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IMPACT OF IMPROVED TECHNOLOGIES ON PRODUCTIVITY AND PROFITABILITY OF RAPESEED-MUSTARD PRODUCTION AT FARM LEVEL IN WEST BENGAL, INDIA

A. Dutta*

Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia-741252

ABSTRACT

Ten year study of front line demonstrations (FLDs) on rapeseed-mustard was conducted to assess the potentiality of improvised production technology. In West Bengal, Rapeseed-mustard is the major oilseed crop contributing 53% of total oilseed production of the state. One of the major constraints is low productivity of this crop due to non adoption of recommended package of practices and situation-specific improved varieties by most of the growers. Data used for this study were pertained to FLDs in rapeseed-mustard conducted under 'Integrated Scheme on Oilseeds, Pulses, Oil palm and Maize (ISOPOM)' during 2005-06 to 2014-15. The study revealed 27% yield advantage by the adoption of improved varieties almost with other practices. The other components *viz.*, adoption of right method and time of sowing, seed treatment, application of sulphur and boron, integrated fertilizer and irrigation management, integrated pest and disease management showed 37, 32, 26, 32, 26 and 28% respectively yield advantage over farmers' practice. Popularization of these proven technologies to the rapeseed- mustard growers will help them to get higher economic returns with sustainable production system of the state.

Keywords: Economic potentials, FLD, improved technologies, rapeseed-mustard

INTRODUCTION

India accounts for 12-15% of world's oilseed area, 7-8% of oilseeds output, 6-7% of vegetable oil production, 9-12% of vegetable oil import and 9-10% of vegetable oil consumption (Hegde, 2009). The country produces seven edible oilseed crops *viz.*, groundnut, rapeseed-mustard, soybean, sunflower, sesame, safflower and niger and two non edible oilseeds *viz.*, castor and linseed (Paroda, 2013). Despite having the largest area under oilseeds in the world (26.77 M ha), India currently

* Corresponding author email: amitavapors@gmail.com

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imports about 50% of total oil requirement (2011-12) at a huge cost of ₹56,000 crores (1 US$ = ₹68) (Paroda, 2013). Though the diverse agro ecological conditions of West Bengal are also favourable for growing all these nine oilseeds, rapeseed-mustard, groundnut, sesame and sunflower are the major oilseed crops grown in the state. Rapeseed-mustard solely contributes 53% of total oilseed production with productivity of 764 kg ha^{-1} in the state during 2008-09 (Dutta, 2014). The productivity of rapeseed-mustard in the state is comparatively low. Realizing this situation, a ten year long demonstrations of improved rapeseed-mustard varieties along with improved production practices were conducted under ISOPOM during 2005-06 to 2014-15. This paper captures the productivity potentials and profitability of improved rapeseed mustard production technologies under real farm situations demonstrated through frontline demonstrations (FLDs) in West Bengal.

MATERIALS AND METHODS

The Technology Mission on Oilseeds (TMO) launched by Government of India in 1986 had a significant impact on overall oilseeds production of the country by raising it from 10.83 million tons in 1984-85 to 24.35 million tons in 1996-97 (Venkattakumar et al., 2009). Thereafter there was a plateau in oilseed production when bulk amount was imported. To meet the huge demand of edible oils in the country, the Department of Agriculture and Cooperation (DAC) started implementing the Integrated Scheme on Oilseeds, Pulses, Oil palm and Maize (ISOPOM) mainly to benefit the small and marginal farmers as most of the oilseed area in the country is with this category of farmers. Under this scheme, FLDs are conducted every year by Pulses and Oilseeds Research Station, Berhampore, Murshidabad, West Bengal, under the close supervision of scientists for transfer of technology to minimize the yield gap through validation and demonstration of improved oilseed production technology under real farm situations (Dutta, 2011). These demonstrations included different component technologies, classified as non-monetary (*viz.,* choice of improved varieties, improved cultivation method and optimum time of sowing), low-cost (*viz.,* seed treatment, application of sulphur and boron), and cost effective (*viz.,* integrated fertilizer and irrigation management, integrated disease management and integrated insect management) production technologies (Table 1). During the period from 2005-06 to 2014- 15, 243 FLDs on rapeseed-mustard were carried out in rabi season in an average area of one acre per demonstration. The result showed that there was a wide yield gap between improved technology (IT) and farmers' practice (FP). In case of local check plots, existing practices being used by farmers followed were considered. In general the soils of the area were sandy loam with medium fertility status, medium in K_2O and low in available N, P_2O_5 and C. The results of these demonstrations conducted at various locations over the years (*Anon*., 2005, 2006,

2007, 2008, 2009, 2010, 2011, 2012, 2013 and 2014) have been summarized in the present paper based on data collected from FLD plots as well as the data on local practices commonly adopted by the farmers.

