** was given for promoting Plant Variety Registration for the year 2010-11.

Dr. VK Yadav (Senior Scientist, Extension) - **Young scientist award** 2011 conferred by Society of Extension Education, Agra for outstanding contribution in the field of Extension Education during 6th National Extension Education Congress

held at ICAR Research Complex for Goa, Goa during December 17-19, 2011

Dr. Ishwar Singh (Senior Scientist, Plant Physiology) - **Academy for Advancement of Agricultural Sciences Senior Award-2011** conferred by Indian Society for Plant Physiology (ISPP) for outstanding contribution in the field of plant physiology during 53rd National Conference of Plant Physiology (NCPP-2011), Mumbai by Dr. S. K. Datta, DDG (Crop Sciences)-ICAR, New Delhi on November 24th, 2011 .

Dr. Dharam Paul Chaudhary (Senior Scientist, Biochemistry) **- Young scientist award** by the Society for Recent Development in Agriculture during the International conference on Issues for climate change, land use diversification and

biotechnological tools for livelihood security held at SVPUA&T, Meerut during October 8-10, 2011.

Chikkappa G. Karjagi (Scientist, Plant Breeding) - **Jawaharlal Nehru Award** for Outstanding Doctoral Thesis Research in Agricultural and Allied Sciences in the discipline of Crop Science by Indian Council of Agricultural Research, New Delhi on the occasion of Foundation Day of the ICAR (16th July, 2011).

Dr. Meena Shekhar (Senior Scientist, Plant Pathology)- **Best Poster Award** for poster entitled "Comparision of cultural and analytical methods for estimation of aflatoxin B_1 from isolates of *Aspergillus flavus* isolated from maize grain samples obtained from various maize growing areas of India" in XI Asian Maize Conference, Nanning, P.R. China, November, 7-11, 2011.

Significant events

♦ Annual Maize Workshop

The 54th Annual Maize Workshop was held at Tamil Nadu Agricultural University (TNAU), Coimbatore from the April, 2–4, 2011. During pre-workshop session the Project Director, Dr R. Sai Kumar welcomed the delegates and presented an overview of maize scenario in India. This was followed by concurrent sessions of different disciplines (Breeding, Agronomy, Pathology and Entomology) wherein the work done at AICRP centers was presented. Dr. M. Paramathma, Director of Research, TNAU, Coimbatore welcomed the dignitaries and delegates attending the 54th Annual Maize Workshop. The workshop was inaugurated by Dr. Swapan Kumar Datta, DDG (Crop Science), ICAR. He mentioned the potential for export and income generation through maize. He also emphasized on value addition, biofortification and low phytate maize thereby bridging the research gaps which needs immediate attention to be addressed jointly by public and private sector. The maize expert system jointly developed by IASRI & DMR was launched by Dr. S.K. Datta. Dr. P. Murugesa Boopathi, Vice Chancellor, TNAU, the Guest of Honour, while delivering keynote address emphasized the commercial and industrial potential of maize. Dr. R.P. Dua mentioned the role of research and development in bringing out climate ready maize of climate change. The dignitaries released sixteen technical bulletins/documents published by DMR and other AICRP centres related to different aspects of maize. One patent technology; 'Insect Rearing Cage' was released and website 'Agri*Daksh*' – A tool for development of online expert system was launched. Dr. R. Sai Kumar, Project Director, DMR presented the Director's report for the year 2010-11 highlighting the performance of promising hybrids in different maturity groups, the transfer of technology for boosting maize production, training programmes for farmers, scientists and subject matter specialists of different states. Dr Sain Dass presented the "Impact of Single Cross Hybrid (SCH) Technology" stressing maize export, employment generation *etc*. in India and abroad. The session ended with the vote of thanks by Dr. K. Thiyagarajan, Director of (CPBG), TNAU.

Hybrids identified for release in Workshop

Maturity Group	Hybrids
Late maturity	X7B 401
	MCH 38
Medium maturity	KMH – 3712
	MCH 37
Late maturity	Mon 29 and Mon 27 (*Rabi*)

Plenary session showcased the recommendations of the three days of workshop. The following were the recommendations of different disciplines

Breeding

1. Data on two replications should be taken for shelling percentage and moisture percentage.
2. All the rejected data based on CV *etc* should also appear in Table in the co-ordinated book.
3. Single replication data cannot be included and analyzed for the co-ordinated trials.
4. DMR should supply the soft copy of data sheet in MS EXCEL to the centers in time and centers will enter their data in the supplied data sheet only.
5. On the point of sowing only one replication of maize trials, the Project Director should write to Vice-Chancellors for providing more land for maize, otherwise in the next plan the Project Director should recommend for the change in the center in review of co-ordinated system.
6. There should be change in the nomenclature of new entries for each center entering the co-ordinating evaluation, which can be discussed in the workshop.
7. Data on dry fodder parameters like *in vitro* digestibility, protein and other parameters should be generated on AET II QPM entries.

