



P-ISSN: 2349-8528

E-ISSN: 2321-4902

www.chemijournal.com

IJCS 2020; 8(4): 908-912

© 2020 IJCS

Received: 11-05-2020

Accepted: 13-06-2020

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Gap analysis and economics of front line demonstrations in moth bean [*Vigna aconitifolia* (Jacq.) Marechal] under rainfed conditions of Rajasthan

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DOI: <https://doi.org/10.22271/chemi.2020.v8.i4f.9720>

Abstract

Performance analysis in terms of gap analysis, yield enhancement and economic viability of improved production technologies of moth bean vis-à-vis farmers' practice was evaluated through front line demonstrations at farmers' field during *khari* seasons of 2015, 2016 and 2018. The front line demonstrations were conducted by Krishi Vigyan Kendra, Bikaner-II, Rajasthan. Recommended technologies for the agro-climatic zone (Hyper Arid Partial Irrigated Plain Zone, numerated as IC) developed by the university were adopted in letter and spirit for cultivating moth bean. Improved varieties of moth bean recommended for the region viz., RMO 257, CAZRI Moth 2 and RMO 257 were grown under demonstrations. Selection of farmers' were done following due technique of Participatory Rural Appraisal (PRA). The experimental results reveal that grain yield under demonstrations ranged from 520 to 610 kg/ha with a mean of 567 kg/ha. In per cent terms, scaling in productivity following improved technology ranged from 18.96 to 30.00% with an average value of 23.26% (over the Farmers' practice). Moreover, average yield gaps for extension, technology and technology index were 50, 107 kg/ha and 8.11 per cent, respectively. Demonstration of improved technologies also fetched average gross (₹35,838/ha), net return (₹24,622/ha) and additional return (₹5,605/ha) in comparison to Farmers' practice. Demonstration of improved technology also resulted in realizing higher incremental cost benefit ratio (4.8) and benefit: cost ratio (2.20) compared to the Farmers' practice (1.89) during three years study period. This enhancement in grain yield and economics of moth bean under demonstrations clearly showed the impact of adoption of improved technology over farmers' practice in Hyper Arid Partial Irrigated Plain Zone of Rajasthan.

Keywords: frontline demonstrations, moth bean, profitability, technology gap, yield gap

Introduction

Pulses are playing a significant role in existing farm production systems by enriching soil health. Pulses are also providing food and nutritional security and ensuring agro-ecological sustainability to country's ever-growing population. Pulses serve as cheapest and concentrated source of protein and amino acids to vegetarians and weaker sections and are regarded as "poor man's meat". In India, total production of pulses is 25.42 million tonnes with an acreage of 29.81 million hectares with the productivity of 853 kg/ha (Anonymous, 2020) [3]. Likewise, in Rajasthan total pulses production is 3.41 million tonnes from an area of 5.33 million hectares with the productivity of 639 kg/ha (Anonymous, 2019) [2]. The scenario of moth bean production in Rajasthan is 0.323 million tonnes with an acreage of 1.043 million hectares with the productivity of 310 kg/ha (Anonymous, 2018) [1]. In Bikaner district, the study area, moth bean is grown in an area of 3.16 lakh hectare and contributes production over 1.19 lakh tonnes with the productivity of 377 kg/ha (Anonymous, 2018) [1].

Moth bean (*Vigna aconitifolia* (Jacq.) Marechal) is a minor legume crop. It is a short duration, deep rooted legume recognized for its twin benefits of tolerance for drought and heat. It has ability to grow under harsh climate, low rainfall and poor soil conditions and considered as most significant pulse crop of arid Rajasthan (Sharma and Ratnoo, 2014) [18]. Additionally, moth bean is a potential reservoir of proteins, essential minerals and vitamins and providing nutritional security to vegetarians of arid region. It is also used as cover crop and shields soil from solar heat, retain soil moisture and prevent losses of organic matter and retards soil