Table 1. Cultural Practices applied for improved technologies and farmer practices during 2005-06 to 2014-15

Cultural Practices	Improved Technologies (IT)	Farmer Practices (FP)
Varieties	Pitambari, NRCYS 05-02,Kalyan,JD-6	Locally available varieties
Time of sowing	Within October	Very late. End of November to December after harvest of Kharif Paddy
Method of Sowing	Line Sowing	Broadcasting
Fertilizer Application	Toria (N: P_2O_5:K_2O) @ 80 :40:40 Kg/ha Yellow Sarson (N: P_2O_5:K_2O) @ 100 :50:50 Kg/ha Mustard (N: P_2O_5:K_2O) @ 120 :60:60 Kg/ha	More N (urea) application, less P_2O_5 and K_2O application without maintaining balanced and recommended dose.
Irrigation	Toria -one Yellow Sarson- one to two Mustard – two to three	one to two depending on availability
Plant Protection	Seed treatment followed by spray of fungicides and insecticides as per schedule.	No Seed treatment. No spray of fungicides and Insecticides at proper time.

RESULTS AND DISCUSSION

Non-monetary production technologies

Choice of varieties is a pre-requisite for getting higher production in any area. The popular variety B-9 (Benoy) in farmers practice showed very poor yield in several places due to cultivation of very old varieties, late sowing, infestation of diseases and insect. The yield increase due to improved varieties ranged from 14 to 47% with the mean value of 27% during 2005-06 to 2014-15. The improved variety Kalyan (WBBN-1) showed 47% yield advantage over local variety B-9 during 2006-07 (Appendix 1). The benefit cost ratios (BCR) due to improved varieties were 2.63 and 2.32 with IT and FP plots respectively. Overall, choice of improved varieties of rapeseed-mustard showed ₹5698 ha^{-1} additional net returns than the local varieties (Table 2). Non adoption of row spacing leads to uneven population which might

affect branching, siliqua plant^{-1} and seed setting leading to poor seed yield plant^{-1}. The crop was broadcasted resulting poor yield and was sown mostly after harvest of aman *rice* when normal time of sowing was over. Besides this, rise of temperature during flowering and maturity period due to late sowing results; high incidence of insects and diseases and also force maturity of the crop, thereby reduces seed and oil yields. The (IT) of right time and method of sowing (Appendix 1) showed 35-39% seed yield advantage with additional net returns of ₹ 7800-10,807 ha-1. BCR values of IT were 2.21-4.86 during the period (Appendix 1). Overall, the seed yield increased by using IT was 37% with additional net returns of ₹9207 ha^{-1} (Table 2).

Low-cost production technologies

Adoption of seed treatment with chemicals showed 32% yield advantage with additional net return of ₹7,275.00 ha^{-1} and BCR of 3.98 during 2006- 07 (Table 2 and Appendix 1). Application of sulphur and boron was essential for increasing the oil content and seed yield of mustard. Rapeseed mustard is very much sensitive to boron and its deficiency at flowering stage affect pollen viability and abortion of stamens and pistils resulting low seed yield (Dell and Lonbian, 1997). The demonstration during 2007-08 showed increased seed yield to the tune of 26% with additional net returns of ₹ 3,905 ha^{-1} with corresponding BCR of 2.31 (Table 2 and Appendix 1).

Cost effective production technologies

Demonstration of optimum dose of fertilizer and application method with appropriate time of irrigation was conducted in different years at various locations. The results revealed that the seed yield increment ranged from 15 to 60% and additional net returns were ranged from ₹ 3,680 to 16342 ha^{-1} (Appendix 1). Overall, this IT gave 32% seed yield advantage with additional net returns of ₹8155 ha^{-1} and BCR of 2.91 (Table 2). Tripathi et al. (2011) noted similar findings of high seed yield and benefit cost ratio under RDF.

