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Adoption Pattern of Improved Maize Technology in Northern India: Impact on Farm Earning and Trade

Ranjit Kumar, N.P. Singh, R.P. Singh and A.K. Vasisht

Abstract

Maize is the third most important cereal crop in India after rice and wheat. The paper has highlighted the adoption pattern of improved maize technology in the traditional maize growing states, viz. Bihar, Madhya Pradesh, Punjab, Rajasthan and Uttar Pradesh, along with its impact on farm earning and trade prospects. Although, the adoption of modern technology by farmers in this region has been low, the impact of these technologies has been found significant. The yield of hybrid cultivars is more than 4 tonne/ha compared to less than 2.5 tonne/ ha from the traditional cultivars during the *kharif* season. Similarly, during the r*abi* season, yield from hybrids has been about 6 tonne/ha and from composites, 4 tonne/ha. The unit cost of production has declined considerably, adding to the farm profits, and turning maize more profitable in comparison to its competing crops. On the trade front, the major maize importers in the world are the Asian countries which source it from the distant countries like the USA and Argentina. India being located at a shorter distance can offer transport-cost advantage to these countries. It has been suggested that the adoption of improved technologies and improvement in infrastructure and processing could help farmers realize the benefits of trade liberalization.

Introduction

Maize has diversified uses as food, feed and industrial raw material. In India, it is an important staple food for millions of poor. In recent years, significant changes have occurred in the Indian maize sector due to increasing commercialization of the agricultural economy. More than 50 per cent of the maize produced is used as animal feed, and evidences suggest that the demand for maize as feed will increase faster with the rising demand for meat (Delgado *et al.*, 1999).

Division of Agricultural Economics, Indian Agricultural Research Institute, New Delhi- 110012

In 2002-03, India produced 11.11 million tonnes (Mt) of maize from 6.45 million hectares (Mha) of land. Globally, it ranked fifth in terms of area after the USA, China, Brazil and Mexico; but due to its low productivity, India's rank in production is seventh. Many countries like Kuwait, Israel, Jordan and Italy, harvest 10-15 tonnes maize grain/ha, whereas in India, the average maize grain yield has hardly ever exceeded 2 tonnes/ha (Singh *et al.*, 2003). Also there is considerable regional variability in maize yield. The southern states like Andhra Pradesh and Karnataka, which are emerging as important maize producers, have sizeable area under the crop. The maize yield is much higher in these states than other states. On the other hand, the northern states like Uttar Pradesh, Bihar, Rajasthan, Madhya Pradesh and Punjab, which were the heartland of maize production before the Green Revolution, could not reap the benefit of technological developments in the maize sector.

The present study has examined the impact of technological changes on maize yield and income of the farmers in the northern states, which are home to nearly 42 per cent of the population in the country. Maize cultivation being intertwined in the culture of these states, the efforts to promote this crop would go a long way in sustaining the livelihood of the farmers in this area.

Data and Methodology

The primary as well as secondary data were utilized for the purpose of this study. Secondary data were used to examine the changes in area, production and yield of maize crop in the major maize-growing states. These data were collected from the Directorate of Economics and Statistics, Ministry of Agriculture, Govt. of India. Data on trade were compiled from the 'FAOSTAT' database of the Food and Agricultural Organization (FAO). Maize yield and its producers' price (farm gate price) in the major maize-producing countries were compared with those of India to understand the competitive advantage/ disadvantage of Indian maize in the world market.

Primary data on different aspects of maize production were collected from 300 maize growers from five states, viz., Bihar, Madhya Pradesh, Punjab, Rajasthan and Uttar Pradesh, for the year during 2002-03 under the NATP project entitled, "Technological Change and Production Performance in Irrigated Maize-based Agro-ecosystem: The Interplay of Economic, Technological and Institutional Factors".

Expansion and Importance of Maize

Grown in a wide range of production environments, maize area in the country has grown very fast. The spread of improved cultivars and crop