erosion as well (Kumar, 2002) [8]. Moth bean is a hot weather and drought resistant legume. Local landraces of moth bean prevalent among farmers' are of longer duration (75-85 days), produce less fodder and are susceptible to insects, pests and diseases. The maturity period of most of the improved varieties is 60-70 days. Both grain and fodder production are higher by 100-125% and 30-40% respectively in these varieties (Kumar 2002a) [9]. All the improved varieties of moth bean are tolerant to yellow mosaic virus. The moth bean variety RMO 257 besides being disease resistant, is tolerant to thrips and other sucking insects. The variety CAZRI MOTH-2 developed by CAZRI is a very high yielder (800-1000 kg/ha) and is also tolerant to virus and *Xanthomonas* infestations. The production and productivity of moth bean is highly erratic and varies with the amount and distribution of rainfall (Narain *et al.*, 2001) [13]. Moreover, in Rajasthan, average productivity of moth bean is much lower than the potential productivity of improved cultivars. The lower productivity of moth bean attributed to several factors *viz.*, growing of the crop under moisture stress, marginal lands with very low inputs and without pest and disease management, non-availability of high yielding varieties and late sowing. For achieving better yields, selection of proper genotypes, optimum plant population, optimum plant population and improved production technologies are also the additive factors and front line demonstration is an important method of transferring the latest technologies to farmers' (Singh *et al.*, 2012; Patil *et al.*, 2019) [23, 15]. By which, farmer's learn improved production technologies under real farming situation. Further, demonstrations are designed carefully where provisions are made for speedy dissemination of technology among farming community through organization of other supportive extension activities, such as field days and farmer's convention. Therefore, keeping the above facts in view, front line demonstrations were conducted in Bikaner district of Rajasthan with the specific objectives to find out gap analysis and economics using improved technologies under front line demonstrations in moth bean.

Materials and Methods

The investigation was carried out in operational area of Krishi Vigyan Kendra, Bikaner-II which falls under Hyper Arid Partial Irrigated Plain Zone (IC) of Rajasthan. Typically, the zone covers an acreage of 7.70mha, with average rainfall of

100-350 mm, and mean maximum temperature 48 °C and mean minimum temperature 3.0 °C. Under the investigation, a total of 60 demonstrations were conducted during *kharif* seasons of 2015, 2017 and 2018. These demonstrations were carried out under the supervision of KVK scientists at farmers' field in four blocks (Lunkaransar, Chhatargarh, Khajuwala and Pugal) of Bikaner district. The selection of cultivators was done on the basis of Participatory Rural Appraisal (PRA). Each demonstration was conducted on an area of 0.4 ha, and 0.4 ha area adjacent to the demonstration plot was kept as (local check) farmers' practice. The package of improved technologies like improved varieties, optimum seed rate, line sowing, balanced nutrition, seed treatment and full package were used in the demonstrations. The variety RMO 257 and CAZRI MOTH-2 of moth bean were sown under the demonstrations. However, under local check plots, farmers' practices being followed by farmers' were undertaken (Table 1). In general, soils of the area under study were sandy and sandy loam in texture with low in fertility status, which contains low organic carbon (0.09-0.25%), low available P (11-14 kg/ha) and medium available K (185-196 kg/ha). The spacing was 30 cm between rows to row and 10 cm between plants to plant were maintained in demonstration plots. The thinning and weeding were done invariably 30-35 days after sowing to ensure optimum plant population and recommended crop geometry. As densely populated moth bean adversely affects growth and yield. Seed sowing was done at the first rains of monsoon usually falls in first week of July with a seed rate of 10 kg/ha. The improved technologies followed under front line demonstrations and farmers' practice are presented in Table 1. The recommended package of practices of moth bean crop released by SKRAU, Bikaner for Agro-climatic Zone (IC) were followed. Data with respect to grain yield from FLD plots and farmers' practices adopted by the farmers' of the area were collected and evaluated for gap analysis, and calculating the economics. The yield and economics of data was obtained from 60 respondents from four selected blocks for a period of three years. The yield data were collected from both the demonstration plots and farmers' practice by random crop cutting methods and analyzed by using simple statistical tools. The Technology yield gap, extension yield gap and technology index were calculated using following formulae (Shivran *et al.*, 2020) [22] given as under:

$$\text{Per cent increase in yield} = \frac{\text{Demonstration yield (kg/ha)} - \text{Farmers' practice yield (kg/ha)}}{\text{Farmers' practice yield (kg/ha)}} \times 100$$

Technology yield gap (kg ha⁻¹) = Potential yield (kg ha⁻¹) - Demonstration yield (kg ha⁻¹)

Extension yield gap (kg ha⁻¹) = Demonstration yield (kg ha⁻¹) - Farmers' practice yield (kg ha⁻¹)

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

Unlikely, economics of the demonstrations under improved technology and farmers' practice were recorded. Based on economics, additional cost, additional returns and incremental B:C ratios were calculated. These economic parameters were analyzed using the formulae given below (Shivran *et al.*, 2020) [22]:

Additional cost (₹/ha) = Demonstration cost (₹/ha) - Farmers' practice cost (₹/ha)

Additional returns (₹/ha) = Demonstration returns (₹/ha) - Farmers' practice returns (₹/ha)

Incremental B: C ratio = Additional returns (₹/ha) ÷ Additional cost (₹/ha).

