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Scientific Technological Interventions on Rapeseed and Mustard: Recent Advances and Future Prospects

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

In order to increase production, popularization of improved technology as well as for uplifting the socio-economic conditions of the small and marginal farmers of Sonitpur district which typically lies in North Bank Plain Agro-climatic Zone of Assam, a Crop demonstration was conducted among 100 numbers of agricultural beneficiaries in 5 clusters namely Chaiduar, Bihaguri, Balipara, Dhekiajuli and Gabhoru in the year 2020-2021 for the popularization of technology as well as cultivars. Selection of the beneficiaries and Villages were done based on their cropping sequence by the resource person working under the project entitled "Augmenting Rapeseed-Mustard Production of Assam farmers for Sustainable Livelihood Security" linked with Assam Agribusiness and Rural Transformation Project (APART) scheme. During the period of the cropping season, the selected farmers for adoption had shown keen interest in attending farmer's technical training programme conducted at the cluster level for adopting scientific production techniques and methods gradually, which was considered as a very important technique to be followed by the marginal farmers of Assam to obtain good crop population and ultimately higher yield. Adopting

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scientific agricultural techniques had helped farmers to reduce the labour cost thus benefitted the farmers by reducing the cost of cultivation. Due to its suitable soil and agro-climatic conditions as well as through their dedication and continuous efforts towards farming, they could be able to achieve higher yield and income within a short period of time as well as could motivate the other small and marginal farmers of nearby villages for further uplifting their economic status thereby preserving their ancestral occupation for future generations.

Keywords: Rapeseed mustard; varietal selection; scientific production technology; yield potential; socio-economic conditions.

1. INTRODUCTION

Edible oilseed crops have a significant contribution to Indian agriculture. Oilseeds form the second-largest agricultural commodity in India after cereals sharing 14% of the gross cropped area and accounting for nearly three percent of gross national product and 10% value of all agricultural products [1,2]. Oilseeds such as rapeseed and mustard as well as local Toria also play an important role in the agrarian economy of Sonitpur district of Assam. It has also been considered as one of the most dynamic sources of vegetable oils and in terms of production, globally it ranks second-largest oilseed crop after soyabean [3]. This district is endowed with a wide variety of agro-climatic conditions and soil types that enable the cultivation of various oilseed crops. All these oilseed crops are major oilseeds of the district. Low productivity of oilseeds is mainly due to their cultivation under rain-fed conditions and in marginal lands but to some extent, crops are also being irrigated through artificial irrigation. Besides this, the use of sub-optimal doses of chemical fertilizers and nonadoption of plant protection measures further aggravate the problem of poor productivity in oilseeds. Keeping in view the importance of oilseeds in food security and being a vital component of sustainable farming systems, the present investigation was undertaken to analyze the impact of oilseed technology transfer through Field Demonstrations for sustainable productivity of oilseeds in Sonitpur district of Assam. In order to have a clear and concise understanding regarding field demonstrations among the small and marginal farmers of Assam, it has been described as a long term extension of educational activities conducted in a precise manner in the farmers' fields of the crop demonstrations allotted villages of the particular block of the district in order to showcase the new and improved technologies and farmers practice. Hence it is rightly said that "Seeing is believing" is the basic propaganda of field demonstrations. Field demonstrations are likely to be an outcome for providing knowledge and educating farmers through its results derived in terms of acquiring higher yield, good quality seeds with higher oil content, varieties resistant to diseases and pests as well as identification of the superior varieties resistant in terms of disease and pest as well as popularisation of the varieties among the farmers of the nearby villages of the district. Apart from that, it also educates the farmers in order to understand the economics of input-output ratio and net returns. It also builds confidence amongst them for further adoption of improved technologies and practices which they had adopted in the previous years. In field demonstrations, the farmers get an opportunity to observe the crops themselves, interact with the resource persons or extension workers on the field itself, get help in identification of the occurrence of various pests and diseases of the particular crops from the resource persons as well as clarify doubts on the spot itself. Hence the present investigation was mainly emphasized based on the data obtained through field demonstrations conducted in the year 2020-2021 under ICAR Directorate of Rapeseed Mustard Research (DRMR) by the adoption of improved technologies and practices among the farmers of Sonitpur district of Assam for further aiming in doubling farmer's income.

