



# Director's Review

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## Review of Research of AICRP on Maize - 2014

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### Trends in area, production and productivity of maize

The final estimates of 2014-15 have indicated an increase in of maize production over last two years and it has touched 24.35 million tonnes, which is the highest so far in the history of maize production in India. The trends in last three years indicate that area under maize cultivation expanding not only in *rabi* but also *kharif* season (Table 1). The major increase in the area has occurred during recent past in the states of Maharashtra, Bihar, Jharkhand, Madhya Pradesh, Chhattisgarh, Tamil Nadu and West Bengal. On the other hand, area under maize cultivation is showing declining trends in Rajasthan, Gujarat, and Uttar Pradesh in recent past.

The productivity of maize is also increasing in recent years both during *rabi* and *kharif* season. The productivity increasing in the states of Haryana, Bihar, Chhattisgarh, Jammu & Kashmir, Jharkhand, Madhya Pradesh, Odisha, West Bengal and Andhra Pradesh.

Table 1: Maize area, production and yield statistics in Indian states from 2011-12 to 2013-14

State/ UT	Season	Area ( '000 Hectares)			Production ( '000 Tonnes)			Yield (Kg/ha)		
		2011-12	2012-13	2013-14	2011-12	2012-13	2013-14	2011-12	2012-13	2013-14
Andhra Pradesh	Kharif	531.0	565	622.0	1493.0	2342	2168.9	2812	4145	3487
	Rabi	333.0	407	441.0	2165.0	2513	2799.0	6502	6174	6347
	Total	864.0	972	1063.0	3658.0	4855	4967.9	4234	4995	4673
Arunachal Pradesh	Kharif	40.5	*	*	58.1	*	*	1434	NA	NA
	Rabi	6.0	*	*	10.4	*	*	1736	NA	NA
	Total	46.5	*	*	68.5	*	*	1473	NA	NA
Asom	Kharif	21.3	21.3	21.0	15.3	23.7	17.0	719	1113	810
Bihar	Autumn	263.9	261	291.9	622.4	646.2	613.9	2358	2476	2103
	Rabi	411.0	424.6	459.8	988.3	1829.6	1403.8	2404	4309	3053
	Total	675.0	685.6	751.7	1610.7	2475.8	2017.7	2386	3611	2684
Chhattisgarh	Kharif	104.0	107.2	111.1	172.0	207.5	229.1	1654	1936	2062
Gujarat	Kharif	387.0	373	333.0	539.0	625	434.0	1393	1676	1303
	Rabi	129.0	85	128.0	247.0	166	258.0	1915	1953	2016
	Total	516.0	458	461.0	786.0	791	692.0	1523	1727	1501
Haryana	Kharif	9.0	9	9.0	24.0	23	27.0	2667	2556	3000
Himachal Pradesh	Kharif	294.2	294.3	292.1	715.4	657.2	679.0	2432	2233	2325
Jammu & Kashmir	Kharif	314.0	310.9	298.7	505.0	512.3	530.5	1608	1648	1776
Jharkhand	Autumn	207.4	243.4	253.4	305.6	435.8	504.5	1473	1790	1991
	Rabi	8.1	5.9	6.3	15.9	15.9	11.8	1970	2695	1873
	Total	215.5	249.3	259.7	321.5	451.7	516.2	1492	1812	1988
Karnataka	Kharif	1206.0	1162	1250.0	3644.0	2978	3590.0	3022	2563	2872
	Rabi	143.0	160	132.0	441.0	497	394.0	3084	3106	2985
	Total	1349.0	1322.0	1382.0	4085.0	3475.0	3984.0	3028	2629	2883
Madhya Pradesh	Kharif	862.8	845.4	1003.0	1287.4	1513.6	1510.2	1492	1790	1506

State/ UT	Season	Area ( '000 Hectares)			Production ( '000 Tonnes)			Yield (Kg/ha)		
		2011-12	2012-13	2013-14	2011-12	2012-13	2013-14	2011-12	2012-13	2013-14
Maharashtra	Kharif	736.0	689	955.0	2127.0	1582	2479.2	2890	2296	2596
	Rabi	145.0	133	254.0	306.0	242	596.0	2110	1820	2346
	Total	881.0	822	1209.0	2433.0	1824	3075.2	2762	2219	2544
Manipur	Kharif	20.0	*	*	35.4	*	*	1768	NA	NA
	Rabi	4.9	*	*	10.5	*	*	2165	NA	NA
	Total	24.9	*	*	45.9	*	*	1845	NA	NA
Meghalaya	Kharif	17.4	*	*	26.5	*	*	1529	NA	NA
Mizoram	Kharif	6.7	*	*	8.1	*	*	1214	NA	NA
	Rabi	0.2	*	*	0.3	*	*	1238	NA	NA
	Total	6.9	*	*	8.4	*	*	1214	NA	NA
Nagaland	Kharif	68.5	*	*	134.3	*	*	1960	NA	NA
Odisha	Kharif	98.9	90.9	91.5	202.3	217.5	253.2	2046	2393	2767
	Rabi	4.0	3.6	3.7	9.9	10	10.5	2496	2778	2838
	Total	102.9	94.5	95.3	212.2	227.5	263.7	2063	2407	2767
Punjab	Kharif	126.0	129	130.0	502.0	475	507.0	3984	3682	3900
Rajasthan	Kharif	1039.1	978.4	916.4	1644.9	1725.2	1463.8	1583	1763	1597
	Rabi	6.5	7.8	10.3	22.2	29.9	38.4	3434	3833	3728
	Total	1045.6	986.2	926.7	1667.0	1755.1	1502.2	1594	1780	1621
Sikkim	Kharif	40.0	*	*	66.2	*	*	1657	NA	NA
Tamil Nadu	Kharif	176.3	171.3	175.2	1001.7	609	995.5	5682	3555	5682
	Rabi	104.3	119.6	125.0	693.8	337.2	640.6	6649	2819	5125
	Total	280.6	291	300.2	1695.5	946.2	1636.1	6042	3252	5450
Tripura	Kharif	3.7	*	*	5.1	*	*	1353	NA	NA
Uttar Pradesh	Kharif	745.0	698	696.0	1232.0	1154.5	1151.2	1654	1654	1654
	Rabi	42.0	38	44.0	76.0	80	85.4	1810	2105	1941
	Total	787.0	736	740.0	1308.0	1234.5	1236.6	1662	1677	1671
Uttarakhand	Kharif	28.0	27.9	25.0	41.0	40.1	35.0	1464	1437	1400
	Rabi	*	0.1		*	0.1			1000	
	Total	28.0	28	25.0	41.0	40.2	35.0	1464	1436	1400
West Bengal	Kharif	34.1	40.6	43.7	77.3	96.8	117.4	2270	2384	2686
	Rabi	63.8	65	85.0	286.8	320	405.0	4497	4923	4765
	Total	97.8	105.6	128.7	364.1	416.8	522.4	3722	3947	4059
A & N Islands	Kharif	0.2	*	*	0.3	*	*	2125	NA	NA
D & N Haveli	Kharif	0.1	*	*	0.1	*	*	1000	NA	NA
	Rabi	0.0	*	*	0.0	*	*	1000	NA	NA
	Total	0.2	*	*	0.2	*	*	1000	NA	NA
Others	Kharif	-	194.1	208.0	-	332.6	370.1	NA	1714	1779
	Rabi	-	8.7	10.7	-	23.1	28.4	NA	2655	2654
	Total	-	202.8	218.7	-	355.6		NA	1753	1822
All India	Kharif	7381.2	7214.5	7726.1	16486	16197	17677	2234	2245	2288
	Rabi	1400.7	1458.2	1699.8	5273	6064	6671	3765	4158	3925
	Total	8713.4	8672.7	9425.8	21625	22261	24347.5	2482	2567	2583