Late sowing of rapeseed-mustard in farmers practice severely damaged by insects mainly by aphids. Proper plant protection measures increased seed yield by 6-58% yield advantage with an additional net returns of ₹1265-14115 ha^{-1}. During the ten years period insect management registered 26% yield advantage with additional net returns of ₹5573 ha^{-1} and BCR of 2.45 (Table 2 and Appendix 1). Among the rapeseed-mustard diseases alternaria blight was the major disease in West Bengal. Appropriate disease management practices demonstrated seed yield increase ranged from 11-55% with additional net returns of ₹2033-12732 ha^{-1}. Overall disease management practices increased seed yield to the tune of ₹6157 ha^{-1}and BCR of 2.25 (Table 2 and Appendix 1).

Table 2. Impact of FLDs on non-monetary, low-cost and cost-effective production technologies of rapeseed-mustard under real farm situations

Sl. No.	Component	FLDs	Seed yield (kg ha^{-1})		% increase in yield	Cost of cultivation		Gross return		Additional net return	BCR	
			IT	FP		IT	FP	IT	FP		IT	FP
1.	Non monetary production technology											
	a) Adoption of improved variety	85	1258	1001	27	11376	9992	33632	26798	5698	2.63	2.32
	b) Adoption of right time and method of sowing	12	1598	1170	37	9353	8416	36557	26793	9207	3.75	2.98
2.	Low- cost production technology											
	a) Adoption of seed treatment practice	5	1524	1154	32	7230	5809	28817	21542	7275	3.98	3.71
	b) Application of sulphur and boron	4	893	708	26	8494	7601	19635	15730	3905	2.31	2.07
3.	Cost -effective production technology											
	a) Balanced fertilizer and irrigation	29	1270	960	32	11079	9102	34129	24504	8155	2.91	2.43
	b) Insect management	46	1295	1025	26	12113	10090	34212	27150	5573	2.45	2.21
	c) Disease management	62	1199	941	28	12290	10455	32505	25006	6157	2.25	1.93

BCR: Benefit: Cost ratio; FP: Farmers' practice; IT: Improved technology; FLD: Frontline demonstration

Appendix 1. Impact of improved rapeseed–mustard production technologies under real farm situations during 2005-06 to 2014-15

			Seed yield (kg ha^{-1})		% increase in yield	Cost of cultivation (Tk/ha) (₹)		Gross return (Tk/ha) (₹)		Additional net return (Tk/ha) (₹)	BCR	
Year	Component	FLDs	IT	FP		IT	FP	IT	FP	IT	IT	FP
2014-15	Improved variety	5	1380	990	39	18673	14005	51750	37125	9957	1.77	1.65
	Balanced fertilizer and irrigation	5	1635	1025	60	21738	15205	61312	38438	16342	1.82	1.53
	Insect management	5	1563	990	58	21888	14530	58598	37125	14115	1.68	1.56
	Disease management	5	1360	880	55	19573	14305	51000	33000	12732	1.61	1.31
2013-14	Improved variety	10	1327	1111	20	18100	16900	46761	38909	6652	1.58	1.30
	Insect management	5	1272	1198	6	17474	16900	38146	35940	1635	1.18	1.13
	Disease management	5	1031	912	14	17171	16900	30492	27366	3305	0.8	0.62
2012-13	Improved variety	14	1179	1044	18	14253	12840	35354	30127	3813.5	1.48	1.35
	Insect management	7	1032	938	10	14087	12840	30956	28147	1562	1.20	1.19
	Disease management	17	973	867	13	14002	12840	29195	26000	2033	1	1.02
2011-12	Improved variety	8	985	846	17	13113	11518	29561	25365	2600	1.25	1.20
	Balanced fertilizer and irrigation	7	1288	917	40	13808	11518	38630	27499	8841	1.80	1.39
	Insect management	8	1094	888	23	13808	11518	32831	26636	3904	1.38	1.31
	Disease management	17	1153	855	35	13808	11518	34604	25651	6663	1.51	1.23
2010-11	Improved variety	8	1425	1056	35	11942	9938	35625	26406	7215	1.98	1.66
	Right time and method of sowing	4	1625	1198	36	12662	10990	40625	29938	9015	2.21	1.72
	Insect management	4	1618	1088	49	13422	9990	40438	27188	9818	2.01	1.72