Entomology

1. Maize intercropped with cowpea (in furrows) in the ratio of 2:1 to minimize *Chilo* infestation
2. Adoption of a newly developed versatile insect rearing cage for entomology experimentation
3. Use of newly developed Susceptibility Index for screening maize germplasm against *Sitotroga cerealella*

Agronomy

1. All centers should select best germplasm for different seasons and locations for conduction of Agronomy trials.
2. Plan of work for cropping sequence in weed management trials is to be included.
3. All the centers should work out economics of different trials conducted by them and submit these data to DMR. Further it was also suggested to create one post of Economist at DMR to work out economic feasibility of any technology created and developed by the AICRP Maize Agronomy.
4. There is a need to create one post of agronomist at TNAU, Coimbatore as maize is now emerging crop spreading its area in the state at faster rate for conducting research on maize production aspects.
5. The DMR should supply seed material for conducting seed production trial in sufficient amount to all centres well in advance. In seed production trial parents of hybrid mostly cultivated and popular in the particular zone is to be selected.

Pathology and Nematology

1. Udaipur centre should come out with a status report on CLS and brown spot diseases in the Rajasthan State. The report should cover the extent of spread, losses caused, land races and varieties being cultivated in the endemic areas.
2. BLSB has assumed a serious problem in Rajasthan and Himachal Pradesh as reported by respective scientists from Udaipur (Zone V) and Dhaulakuan (Zone I). It is recommended that these two centres should carry out screening trials against BLSB. Besides this, Midnapur centre, Department of Agriculture, West Bengal in Zone III should also conduct trials against BLSB under artificially inoculated conditions.
3. The centre identified for conducting yield loss assessment trials should provide the data in uniform format. The most susceptible popular varieties should be used in trials and data on disease scores of protected and unprotected treatments yield in kg/ha, replication wise data and details of treatment applied should be provided.
4. The centres should provide useful data from the Disease Trap Nursery under natural condition only in the prescribed proforma supplied by DMR.
5. The arrangement for reimbursement of TA/DA incurred for survey and surveillance programme should continue for the identified centres (Mandya, Dhaulakuan, Pantnagar and Udaipur). It is recommended that expenditure should be reimbursed by DMR subject to a maximum of Rs 10,000/- on actual cost basis.
6. Hot spot locations like Mandya (TLB, Polysora rust and SDM), Delhi (BLSB and Charcoal rot), Udaipur (FSR and RDM) showed develop resistant source germplasm against these diseases as a long term strategy.
7. Hyderabad centre should conduct a survey of Andhra Pradesh especially Karimnagar and adjoining maize growing districts to prepare a status report on the occurrence of Late Wilt (*Cephalosporium* spp.)

♦ Research Advisory Committee (RAC)

Research Advisory Committee of the Directorate of Maize Research, Pusa Campus, New Delhi was held on 13th June, 2011 under the chairmanship of Dr. J.B. Chowdhury. The Action Taken Report was presented by the Member Secretary and the minutes were confirmed. Dr. R. Sai Kumar, Director, highlighted the significant research achievements of the Directorate. He emphasized on the production and promotion of single cross hybrid seeds of normal, quality protein maize, baby corn, sweet corn, pop corn and high oil content maize *etc*. The identification of sources of resistance against biotic and abiotic stresses and their use in cultivar development, conservation tillage, maize cropping systems and improved nutrition.

Members of RAC

Name of the Officer	Designation & Affiliation	Position
Dr. J.B. Chowdhary	Ex- Vice Chancellor, CCS HAU, Hisar & GBPUAT, Pantnagar	Chairman
Dr. Basant Ram	Ex-Vice Chancellor, NDUAT, Faizabad , Uttar Pradesh	Member
Dr. M. Udai Kumar	Ex- Professor & Head, Division of Crop Physiology, UAS, JKVK Campus, Bangalore	Member
Dr. N.S. Malhi	Ex- Sr. Maize Breeder & Ex- Director of Extension, PAU, Ludhiana, Punjab	Member
Dr. Baldeo Singh	Retd. Jt. Director (Extension), IARI & Professor (Extension), College of PG Studies, Central Agricultural University, Umiam, Barapani	Member
Dr. Sain Dass	Ex-Project Director, DMR, Pusa Campus, New Delhi	Member
Dr. R. Sai Kumar	Project Director, DMR, Pusa Campus, New Delhi	Member
A.S. Dhatt	Advisor Agriculture, SRTT, Ludhiana, Punjab	Member
Dr. K.S. Hooda	Principal Scientist, DMR, Pusa Campus, New Delhi	Member Secretary
Dr. P.C. Sharma	Dean, School of Biotechnology, GGS Indraprashta University, New Delhi	Member
Dr. R.P. Dua	ADG (FFC), ICAR, Krishi Bhawan, New Delhi	Member

♦ Institutional Management Committee (IMC)

DMR conducted the third IMC meeting on May 18, 2011 under the chairmanship of Dr. Sai Kumar (Director, DMR). The progress of ongoing activities of DMR was highlighted along with progress report since last IMC meeting. The members appreciated the efforts of DMR. Under the provisions of Rule 66(A) of the Rules of the Indian Council of Agricultural Research (ICAR) Society, the Union Minister of Agriculture and the president of ICAR Society has nominated the following official members in the Management Committee of Directorate of Maize Research, New Delhi for a period of three years with effect from 16.4.2012.