\*Included in the others

**New hybrids and varieties for different ecologies:** Seventeen maize hybrids were released by Central Sub- Committee on Crop Standard and Notification of Varieties for different agro-climatic conditions of the country. Among these, 11 public-bred and 6 are proprietary hybrids released for different production ecologies. Of these, six are late maturing, seven medium maturing, two early and two are extra-early maturing hybrids. Eleven hybrids are for *kharif* season, five for *rabi* season and one for both *rabi* and *kharif* seasons. The detailed information on notification is presented below:

S No	Cultivar	Pedigree	Centre/ Company	Notification details	Area of adaptation	Maturity	Average yield (t/ha)	Other characteristics	Season
1.	CoH (M) 10 (CMH 08-433)	(UMI 1200 X UMI 1210) X UMI 1230	TNAU, Coimbatore	28/01/2015 268(E)	Andhra Pradesh, Tamil Nadu, Karnataka, Maharashtra, Rajasthan, Gujarat, Madhya Pradesh and Chhatisgarh	Medium	7.2	Orange-yellow, semi-dent resistant to MLB, RDM	Kharif
2.	HM-13 (HKH-317)	HKI-488-1RG X HKI-193-1	CCSHAU, Karnal	28/01/2015 268(E)	Jammu and Kashmir, Himachal Pradesh and Uttarakhand	Early	6.6	Yellow with cap, flint and resistant to MLB, TLB, BLSB, C. rust and PFSR	Kharif
3.	PMH6 (JH 31292)	LM 13 X SE 546	PAU, Ludhiana	28/01/2015 268(E)	Bihar, West Bengal, Jharkhand, Odisha and Uttar Pradesh	Medium	6.3	Yellow, flint	Kharif
4.	NMH-713	NM-115 X NM-45	Nuziveedu Seeds Limited	28/01/2015 268(E)	Uttar Pradesh, Bihar, Jharkhand, Odisha, Andhra Pradesh, Karnataka, Tamil Nadu and Maharashtra	Late	9.49	Yellow, dent	Rabi
5.	NMH-731	NM-206 X NM-85	Nuziveedu Seeds Limited	28/01/2015 269 (E)	Gujarat, Rajasthan Chhattisgarh, Madhya Pradesh, Andhra Pradesh, Karnataka, Tamil Nadu and Maharashtra	Late	5.4	Orange-yellow, semi-dent	Rabi

S No	Cultivar	Pedigree	Centre/ Company	Notificati on details	Area of adaptation	Maturity	Average yield (t/ha)	Other characteri stics	Seaso n
6.	KMH-25K45 (BUMPER)	KML-5254 X KML- 2286	Kaveri Seed Company Ltd., Andhra Pradesh	28/01/20 15 271 (E) and 30/07/20 14 1919 (E)	Punjab, Haryana, Delhi, Uttar Pradesh, Andhra Pradesh, Telangana, Karnataka, Maharashtra, Tamil Nadu Rajasthan, Gujarat, Madhya Pradesh and Chhattisgarh	Late	9.0	Yellow, semi-dent	Rabi
7.	NMH-1242	NM-161 X NM-250	Nuziveedu Seeds Limited	28/01/20 15 272 (E)	Andhra Pradesh, Tamil Nadu, Maharashtra, Karnataka, Punjab, Haryana, Delhi, Uttar Pradesh, Rajasthan, Gujarat, Chhattisgarh and Madhya Pradesh	Medium	7.3	Yellow, dent and moderately tolerant to MLB	Rabi
8.	CoH (M)7 (CMH 08-287)	UMI 1210 X UMI 1220	TNAU, Coimbatore	30/07/20 14 1919 (E)	Uttar Pradesh, Bihar, Jharkhand, Odisha, Andhra Pradesh, Telangana, Tamil Nadu, Maharashtra and Karnataka	Late	7.8	Orange- yellow, dent and resistant to MLB, PR, TLB, BSDM, C. rust	Kharif
9.	CoH (M)8 (CMH 08-292)	UMI 1201 X UMI 1230	TNAU, Coimbatore	30/07/20 14 1919 (E)	Uttar Pradesh, Bihar, Jharkhand, Odisha, Andhra Pradesh, Telangana, Tamil Nadu, Karnataka, Rajasthan, Gujarat, Madhya Pradesh, Chhattisgarh, Punjab, Haryana,	Medium	7.1	Orange- yellow, semi-dent, resistant to MLB, TLB, RDM, DM	Kharif

S No	Cultivar	Pedigree	Centre/ Company	Notificati on details	Area of adaptation	Maturity	Average yield (t/ha)	Other characteri stics	Seaso n
					Delhi and Maharashtra				
10.	CoH (M) 9 (CMH 08-350)	UMI 1205 X UMI 1230	TNAU, Coimbatore	30/07/20 14 1919 (E)	Uttar Pradesh, Bihar, Jharkhand, Odisha, Rajasthan, Gujarat, Madhya Pradesh and Chhattisgarh	Medium	6.4	Orange- yellow, semi- dent, resistant to MLB, TLB, RDM, DM	Kharif
11.	DHM 121 (BH 41009)	BML 45 X BML 6	ANGRAU, Hyderabad	30/07/20 14 1919 (E)	Odisha, Bihar, Jharkhand, West Bengal , Gujarat, Rajasthan, Chhattisgarh and Madhya Pradesh	Medium	5.4	Yellow, semi-dent and tolerant to moisture stress conditions	Kharif
12.	GH 0727 (Shrushiti)*	CI4 x KDMI-15	ARS, Arabhavi	30/07/20 14 1919 (E)	Karnataka	Late	7.5	Orange- yellow	Kharif
13.	Vivek Maize Hybrid 47 (FH 3513)	V373 x V391	VPKAS, Almora	30/07/20 14 1919 (E)	Utrakhhand, Himachal Pradesh, Jammu & Kashmir, Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Tripura and Sikkim	Early	6.9	Yellow with white cap, semi flint and moderately resistant to MLB and C. rust	Kharif