			Seed yield (kg ha-^{1})		% increase in yield	Cost of cultivation (Tk/ha) (₹)		Gross return (Tk/ha) (₹)		Additional net return (Tk/ha) (₹)	BCR	
Year	Component	FLDs	IT	FP		IT	FP	IT	FP	IT	IT	FP
	Disease management	4	1570	1045	50	13442	9990	39250	26125	9693	1.92	1.62
2009-10	Improved variety	8	1134	863	32	8244	7773	27453	22425	4557	3.33	2.88
	Balanced fertilizer and irrigation	4	1188	884	34	8333	7732	29138	22493	6645	3.50	2.90
	Right time and method of sowing	3	1425	1057	35	8683	8167	36167	25360	10807	4.17	3.11
	Insect management	2	1310	990	32	8983	7897	32610	23760	8850	3.91	3.00
	Disease management	3	1463	1140	28	8404	7718	35120	27360	7760	4.18	3.54
2008-09	Improved variety	8	1354	1193	14	7673	7405	31148	27428	3720	4.06	3.70
	Balanced fertilizer and irrigation	4	978	818	20	8288	7405	22483	18803	3680	2.71	2.54
	Insect management	4	1285	1058	22	8288	7405	29555	24323	5232	3.57	3.26
	Disease management	4	1035	828	25	8288	7405	23805	19032	4773	2.87	2.57
2007-08	Improved variety	8	1015	836	21	7418	7937	22330	18508	3822	3.01	2.33
	Application of sulphur and boron	4	893	708	26	8494	7601	19635	15730	3905	2.31	2.07
	Insect management	4	828	770	8	8865	8062	18205	16940	1265	2.05	2.10
	Disease management	4	938	800	17	8565	8062	20625	17500	3025	2.41	2.16
2006-07	Improved variety	10	1335	911	47	6794	5641	24715	17114	7601	3.64	3.03
	Balanced fertilizer and irrigation	5	1258	1098	15	6664	6157	25160	19764	5396	3.77	3.21

			Seed yield (kg ha-^{1})		% increase in yield	Cost of cultivation (Tk/ha) (₹)		Gross return (Tk/ha) (₹)		Additional net return (Tk/ha) (₹)	BCR	
Year	Component	FLDs	IT	FP		IT	FP	IT	FP	IT	IT	FP
2005-06	Right time and method of sowing	5	1744	1254	39	6715	6092	32880	25080	7800	4.86	4.10
	Seed treatment practice	5	1524	1154	32	7230	5809	28817	21542	7275	3.98	3.71
	Insect management	5	1520	1206	26	7155	5601	29636	22401	7235	4.15	3.13
	Improved variety	6	1447	1158	25	7553	5960	31620	24578	7042	4.18	4.12
	Balanced fertilizer and irrigation	4	1273	1018	25	7640	6592	28050	20025	8025	3.87	3.03
	Insect management	2	1425	1120	27	7160	6160	31150	29040	2110	3.35	3.70
	Disease management	3	1266	1146	11	7356	5353	28453	23020	5433	3.86	3.30

BCR: Benefit Cost ratio; FP: Farmers' practice; IT: Improved technology; FLD: Frontline demonstration

Impact of field level demonstrations (FLDs)

Altogether 243 number of demonstrations were conducted during the period from 2005-06 to 2014-15 at the farmers field. Maximum seed yield was obtained by adoption of improved cultivation method and optimum time of sowing (1598 kg ha^{-1}) followed by adoption of seed treatment practices(1524 kg ha^{-1}) (Figure 1). These two technologies involve no or minimum cost. The first component (nonmonetary technologies), adoption of improved varieties and adoption of improved cultivation method and optimum time of sowing showed 27 and 37% seed yield advantage over farmers practice (FP) (Figure 2), respectively and therefore, farmers can adopt these two technologies without incurring any additional cost. The second component (low-cost production technologies), adoption of seed treatment practice and application of Sulphur and Boron showed 32 and 26% seed yield advantage over FP, respectively, and hence, these two technologies would also be useful for them to have higher additional returns at minimum costs. The third component including all cost effective production technologies *viz.*, integrated fertilizer and irrigation management, integrated insect and disease management showed 32, 26 and 28% seed yield advantage, respectively (Figure 2). Hence judicious application of cost effective components is very much essential to get maximum additional net return.