Members of IMC

S.No.	Name of the Officer	Designation & Affiliation	Position
1.	Dr. R Sai Kumar	Director, Directorate of Maize Research, New Delhi	Chairman
2.	Joint Director (Agriculture)	Development Department, Govt. of NCT, New Delhi	Member
3.	Director (Agriculture)	Govt. of Haryana, UT Chandigarh	Member
4.	Dr. Vijayraghvan	Joint Director (Extn), IARI, Pusa Campus Pusa, New Delhi	Member
5.	Dr. P. Kumar	Principal Scientist, Directorate of Maize Research, New Delhi	Member
6.	Dr. Pratibha Sharma	Principal Scientist (Plant Physiology), IARI, Pusa Campus, New Delhi	Member
7.	Dr. S. Vanila	Principal Scientist , NCIPM, New Delhi	Member
8.	Dr. T.R. Sharma	Principal Scientist , NRCPB, New Delhi	Member
9.	Dr. R.P Dua	ADG (FFC), ICAR, New Delhi	Member
10.	Financial & Administrative Officer	NRCPB, Pusa, New Delhi	Member
11.	Administrative Officer	DMR, New Delhi	Member Secretary

♦ Institutional Research Council (IRC)

Institute Research Council meeting of DMR under the chairmanship of Dr. R. Sai Kumar, Director (DMR) was conducted on the June 14, 2011. Dr. Sai Kumar welcomed the experts and the participants and presented an overview of maize research in India. Scientists of DMR presented the significant achievements of their respective *in house* projects, plan of work ahead and new project proposals. Six new projects were approved. The experts put forth their valuable suggestions.

Members of IRC

Name of the Officer	Designation & Affiliation	Position
Dr. R Sai Kumar	Director, DMR, New Delhi	Chairman
Dr Vinay Mahajan	Principal Scientist, Plant Breeding	Member Secretary
Dr VP Ahuja	Principal Scientist, Breeding (Retd.)	Expert
Dr Sain Dass	Ex-Project Director (Retd.), DMR	Expert
Dr KTP Gowda	Professor, Plant pathology	Expert

♦ Institutional Biosafety Committee (IBSC)

Institutional Biosafety Committee (IBSC) meeting was held on August 18, 2011 at Directorate of Maize Research to review the biosafety aspects of research activities. Dr. Sai Kumar (Director, DMR) was the chairman. IBSC was briefed on 'Development of Stem Borers Resistant Transgenic Maize' and 'Baseline Susceptibility of multiple populations of *Chilo partellus, Sesamia inferens* and *Helicoverpa armigera* for three Bt insecticidal proteins'. Dr. P Kumar highlighted precautions taken and safety procedures adopted in on-going biotechnological research programmes. The members visited biotechnology and entomology laboratories.

Members of IBSC

Name	Designation	Position
Dr. R. Sai Kumar	Director	Chairman
Dr. Pradyumn Kumar	Principal Scientist	Member Secretary
Dr. Jyoti Kaul	Principal Scientist	Member
Dr. Chikkappa G. Karjagi	Scientist	Member
Dr. C. M. Parihar	Scientist	Member
Dr. S. Vennila	Principal Scientist	Member
Dr. Anita Srivastava	Medical Officer In-charge	Member
Dr. Amar Kumar	Professor	Member

♦ Institutional Technology Management Committee (ITMC)

At the institution level, the ITMC chaired by Director of the Institution is the highest decision making body related to all issues of the IP management and technology transfer/ commercialization.

Members of ITMC

Name	Designation	Position
Dr. Sai Kumar	Director, DMR	Chairman
Dr. Pradyumn Kumar	Principal Scientist	Nodal Officer
Dr. Jyoti Kaul	Principal Scientist	Member
Dr. Meena Shekhar	Senior Scientist	Member
Dr. Ishwar Singh	Senior Scientist	Member
Dr. K.P. Singh	Scientist, Senior Scale	Member
Dr. Usha Nara	Research Associate, IPR	Member

Date of meeting	Purpose
June 09, 2011	♦ Signing of MoU ♦ Payment of consultancy charges to the site selection committee other than DMR members
March 22, 2011	Discussion on the activities mentioned in the MoU before signing with SBPL at DMR
April 10, 2012	Discussion on filing of forms for early publication and examination of the Patent application 923/ DEL/ 2011
April 18, 2012	Signing the MoU with Amar Chand& Company, Ambala Cantt., Haryana

♦ Quinnquennial Review Meeting 2006-2010

The Quinnquennial Review Meeting for the year 2006-2010 was held at four different centers in the month of February and March 2012. The venues of these meeting were Karnal, Udaipur, Hyderabad and Patna which covered centres of Zone II, III, IV and V. All the centres presented their five year work in maize at these meetings. Dr. R. R. Hanchinal, Vice Chancellor, UAS, Dharwad chaired these meetings and reviewed the work of all the centres in the above mentioned zones.