S No	Cultivar	Pedigree	Centre/ Company	Notificati on details	Area of adaptation	Maturity	Average yield (t/ha)	Other characteri stics	Seaso n
14.	Vivek Maize Hybrid 53 (FH 3556)	V407 X V409	VPKAS, Almora	30/07/20 14 1919 (E)	Uttarakhand, Himachal Pradesh, Jammu & Kashmir, Uttar Pradesh, Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Tripura and Sikkim	Extra- early	6.9	Yellow, semi-flint	Kharif
15.	Vivek Maize Hybrid 51 (FH 3554)	V405 X V409	VPKAS, Almora	30/07/20 14 1919 (E)	Gujarat, Rajasthan Chhattisgarh and Madhya Pradesh	Extra- early	5.1	Yellow, semi-flint, moderate resistance to MLB, FSR, RDM and CLS	Kharif
16.	Bio 9544 (BIO151)	By070-nm (BIOSEE D KNPR- 3) X BIO PCI001- nm (BIO PT963018 )	Bioseed Research India Pvt. Ltd.	30/07/20 14 1921 (E)	Jammu & Kashmir, Himachal Pradesh, Uttarakhand, Andhra Pradesh, Tamil Nadu, Karnataka, Maharashtra, Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Tripura, Punjab, Haryana, Delhi, Uttar Pradesh, Bihar, Jharkhand, Odisha, Rajasthan, Gujarat, Madhya Pradesh and Chhattisgarh	Medium	7.3	Orange- yellow, semi- dent	Kharif & Rabi

S No	Cultivar	Pedigree	Centre/ Company	Notification details	Area of adaptation	Maturity	Average yield (t/ha)	Other characteristics	Season
17.	P3522 (X35A019)	PH6MT X PH1SP	Pioneer Overseas Corporation, Karnataka	24/04/2014 1146(E)	Punjab, Haryana, Delhi, Uttarakhand, Uttar Pradesh, Bihar, West Bengal, Jharkhand, Orissa, Andhra Pradesh, Tamil Nadu, Maharashtra, Karnataka, Gujarat, Rajasthan, Madhya Pradesh and Chhattisgarh	Late	9.1	Yellow-orange, semi-flint	Rabi

**Registration of germplasm lines and cultivars:** Three promising inbred lines viz., DMR QPM 58 (early maturing QPM), DMR QPM-03-124 (medium maturing QPM) and DMR E63 (WNZPBTL 9) as source of resistance to pink borer were registered at NBPGR, New Delhi.

**Registration under PPV&FR Act, 2001:** One hybrid viz., HM-11 (HKH-1237) and two OPVs [Vivek Sankul Makka 35 (VL 113) and Bajaura Makka-1] were registered under PPV&FR Act, 2001.

**DUS testing and identification of additional locations:** DUS testing of 111 genotypes was undertaken in kharif 2014. Additionally, three locations, viz. VPKAS Almora, PAU Ludhiana and ICAR research Complex for NE Meghalaya were identified for testing of candidate entries of maize.

**Breeder seed production:** A total of 44.66 q of breeder seed of 17 OPVs and parental lines of 16 hybrids was indented by the Department of Agriculture and Cooperation, Ministry of Agriculture, GOI. The indented quantity was allocated (BSP-I) to 13 AICRP (maize) centres. Against the indent, 27.68 quintals has been produced till March, 2015.

**Public-private partnership for up-scaling the hybrid adoption:** A memorandum of agreement was signed between AICMIP, Ludhiana and M/s Aishwarya Seeds India Private Limited for outsourcing seed production and marketing of hybrids PMH-5 and PMH-6 by company. The Ludhiana centre has offered non-exclusive rights to produce and market the seed of two hybrids. Hybrid PMH 5 (JH 31110) is a short duration single-cross hybrid between LM 16 x LM 18 and recommended for cultivation in Gujarat, Rajasthan, MP and Chhattisgarh during



Kharif season. It contains 11% protein and 5% oil in its grains. It matures in about 84 days. Hybrid PMH 6 (JH 31292) is a stable and high yielding medium duration single-cross hybrid between LM 13 x LM 19 recommended for cultivation under good management and irrigated conditions during *Kharif* season for Bihar, West Bengal, Jharkhand, parts of UP and Orissa. The plants are tall with little high ear placement. This hybrid has thick cobs with dull yellow orange flint/semi flint grains. It is highly responsive to good management conditions and takes about 90 days to mature.

The seed production of QPM hybrids developed by different centres is being taken up during last three years and it has been further expanded with the National Seeds Corporation (NSC), Gujarat State Seed Corporation (GSSC) and Rajasthan State Department of Agriculture. The seed production of hybrids HQPM 1 and HQPM 5 is being taken up in Rajasthan by the State Department of Agriculture, while the seed production of CO-6 is being taken up in Gujarat by GSSC. The total target for these hybrids is more than 50,000 q. This partnership effort between public and private sectors is becoming stronger with time in category of both QPM and non-QPM hybrids.

**Strengthening the testing network:** In view of expansion of maize cultivation in newer ecologies, there is need of strengthening the testing of experimental hybrids in different zones. In this effort, 30 volunteer centres were added in the states of UP, Gujarat, Maharashtra, Tamil Nadu, Punjab, Haryana, Bihar, Karnataka, and West Bengal. This has resulted more rigorous testing especially in Advance Trials. Five new AICRP centres have also been added in the states of West Bengal, Bihar, Maharashtra and Manipur.

**Germplasm enhancement and diversification through ICAR-CIMMYT partnership research:** In order to further strengthening the development of hybrid-oriented breeding material, 61 nurseries and trials were grown at 22 centers. This trait-specific nurseries targeting various ecologies helped in further intensifying the collaborative research between ICAR and CIMMYT and helped breeders to select the suitable material right in their respective target ecologies.

**Expanding Winter Nursery Centre for AICMIP partners:** A total of 1244 maize accessions were provided to 29 AICRP centres and 36 scientists. The distributed germplasm included lines for specific traits like yellow corn (854), white corn (110), QPM (45), sweet corn (171), popcorn (41) and oil corn (23). The total number of samples distributed to various centres was 3672.