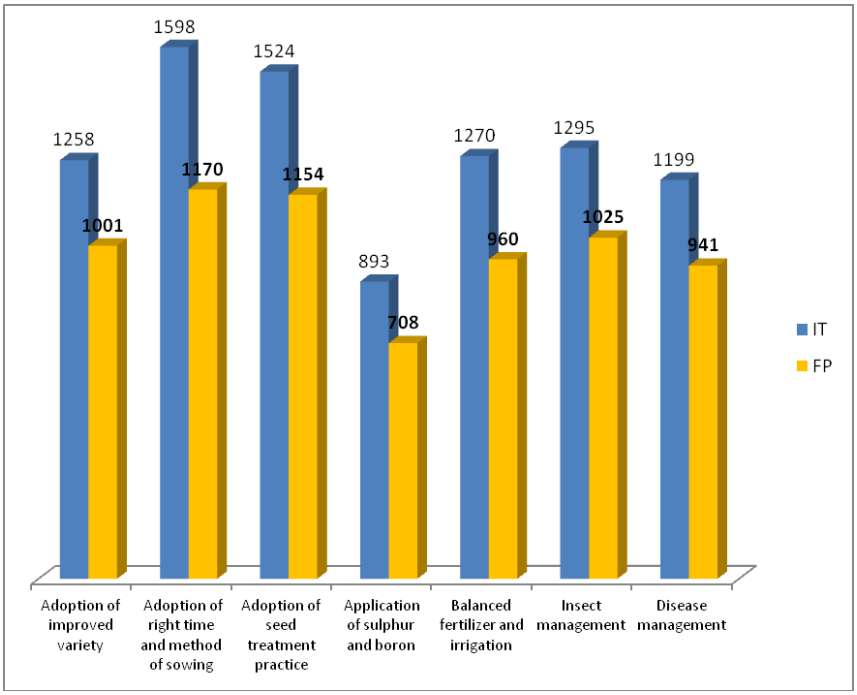

Figure 1. Comparison of seed yield (kg ha^{-1}) under IT (Improved Technology) and FP (Farmers Practice)

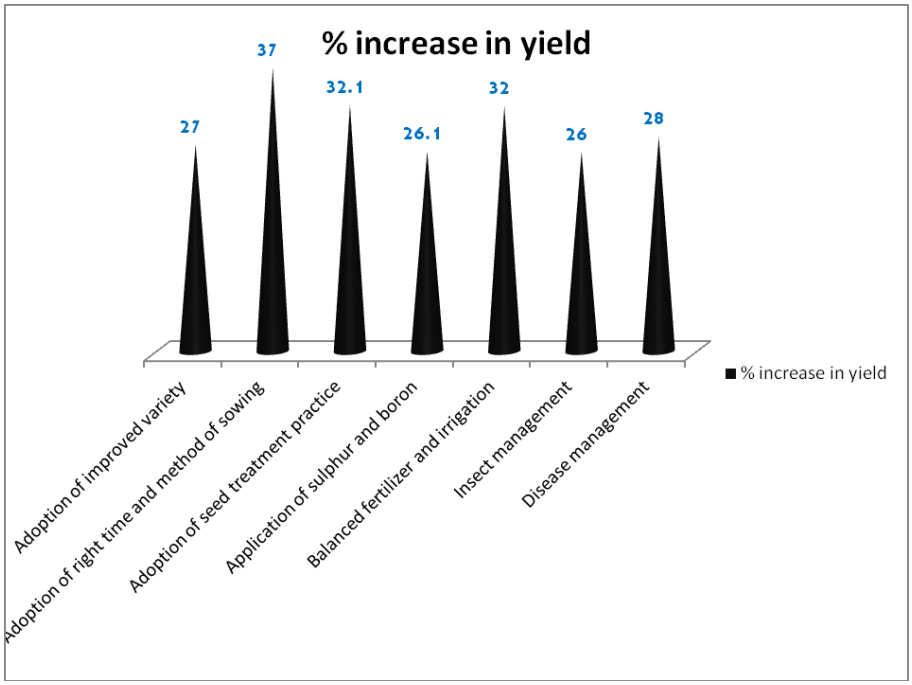

Figure 2. Percent increase of seed yield (kg ha^{-1}) due to different components of improvised technology

CONCLUSION

The FLDs have shown the potential of improved technology (IT) to boost up the productivity significantly and increased the income of the farmers. Adoption of improved cultivation method and optimum time of sowing resulted maximum additional net return (₹9,207 ha^{-1}) followed by integrated fertilizer and irrigation management (₹ 8155 ha^{-1}) and adoption of seed treatment practice (₹7275 ha^{-1}). Popularization of these aforesaid ITs among the oilseed growers would help to get remunerative and sustainable yield with higher economic returns and finally enhance overall oilseed production without bringing more area under these crops in the country. The per capita consumption of vegetable oil is rising continuously. The country needs to produce at least 66.0 mt of oilseeds by 2020. Hence a concerted effort involving extension agencies, the State Department of Agriculture and research scientists should be directed to increase the knowledge and adoption by the farmers. Thus the adoption of improved technologies will boost up the oilseed production of the state as well as of the country.

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