QRT Meeting at Hyderabad

QRT Meeting at Patna

QRT Meeting at Udaipur

♦ Hindi Activities

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Distinguished visitors / foreign delegates

World Food Laureate Dr. SK Vasal & Dr. R. Saikumar, Director, DMR

A delegation from Mozambique under the leadership of Dr. Inaciu Calvino Maposse, President of Scientific Council of Agriculture visited DMR on June 9, 2011.

Dr. S. Ayappan, Director General and Secretary DARE, Dr S.K. Dutta, Deputy DG (Crop Science), Dr. Sain Dass with Dr. R Sai Kumar, Director (DMR) visited DMR fields (*kharif* 2011) on September 9, 2011

A delegation from CAAS, China visited DMR

Shri AK Basu, Secretary Ariculture, Dr. SK Dutta, Deputy DG (CS), Dr. Gurbachan Singh, Chairman ASRB, Dr. HS Gupta, Director (IARI) with Dr. R Sai Kumar, Director (Maize)

Dr. A.K. Singh DDG (NRM) visited on October 17, 2011

Principal Secretary (Agriculture), Govt. of AP with Director (Maize) quite impressed with the performance of DHM117

Dr.B.S.Dhillon visited DMR (July 23, 2011; October 15, 2011)

Dr. R.B.Singh, President NAAS visited DMR (*kharif* 2011)

Dr.R.S.Paroda, former Secretary DARE abd DG,ICAR visited DMR

DDG (Agricultural Extension) visiting maize exhibits in DMR, New Delhi

Human Resource Development

Name	Programme	Venue	Date
International trainings			
Dr. K.P. Singh	Carbon nanotubes-based biosensor for agriculture	University of California, Riverside	28 April-27 July, 2011
National Trainings			
Dr. Bhupender Kumar	Intensive Maize Training for Fresher's	Winter Nursery Centre,Hyderabad	28-29 October, 2011
	Awareness-cum-Training Programme on Plant Variety Protection and Farmers' Rights with Special reference to Maize	Winter Nursery Centre, Hyderabad	30 October, 2011
	21 days Training - Data Mining Techniques and Tools for Knowledge Discovery in Agricultural database	IASRI, New Delhi	03- 23 November, 2011
Dr. Avinash Singode	21 days Training - Molecular approaches for allele mining and crop improvement	Division of Genetics, IARI	5-25 January, 2012
Dr. Chikkappa GK	Workshop and Training Program on Sampling and Detection Methods Applied to Transgenic Crops	ILSI-India in NIN, Hyderabad	17- 19 November, 2011
	Intensive Training on Maize for Fresher's	DOR, Hyderabad	28-29 October, 2011
	Awareness-cum Training Programme on PPV&FRA	DOR, Hyderabad	30 October, 2011
Dr. Dharam Paul Chaudhary	Genetics/Genomics Data Analysis using SAS	IASRI, New Delhi	19-24 September, 2011
Ms. Sapna	Genetics/Genomics Data Analysis using SAS	IASRI, New Delhi	19-24 September, 2011
	Fermentation technology	IARI New Delhi	09-22, December, 2011
Dr. S.L. Jat	Censor based application for enhancing input-use efficiency by Wireless irrigation and Fertigation control	WTC, New Delhi.	14-27 February, 2012
	21 days Training- Recent Advances in Designing and Analysis of Agricultural Experiments	IASRI, New Delhi	29 November - 19 December, 2011
Dr. C.M. Parihar	21 days Training- Recent Advances in Designing and Analysis of Agricultural Experiments	IASRI, New Delhi	29 November - 19 December, 2011

Name	Programme	Venue	Date
Dr Nirupma Singh	Awareness-cum-training program on Plant Variety Protection and Farmers Rights with special reference to Maize	Aterna village, Haryana.	29 February, 2012
Dr. R. Ambika Rajendran	Awareness-cum-training program on Plant Variety Protection and Farmers Rights with special reference to Maize	Aterna village, Haryana.	29 February, 2012
	Breeding for biotic and abiotic stresses in crop plants	Tamil Nadu Agricultural University, Coimbatore	09 - 29 November, 2011

Participation in Conferences / Meetings / Seminar / Symposium / Workshops (International / National)