**Developing and testing new experimental hybrids:** During *Kharif* 2014, 414 new maize hybrids were evaluated in All India coordinated trials, which was the highest figure ever of entries received for AICRP testing. Of 414 genotypes, 297 entries were evaluated in initial varietal trial (IVT), 67 were under advance varietal trial-I (AVT-I), 10 in advance varietal trial-II (AVT-II), 12 entries in quality protein

maize (QPM), 13 in sweet corn, 8 in popcorn and 7 in baby corn trials. Total fifteen breeding trials (four each of IVT, AVT-I, specialty corns and three of AVT-II) were constituted for evaluation at 59 locations (29 regular and 30 volunteers) across country. Total of 20 check varieties belonging to different maturity groups were used in different breeding trials constituted for various maturity groups and types of maize. Trials data received from 53 locations were reviewed and analyzed critically for yield and related traits. The test entries were promoted from IVT to AVT-I and AVT-I to AVT-II, based on the 5% superiority (in late maturity, QPM, sweet corn, popcorn and baby corn trials) and 10% superiority (in medium, early and extra early trials) over the best check for grain yield in respective zones. In case of medium, early and extra early maturity, beside yield superiority, days to 50% silking, are also considered as another important criteria.

During *Rabi* 2013-14, 101 maize entries were evaluated in 9 different breeding trials (three each of IVT, AVT-I, two of AVT-II and one of QPM) at 18 locations across four maize zones of country. Of total 101, genotypes, 63 were evaluated in IVT, 28 were in AVT-I, 8 in AVT-II and 2 entries were in QPM. Total of 7 checks belonging to different maturity groups were used in breeding trials constituted for various maturity groups and types of maize. Of 101 entries evaluated, the 22 test entries were promoted from IVT late to AVT-I late (Trial 1 to Trial 4), 11 from IVT medium to AVT-I medium (Trial 2 to Trial 5), 1 from IVT early to AVT-I early (Trial 3 to Trial 6). In advance varietal trial I, 15 entries were promoted from AVT-I late to AVT-II late (Trial 4 to Trial 7), 5 were from AVT-I medium to AVT-II medium (Trial 5 to Trial 8), 1 entry was promoted from AVT-I early to AVT-II early (Trial 6 to Trial 9) and one entry was promoted from QPM 1 to QPM 2. These entries were promoted based on the 5% superiority over the best check in late maturity, 10% in medium, early, extra early and 5% superiority in grain yield in QPM trial.

**Addressing the need across regions:** The entire maize area is divided in five major zones (Zone I, Zone II, Zone III, Zone IV and Zone V) for effective evaluation of the maize breeding materials and experimental cultivars. The details of maize growing states included in these zones are given below:

Zone	State(s)
Zone I	Jammu and Kashmir, Himachal Pradesh, Uttarakhand (Hill region), North Eastern Hill Regions (Meghalaya, Sikkim, Assam, Tripura, Nagaland, Manipur, Arunachal Pradesh)
Zone II	Punjab, Haryana, Delhi, Uttarakhand (Plain), Uttar Pradesh (Western region)

Zone	State(s)
Zone III	Bihar, Jharkhand, Odisha, Uttar Pradesh (Eastern region), Chhattisgarh, West Bengal
Zone IV	Maharashtra, Karnataka, Andhra Pradesh, Tamil Nadu
Zone V	Rajasthan, Madhya Pradesh, Gujarat

Total of 59 locations (29 regular and 30 volunteers) were identified for conducting different breeding trials. Advance varietal trials I & II of various maturities were allotted to the volunteer centers. The IVT and AVT-I & II (late maturity) trials were not allotted in zone-I, this is because of no requirement of late maturity genotypes in this zone.

During *kharif* 2014, different breeding trials were organized at 11 test locations in Zone-I, 9 in Zone-II, 10 in Zone III, 16 in Zone IV and 13 test locations in Zone-V. All the normal maize entries were tested under four maturity group viz., late, medium, early and extra early.

For effective maize testing, *rabi* 2013-14 trials were conducted in four maize growing zones viz., zone-II, zone-III, zone-IV and zone-V. No trials were allotted in zone-I due to non-suitability of maize in these regions during *rabi* season. Nine different breeding trials were constituted having 101 test entries and 7 checks varieties of various maturity groups. Trials were evaluated at 18 test locations across the four zones.

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### Crop Production

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The major agronomic research areas during *kharif* 2014 were optimization of nutrient application and planting density of pre-released maize hybrids; suitable intercrop/s and planting pattern in rainfed areas with residue management; site specific nutrient management (SSNM); tillage systems; and organic manuring for maize production. The *rabi*, 2013-14 trials were mainly focused on pre-released genotypic response to nutrient (NPK) levels; nutrient and tillage practices on maize-wheat-mungbean, rice-maize, maize-chickpea; and maize-mustard cropping system.

**Evaluation of pre-release hybrids under varying planting density and nutrient levels:** A total of 17 pre-release hybrids of different maturity groups under AVT-2 were evaluated with 9 national checks under two densities (83,333/ha and 1,11,111/ha) and two nutrient levels (N:P<sub>2</sub>O<sub>5</sub>:K<sub>2</sub>O kg/ha) i.e. 150:50:60 and 200:60:80 for early maturity hybrids. However, medium and late maturing hybrids

were evaluated with 200:65:80, 250:80:100 nutrient levels at 17 centers of all the five maize growing zones of the country. Results showed that different hybrids responded differently to varying planting densities. The yield enhancement varied from 7.6 to 16.1 % in various hybrids. The most responsive hybrids to higher planting densities were identified as FH-3626, FH-3605, KMH-7021, CMH 10-531, DKC-9145, NMH-1265 and Geo Premium Gold, while other hybrids viz. EH-2212, Rasi-3033 and LTH-22 were found to be less responsive.

In *rabi* 2013-14, in all the zones (III, IV and V) except Zone II (Responded up to 200:80:80) of the country, it was observed that pre released genotypes of late maturing group responded up to the highest dose *i.e.* 250:95:95 N:P<sub>2</sub>O<sub>5</sub>:K<sub>2</sub>O kg/ha. Similarly the medium maturing genotypes also responded up to highest dose *i.e.* (250:95:95 N:P<sub>2</sub>O<sub>5</sub>:K<sub>2</sub>O kg/ha) in zone IV and V. While pre-released QPM genotypes responded up to highest dose in Zone III and Zone IV; while in Zone II and Zone V it responded up to medium dose of 200:80:80 N:P<sub>2</sub>O<sub>5</sub>:K<sub>2</sub>O kg/ha.

**Effect of planting systems and intercropping with and without residue retention under rainfed conditions:** The experiments were conducted at 7 locations for enhancing rainfed maize productivity in different agro-climatic conditions during *kharif* to find out suitable intercrop and residue management options. The retention of residue helped in enhancing maize productivity by 9 to 29% at Bajaura (Zone I), Ranchi and Ambikapur (Zone III), and Banswara (Zone V) while there was no significant effect at Srinagar (Zone I) and Bhubaneswar (Zone III). The adoption of soybean or blackgram as intercrop were found effective at Bajaura (Zone I), Ambikapur and Ranchi (Zone III), Banswara and Udaipur (Zone V), while cowpea was found best intercrop at Srinagar (Zone I) and groundnut at Bhubaneswar (Zone III). The adoption of paired row (84:50 cm) planting gave significantly higher yield by 5% to 11% at Ranchi, Ambikapur (Zone III), Banswara and Udaipur (Zone V) while uniform row (67 cm) planting was found significantly superior with 7.6 to 29% yield increase at Srinagar (Zone I) and Bhubaneswar (Zone III).