Table 1. Production performance of major maize-growing states

States	TE 2001-02			Period 1990 - 2001			
				Growth rate, %		C.V. %	
	Area (% share)	Production (% share)	Yield (kg/ ha)	Area	Yield	Area	Yield
Selected states	**56.84**	**49.20**	**1674**				
Bihar	11.36	13.18	2184	0.44	2.88	9	13
Madhya Pradesh	13.30	10.87	1537	-0.33	2.75	2	20
Punjab	2.53	3.60	2671	-1.46	3.54	7	17
Rajasthan	14.93	9.41	1186	0.28	1.93	3	19
Uttar Pradesh	14.71	12.14	1554	-1.40	1.60	6	14
Other States	**36.96**	**45.20**	**2271**				
Andhra Pradesh	7.14	12.05	3177	4.28	3.94	19	16
Gujarat	6.29	5.44	1628	1.56	3.86	6	25
Himachal Pradesh	4.59	5.79	2377	-0.48	1.68	2	9
Karnataka	9.49	14.41	2859	9.11	0.00	34	10
Maharashtra	4.46	3.34	1410	8.36	2.38	30	26
Jammu & Kashmir	5.01	4.17	1567	1.07	-0.48	4	8
All-India	**100 (6.53)***	**100 (12.28)****	**1882**	**1.11**	**2.56**	4	**11**

* area in million hectares, ** production in million tonnes

management practices have helped in a continuous growth of maize yields. Total maize area in the country expanded from 3.36 million hectares in 1950-52 to 6.53 million hectares in 2001-02. Amongst the states, Karnataka witnessed the maximum increase in maize area. On the other hand, in the states like Uttar Pradesh, Punjab and Bihar, there was a squeeze in the maize areas.

In the northern states, trade-off between *kharif* maize and rice favoured the latter, and hence the rice area expanded steadily at the cost of maize. It is evident from Table 1 that the five selected states account for 57 per cent of the maize area in the country and contribute nearly 50 per cent to the total maize production. On the other hand, six other states cover only 37 per cent of maize area and contribute 45 per cent to the total production. This is because of higher yield in the latter group of states as compared to the former one. It has also been observed that during the previous decade (1990- 2001), there was either no growth in the maize area in the northern states or it decelerated significantly. However, the growth in yield was impressive. Surprisingly, growth in maize yield has become stagnant in the Karnataka state, a major maize-producer in the country. Secondly, significant growth in maize area in Andhra Pradesh, Karnataka and Maharashtra was coupled with very high variability. Moreover, variability in maize in all these states has been higher than that of the national average.

The spread of improved cultivars and crop management practices gave a commercial orientation to maize cultivation and helped in realizing an impressive growth in maize yields during the recent years (Table 2). The substantial improvement in maize production came from the significant rise in yield. It could be attributed to a steady increase in maize area under high-yielding varieties (HYVs) and better irrigation. Rising yields, coupled with a steady expansion in area (particularly winter maize in some parts of the country) led to a strong growth in maize production. However, as compared to the world average of 3.8 tonnes/ha, the yield of maize realized in the country is very poor and is a matter of concern for India (Singh *et al.*, 2002).

Table 2. Maize yield and area under HYVs and irrigation in India, TE 1966-67 to 1996-97

Year	Yield (kg/ha)	Maize area under HYVs (per cent)	Maize area under irrigation (per cent)
TE 1966-67	993	6.09	14.65
TE 1971-72	1049	8.64	16.18
TE 1981-82	1100	30.12	19.26
TE 1991-92	1509	46.23	22.20
TE 1996-97	1628	58.40	22.07

Table 3. Distribution of maize area under different types of cultivars on selected farms

(per cent)

State	Maize area per farm (ha)	Local	Improved cultivars		
			Composite	Hybrid	Total
Bihar- *kharif*	1.50	49.83	42.02	8.15	50.17
Bihar- *rabi*	1.35	Nil	26.52	73.48	100.00
Madhya Pradesh	0.94	12.75	19.15	68.10	87.25
Punjab	1.37	7.60	4.80	87.60	92.40
Rajasthan	1.19	61.34	3.36	35.29	38.65
Uttar Pradesh	0.54	75.93*	3.70	20.37	24.07

*Includes commonly grown *Jaunpuri1*, *Jaunpuri Safed* and *Meerut local* maize cultivars

Adoption of Improved Cultivars

With initiation of seed policy reforms during the late-1980s, many private companies plunged into maize research, which was earlier in the domain of public sector. This change led to a spurt in the development and dissemination of new and improved maize cultivars. Though farmers allocated very less acreage to maize crop in the five selected states (Table 3), they were increasingly growing different HYVs/ cultivars of maize. A detailed list of varieties/ cultivars of maize grown by the farmers in each state is given in Appendix I.