2. METHODOLOGY

A field demonstration on rapeseed and mustard was conducted in the year 2020-2021 in the above-mentioned clusters under adopted villages in Sonitpur district of Assam. The district is located in the North Bank Plain Agro-climatic Zone of Assam. Sonitpur district is surrounded by Kameng district of Arunachal Pradesh in the north, mighty river Brahmaputra in the south, Lakhimpur district in the East as well as Darrang district in the West. The district lies in between 26.28-27.08 degree north latitude and 91.19 to 93.47 degree east longitude. Cropping systems prevailing in the demonstration area were Rice followed by Mustard and Maize. Truthfully

leveled Seeds (TFL) of mustard of three cultivars such as DRMR 150-35, PM-28, and NRCHB 101 were provided by ICAR, Directorate of Rapeseed Mustard Research (DRMR) Sewar Bharatpur. Cluster-wise and variety-wise allotment of mustard seeds under ICAR DRMR APART in Sonitpur district has been presented in Table 1. Inputs such as Urea, Single super phosphate (SSP), Murate of Potash (MOP) and Borax were also provided by the Department of Agriculture, Sonitpur Assam. The field demonstrations involving mustard cultivars such as DRMR 150-35, PM-28, NRCHB 101 with recommended doses of fertilizers i.e.: Urea 32 kg, SSP 62 kg, MOP 17 kg and Borax 2.5 kg rates per 0.25 ha respectively were applied in split doses in the crop demonstrated plots of the farmers field. Basal doses of fertilizers specifically Urea at rate of 16 kg at the time of sowing and another dose as top dressing at pre-flowering stage was applied after 45 days of sowing. Size of improved plot was 0.25 ha and farmers plot was 0.05 ha. Type of soil in crop demonstrated area was sandy loam with a pH of around 7-7.5. Seeds were sown in a field plot of size 0.25 ha with row to row spacing of 30 cm and a plant to plant spacing of 10 cm which was maintained through thinning, manual weeding and other intercultural operations after 25 days of sowing was done. Line sowing method at a spacing of 30x10 cm was followed in order to maintain uniform plant population as well as to increase production. An indigenous technological method such as rope and (desi) Mould Board Plough was used for preparing lines and furrows at a depth of 2 cm in order to sow seeds. In Assam, sowing is normally undertaken from 15th of October till 15th of November. However, due to heavy spells of rainfall, sowing time is delayed in some parts of Assam which can cause severity in insect pest infestation particularly Mustard Aphid (*Lipaphis erysimi*) and Mustard sawfly (*Athalia proxima*) causing damage by sucking juice from the tender leaves during vegetative stage. Farmers used indigenous technology knowhow (ITK) for uniform sowing of seeds such as piercing of disposable plastic bottles at the bottom thereby shaking it for free flowing of the seeds at a smaller quantity. First irrigation was practiced after 25 days of sowing during vegetative stage. Source of irrigation was artificial irrigation in the form of sprinkler irrigation to avoid water logging in demonstrated plots. In case of pest and disease infestation, occurrence of mustard sawfly (*Athalia proxima*), mustard aphid (*Lipaphis erysimi*) and bihar hairy caterpillar (*Spilosoma obliqua*) at vegetative stage of crop growth was observed making irregular holes in tender leaves during the month of December 2020 at a temperature ranging from 10-18 degree Celsius. The rainfall and daily weather data was collected from Department of Agro-meteorology, Biswanath Chariali College of Agriculture, (BNCA) of Sonitpur district of Assam (Fig. 1).

