

Original Research Article

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Growth Parameters and Yield of Maize Varieties (*Zea mays* L.) in Tribal Hills Area of Pali District, Rajasthan, India

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ABSTRACT

Maize is the most important world's leading cereals crop which can be grown in diverse seasons, ecological and uses and known as queen of cereal due to unparallel productivity among cereal crops. Front line demonstrations (FLDs) on maize were laid down at 180 farmers' fields to demonstrate production potential and economic benefits of improved production technologies comprising high yielding varieties namely PEHM-2, PM-3, PM-5, PSM 2 and PM 4 in Pali district of arid zone of Rajasthan state during *Kharif* seasons from 2011 to 2017 in rainfed farming situation. The improved production technologies recorded an additional yield ranging from 3.10 to 9.9 q/ha with a mean of 6.6 q/ha. The per cent increase yield under improved production technologies ranged from 24.4 to 52.1 (PM-3), 29.6 to 57.1 (PM-5), 16.4 to 36.4 (PEHM-2), 41.8 to 58.4 (PM-4) and 29.6 (PSM-2) in respective years. The average extension gap, technology gap and technology index were 6.6q/ha, 13.4q/ha and 36.9 per cent, respectively in different varieties of maize. The improved production technologies gave higher benefit cost ratio ranging from 2.7 to 4.8 with a mean of 3.3 compared to local checks (2.0) being grown by farmers under locality. From the result of the findings that the maximum number of the respondents had medium level of knowledge and extent of adoption regarding recommended maize production technology. The study reported lack of suitable HYV as major constraints by beneficiaries is rank first followed by low technical knowledge. The productivity of maize per unit area could be increased by adopting feasible scientific and sustainable management practices with a suitable variety. Considering the above facts, frontline demonstrations were carried out in a systematic and scientific manner on farmer's field to show the worth of a new variety and convincing farming community about potentialities of improved production management technologies of maize for further adoption by the farming community.

Keywords

Adoption, Knowledge, Constraints, FLD, Varieties and maize

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Introduction

Maize (*Zea mays* L.) is the most important world's leading cereal crop which can be grown in diverse seasons, ecologies and uses

and known as queen of cereal due to unparallel productivity among cereal crops. Globally, it is cultivated on more than 160 m ha area across 166 countries having wider diversity of soil, climate, biodiversity and

management practices. In India, maize occupies third position both in area and production followed by rice and wheat (Anonymous, 2017) According to latest data (2016-17), it is being cultivated on 8.6 m ha with 80 per cent area during *kharif* season. The current maize production is 21.7 million tones with an average productivity of 24.35 q/ha. The productivity of India is just half than the world productivity. In Rajasthan it is grown on 0.97 m ha area with production 1.84 m tones and productivity of 1888 kg/ha (Anonymous, 2016-17). During recent years, Pali district of Rajasthan has emerged as the leading one in maize production in the state.

The productivity of maize in the district is very low as compared to average national productivity (24.35 q/ha). Lack of suitable high yielding variety as well as poor knowledge about production practices are ascribed as main reasons for low productivity of maize in the district. The productivity of maize per unit area could be increased by adopting recommended scientific and sustainable management production practices using suitable high yielding varieties namely PEHM-2, PM-3, PM-5, PSM 2 and PM 4 (Das *et al.*, 2007; Dhaka, 2010; Ranawat *et al.*, 2011).

Frontline demonstration is the new concept of field demonstration evolved by the Indian Council of Agriculture Research (ICAR) with main objective to demonstrate newly released crop production and protection technologies and its management practices in the farmers' fields under different agro-climatic regions of the country under different farming situations. While demonstrating the technologies in the farmer's fields, the scientists are required to study the factors contributing higher crop production, field constraints of production and thereby generate production data and feedback information. Taking into account the above considerations, frontline demonstrations

(FLDs) were carried out in a systematic manner on farmer's field to show the worth of a new variety and convincing farmers to adopt improved production management practices of maize for enhancing productivity of maize.