Name	Programme	Venue	Date
International			
Dr. R. Sai Kumar Dr. Sangit Kumar Dr. P. Kumar Dr. V Mahajan Dr. K.S. Hooda Dr. Meena Shekhar Dr. Ashok Kumar Dr. J.C. Shekhar Dr. A.K. Singh Dr. Avinash Singode Dr. V.K. Yadav	11th Asian Maize Conference	Nanning, Guangxi, China	7- 11 November, 2011
Dr. A.K. Singh	Maize and Wheat CGIAR Research Programs	CIMMYT, Mexico	06-20 January, 2012
Dr. C.M. Parihar	5th World Congress on Conservation Agriculture Incorporating the 3rd Farming systems Design Conference	Brisbane, Australia	26-29 September, 2011
Dr. R. Sai Kumar Dr. Jyoti Kaul Mr. Manavannan A. Dr. V.K. Yadav	Abiotic stress tolerant maize for increasing income and food security among the poor in South and Southeast Asia	University of Hohenheim, Stuttgart, Germany	30 May - 01 June, 2011
National			
Dr R Ambika Rajendran	National Symposium on Innovative and Modern Technologies for Agricultural Productivity, Food Security and Environmental Management	Society for Applied Biotechnology, Mangalore, Karnataka	July, 22-23, 2011

Dr. Bhupender Kumar	Public Private interface meeting	CCSHAU regional research station, Karnal	01 October, 2011
Dr. Ashok Kumar	National Seminar on Transfer of technology of strategic pesticides use to enhance agriculture production and food security	New Delhi	1 June, 2011
	National workshop of All India Coordinated research Project for Investigations on Soil Test Crop Response Correlation	IISS, Bhopal 2011	28-29 July,
	University-Industry Interaction on maize	CCS Haryana Agricultural University Regional Research Station, Uchani, Karnal	1 October, 2011
	XXVI Biennial workshop of All India Coordinated Research Project of Micro and Secondary Nutrients and Pollutant Elements in Soils and Plants	BCKV, Kalyani (WB)	10-12 February, 2012
	National Seminar on Indian Agriculture: Preparedness for Climate Change	NASC, New Delhi	March
Dr. Ishwar Singh	National Seminar on Sustaining Crop Productivity though Physiological Intervention	Ramnarain Ruia College, Mumbai	24-25 November, 2011
	5th meeting of CGIAR Independent Science Partnership Council (ISPC)	NASC Complex	26 – 29 March, 2012
	Conference - Tribal farmers of Kashmir Valley	SKUAT-K, Srinagar (J &K)	31 March, 2012
Dr. V.K. Yadav	National Extension Education Congress on Emerging models of technology application for agri- rural development	ICAR Research Complex for Goa. Goa	17-19 December, 2011
Dr. Chikkappa GK	1st ICC International Grain Conference	New Delhi	16-18 January, 2012
Dr. P. Kumar	International Conference on Entomology	Patiala	16-18 February, 2012
Dr. C.M. Parihar	International Conference on Climate change, Sustainable agriculture & Public leadership	NASC, New Delhi	07-09 February, 2012
Dr. S.L. Jat	3rd International zinc symposium on "Improving Crop Production and Human Health	Hyderabad, India	10-14 October, 2011
Dr. K.P. Singh	I Meet on National dialogue for application of nanotechnology in agriculture	Central Institute of Fisheries Education (CIFE), Mumbai	08 -09 October, 2011
	Installation Training Programme and Launch Workshop for the Consotria-based reseach Project "Strengthening Statistical Computing for NARS"	IASRI, New Delhi	02-03 November, 2011
	II Meet on National dialogue for application of nanotechnology in agriculture	TNAU, Coimbatore, Tamil Nadu	11-12 November, 2011
	National Consultation Meet on Nano Agriculture Mission	NASC Complex New Delhi	12 March, 2012

Lectures delivered

Name of Scientist	Topic	Purpose	Place	Date
Dr. Ashok Kumar	Improved Technologies for spices	Training programme on Organic Farming of Rabi crops	CATAT, IARI, New Delhi	February, 7-11, 2011 February, 1-5, 2011
	Maize production Technologies to tribal farmers under	Training programme on Tribal Sub Plan	DMR, New Delhi	October, 12-14, 2011 March, 22-24, 2012
Dr. D.P Choudhary	Maize fodder and its preservation			March 17-19, 2012 March 22-24, 2012 March 26-28, 2012 March 29-31, 2012
Dr. Pradyumn Kumar	Integrated Pest Management			March, 2012
Dr. Meena Shekhar	Integrated Disease Management			March, 2012

T.V./ Radio Talks

Dr. Ashok Kumar	*Makka fasl mein samayik karya*	20.7.11
	Makka fasl mein samayik karya	12.8.2011