To study the adoption of improved maize technology as a whole, a technology adoption index[1] was developed, which could be considered as a catch-all measure of technology adoption practices by the farmers. It was observed that a majority of the farmers (54%) in this region were low

1. The technology adoption practices mainly include area under high yielding varieties (HYVs), appropriateness of irrigation level and dosages of fertilizers. Therefore, the technology adoption index was computed by using the formula:

$$\left[TAI_i = \frac{1}{5}\left[\frac{AH_i}{CA_i} + \frac{NA_i}{NR_i} + \frac{PA_i}{PR_i} + \frac{IA_i}{IR_i} + \frac{KA_i}{KR_i}\right] \times 100\right]$$

where,

i = Number of farmers, say 1,2,3, ..., n; TAI_i = Technology Adoption Index of ith farmer; AH_i = Area under modern maize varieties (ha); CA_i = Total area of maize (ha); NA_i = Quantity of nitrogen applied for maize (kg/ha); NR_i = Recommended dose of nitrogen of maize crop (kg/ha); PA_i = Quantity of phosphorus applied for maize (kg/ha); PR_i = Recommended dose of phosphorus of maize crop (kg/ha); IA_i = Actual number of irrigations applied; IR_i = Recommended number of irrigations; KA_i = Actual amount of potash applied for maize (kg/ha); KR_i = Recommended amount of potash applied for maize crop (kg/ha)

adopters of modern technology (Table 4). Only 26 per cent of the total farmers surveyed fell under the category of 'high adoption'. The trend was very much similar across all the selected states, except in Punjab and Uttar Pradesh, where a majority of maize growers were high adopters.

Table 4. State-wise distribution of sample farmers in terms of adoption level of improved maize technology

(per cent)

State	Low adoption (0 – 33 %)	Medium adoption (34 – 66 %)	High adoption (67 – 100 %)
Bihar	87.20	12.80	Nil
Madhya Pradesh	97.00	3.00	Nil
Punjab	7.00	13.00	80.00
Rajasthan	73.00	24.33	2.67
Uttar Pradesh	2.83	48.67	49.00
Overall	54.22	19.45	26.33

Impact of Improved Cultivars on Maize Yield and Cost of Production

The technological advancement in maize has led to the development of various promising cultivars in the form of hybrids/composites for several regions/locations suiting to the local adaphic factors. Over the years, farmers have adopted these high-yielding cultivars in varying proportions. As discussed earlier, owing to skewed adoption, a majority of farmers could harvest very low yield even with the hybrid cultivars. Very few farmers could harvest even 4-5 tonnes/ha with the traditional as well as composite cultivars during the *kharif* season. However, during the *rabi* season, the crop gave better yields and many farmers could harvest even 7-8 tonnes/ha. But, this rosy picture was not evenly distributed. Within the type of cultivars, there was considerable variability in maize yield (Table 5). Variability was more pronounced during the *kharif* season. A huge difference between the yields of traditional and improved (composite/ hybrid) cultivars was clearly evident. In Uttar Pradesh, local maize varieties like *Jaunpuri 1, Jaunpuri Safed* and *Meerut local* gave better yields than many composite or even hybrid cultivars. This could be the reason of much higher average yield of *kharif* traditional variety in the state than that of other states. Secondly, the hybrid cultivars during the *rabi* season performed better than their counterparts in the *kharif* season. This has opened up new vistas in the maize cultivation in the states like Bihar and Rajasthan.

The rationale behind improvement lies in the enhancement of crop productivity and reduction in per unit cost of production. The improved maize cultivars in these states satisfied these criteria. As is evident from

Table 5. Yield differential and variability among selected maize-growing states of India

State		*Kharif*			*Rabi*
		Traditional	Composite	Hybrid	hybrid
Bihar	Yield (kg/ha)	1919	2284	2151	5990
	C.V. (%)	14.07	7.77	36.86	12.27
Madhya Pradesh	Yield (kg/ha)	1577	2867	3547	N.C.
	C.V. (%)	20.02	15.81	26.57	-
Punjab	Yield (kg/ha)	1969	3266	3625	N.C.
	C.V. (%)	14.82	16.35	13.94	-
Rajasthan	Yield (kg/ha)	1667	2552	3773	4000
	C.V. (%)	33.47	17.72	18.13	11.04
Uttar Pradesh	Yield (kg/ha)	2489	N.C.	4240	5143
	C.V. (%)	36.39	-	17.30	12.44

N.C.- not cultivated.

Table 6, the cost of production decreased by over 20 per cent with the adoption of composite cultivars as compared to the traditional variety during the *kharif* season. Similarly, compared with the hybrid cultivars, the cost of production was less by more than 25 per cent. However, it varied from state to state. During the *rabi* season, most of the farmers grew only hybrid cultivars, a comparison could not be made.