Materials and Methods

The study was conducted in tribal farmers' fields to demonstrate production potential and economic benefits of improved technologies in Pali district tribal hill area of Rajasthan state during *Kharif* seasons from 2011 to 2017 in rainfed farming situation. To popularize the improved maize production practices, constraints in maize production were identified through participatory approach. Preferential ranking technique was utilized to identify the constraints faced by the respondent farmers in maize production. Farmers were also asked to rank the constraints they perceive as limiting production factor for maize cultivation in order of preference. Based on top rank farmers problems identified, front line demonstrations were planned and conducted at the farmer's fields under ICAR and integrated scheme of oilseeds, pulses, oilpalm and maize (ISOPOM). In all, 472 full package frontline demonstrations were conducted to convince them about potentialities of improved varieties of maize *viz.*, PEHM-2, PM-3, PM-5, PSM 2 and PM 4 during *Kharif* seasons from 2011 to 2017 under rainfed farming condition, in light to medium soils with low to medium fertility status under chickpea-maize cropping systems.

Each demonstration was conducted in an area of 0.4 ha and adjacent to the farmer's fields in which the crop was cultivated with farmer's practice/ local variety. The package of practices included were improved varieties, seed treatment, maintenance of optimum plant stand, recommended fertilizers dose, plant protection measures especially grass hopper management. The spacing followed was at

0.60 m x 0.25 m sown between third week of June to first week of July during the five years with the seed rate of 25 kg/ha. All the participating farmers were trained on all aspects of maize production management. To study the impact of front line demonstrations, out of 661 participating farmers, a total of 160 farmers were selected as respondent through proportionate sampling. Production and economic data for FLDs and local practices were collected and analyzed. The Extension gap, technology gap and technology index were calculated using the formula as suggested by Samui *et al.*, (2000).

Extension gap (qha⁻¹) = Demonstration yield (qha⁻¹) – Yield of local check (qha⁻¹)

Technology gap (qha-1) = Potential yield (qha⁻¹) – Demonstration yield (qha⁻¹).

Technology index (%) =
$$\frac{\text{Potential yield} - \text{Demonstration yield}}{\text{Potential yield}} \times 100$$

Knowledge level of the farmers about improved production practices of maize before frontline demonstration implementation and after implementation was measured and compared by applying paired t-test at 5 per cent level of significance. Further, the satisfaction level of respondent farmers about extension services provided was also measured based on various dimensions like training of participating farmers, timeliness of services, supply of inputs, solving field problems and advisory services rendered, fairness of scientists, performance of variety demonstrated and overall impact of FLDs. The selected respondents were interviewed personally with the help of a pre-tested and well-structured interview schedule. Client Satisfaction Index was calculated as developed by Kumaran and Vijayaragavan (2005). The individual obtained scores were calculated by the formula as:

Client Satisfaction Index =
$$\frac{\text{The individual obtained score}}{\text{Maximum score possible}}$$

The data thus collected were tabulated and statistically analyzed to interpret the FLDs results.

Results and Discussion

Constraints in maize production

Farmer’s maize production problems were documented in this study. Preferential ranking technique was utilized to identify the constraints faced by the respondent farmers in maize production. The ranking given by the different farmers are given in Table 1. A perusal of table indicates that lack of suitable high yielding variety (HYV) (83.9%) was given the top most rank followed by low technical knowledge (80.3%), grass hopper infestation (76.7%), vagaries of weather (69.4%). Based on the ranks given by the respondent farmers for the different constraints revealed that lack of suitable HYV, low technical knowledge, grass hopper infestation are the major constraints to maize production and followed by wild animals. Other constraints such low or erratic rainfall, stem borer infestation, stem rot, weed infestation, water lodging, marketing and post-harvest management were found to reduce maize production. Among all the constraints, low soil fertility got least concerns. Other studies (Hassan *et al.*, 1998; Ouma *et al.*, 2002; Joshi *et al.*, 2005; Dhaka *et al.*, 2010; Ranawat *et al.*, 2011; Dhruw *et al.*, 2012; Sreelakshmi *et al.*, 2012) have reported similar problems in maize production.

Performance of FLD

A comparison of productivity levels between demonstrated varieties and local checks is shown in Table 4. During the period under

study, it was observed that the productivity of maize in Pali district under improved production technologies ranged between 15.3 to 28.1 q/ha with a mean yield of 22.9 q/ha. The productivity under improved technologies varied from 17.8 to 25.9, 15.3 to 22.2, 20.3 to 24.5, 24.3 to 26.8 and 28.1 q/ha for the varieties PM-3, PEHM-2, PM-5 and PM 4, respectively as against the yield range between 11.7 to 20.4 with a mean of 16.2 q/ha under farmers local practices and varieties during study period. The additional yield of different varieties under improved production technologies over local practices ranged from 3.1 to 9.4 q/ha with a mean of 6.6 q/ha in comparison to local practice and varieties. The per cent increase yield under improved production technologies ranged from 26.9 to 43.5 (PM-3), 29.6 to 57.1 (PM-5), 16.4 to 36.4 (PEHM-2), 41.8 to 58.4 (PM 4) and 52.4 (PSM 2) in respective years. This increased grain yield with improved production technologies was mainly because of high potential yielding varieties.