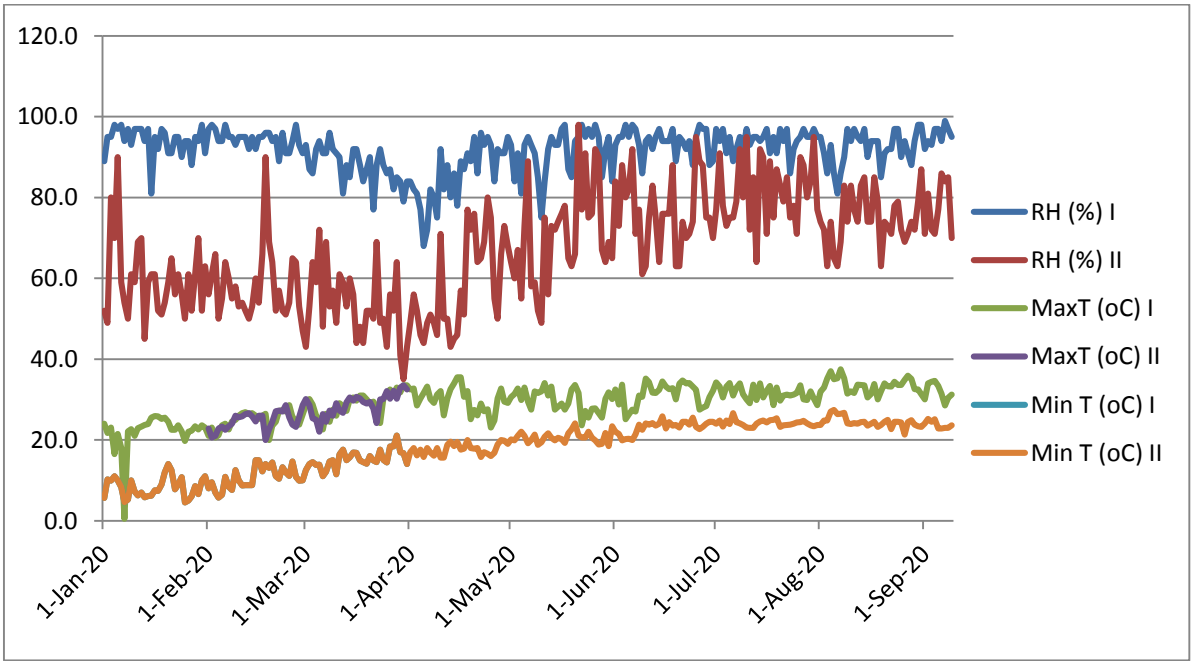

Fig. 1. Graphical representation of daily weather report of relative humidity (%) and temperature

Table 1. Allotment of mustard varieties among five clusters in Sonitpur district of Assam

Cluster	Varieties			Total
	NRCHB 101	**PM-28**	**DRMR 150-35**	20
Dhekiajuli	12 kg (6 no:)	18 kg (9 no:)	10 kg (5 no:)	20
Bihaguri	12 kg (6 no:)	16 kg (8 no:)	12 kg (6 no:)	20
Gabhoru	12 kg (6 no:)	18 kg (9 no:)	10 kg (5 no:)	20
Balipara	10 kg (5 no:)	16 kg (8 no:)	14 kg (7 no:)	20
Chaiduar	40 kg (20 no:)	-	-	-
Total	**86 kg (43 no:)**	**68kg (34 no:)**	**46 kg (23 no:)**	**100**

(N.B Figure in brackets indicates number of demonstrations)

3. RESULTS AND DISCUSSION

3.1 Average Yield

Data on seed yield among the three cultivars revealed that the highest average yield in improved plot was recorded in the cultivar DRMR 150-35 (1536 kg/ha) and ranged from 1232-1680 kg/ha followed by PM-28 with an average yield of 1519 kg/ha which ranged from 1240-1700 kg/ha and the lowest average yield was obtained in the variety NRCHB 101 with an average yield of 1412 kg/ha and was in the range of 1070-1650 kg/ha. In case of farmers plot, maximum average seed yield was also recorded in the cultivar DRMR 150-35 (1093 kg/ha) and ranged from 940-1220 kg/ha followed by the variety PM-28 with an average yield of 1076 kg/ha and ranged from 940-1200 kg/ha and the lowest average yield in farmers plot was recorded in the variety NRCHB 101 (1015 kg/ha) and ranged from 800-1160 kg/ha. An average yield of three cultivars has been shown graphically in Fig. 2. Average value of 100 demonstrations in terms of seed yield in improved plot was 1476.94 kg/ha while in farmers plot, it was recorded to be 1053.85 kg/ha. Introduction of high yielding varieties and demonstration of improved technology through Field Demonstrations on mustard along with timely sowing of seeds would eventually lead to higher adoption among the farmers in the region. Occurrence of white rust infestation in Indian mustard increases with the delay in date of sowing [4]. These results are in corroboration with the findings of other researchers indicating the increase in yield of mustard is primarily due to selection of high yielding varieties in addition to improved management practices and time of sowing [5,6].