Profitability of Maize Cultivation *vis-à-vis* Its Competing Crops

The changing global scenario in agriculture is expected to affect the prospects of cultivation of every crop and maize is not an exception. To examine the competitive strength of this crop, an exercise was carried out to compare the net returns received after adjusting for the paid-up costs from the gross value of output for maize and its competing crops. Competing

Table 6. Reduction in the cost of production of maize due to adoption of improved cultivars in different states

State	*Kharif* traditional (Rs/q)	*Kharif* composite (Rs/q)	Reduction due to composite (%)	*Kharif* hybrid (Rs/q)	Reduction due to hybrid (%)
Bihar	305	224	26	198	35
Madhya Pradesh	364	317	13	277	24
Punjab	326	246	25	247	24
Rajasthan	595	395	33	337	43
Uttar Pradesh	365	N.C.	N.A.	285	22

N.C.- Not cultivated,N.A.- Not applied

crops were decided on the basis of the next best crop having the highest cultivated area under it in the districts in the selected states.

Maize was found to compete with paddy in Bihar, Punjab and Uttar Pradesh; with soybean in Madhya Pradesh; and with groundnut in Rajasthan during the *kharif* season. During the *rabi* season, it competed with the wheat crop. The study revealed that the composite as well as hybrid maize crops provided more profit than the competing crops in all the selected states, except Punjab (Table 7). But, cultivation of the traditional variety of maize did not seem to be a better choice. During the *rabi* season also, the profit was much higher from hybrid maize than wheat. This was due to the fact that paddy and wheat were high resource demanding crops. The cost of cultivation of these crops was much higher than that of hybrid maize, while the yields of these crops were at par. The output/input ratio in most of the selected states was found in favour of maize. In Punjab, paddy cultivation is highly mechanized, resulting in a considerable labour saving in comparison to that in maize. Thus, the farm level analysis inferred higher profitability of maize as against its competing crops.

Implications for Maize Trade

Demand for maize has been growing rapidly in both the domestic as well as international markets. An analysis of different uses of maize in the country indicated that domestic demand for maize grew faster during 1990-2001 than during 1980-90, mainly due to its increased utilization as feed and industrial raw material (Table 8). Although, India has often depended on imports of maize, its volume has increased in recent years. Contrary to it, many researchers have opined in the past that Indian maize was competitive in the world market, as Nominal Protection Coefficient (NPC) was estimated as less than one (Chand, 1999). But, due to the depressed price regime in the international market since 1998, wherein the prices have plummeted to nearly 3/5th of its level in 1997, the competitiveness of Indian maize in world market may not remain a realistic proposition. The competitiveness will beckon on increased adoption of improved cultivars in larger area, thereby obtaining reduction in per unit cost of production. However, the EXIM Policy for coarse cereals, in general, is still restrictive in the country as import of these commodities are canalized through Food Corporation of India, while export is permitted subject to an annual quantitative ceiling of one lakh tonnes.

Besides expanding domestic market, Indian maize has considerable potential for exports. The United States of America, Argentina and China are the major maize-exporting countries in the world and they together account for more than 80 per cent of global export of maize (Table 9).

Table 7. Economics of cultivation of maize and its competing crops in selected states

(Rs/ha)

Particulars	*Kharif* season				*Rabi* season	
	Traditional maize	Composite maize	Hybrid maize	Competing crop[1]	Hybrid maize	Competing crop[2]
Bihar						
Input cost	5849	5773	6531	12163	16932	14479
Output value	9672	11554	14778	15477	29446	21409
Net return	3823	5781	8248	3577	12514	6930
Output/ input ratio	1.65	2.00	2.26	1.27	1.74	1.48
Madhya Pradesh						
Input cost	5625	8604	10546	10087	-	-
Output value	6889	12076	16917	15944	-	-
Net return	1264	3472	6371	5857	-	-
Output/ input ratio	1. 22	1. 40	1. 60	1. 58	-	-
Punjab						
Input cost	6427	8009	8956	13160	-	-
Output value	13035	17935	19637	32502	-	-
Net return	6608	9925	10682	19341	-	-
Output/ input ratio	2.03	2.24	2.19	2.47	-	-
Rajasthan						
Input cost	9506	10212	12881	14663	17070	15639
Output value	10841	16538	22895	13527	24722	26081
Net return	1335	6326	10014	-1126	7652	10442
Output/ input ratio	1.14	1.62	1.78	0.92	1.45	1.67
Uttar Pradesh						
Input cost	8601	12295	-	9716	12857	10426
Output value	11915	22217	-	19229	27990	24732
Net return	3314	9922	-	9513	15133	14271
Output/ input ratio	1.39	1.81	-	1.98	2.18	2.37