The variation in the productivity was also caused unusual delay in sowing in some of the farmer's fields. In fields where delayed sowing was done because of prolonged dry spell in the month of July and delay onset of monsoon rains, the crop growth was restricted. The late sowing crop was subjected to relatively less time span available for plant growth and development. Similar yield enhancement in different crops in front line demonstration has amply been documented by Haque (2000), Tiwari and Saxena (2001), Tiwari *et al.*, (2003), Nazrul Islam *et al.*, (2004), Hiremath *et al.*, (2007), Mishra *et al.*, (2009), Tomar *et al.*, (2009), Dhaka *et al.*, (2010), Kumar *et al.*, (2010) and Sreelakshmi *et al.*, (2012). From these results it is evident that performance of improved varieties was found better than the local check under local conditions. Farmers were motivated by results of agro technologies applied in the FLDs trials

and it is expected that they would adopt these technologies in the coming years also. Yield of the front demonstration trials and potential yield of the different varieties of crop was compared to estimate the yield gaps which were further categorized into technology index. The technology gap shows the gap in the demonstration yield over potential yield and it was 13.4 q/ha. The observed technology gap may be attributed to dissimilarities in soil fertility, salinity and erratic rainfall and other vagaries of weather conditions in the area. Hence, to narrow down the gap between the yields of different varieties, location specific recommendation appears to be necessary. Technology index shows the feasibility of the variety at the farmer's field. The lower the value of technology index more is the feasibility. Table 4 revealed that the technology index value was 36.9.

The findings of the present study are in line with the findings of Sawardekar *et al.*, (2003), Hiremath and Nagaraju (2009) and Dhaka *et al.*, (2010). The economic feasibility of improved technologies over traditional farmer's practices was calculated depending on the prevailing prices of inputs and output costs (Table 5). It was found that cost of production of maize under improved technologies varied from Rs.8550 to Rs. 12500 ha⁻¹ in case of PM-3, Rs. 8790 to Rs. 9220 ha⁻¹ for PM-5, Rs. 8660 to Rs. 10900 ha⁻¹ for PEHM-2, Rs. 8180 to Rs. 12300 ha⁻¹ for PM 4 and Rs.9700 ha⁻¹ in case of PSM 2 with an average of Rs. 9744.4 ha⁻¹ with an average of Rs. 9372.5 ha⁻¹ in local practice. The additional cost incurred in the improved technologies was mainly due to more costs involved in the cost of improved seed only. Front line demonstrations recorded higher mean gross returns (Rs. 32466.7 ha⁻¹) and mean net return (Rs.22722.2 ha⁻¹) with higher benefit ratio (3.3) under improved technologies of different improved varieties of maize as compared to local checks.

Table.1 Ranking given by farmers for different constraints (N=160)

S. No.	Constraints	Percentage	Ranks
1	Lack of suitable high yielding variety	83.9	I
2	Stem rot diseases	33.8	VII
3	Stem borer infestation	45.3	VI
4	Low soil fertility	27.2	X
5	Low technical knowledge	80.3	II
6	Wild animals	52.6	V
7	Vagaries of weather (Delay onset of monsoon, early withdrawn of monsoon and mid season drought)	69.4	IV
8	Weed infestation	29.3	VIII
9	Grass hopper infestations	76.7	III
10	Water lodging	30.9	IX
11	Marketing	26.5	XI
12	Post harvest management	23.7	XII

Table.2 Compression between knowledge levels of the respondents farmers about improved farming practices of maize (N=160)

Mean score			Calculated “t” value
Before implementation	FLD After implementation	Mean difference	
33.7	67.8	34.1	7.98*

*Significant at 5 % probability level; FLD= Front Line Demonstration

Table.3 Extent of farmers satisfaction of extension services rendered (N=160)