**Nutrient management in maize based cropping system under different tillage practices:** In maize-wheat-mungbean cropping system under irrigated conditions, zero tillage planting resulted in 8 and 18% higher yields over conventional tillage at Karnal (Zone II) and Banswara (Zone V), respectively. In this system, from amongst various nutrient management practices, SSNM resulted in significantly higher yield at Pantnagar (Zone II), Banswara and Chhindwara (Zone V), while Farmers fertilization practices (FFP) resulted significantly higher yield at Karnal (Zone II) and Udaipur (Zone V). In maize-mustard/chickpea system under rainfed condition planting of maize with zero tillage resulted in significantly higher yields by 21%, 12% and 10% over conventional tillage at Kashmir (Zone I), Delhi (Zone II) and Banswara (Zone V), respectively. Amongst nutrient management in this system, SSNM resulted in significantly higher yield at Delhi

(Zone II), while it remained at par with 100% RDF at Srinagar, Banswara and Chhindwara.

**Nutrient management for maize genotypes under different cropping systems:** The trial was conducted at thirteen locations and it was found that SSNM based on the nutrient expert gave 4.5 to 22.9% higher yield of maize over recommended fertilizer practices (RDF) in all zones except Zone IV. However, RDF resulted better at Srinagar (Zone I) and FFP resulted significantly better at Karnal (210:95:50 kg/ha N:P<sub>2</sub>O<sub>5</sub>:K<sub>2</sub>O) and Hyderabad (215:90:50 kg/ha N:P<sub>2</sub>O<sub>5</sub>:K<sub>2</sub>O) due to higher use of fertilizers by farmers. Amongst various maize hybrids tested, PMH-3 provided significantly higher yield of at Bajaura (Zone I), Chhindwara, Jhabua (Zone V) and Ludhiana (Zone II), PAC-740 at Kangra (Zone I), DKC-7074 at Srinagar (Zone I), CMH-08-292 at Kamal (Zone II) and Hyderabad (Zone IV), Banswara and Jhabua (Zone V), CMH-08-350 at Ranchi (Zone III), CMH-08-287 at Arabhavi (Zone IV) and DHM-117 at Karimnagar (Zone IV) was obtained over other hybrids.

**Effect of planting density and nutrient management practices on the performance of hybrids in *Kharif* season:** An experiment was conducted to maximize the yield of popular hybrids through planting density and nutrient management optimization at 17 locations. It was found that hybrids viz. PMH-1, DKC-9125, Hishel, P-3441, NK-6240, 900M Super, HQPM-1, DHM-117 and Pratap QPM-1 responded to high density (1,00,000 /ha) in Zone II (Ludhiana), Zone III (Bhubaneswar), Zone IV (Arbhavi) and Zone V (Banswara and Udaipur) by 5.7, 6.2, 4.3, 13.8 and 11.2% higher yield over normal density (83,333/ha), respectively. Amongst various nutrient management practices SSNM resulted in significantly (4-18.8 %) higher yield at Ludhiana (Zone II), Srinagar (Zone I), Dholi (Zone III), Banswara and Chhindwara (Zone V) while STCR was found significantly superior at Karnal, Pantnagar (Zone II), Bhubaneswar, Ranchi (Zone III), Hyderabad Zone IV), Godhra and Udaipur (Zone V), respectively. However RDF proved better only at Bahraich (Zone III).

**Long-term trial on integrated nutrient management in maize-wheat cropping system:** To explore the possibilities of organic maize production this long term experiment was initiated in *kharif* 2014. Significantly highest maize grain yield was obtained with 100% RDF + 5 t/ha FYM. However, 100% RDF was found at par with 10 t/ha FYM + Azotobacter application which show that the organic maize production is possible. Economic analysis showed a new path for organic maize cultivation and it was found that maize + cowpea as intercrop with FYM 10 t/ha + Azotobacter resulted in highest net returns with B:C ratio of four.

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## Crop Protection and Resistance Breeding

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### Pathology

A total of 18 trials (17 in *Kharif* 2014 and one in *Rabi* 2013-14) of Maize Pathology were conducted under sick plot/artificially created epiphytotics at identified hot spot locations [Bajaura, Almora, Dhaulakuan in Zone I; Ludhiana (*Rabi & Kharif*), Delhi, Karnal, Pantnagar in Zone II; Dholi (*Rabi & Kharif*), Bhubaneswar, Midanapur (*Rabi & Kharif*) in Zone III; Arbhavi (*Rabi & Kharif*), Coimbatore (*Rabi & Kharif*), Mandya (*Rabi & Kharif*), Hyderabad (*Rabi & Kharif*) in Zone IV and Udaipur in Zone V]. A total of 551 entries in both seasons and 224 inbred lines (in *kharif* only) were screened against Maydis leaf blight (MLB), Turcicum leaf blight (TLB), Banded leaf and sheath blight (BLSB), Sorghum downy mildew (SDM), Rajasthan downy mildew (RDM), Curvularia leaf spot (CLS), Post-flowering stalk rots (PFSR), Bacterial stalk rot (BSR), Common rust, Polysora rust and Cyst nematode. Yield loss trials were conducted at Almora and Dhaulakuan centres. Trap nursery trial for disease occurrence was conducted at Dholi, Karnal, Mandya, Udaipur, Pantnagar, Delhi, Hyderabad, Ludhiana, Coimbatore, Arbhavi, Bajaura, and Bhubaneswar centres.

In addition, disease surveys were conducted at farmers' fields in Himachal Pradesh and Uttarakhand (Zone I), Ludhiana (Zone II), Odisha (Zone III), Karnataka (Zone IV), Rajasthan and Gujarat (Zone V) to assess overall disease scenario during the crop season. Study on management of nematode and its interaction with PFSR, termite and stem borer in maize was taken up by Udaipur centre. Disease management trials for development of integrated disease management (IDM) module in maize were conducted at Bajaura, Ludhiana, Karnal, Delhi, Pantnagar, Dhaulakuan, Bhubaneswar, Godhra, Almora, Arbhavi, Udaipur and Mandya.