Note: 1. Competing crops during the *kharif* season: Paddy in Bihar, Punjab and Uttar Pradesh; soybean in Madhya Pradesh and; groundnut in Rajasthan
2. Competing crops during the *rabi* season: Wheat in Bihar, Rajasthan and Uttar Pradesh

Table 8. Commodity balance of maize in India, 1980- 2001

Particulars	Quantity ('000 tonnes)			Growth rates (%)	
	1980-81	1990-91	2001-02	1980-90	1990-01
Production	6486	8863	12280	2.31	3.64
Imports	11	92	106	-25.8	91.73
Exports*	0	0	60	13.95	46.42
Domestic supply	6497	8955	12326	2.37	3.67
Domestic usages					
Food	3721	3542	3658	-0.49	0.32
Feed	1150	2854	6147	9.52	7.97
Seed	120	124	131	0.33	0.55
Industrial uses	752	915	1701	1.98	6.40
Waste	754	1520	689	7.26	-7.61

Source: Information on maize import and export was taken from the 'FAOSTAT' database. For domestic uses, the estimates were based on the Expert's opinion used under the NATP project entitled, "Technological Change and Production Performance ... ... Institutional Factors".

*India has been exporting a small quantity of maize since 1997 to the nearby Asian countries like, Bangladesh, Bhutan, Indonesia, Malaysia and Philippines, but in inconsistent manner.

Table 9. Major maize-exporting countries to Asia

(in per cent)

Exporting country	Share in world maize export			Share in the total maize export to Asian countries		
	TE 1985	TE 1995	TE 2001	TE 1985	TE 1995	TE 2001
USA[1]	71.60	78.41	65.34	41.81	64.96	55.33
Argentina[2]	11.25	8.54	12.97	23.68	38.77	35.12
China[3]	3.14	4.45	10.02	66.01	88.82	96.83
World	100.00 (60.60)	100.00 (61.06)	100.00 (75.07)	41.95	48.62	52.13

Figures within the parentheses are total maize export (in million tonnes) in the world.

Source: FAOSTAT database

Note: Major importing countries of Asia from

[1]USA: Japan, China, Korea, S. Arabia, Turkey, Israel, Indonesia, Lebanon, Philippines, etc.

[2]Argentina: Korea, Iran, S. Arabia, Jordan, Japan, Malaysia, Yamen, UAE, Syria, Kuwait, etc.

[3]China: Korea, Malaysia, Japan, Vietnam, Sri Lanka, Bangladesh, Philippines, etc.

Table 10. Maize yield and producer's price differential for major maize-exporting countries *vis-à-vis* India

Exporting country	Maize yield (kg/ ha)			Yield growth, %	Producers' price* (US$/ tonne)	
	TE 1980	TE 1990	TE 2003	1980- 2003	TE 1995	TE 2001
USA	6,309	6,682	8,584	1.55	94	74
Argentina	3,108	3,382	6,150	3.34	67	50
China	2,956	4,112	4,827	2.04	112	109
India	1,071	1,515	1,930	2.37	116	118

*Producers' price is the national average of farm-gate price i.e. what the farmers get from the sale of the maize produce.
Source: FAOSTAT database

Interestingly, the destinations of their maize exports are the Asian countries. These three countries exported 55 per cent, 35 per cent and 97 per cent of their total maize exports to the Asian countries, which are more in the vicinity of India.

During 2001-02, Japan was the largest maize importer in the world followed by South Korea, Egypt, Taiwan and Mexico. While the USA topped the exporters' list followed by Argentina, China and Brazil. But, the main concern for India is its poor maize yield. Though, maize yield in the country has doubled during the previous two decades and the growth has been impressive, but it is not enough to have a sound leverage in the global market. As Table 10 shows, yield of maize in India is only 22 per cent of that in the USA, 31 per cent of that in Argentina and 40 per cent of what China harvests. Because of this, the price of maize is higher in India than in the major exporting countries.