3.2 Yield Increase over Farmers Practice (YIOFP %)

In case of yield increase percentage over farmers practice, it varied between 32.14% - 57.40% and the average percentage was recorded to be 40.38% in the variety DRMR 150-35. Similarly, in variety PM-28, average percentage was recorded to be 41.17% and was in the range of 19.23%-54.51%. Lowest percent was recorded in cultivar NRCHB 101 with an average percentage of 39.11% and ranged from 26.67%-55.55%. Average percent of 100 demonstrations were recorded to be 40.1095%. Hence the data clearly indicates that increase in yield over farmers practice would benefit the farmers by increase in income thereby leading to an economic growth for their better livelihood in the region of the district.

3.3 Cost of Cultivation (COC)

The expenditure on cost of cultivation of an individual farmer was recorded and comparison was done based on improved and farmers plot among three mustard cultivars viz.PM-28, NRCHB-101 and DRMR 150-35. It was calculated based on the expenditure in cost of labour charges during land preparation either with tractor or bullock cart drawn plough, sowing operations, inputs cost, irrigation, intercultural operations, plant protection measures, harvesting, threshing, cleaning and transportation. Family labour charges were included in the demonstration plot. Seeds were supplied directly from Directorate of Rapeseed Mustard Research Sewar, Bharatpur. Data on cost of cultivation revealed that the highest average cost of cultivation was recorded in cultivar DRMR 150-35 (Rs.24265/ha) in improved plot whereas in farmers plot, it was recorded to be Rs. 83669/ha which was comparatively lesser than the improved plot due to non adoption of improved technology and farmers own traditional practice of cultivation. In terms of the cultivar PM-28, average cost of cultivation in improved plot was recorded to be Rs. 23310/ha and in farmers plot was Rs. 83545/ha. Graphical representation in terms of comparison amongst the three cultivars has been

shown in Fig. 3. Lowest value was recorded in the cultivar NRCHB101 with an average cost of Rs. 23070 /ha in improved plot and Rs.18833/ha in farmers plot. In terms of cost of cultivation among 100 demonstrations, it was recorded to be Rs. 23426.92 in improved plot whereas in case of farmers plot, it was recorded to be Rs. 19173.32.

3.4 Gross Monetary Return (GMR) and Additional Net Monetary Return (ANMR)

Regarding economic analysis in terms of GMR with a market price of Rs.55/kg, the highest average value was recorded in the cultivar DRMR 150-35 in improved plot (83669) whereas in farmers plot, average value of GMR was recorded to be Rs. 59556 followed by the cultivar PM-28 with a gross return of Rs.83545 in improved plot whereas in terms of farmers plot gross return of Rs.59180 was recorded. Similarly, in case of the variety NRCHB 101, average value of gross return in improved plot was recorded to be Rs.77660 and in farmers plot was found to be Rs.55825. Average value of gross return among 100 numbers of demonstrations was recorded to be Rs. 80338.55 in improved plot while in farmers plot, gross return value was Rs. 57326. Regarding additional net monetary return, highest average value was recorded to be Rs. 19507 in cultivar DRMR 150-35 followed by the cultivar PM-28 with an average value of Rs. 20330 and the lowest average value was recorded in the cultivar NRCHB 101 of Rs. 17598. Average value amongst 100 numbers of demonstrations was recorded to be Rs.18775. Hence economic analysis in terms of GMR and ANMR indicates that due to the complete adoption of improved technology as well as recommended use of package of practices by the mustard demo farmers, it has become possible to get a satisfactory yield along with gradual increase in economic status of the allotted adoption villages in Sonitpur district of Assam.