Results and Discussion

Improved technology v/s farmers' practice

Before commencement of the front line demonstrations at the farmers' field, participatory rural appraisal was undertaken. Based on this, the gap between farmers' practices and improved technology of moth bean cultivation in Bikaner districts of Rajasthan was worked out (Table 1). Among varying technological interventions, full gap was observed

under the components viz.; varieties, seed treatment, sowing method, fertilizer dose, weed management and plant protection measures. However, partial gap was observed for the components viz.; seed rate and spacing. Although, no gap was noticed for the irrigation. These gaps noticed at the farmers' field are ascribed to the slow pace of extension machineries, coupled with unreached public extension system, poor accessibility of advanced or improved agro-technologies especially among smallholder farmers' and other vulnerable groups (Das and Willey, 1991; Badhala and Bareth 2013;

Shivran *et al.*, 2020) [5, 4, 22]. Further, farmers' used local or old varieties moth bean having low yield potential instead of newly released varieties with inappropriate adoption of improved package of recommended technologies. The gap further intensified due to non-availability of good quality seed and lack of awareness about improved package of production technologies were also some of the other important reasons for low productivity at farmer's field (Sharma 2003; Gorfed *et al.*, 2016; Shayam *et al.*, 2018) [20, 6, 21].

Table 1: Technological interventions under front line demonstration and farmers' practice on moth bean

S. No.	Component	Technological intervention	Farmers' practice	Gap
1	Variety	RMO257 and CAZRI MOTH2	Old mix seed	Full
2	Seed rate	12 kg/ha	25 kg/ha	Partial
3	Seed treatment	Carbendazim 50 WP @2g/kg of seed and <i>Trichoderma viride</i> @ 5g/kg seed	No seed treatment	Full
4	Sowing method	Line sowing	Broadcasting	Full
5	Spacing	30cm × 10cm	No proper spacing	Partial
6	Fertilizer dose	N-P ₂ O ₅ -K ₂ O; 20-40-00kg/ha	No use	Full
7	Weed management	One hand weeding	No weeding	Full
8	Irrigation	Rainfed	Rainfed	Nil
9	Plant protection measures	Imidacloprid 17.8 SL@ 120ml/ha for sucking pests	No use	Full

Grain yield

Comparisons over the years (2015, 2017 and 2018) of yield levels under front line demonstrations and farmers' practice has been investigated (Table 2). It is evident from the findings that under intervention improved technology grain yield of moth bean was found to be substantially higher than that of farmers' practice during all the years of demonstrations. The grain yield under improved technology ranges from 520-620 kg/ha as compared to farmers' practice, wherein it was recorded to the tune of 400-500 kg/ha during the study period. Average yield of 60 demonstrations worked out to 567 kg/ha from improved technology whereas the average yield obtained in case of farmers' practice was 460 kg/ha. These results envisage that the adoption of improved production

technology of mustard cultivation enhanced average yield by 23.26% (Table 2) over farmers' practice. Further, highest grain was fetched by the variety CAZRI Moth 2 under the treatment improved technology (610 kg/ha) during 2017. However, the same variety recorded yield of 500 kg/ha under farmers' practice during 2017. Higher grain yield under improved technology ascribed to better nutrient management (Kumar and Uppar, 2010; Shah *et al.*, 2019) [7, 17] proper crop geometry leading to optimum plant population (Sadashivanagowda *et al.*, 2017) [16], sowing time, seed rate (Yadav *et al.*, 2009) [26] and improved agrotechnology, demonstrations and other management practices (Sharma *et al.*, 2015; Veni *et al.*, 2018) [19, 24].

Table 2: Performance of front line demonstration on moth bean in Bikaner district of Rajasthan

Year	Number of demonstrations	Area (ha)	Variety	Grain yield (kg/ha)		% increase in yield over FP	Extension gap (kg/ha)	Technology gap (kg/ha)	Technology index (%)
				IT	FP				
2015	20	8	RMO 257	520	400	30.00	80	120	13.33
2017	20	8	CAZRI Moth 2	610	500	22.00	40	110	6.15
2018	20	8	RMO 257	571	480	18.96	29	91	4.83
Total	60	24	Average	567	460	23.26	50	107	8.11

IT=Improved technology; FP=Farmers' practice (check)