On the other hand, the northern states under study were found to have huge marketed surplus of maize. From the farms surveys, it was observed that the maize growers in this region were selling their produce to the extent of 60 to 88 per cent (Research Report, 2004). Secondly, these were the traditional maize growers located in close vicinity to Kolkata or Kandla ports. Under such a situation if the adoption of improved maize cultivars/ technologies is pushed up along with export promotion schemes, the region could reap the benefits of expanding global market for maize.

The Tenth Five Year Plan has given adequate thrust on maize, especially on the multiplication of high-yielding seeds on a massive scale and adoption of improved production technologies, which may enhance maize production by about 10-13 Mt even with the existing area of about 6.5 M ha. This is on the assumption that 50 per cent of the present potential (3.5 - 4 t/ha) of

maize is realised. But, to capture the opportunities provided by the trade liberalization, some strategic changes are needed in the maize production. To capitalize on the increased market access and to remain competitive globally, adoption of cost-effective production as well as post-production technologies in the region become imperative. Post-production technology including on-farm handling and storage, covering sanitary and phyto-sanitary measures, need special attention.

Conclusions

Maize is one of the most important cereal crops in India and more than 50 per cent of its production is used as animal feed. This study has highlighted the adoption pattern of improved maize technology in the traditional maize-growing states, viz. Bihar, Madhya Pradesh, Punjab, Rajasthan and Uttar Pradesh. These states together account for more than half of the country's maize area but contribute less than half to the total maize production due to low adoption of modern technology. The impact of adoption of modern technologies has, however, been found very promising. The hybrid cultivars have given more than 4 tonnes/ha grain yields as against 2.5 tonnes/ha from the traditional cultivars during the *kharif* season. Similarly, during the *rabi* season, yield from hybrids has been about 6 tonnes/ha and from composite cultivars around 4 tonnes/ha. The use of composite variety has reduced the cost of production by 13-33 per cent and of hybrid, by 22-43 per cent compared to that of local varieties. It has made maize crop more profitable than its competing crops in *kharif* as well as *rabi* seasons.

The recent growth in yield accruing from the increased level of adoption of hybrids in the traditional maize-growing areas has opened up many vistas for the farmers. Besides, meeting the domestic requirements of food, feed and industry; the region may now look for opportunities in the international market, particularly in the far-east Asian countries, as these countries import maize from distant countries like the USA and Argentina at a higher transportation cost. The technological development in the maize sector in the past could not make much headway in the northern and central states of India due to the weak parastatals. The lack of market infrastructure and processing facilities (assembling, drying and processing of product) are the major hurdles in harnessing the opportunities unfolded by trade liberalization. Hence, removal of the institutional and infrastructural bottlenecks on the one hand and technological push on the other require policy intervention to increase maize production and trade.

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Appendix I

High-yielding varieties of maize being cultivated in the study area

State	Districts	Name of Variety/ Cultivar
Bihar	Begusarai	Bisco, Masinabeej, Cargil, Ganga-2, Laxmi, Mahyco, Proagro, Shankar, Kanchan, Hi-starch, Pioneer
	Samastipur	Cargil, Hi-starch, Proagro, Rallis, Bisco, Ganga-2, Kanchan, Laxmi, Mahyco, Pioneer
	Vaishali	Cargil, Proagro, Pioneer, Hi-starch, Ganga-5, Masinabeej, Ganga-2, Luxmi, Pioneer
M. P.	Shahdol	Hi-shell, Hy - 4640, PAC-9714
	Chhindwara	Chandan- 3, Ganga - 5
	Mandsaur	Hy- 309, Chandan-3, Ganga-2, Ganga-5, GM-8, Hy-4640, PAC - 9712
Punjab	Jalandhar	Hy-4640, K101, K-25, Kanchan, Pratap, Sartaj, Swarna, Sriram
	Hoshiarpur	Hy-4640, K-25, Kanchan, Paras, Sriram, Kohinoor, Prabhat, Pratap, Sartaj, Swarna
	Patiala	Cargil-501, Govinda, Mahyco, Pratap, Proagro, Seed-Tech
Rajasthan	Banswara	Kanchan, Kaveri, PAC-701, Pioneer, Sriram, Navjyot
	Chittorgarh	ITC-701, Mukta, Sriram, Pioneer, Swarna, Novjyot
	Bhilwara	Bio-seed, Ganga-2, ITC-701, JK, Cargil, Kanchan, Proagro, Sona, Soobeej
U. P.	Baharaich	Sartaj, Daccon - 107, Azad uttam
	Jaunpur	Jaunpuri, Ganga-11
	Bulandshahar	Meerut yellow, Gaurav, Sweta, Ganga-2