Satisfaction level	Number	Percent
Low	23	14.8
Medium	105	65.6
High	32	20.0

Table.4 Yield of maize as influenced by improved production technologies and high yielding varieties over local practices in farmer’s fields (2009-2015)

Year	Variety	Area (ha)	No. of Demo.	Yield (q/ha)		Add. over check (q/ha)	Yield local	% increase over local	EG (q/ha)	TG q/ha)	TI (%)
				IP	FP						
2011	PM-3	12	30	17.8	11.7	6.1		52.1	6.1	18.9	51.4
	PEHM 2	20	50	15.3	11.7	3.6		30.8	3.6	21.5	58.6
2012	PM 3	15	36	19.9	14.1	5.0		35.5	5.0	16.8	45.8
	PM 5	15	36	20.3	14.1	6.2		43.9	6.2	16.4	44.7
2013	PM 5	08	20	24.5	18.9	5.6		29.6	5.6	11.7	32.3
	PEHM 2	10	25	22.0	18.9	3.1		16.4	3.1	14.2	39.2
	PSM 2	06	15	28.1	18.9	9.9		52.4	9.9	8.1	22.4
	PM 4	13	32	26.8	18.9	7.9		41.8	7.9	9.4	26.0
2014	PM 5	09	22	23.1	14.7	8.4		57.1	8.4	13.1	36.2
	PM 3	20	50	21.1	14.7	6.4		43.5	6.4	15.1	41.7
2015	PM 3	07	17	20.4	16.4	4.0		24.4	4.0	15.8	43.6
	PEHM 2	10	25	22.2	16.4	5.8		35.4	5.8	14.0	38.7
	PM 4	05	12	25.8	16.4	9.4		57.3	9.4	10.4	28.7
2016	PM 3	12	30	25.9	20.4	5.5		26.9	5.5	10.3	28.5
	PEHM 2	05	12	21.0	15.4	5.6		36.4	5.6	15.2	42.0
	PM 4	05	12	24.3	15.4	9.0		58.4	9.0	11.9	32.9
2017	PM 3	15	36	23.6	17.7	5.9		33.3	5.9	12.6	34.8
	PM 4	05	12	29.7	17.7	12.0		67.8	12.0	6.5	18.0
	Average	192	26.2	22.9	16.2	6.6		41.3	6.6	13.4	36.9

IP= Improved practice, FP= Farmers practice, EG= Extension gap, TG= technology gap, TI= Technology index

Table.5 Cost of cultivation (Rs. ha⁻¹) net return and benefit cost ratio of maize as affected by improved production technologies over local practices

Year	Variety	Total cost of cultivation		Gross return (Rs ha ⁻¹)		Net return (Rs ha-1)		B:C ratio		Add. Cost of cultivation	Add. Net returns (Rs.ha ⁻¹)
		IP	FP	IP	FP	IP	FP	IP	FP		
2011	PM-3	8550	8405	23500	18900	14950	10495	2.7	2.2	145	4455
	PEHM 2	8660	8520	24800	17800	16140	9395	2.9	2.0	140	6745
2012	PM 3	8970	8850	27500	20600	18530	11750	3.1	2.3	120	6780
	PM 5	8790	8650	30800	21000	22010	12440	3.5	2.4	140	7570
2013	PM 5	8890	8560	32900	23000	24010	14440	3.7	1.6	330	9570
	PEHM 2	9080	8970	34500	23000	25420	14030	3.8	2.5	110	11390
	PSM 2	9700	9630	36700	23000	27000	13370	3.8	1.3	70	13630
	PM 4	9690	9560	30400	23000	20710	13440	3.1	2.4	130	7270
2014	PM 5	9520	9400	33200	25600	23680	16200	3.5	2.5	120	7480
	PM 3	9970	9780	29600	21600	19630	11820	2.9	2.2	190	7810
20135	PM 3	9780	9650	32400	21600	22620	11950	3.3	2.2	130	10670
	PEHM 2	9650	9450	35600	19800	25950	10350	3.6	1.7	200	15600
	PM 4	8180	7900	39000	21700	30820	13800	4.8	2.7	280	17020
2016	PM 3	9870	9660	31600	22800	21730	13140	3.2	2.3	210	8590
	PEHM 2	10900	9870	28700	20250	17800	10380	2.6	2.0	1030	7420
	PM 4	10400	9800	36500	20300	26100	10500	3.4	1.9	600	15600
2017	PM 3	12500	11050	37800	25400	25300	14350	3.0	1.8	1450	10950
	PM 4	12300	11000	38900	29050	26600	18050	3.2	1.5	1300	8550
	Average	9744.4	9372.5	32466.7	22133.3	22722	12772.2	3.3	2.0	371.9	9838.9