### A. Host plant resistance:

i. **Hybrids:** The hybrids having multiple disease resistance (MDR) in advance trials are:

- **Kharif 2014:**

- **AVT I & AVT II (late maturity):** Twenty three hybrids *viz.*, VNR 31834 (RDM, CLS), X35D601 (FSR, RDM, CLS), DKC 9133(IM9133)(FSR, RDM, CLS), DKC 9141 (IM8539)(FSR, CLS), HTMH 5108(FSR, CLS), HTMH 5202 (FSR, CLS), HTMH 5404(C.ROT, FSR), RMH-972(C.ROT, FSR, CLS), SUPER GA-105 (FSR, CLS), VNR 31355 (RDM, CLS), Siri 4527(MLB, FSR, RDM, CLS), JH 12247 (MLB, FSR, CLS), Bio 032 (BB032)(FSR, CLS), CP.999(MLB, C.ROT, FSR, RDM, BSR, CLS), DAS-MH-105(MLB, FSR, RDM, CLS), IM 8556(MLB, FSR, RDM, CLS), JANAHIT (MLB, RDM, CLS), PRO-392(MLB, CLS), NMH-1265 (MLB, RDM, CLS), Geo Primium Diamond (MLB, RDM, CLS), PMH 1-C (MLB, C.ROT, FSR, RDM, CLS), PMH 3-C (MLB, FSR, CLS), Bio-9681-C (FSR, RDM, CLS).

- **AVT I & AVT II (medium maturity):** Twenty one hybrids viz., LG 32.82 (C.ROT, FSR, BSR), CMH 10-547 (FSR, RDM, CLS), DKC 9144 (IM8478) (FSR, RDM, CLS), DKC 9149 (IM8581)(FSR, RDM, CLS), FCH 11231(FSR, RDM, CLS), S-6750 (FSR, RDM, CLS), TH-38(FSR, CLS), CMH 11-582 (MLB, FSR), DKC 8144 (IM 8479 )(FSR, CLS), Kuber Shakthi (FSR, CLS), AQH 8 (FSR, CLS), HTMH 5402 (C.ROT, FSR, RDM), EH-2240(FSR, CLS), EHL 3412(FSR, RDM, BSR), KMH-5951 (FSR, RDM), PRMH-2177 (C.ROT, FSR), KDMH 2705 (FSR, CLS), KNMH 4010131(MLB, FSR), DKC 9145 (IJ8533) (FSR, RDM), Rasi-3033(FSR, RDM), Bio -9637(C)(FSR, RDM, CLS).
- **AVT I & AVT II (early maturity):** Thirteen hybrids viz., AH 1261(FSR, CLS), DMH-63(FSR, CLS),FH 3669(MLB, FSR, RDM), GWH 0712(FSR, RDM), CMH 11-579 (FSR, CLS), CMH 11-611(MLB, FSR, CLS), CMH 11-626(MLB, FSR), CMH 11-629 (MLB, FSR, CLS), B-52 (FSR, RDM), EH-2214 (MLB, FSR, RDM, BSR, CLS), NMH-1258 (MLB, CLS), EH-2212 (FSR, BSR), KMH-7021(FSR, RDM).
- **AVT I & AVT II (extra early maturity):** Six hybrids viz., KH-7502(FSR, RDM, CLS),Vivek Hybrid-43(C),(FSR, RDM, CLS),PMH-1-F (MLB, FSR, CLS), BIO 9681-F (FSR, CLS), PMH3-F (MLB, FSR, RDM, CLS), HM 10-F(FSR, CLS).
- **Promising hybrids having resistance to cyst nematode:** Twenty eight hybrids viz.; ADV 0990293, IN 8570, VNR 4325, JKMH 4023, JH13094, JH 13270, RMH-726, CMH 11-593, LMH 314, HT 51412607, JH 13121, JH 31607, CMH 11-584, DH 1405, DH 1401, CMH 12-697, CMH 12-691, AH-1320, X35D601, CP.999, DAS-MH-105, CMH 11-582, CMH 11-617, CMH 11-629, EH-2214, VIVEK QPM9-C, VEHQ 14-1, and CMH 11-659 exhibited moderately resistant reaction to cyst nematode (*Heterodera zeae*).

## ii. Rabi 2013-14:

- A total of 96 genotypes were evaluated against major diseases of maize under artificially created epiphytotics at various hot spot locations i.e. sorghum downy mildew (SDM) at Coimbatore and Mandya, charcoal rot (C. Rot) at Arabhavi, Ludhiana and Hyderabad, banded leaf and sheath blight (BLSB) at Midnapur and turcicum leaf blight (TLB) at Dholi. Promising hybrids are:

**TLB:** A 7501, NMH-1247, PRO-385, X 35B349, GK 3149, Venus, Megan-G, PMH-189, X 35C537, DADA, CP-999, GK 3118, IM 8222, CSM 1, KMH-4210, Bio 9662, DMRH 1302, AH 1315, NMH-51, IM 8013, IL 8033, IH-061, DMRH 1304, AH 1313

**SDM:** A 7501, X 35B349, GK 3150, NMH-51

**Charcoal rot:** A 7501, Bisco X 5141, NMH-1247, PRO-385, X 35B349, Bisco X 6573, X-1228, KH-K25 Gold, II 8212, DKC 9120, IL 8534, X

35C537, P 3533, TH 22, CP-838, CP-999, CP-111, GK 3118, GK 3155, HTMH 5108, HTMH 5202, KH-2192, KMH-1411, IM 8226, Rasi 393, Rasi 950, VEH 13-1, CSM 1, JH 248, DMRH 1308, , KH-K26, IJ 8521, IL 8536, IL 8537, IJ8214, BL 798, BL 900, KH-517, IM 8303, VaMH 08015, CSM 2, DMRH 1301, DMRH 1302, DMRH 1306, DMRH 1307, AH 1314, AH 1315, B-52, IM 8013, IL 8033, IL 8235, IH-072, IH-061, IHQ-091, DMRH 1303, DMRH 1304, DMRH 1305, AH 1312, AH 1313, QPM-3

**Multiple disease resistance:** A 7501, X 35B349, NMH-51.

**iii. Inbred lines:** Out of 231 inbreds evaluated, 60 were having multiple disease resistance (MDR) viz.; HKI163, HKI 193-1, HKI 1105, HKI 1344, CM 117-3-2-1-1-1-2-1, CM 132, CM 501, CM 502, CM 123, CM 128, CML 446, CUBA 377, IIMR QPM-03-124, DMSC 8, HKI 1040-11-7, HKI 164-D-3-3-2, HKI 193-2-2-1, HKI 226, HKI 31-2, HKI 323, HKI-2-6-2-4(1-2)-4, HKIMBR 139-2, HYD05R/204-1, JCY 2-7-2-1-1-B-1-2-1-1, Temp.HOC15, WS KHOTHAI-1-WAXY-1-1, EI 670, EI 708, EI 561, BML13, BML15, BML 8, CM 202, CM 500, CML 451Q, CML 44, CML117-3-4-1-1-4-1, CML165, CML 3, DMSC 16-1, DTPWC 9-F31-1-1-3, HKI C 322, HKI PC 8, HKI 164-4(1-3), HKI-164-7-4-2, HKI 191-1-2-5, HKI-484-5, HKIC 78, JCY 2-2-4-1-1, KML 3-3, LM 5, T2STR 1107, Tempx Trop(H0)QPM-B-B-B-57-B-B, WINPOP-43, WSC Shrunken X MUS MADHAU