3.5 Benefit Cost Ratio (B: C Ratio)

Data on Benefit cost ratio was recorded and comparison was made among the improved and farmers plot. In the improved plot, the highest value was recorded in cultivar DRMR 150-35 with an average value of 3.56 whereas in the farmers plot, the average value was found to be 3.03 followed by the cultivar PM-28 with an average value of 3.58 in improved plot and 3.07 was recorded in farmers plot. The lowest value (3.36) in improved plot and farmers' plot (2.96) was observed in NRCHB 101. Overall ratio among 100 numbers of demonstrations in improved plot was recorded to be 3.43 whereas on the other hand, in farmers plot benefit-cost ratio was found to be 2.99. Technologies like application of recommended doses of fertilizers and weed control along with plant protection measures have been found to have higher potential in terms of increase in B: C ratio and seed yield.

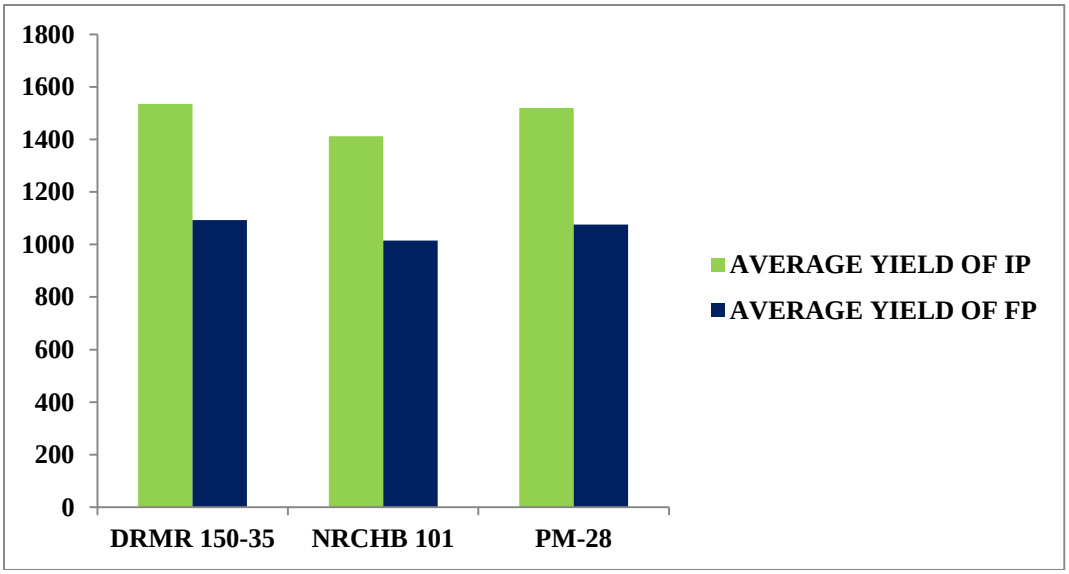

Fig. 2. Comparison of Average yield of the cultivars DRMR 150-35, NRCHB 101 and PM-28 in Improved Plot and Farmers Plot

Table 2. Mean of the varieties DRMR 150-35, NRCHB 101 and PM-28

Varieties used in IP	Situation Irrigated/ Rainfed	Varieties used in FP	Mean yield (kg /ha)		YIOFP (%)	COC (Rs/ha)		GMR (Rs/ha)		ANMR (Rs/ha)	B: C Ratio	
			IP	FP		IP	FP	IP	FP		IP	FP
NRCHB 101	Rainfed cum Irrigated	NRCHB 101	1412 (1070-1650)	1015 (800-1160)	39.11	23070	18833	77660	55825	17598	3.36	2.96
DRMR 150-35	Rainfed cum Irrigated	DRMR 150-35	1536 (1232-1680)	1093 (1000-1200)	40.38	24265	19659	83669	59556	19507	3.458	3.03
PM-28	Rainfed cum Irrigated	PM-28	1519 (1240-1700)	1076 (940-1220)	41.17	23310	19275	83545	59180	20330	3.58	3.07
			1476.94	1053.85	40.1095	23426.9	19173	80338.55	57326	18775	3.43	2.99

Abbreviations used IR: Irrigated; RF: Rainfed YIOFP: Yield increase over farmer's practice; CoC: Cost of cultivation; GMR: Gross monetary return; ANMR: Additional Net Monetary Return; IP: Improved practices; FP: Farmers' Practices; B: C: Benefit: Cost