IP= Improved practices, FP= Farmer practices

These results are in line with the findings of Gurumukhi and Mishra (2003), Sawardekar *et al.*, (2003), Sharma (2003), Hiremath *et al.*, (2007), Hiremath and Nagaraju (2009) and Sreelakshmi *et al.*, (2012). Further, additional cost of Rs. 371.9 ha⁻¹ in demonstration has yielded additional net returns of Rs. 9838.9 ha⁻¹ with incremental benefit cost ratio 2.0 suggesting its higher profitability and economic viability of the demonstration. Similar results were also reported by Hiremath and Nagaraju (2009) and Dhaka *et al.*, (2010) in maize crops. The results from the present study clearly brought out the potential of improved production technologies in enhancing maize production and economic gains in rainfed farming situations conditions of this region of Rajasthan. Hence, maize production technologies have broad scope for increasing the area and productivity at each and every level.

Increase in knowledge

Knowledge level of respondent farmers on various aspects of improved maize production technologies before conducting the frontline demonstration and after implementation was measured and compared by applying paired 't'-test. It could be seen from the Table 2 that farmers mean knowledge score had increased by 34.1 after implementation of frontline demonstrations. The increase in mean knowledge score of farmers was observed significantly higher. As the computed value of 't-test' (7.98) was statistically significant at 5 % probability level. The results are at par with Narayanaswamy and Eshwarappa (1998) on pulses crops, Singh and Sharma (2004) on mustard crop, Singh *et al.*, (2007) on different crops like soybean, pigeon pea, black gram and Dhaka *et al.*, (2010) on maize crop. It means there was significant increase in knowledge level of the farmers due to frontline demonstration. This shows positive impact of frontline demonstration on

knowledge of the farmers that have resulted in higher adoption of improved farm practices. The results so arrived might be due to the concentrated educational efforts made by the scientists.

Farmer's satisfaction

The extent of satisfaction level of respondent farmers over extension services and performance of demonstrated variety was measured by Client Satisfaction Index (CSI) and results presented in Table 3. It is observed that majority of the respondent farmers expressed medium (65.6%) to the high (20.6%) level of satisfaction for extension services and performance of technology under demonstrations whereas, very few 14.8 per cent of respondents expressed lower level of satisfaction. The results are in close conformity with the results of Narayanaswamy and Eshwarappa (1998) on pulses crops, Kumaran and Vijayaragavan (2005) on mustard & gram crops and Dhaka *et al.*, (2010) on maize crop, Dash and Rautaray (2017) and Dash *et al.*, (2018) in green gram crop. The medium to higher level of satisfaction with respect to services rendered, linkage with farmer's and technologies demonstrated *etc.* indicate stronger conviction, physical and mental involvement in the frontline demonstration which in turn would lead to higher adoption. This shows that the relevance of frontline demonstrations. It indicates that maize grown with low yield are identified by low knowledge, un-favorable attitude towards high yielding varieties, low risk bearers with negative perception of maize production technology. In other wards it may also due to then socio-economic status, lower holdings and unavailability of inputs and credit facilities and to some extent supply and marketing problems. This is a point of concern for research and extension functionaries to disseminate improved maize

production technologies for raising the productivity of maize at all the levels.

On the basis of the result obtained in present study it can be concluded that the yield gap between conventional practices and improved production technologies was perceptibly higher, there is urgent need to make stronger extension services for educating the cultivators in the implementation of improved production technology. However, the yield level under FLD was better than the local varieties and performance of these varieties could be further improved by adopting recommended production technologies. Hence, it can be observed that increased yield was due to adoption of high yielding varieties and conducting front line demonstration of proven technologies. Yield potentials of crop can be increased to greater extent. This will subsequently increase the income as well as the livelihood of the farming community. From the above research findings it can be also concluded that the maximum number of the respondents had medium level of knowledge and extent of adoption regarding recommended maize production technology. The study reported lack of suitable HYV as major constraint by the beneficiaries and is ranked first followed by low technical knowledge.

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