On-going Projects

Name of the Project	Principal Investigator	Co- Principal Investigator	Duration
Plant Breeding and Genetics			
Development of quality protein maize single cross hybrids	Dr. Jyoti Kaul	Dr. Nirupma Singh Dr. Ambika Rajendran Dr. Dharam Paul Dr. Sangit Kumar Dr. P.Kumar	June 2007 to May 2012
Development of normal maize single cross hybrids for different maturity group	Dr. Bhupender Kumar	Dr. Vinay Mahajan Dr. Avinash Singode Dr. C.G.Karjagi Dr. Sangit Kumar Dr. P.Kumar	June 2007 to May 2012
Breeding for baby corn and high oil single cross hybrids	Dr. Ambika Rajendran	Dr. Vinay Mahajan Dr. Dharam Paul Dr. Manivannan A. Dr. Sangit Kumar Dr. P. Kumar	June2007 to May 2012
Development of sweet corn and popcorn hybrids in maize.	Dr. C.G. Karjagi	Dr. Vinay Mahajan Dr. Avinash Singode Dr. Ambika Rajendran Dr. J.C.Sekhar Dr. Meena Shekhar Dr. Dharam Paul	June2007 to Dec 2012
Molecular characterization of elite maize inbred lines	Dr. Avinash Singode	Dr. Manivannan A. Dr. Jyoti Kaul	May 2010 to April 2015
In-vitro characterization of regeneration capacity of maize genotypes	Mr.Yatish K.R	Dr. Avinash Singode Dr. Jyoti Kaul	May 2010 to April 2015
Breeding for low temperature tolerance in maize	Dr. Nirupma Singh	Dr. Ambika Rajendran Dr. Avinash Singode Dr. Ramesh Kumar Dr. J.C.Sekhar Dr. Ishwar Singh Dr. Meena Shekhar	July 2011 to June 2016
Development of late maturity single cross hybrids in maize	Dr. Bhupender Kumar	Dr. G.K. Chikkappa Dr. Vinay Mahajan Dr. J.C.Sekhar Dr. K.S. Hooda Dr. C.M. Prihar Dr. Ganpati Mukri Mr. Vishal Singh Mr. Abhijeet Dass Mr. Yathish K.R	April 2011 to March 2016

Name of the Project	Principal Investigator	Co- Principal Investigator	Duration
Breeding for drought tolerance in maize	Dr. Bhupender Kumar	Dr. G.K. Chikkappa Dr. Vinay Mahajan Dr. J.C.Sekhar Dr. Ishwar Singh Dr. S.L.Jat Dr. Ganpati Mukri Mr. Vishal Singh Mr. Abhijeet Dass Mr. Yathish K.R	April 2011 to March 2016
Development of medium maturity inbred lines and single cross maize hybrids	Dr. G.K. Chikkappa	Dr. Bhupender Kumar, Dr. K.S. Hooda, Dr. Vinay Mahajan Dr. J.C.Sekhar Dr. C.M. Prihar Dr. G. Ramesh Mr. Abhijeet Dass	April 2011 to March 2016
PLANT BIOCHEMISTRY			
Biochemical studies on shelf-life of carotenoids in maize	Ms. Sapna	Dr. Dharam Paul Dr. Nirupma Singh	April 2011 to March 2016
Chemical and biological evaluation and nutritional quality of specialty corn	Dr. Dharam Paul Chaudhary	Ms. Sapna, Jyoti Kaul	
AGRONOMY			
Evaluating conservation tillage practices for improving resources use efficiency in maize based cropping system	Dr. C.M. Prihar	Dr. P. Kumar Dr. .Sangit Kumar Dr. Ishwar Singh Dr. K.P. Singh Dr. Chikkappa G.K	July 2008 to June 2013
Evaluating interactive effects of plant geometry and fertility levels on the productivity of full season maize genotypes under irrigation conditions.	Dr. S.L. Jat	Dr. A. K. Singh Dr. C.M. Prihar Dr. Ashok Kumar Dr. Chikkappa, G.K	July 2010 to June 2015
Weed management strategies against complex weed flora in maize based cropping system.	Dr. Aditya Kumar Singh	Dr. S.L. Jat Dr. C.M. Prihar Dr. Ashok Kumar	June 2010 to May 2015
Diversified maize based cropping system for higher productivity and sustained soil health	Dr. Ashok Kumar	Dr. A. K Singh Dr. Ishwar Singh Dr. Dharam Paul Dr. C.M. Prihar Dr. S.L. Jat Dr. G.K. Chikkappa	July 2011 to June 2016
PHYSIOLOGY			
Identification, Characterization and Utilization of Source of Tolerance to Drought and High Temperature Stress in Maize	Dr. Ishwar Singh	Dr. M.L. Jat Dr. R.P. Singh	April 2008 to March2013