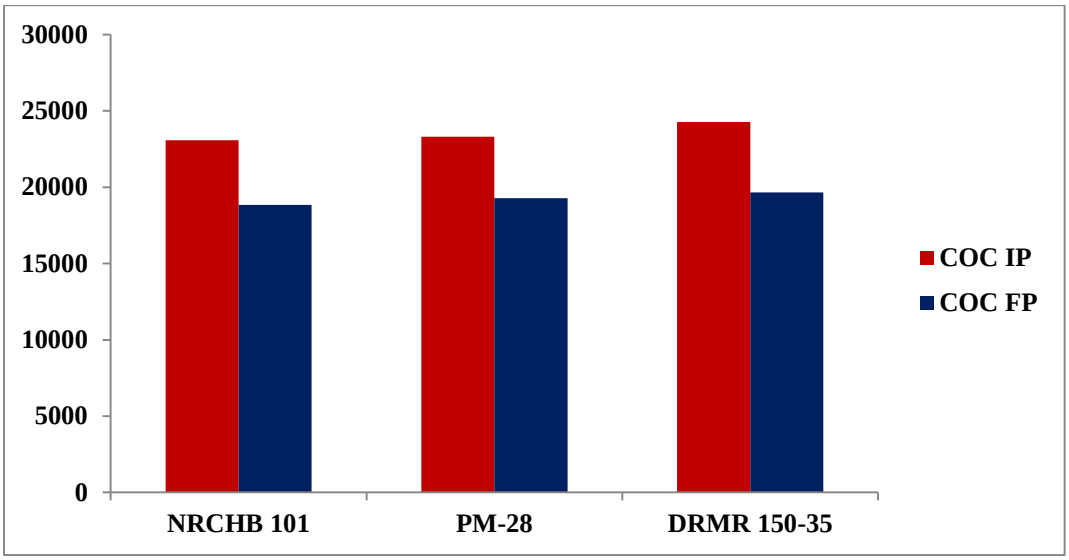

Fig. 3. Comparison of average cost of cultivation of three cultivars in Improved Plot (IP) and Farmers Plot (FP)

4. CONCLUSIONS

The individual parameters do not fully capture the yield advantage due to the adoption of technology, hence an integrative method using a combination of parameters should be used in the prioritization of technology for the farmers. Adoption of improved technology and authentic farming methods brings a significant impact on the increase in production, productivity as well as popularisation of the high-yielding rapeseed mustard cultivars. Based on the present investigations carried out in the year 2020-2021, it can be concluded that comparison among improved and farmers plot in terms of seed yield, cost of cultivation, yield increase over farmers practice as well as economic analysis specifically Gross Monetary Return, Additional Net Monetary Return and Benefit-Cost Ratio, were done through which awareness could be created amongst the small and marginal farmers of Sonitpur district of Assam for distinguishing and understanding the advantages of the adoption of new and improved technological intervention and also to educate them for further popularization of these authentic farming techniques in order to diversify and preserve and strengthen their ancestral and upcoming generations.

5. FUTURE PROSPECTS

Based on the results obtained from the field demonstrations in addition to the current scenario of economic conditions of marginal farmers and their adoption of cropping sequence particularly in the areas of cultivation of Sali paddy (winter paddy) followed by Rapeseed and Mustard followed by Maize, variety DRMR 150-35 is highly recommended for achieving higher yield and oil content since the farmers solely rely on the income generated by the seasonal crops. Moreover, farmers can be encouraged to replace the cultivation of long-duration paddy varieties with short and medium-duration paddy varieties for timely sowing of the crop. In order to increase in yield and to further extend areas into an agricultural sector particularly in the case of rapeseed mustard production, concept of beekeeping would further be considered to be a resourceful technique for the marginal farmers prevailing in district. Since rapeseed mustard is an entirely self-pollinated crop, hence pollination and fertilization are not meant to be taken place unless it is introduced by honeybees. Mustard grown farmers should be recommended to keep bee boxes beside their mustard fields during the flowering period with an aim to boost yields and collect honey at the same time.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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