## **B. Disease management:**

- i. Fungal diseases:** Field experiments on disease management in maize were conducted at hot spot locations in AICRPM during *Kharif* 2014 to identify promising components. Trifloxystrobin 25%+tebuconazole 50% (0.05%) was found best in containing BLSB (50.69% disease control) followed by validamycin (0.1%) with 43.27% disease control. Tebuconazole (0.5%) was found significantly superior in management of TLB (38.4% disease control) whereas azoxystrobin (0.05%) was effective in management of common rust (53.8% disease control). Seed treatment with *R. serpentine* leaves (0.5 ml extract /liter water) followed by foliar spray of carbendazim 12 WP+mancozeb 63 WP @ 0.3% resulted in significant higher MLB control (40.7% disease control). The combination of propiconazole+mancozeb ST (1:1) @ 4 g/Kg seed+foliar spray (0.25%) before flowering provided significantly control of PFSR (C. Rot and FSR). However, fungicidal seed treatment with metalaxyl+mancozeb (1:1) @ 0.25% and foliar spray (0.25%) was found highly effective in managing SDM at Mandya.
- ii. Cyst nematode:** Use of lantana (*Lantana camera*) leaf at 2 q/ha as organic amendment proved best with respect to reduced nematode population (28.35–41.75%) followed by neem cake at 2 q/ha (31.35-45.26 %) and lantana leaf at 1 q/ha (17.91- 28.42 %) over check.

## **Entomology**



**Evaluation of germplasm against stem borers under AICRP:** During Kharif 2014, AICRP trials of 94 entries of different maturity periods were evaluated at Delhi, Karnal, Kolhapur, Hyderabad, Ludhiana and Udaipur for resistance against *Chilo partellus* under artificial infestation.

The entries were sown in two rows When the plants were 14-16 days-old; 10-12 black-headed eggs of *C. partellus* laid on butter paper were pinned in the whorl. The eggs hatched within few hours and the neonate larvae nibbled on the leaves and found their way in the stem. After 25 days of release of eggs, plants were observed for level of infestation by recording the leaf injury rating on 1 (no incidence) to 9 (dead heart formation) scale.

The following entries registered leaf injury rating (LIR) less than that of checks.

*Full Season Maturity lines:* Zone II: DKC 9133(IM9133), HTMH 5108, KMH-2811, JH 12247, IM 8556, JANA HIT, PRO-392, NMH 1265; Zone IV: VNR 31834, X35D601, DKC 9133(IM9133), HTMH 5108, HTMH 5404, RMH 972, SIRI 4527, JH 12247, IM 8562, CP. 999, DAS-MH-105, JANA HIT, PRO 392, NMH 1265 Zone V: X35D601, DKC 9133 (IM9133), DKC 9141 (IM8539), HTMH 5108, RMH 972, IM 8562, JANA HIT and PRO 392

*Medium Maturity lines:* Zone II: LG 32.82, AQH 4, CMH 10-547, DKC 9144, (IM8478), DKC 9149, (IM8581) ,FCH 11231, JKMH 4545, S-6750, TH-38, AQH 9, CMH 11-582 ,DKC 8144, (IM 8479 ), HTMH 5402, BH 41150, CMH 11-617 EH-2205, EH-2240,EHL 3412, KDMH 2705, KNMH 4010131, Kuber shakthi, AQH 8, DKC 9145 (IJ8533); Zone IV: TH 38, AQH 9, AQH 8, BH 41150, CMH 11-617, EH-2205, EH-2240, EHL 3412, PRMH-2177, KNMH 4010131; Zone V: DKC 9149 (IM8581), JKMH 4545, TH 38, CMH 11-617 and EH-2240

*Early Maturity lines:* Zone II: DMH-63, FH 3669, MEH 1-12-13, GWH 0712, CMH 11-579, CMH -11-611, CMH-11-626, NMH-1258, EH 2212, FH 3605, FH 3626, KMH 7021, CMH 10-531; Zone IV: DMH 63, FH 3669, MEH 1-12-13, GWH 0712, CMH 11-579, CMH 11-595, CMH 11-611, CMH 11-629, NMH 1258, JH 31613, EH 2212, FH 3605, FH 3626, KMH 7021, CMH 531; Zone V: MEH 1-12-13, CMH 11-611 and EH 2214

*Extra Early Maturity lines:* All the nine entries have LIR more than check.

During Rabi, 2013-14, out of 44 maize germplasm screened under artificial infestation against *Sesamia inferens* and *C. partellus* at Hyderabad and Kolhapur respectively, entries A 7501, Bio 237 and X35B349 were found to have LIR less than check against *S. inferens* and A 7501, Bisco X 5141, KMH-7148 and NMH-1247 against *C. partellus* in AVT II Late.

In AVT I-Late, entries GK 3149, GK 3150, X-1228, KH-K25 Gold, KMH-2589, IL 8534, Megan-G, Rasi-750, DADA and TH-2 against *S. inferens* and Bisco X 6573,

GK 3149, X-1228, KH-K25 Gold, II8212, IL 8534, Ivory, Megan G, Rasi 750, P 3533, DADA and TH 22 against *C. partellus* were found to have LIR less than check.

In AVT II and AVT I Medium, all the entries were found to have LIR less than that of check against *S. inferens* and KH-K26 and KMH-4210 against *C. partellus*. In AVT I-Early, KH-K25 was selected against *C. partellus*, while in QPM-3, VEHQ-11-1 was selected for both the stem borers.

**Screening of inbred lines against *Chilo partellus*:** Forty-two inbred lines were evaluated for resistance against *C. partellus*. In Zone II: 21 were moderately susceptible (LIR=3.1-6.0) and 21 highly susceptible (LIR 6.1-9.0); Zone IV: germplasm WNZPBT9, HKI 488 EARLY, CML 49, CML 482 and CML 227 were least susceptible (LIR  $\leq$ 3.0), 33 germplasm moderately susceptible and four highly susceptible; Zone V: Hybrid 9415-BBB-4, CML 49, ABB CYC5342-1, P390AM/CMLC4F230 B2, AEBCYC534-3-1, HKI 326-3, CMI227, P63 C2-BBB 17B and CML 408 were found to be least susceptible whereas 24 moderately susceptible and nine highly susceptible.