Name of the Project	Principal Investigator	Co- Principal Investigator	Duration
ENTOMOLOGY			
Studies on variability among the isolates of *microphomina phaseolina* and *fusarium moniliforme* in maize and identification of sources of resistance against post flowering stalk rots of maize.	Dr. Meena Shekhar	Dr. Sangit Kumar Dr. Jyoti Kaul Dr. K.S. Hooda	Oct 2007 To Sept 2012
Post harvest management of losses due to microbial colonization in stored maize grains.	Dr. Sangit Kumar	Dr. Meena Shekhar Dr. K.S. Hooda	June 2008 to May 2013
Identification of Stable sources of resistance to major diseases of maize.	Dr. K.S. Hooda	Dr. R. Sai Kumar Dr. Sangit Kumar Dr. Meena Shekhar Dr. J.C. Shekhar Dr. Jyoti Kaul Dr. Avinash Singode Dr. G.K. Chikkappa Dr. A. Manivannan	April 2010 to March 2015
ENTOMOLOGY			
Inheritance of resistance in maize pink borer, *sesamia inferens* walker	Dr. J.C. Sekhar	Dr. Jyoti Kaul Dr. K.P. Singh	June 2007 to March 2012
Management of maize insect pests	Dr. Pradyumn Kumar	Dr. R. Sai Kumar Dr. J.C. Sekhar	Jan. 2008 to Dec 2013
Study on biochemical basis of resistance against major pests of maize	Ms. Suby S.B	Dr. P. Kumar Dr. Dharam Paul Dr. J.C. Sekhar Mr. Aditi Kundu	April 2010 to March 2015
Studies on inheritance of resistance of *sitophilus oryzae* (l) and *sitotroga cerealella* (Oliv.) in maize	Dr. P.Lakshmi Soujanya	Dr. J.C. Sekhar Dr. G.K. Chikkappa	Oct 2010 to April 2015
Management of *sitophilus oryzae* (l) and *sitotroga cerealella* (oliv.) infesting stored maize though plant origin pesticides"	Dr. P.Lakshmi Soujanya	Dr. P. Kumar Dr. J.C. Sekhar Dr. Dharam Paul Mrs. Suby. S. B.	June 2011 to April 2016
Biological control of maize pests	Dr. P.Lakshmi Soujanya	Dr. P. Kumar Dr. J.C. Sekhar	June 2011 to April 2016

Name of the Project	Principal Investigator	Co- Principal Investigator	Duration
SOCIAL SCIENCES			
Accelerating adoption of maize production technologies in india.	Dr. V. K. Yadav	Dr. K. P. Singh Dr. M.L. Jat	Jan 2007 to Jan. 2012
Development of web based maize information system.	Dr. K. P. Singh	Dr. Ishwar Singh Dr. V. K. Yadav Dr. M.L .Jat	April 2007 to March 2012
Strengthening and refinement of maize AGRIdaksh	Dr. V. K. Yadav		April 2011 to March 2016

Publications

Research Papers

Anuradha, M. Sreelatha, D. and Sekhar, J.C. 2010. Management of maize stem borer, *Chilo partellus* through intercropping with cowpea. *Indian Journal of Plant Protection* 38(2):202-203.

Arora, S., Kanojia, A.K., Ashok Kumar, Mogha, N. and Sahu, V. 2012. Novel bio-pesticide formulation to escape menace of tomato lepidopteron pests. *Current Science* 102(6) 102(7): 1051-1057

Chikkappa, G.K., Tyagi N. K., Venkatesh, K., Ashish, M., Prabhu, K.V., Mohapatra, T. and Singh, A. K. 2011. Analysis of Transgene(s) (*psy+crtI*) inheritance and its stability over generations in the genetic background of *indica* rice cultivar Swarna. *Journal of Plant Biochemistry and Biotechnology* 20(1): 29–38

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Jat, S.L., Shivay, Y.S. and Parihar, C. M. 2011. Dual purpose summer legumes and zinc fertilization for improving productivity and zinc utilization in aromatic hybrid rice (*Oryza sativa* L.). *Indian Journal of Agronomy* 56(4): 328-333

Meena, K. N., Ashok Kumar, Rana, D. S. and Meena, M. C. 2011. Productivity and nutrient uptake of Maize (*Zea mays*) –Wheat (*Triticum aestivum*) cropping system under different bio-sources and nitrogen levels. *Indian Journal of Agronomy* 56-(30): 98-104

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Mukherjee, I., Kumar, Aman. and Ashok Kumar, 2011. Persistence behavior of combination mix crop protection agents in/on eggplant fruits. *Bulletin of Environmental Contamination and Toxicology*, DOI 10.1007/s 00128-011-0457-y [Online 06 November, 2011]

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Sai Kumar, R., Bhupender Kumar, Jyoti Kaul, Chikkappa G. Karjagi, Jat, S.L., Parihar, C.M. and Ashok Kumar. 2012. Maize research in India-historical prospective and future challenges. *Maize Journal* 1: 1-6

Sain Dass, Jat, S.L., Chikkappa G. Karjagi, Bhupender Kumar, Jyoti Kaul, Parihar, C.M., Ashok Kumar, Kamboj, M.C., Vishal Singh, Yatish, K.R., Jat, M.L. and Singh, A.K. 2012. Genetic enhancement and crop management lead maize revolution in India. *Maize Journal* 1: 7-12

Sekhar, J.C., Rakshit Sujay, Kumar Pradyumn, Venkatesh S., Sharma Rakesh, K., Anuradha M., Sai Kumar, R. Sain Dass 2010. Improvement of resistance level in selected maize genotypes through cycles of selection against pink borer, *Sesamia inferens* Walker. *Indian Journal of Genetics and Plant Breeding* 70(2): 204-206

Sujay Rakshit, Santosh, H. B., Sekhar, J. C. Rabindra Nath, Meena Shekhar, Chikkappa G. Karjagi, Gadag, R. N. and Sain Dass. 2011. Analyses of genetic diversity among maize inbred lines differing for resistance to pink borer and post-flowering stalk rot. *Journal Plant Biochemistry and Biotechnology* 120(2):173-181

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Tanwar, S.P.S., Rokadia, P. and Singh, A.K. 2011. Effect of row ratio and fertility levels on Chickpea (*Cicer arietinum*) and linseed (*Linum usitatissimum*) intercropping system. *Indian Journal of Agronomy* 56(3): 217-222

Tanwar, S.P.S., Singh, A.K., Joshi, N.L. and Shiv Datt. 2011. Combating desertification: fertility status of soils and their management through integrated use of nutrient resources in arid regions of Rajasthan. *Indian Journal of Fertilisers* 7(3): 42-54

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Yadav, V.K. and Supriya, P. 2012. Sustainability Index for scientific maize cultivation practices. Maize Journal 1(1): 88-90

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Yadav, V.K., Supriya, P., Shailesh Kumar and Manikanhaiya, C.Y. 2011. Issues related to low productivity of maize in Haryana. *Indian Research Journal of Extension Education* 11(3): 14-18

Paper presented in Seminar/Symposium/ Workshops/ Conferences /Training

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Institute Publications

- DMR Vision 2030
- Project Director's Report
- Annual Progress Report 2011-12

Appointments / Promotions / Transfers / Retirements

Appointments

Name	Post	Date of Joining
Shri Vishal Singh	Scientist	01-09-2011
Shri K.R Yatish	Scientist	02-09-2011
Dr. Prajnam yadav	Scientist	21-12-2011
Dr. Ganpati Mukri	Scientist	15-09-2011
Dr. Abhijeet Kumar Das	Scientist	24-12-2011
Shri Dharmveer Singh	Upper Division Clerk	13-12-2011

Promotions

Name	Post held	Promoted post	Date of Promotion
Shri K.S Chauhan	A.A.O	A.O	13-12-2011

Transfers

Name & Designation	Transferred from	Transferred to	Date of joining/ Relieving DOR
Shri Rohtas, Administrative Officer	DMR	IARI	26-03-2012
Shri AK Mathur, Administrative Officer	NDRI, Karnal	DMR	22-03-2012

Important Committees

Responsibilities allotted	Name(s) of official(s)
Director's Cell	Santosh - Maintence of records of tour, Directors replies to ICAR, parliamentary, regional committees *etc.*
PME	P Kumar, Manivannan A, Meena Shekhar, A.K Singh, Sapna
RPF Compilation	Sangit Kumar, Ishwar Singh, S.L. Jat
RFD	Chikkappa PGK, Kumar
IRC	V. Mahajan, Bhupender Kumar, Suby SB
RAC	K.S. Hooda, D.P. Chaudhary, Sapna
QRT	P. Kumar
IMC	AO/AAO
ITMU	P. Kumar, Jyoti Kaul
Training In-charge	V.K. Yadav, Nirupma Singh
Building Maintence	Avinash Singode, AAO
Incharge farm operations	C.M. Parihar, S.L. Jat
Incharge Vehicle	S.L. Jat, Chikkappa G.K
Annual Maize Workshop Co-ordination	K.S. Hooda, C.M. Parihar, Chikkappa G.K
Directory Update	S.L. Jat, Sapna
AICRP data analysis	K.P. Singh, Avinash Singode
AICRP annual report	K.P. Singh, Avinash Singode
Variety identification data processing	Jyoti Kaul, Manivannan A
Salient achievement compilation	P Kumar, Manivannan A, A.K Singh, Bhupender Kumar, V.K. Yadav, Ishwar Singh, D.P. Chaudhary, K.S. Hooda.
Director's Report compilation	K.S. Hooda
Annual Report compilation	P. Kumar
Half yearly Report compilation	K.P. Singh, Meena Shekhar, Ambika Rajendran
Website management	K.P. Singh, Avinash Singode
Monthly meeting	Manivannan A, Suby SB
News Letter	Jyoti Kaul, Ishwar Singh
Accounts and Finance Officer duty	A.K Singh, D.P. Chaudhary
Staff Welfare/Hospitality Activity Officer/ Sports	Ishwar Singh, C.M. Parihar, Nirupma Singh
First Aid Officer	Suby SB, Sapna, S.L. Jat
Conference Room Maintanance	Ishwar Singh, V.K. Yadav, Nirupma Singh
Promotion of Entries Preparation	Chikkappa G.K, Bhupender Kumar
Display items	V.K. Yadav
Women Grievance Cell	Meena Shekhar, Ambika Rajendran, Suby SB
Public Information Officer	V.K. Yadav, Ambika Rajendran
IBSC	P. Kumar, Chikkappa GK,
Hindi Cell	V.K. Yadav, D.P. Chaudhary

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5	Ajay Kumar Singh	T-1	NA	
6	Raj Kishore Singh	T-1	NA	
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