**Evaluation of biocontrol agents against *Chilo partellus*:**

*Egg parasitization:* The parasitization was recorded on the freshly laid eggs by *C. partellus* by artificially releasing the adults on HQPM1 and PMH1 at 12 DAG covered by net cage. The plants were harvested and the egg masses obtained were kept under ambient conditions for observing the emergence of parasitoids. No parasitization was observed at Delhi, Ludhiana, Karnal and Kolhapur while 1.32 percent parasitization by *Trichogramma* was recorded at Hyderabad.

*Larval parasitization:* The larvae collected from infested maize plants when reared in laboratory, resulted in 5, 3, 6, 23, 35 and 4% parasitization by *Cotesia flavipes* at Ludhiana, Karnal, Hyderabad Delhi and Kolhapur respectively. The incidence of *Cotesia* was found to be minimum (3.03) at 30 DAG crop while maximum larvae were found parasitized (18.42%) at 50 DAG of maize crop. The incidence of *Cotesia* decreases thereafter as observed from number of parasitized larvae recovered from the plants dissected at 60 and 70 DAG.

**Efficacy of insecticides:** The efficacy of four insecticides Chlorantriliprole 20 SC, Flubendiamide 480 SC, Novaluron 10EC and Deltamethrin 2.8 EC was evaluated at AICRP centres during Kharif, 2014. Flubendiamide 480 SC followed by Chlorantriliprole 20 SC was found to be most effective, based on leaf injury rating observed at 25 days after infestation.

**Validation of formula for crop loss assessment:** The formula for crop loss assessment caused by *C. partellus* was validated for second year during kharif 2014 at Delhi and Ludhiana centres. The estimated yield varied 3% from the actual yield obtained.

**Pest management in maize through habitat management:** Habitat management including cowpea as intercrop and sorghum as trap crop in maize for stem borers was practiced at IIMR farm, Ladhowal, Ludhiana. Sesamum and marigold were raised as alternate source of pollen, nectar and shelter for adult parasitoids. Maize crop with Sesamum and marigold was found to be the best in terms of LIR (1.25) and percent dead hearts (0.01) observed at 30 DAG. Intercropping of sorghum with marigold on borders of maize crop was found the next best treatment. The plant damage in the form of leaf injury and dead hearts was less than control in all the treatments.

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### Quality Evaluation

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Characterization and identification of suitable germplasm is the major prerequisite in developing nutritionally improved maize cultivars. The biochemistry laboratory of Indian Institute of Maize Research is the centralized analytical facility in developing quality protein maize cultivars across India. During the period of 2014–15, a large number of samples received from different centres were analyzed for various quality parameters viz. protein, tryptophan, lysine, oil, sugar, starch, etc. Around 1050 samples were analyzed for protein quality, 98 for sugar, 149 for starch, 66 for oil content, 80 for starch profile i.e. amylose and amylopectin content and 80 for resistant starch content.

A set of 590 newly introduced inbred lines received from Winter Nursery Center, Hyderabad were analyzed for protein quality and other biochemical parameters and subsequently categorized as QPM, high oil and sweet corn lines etc. A large number of inbred lines from IIMR were analyzed for protein quality and the promising material was selected based on the quality threshold and extent of modification. Five inbreds were identified as potentially high oil lines.

In an important experiment a set of 80 hybrids from both public and private sectors was analyzed for carbohydrate profile and resistant starch content. The results revealed that significant variation exists for the carbohydrate profile and starch content among hybrids. Starch is classified into three groups depending upon the rate of release and absorption of glucose in the gastrointestinal tract: rapidly digestible starch (RDS), slowly digestible starch (SDS) and resistant starch (RS). In terms of sugar content Pratap QPM Hybrid was found to be the best, whereas Rasi 3033 was identified as high starch hybrid. LG 3271 exhibited highest amylose, whereas NMH 731 exhibited the highest amylopectin content in starch. The hybrid LG 3271 was found to be best genotype followed by P3502, KH 2192 and HQPM 1 in terms of resistant starch content.

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### Technology Demonstrations

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The Indian Institute of Maize Research is provided extension services and extension personnel and farmers in different states through organizing training programmes and conducting Frontline Demonstrations (FLDs) during *rabi* and spring season of 2013-14 and thereafter during *kharif*, 2014 under NFSM scheme of Ministry of Agriculture, Government of India. These demonstrations were laid out in twenty states by thirty centers/agencies/NGOs. IIMR, AICRP centers, different agencies and NGOs conducted 3684 FLDs including 1488 during *rabi* 2013-14, 791 in spring 2014 and 1405 FLDs during *kharif* 2014. An average grain yield of 5285 kg/ha was recorded which showed an increase of 105% over all India average yield of maize. This highlights the potential of further enhancing the yield levels of maize across India.

Table 2: Details of FLDs conducted during different seasons in 2014-15

States covered	No. of FLDs (acres)	Range of average yield (kg/ha)
<i>Rabi</i> 2013-14		
Andhra Pradesh, Assam, Bihar, Gujarat, Maharashtra, Madhya Pradesh, New Delhi, Odisha, Tamil Nadu, Uttar Pradesh, Mizoram, Nagaland, Manipur, Tripura, Meghalaya	1488	3680-8376
Spring 2014		
Arunachal Pradesh, Bihar, Rajasthan, Uttar Pradesh, Haryana, Punjab, Odisha, Chhattisgarh, New Delhi	791	4433-6794
<i>Kharif</i> 2014		
Andhra Pradesh, Gujarat, Haryana, Himachal Pradesh, Jammu & Kashmir, Jharkhand, Karnataka, Maharashtra, Odisha, Rajasthan, Tamil Nadu, Uttar Pradesh, Uttrakhand	1405	1648-6843

**Tribal Sub Plan scheme:** Under TSP scheme, 171 demonstrations were carried out at tribal farmer's field by IIMR through its AICRP centers in the states of Maharashtra, Kamataka, Uttar Pradesh, Odisha, Madhya Pradesh and Andhra Pradesh. The mean yield under the demonstration varied from 2875 to 6555 kg/ha with 9 to 88% increase over average state yield during 2014.

The IIMR organized 10 national-level trainings for tribal farmers of Assam, Andhra Pradesh, Bihar, Chhattisgarh, Delhi, Gujarat, Jammu and Srinagar, Jharkhand, Madhya Pradesh, Odisha, Rajasthan and Uttar Pradesh. One Regional level training each in Bihar and Maharashtra was also conducted by IIMR. The inputs like seed of

latest hybrid and maize shellers were also distributed to the trainee farmers. The literature in the form of posters and booklets related to maize technologies was also provided to tribal farmers. Farmers' training and four field days were also organized by AICRIP centers in Karnataka, Odisha, Madhya Pradesh and Andhra Pradesh under TSP scheme.