Gap analysis

Yield gap analysis, is an important measure to analyze the differences or yield gap due to extension strategies (=extension gap), technological strategies (=technology gap) and scope of bridging the gap (=technology index). In extension terms, the extension gap or extension yield gap is the difference or gap between the yield under demonstration plot and farmers' practice (control) plot. Under this experimentation, the extension yield gap ranges from 29-80 kg/ha with an average extension yield gap of 50 kg/ha (Table 3) during all the years of demonstrations. So as to enhance the farmers' income, there is need to decrease this wider extension gap through implementation of latest agro-techniques (Verma and Dayanand, 2013; Meena and Singh, 2016) [25, 11]. Such yield gap attributed to adoption of improved technology especially high yielding varieties, line sowing with the help of seed cum fertilizer drill with balanced nutrition, weed management and appropriate plant protection

measures in demonstrations which resulted in higher seed yield than the farmer's practices.

The study further exhibited a wide technology gap during different years of experimentation. The technology gap over the years' ranges from 91-120 kg/ha. Moreover, the average technology gap observed was 107 kg/ha. The differences in technology gap over the years ascribed to better performance of recommended varieties with different interventions and more feasibility of recommended technologies (Verma and Dayanand, 2013; Meena and Singh, 2016; Kumawat *et al.*, 2017; Pagaria *et al.*, 2019) [25, 11, 17, 14].

Similarly, the technology index for all demonstrations in the study were in accordance with technology gap. Higher technology index reflected the inadequate transfer of proven technology to growers and insufficient extension services for transfer of technology. On the basis of three years study, on an average 8.11% technology index was recorded (Table 2). Further, technology index over the years ranges from 4.83 to

13.33%. Hence, it can be inferred that the awareness and adoption of improved varieties of moth bean with recommended scientific package of practices have increased in rainfed areas of the Bikaner district during the

advancement of study period. These findings are in the conformity of the results of study carried out by Meena and Singh (2016) [11].

Table 3: Economic analysis of moth bean demonstration in Bikaner district of Rajasthan

Year	Improved technology				Farmers' practice				Additional cost (₹/ha)	Additional net return (₹/ha)	ICBR
	Gross cost (₹/ha)	Gross return (₹/ha)	Net return (₹/ha)	B:C ratio	Gross cost (₹/ha)	Gross return (₹/ha)	Net return (₹/ha)	B:C ratio			
2015	10,800	33,800	23,000	2.13	9,600	26,000	16,400	1.71	1,200	6,600	5.5
2017	11,500	36,600	25,100	2.18	10,300	30,000	19,700	1.91	1,200	5,400	4.5
2018	11,350	37,115	25,765	2.27	10,250	31,200	20,950	2.04	1,100	4,815	4.4
Average	11,217	35,838	24,622	2.20	10,050	29,067	19,017	1.89	1,167	5,605	4.8

Economics

Different variables viz.; seed, fertilizer, ploughing and pesticides were considered as cash input for the demonstrations as well under farmers' practice. The economics of the improved technology over farmers' practice were calculated depending on the prevailing market prices of the inputs and outputs for the particular year (Table 3 and Figure 1). It was observed that the cost of cultivation (=Gross cost) of moth bean varied from ₹10,800 to ₹11,500/ha with an average of ₹11,217/ha under improved technologies. However, cost of cultivation of moth bean ranged from ₹9,600 to ₹10,300/ha with an average of ₹10,050/ha under farmers' practices. Improved technology also yielded higher net returns (ranged from ₹23,000 to ₹25,765/ha with the mean of ₹24,622/ha for three years) while, net returns of ₹16,400 to ₹20,950/ha were recorded under farmers' practices. On an average, net return of ₹19,017/ha was recorded under farmers' practice. The average additional cost and net returns of ₹1,167/ha and ₹5,605/ha, respectively were recorded with the incremental cost benefit ratio of 4.8. The higher benefit cost ratio of 2.27 and 2.18 was observed following inception of improved technology in the year 2018 and 2017 respectively. On an average, benefit: cost ratio under improved technology and farmers' practice were 2.20 and 1.89, respectively. Higher benefit cost ratio under improved technology was ascribed to the harnessing of higher yield in comparison to farmers practice. Hence, higher benefit cost ratio proved the economic viability of the technology interventions and motivated the farmers for adoption of improved technologies. These findings corroborate with that of reported by Meena *et al.*, (2012); Gorfed *et al.*, (2016); Meena and Singh (2016); Kumawat *et al.*, (2017) and Sadashivanagowda *et al.*, (2017) [12, 6, 11, 10, 16].

Conclusion

Improved technologies are more productive, remunerative and sustainable compared with farmers' practices. On an average, higher gross returns (₹35,838/ha), net returns (₹24,622/ha), ICBR (4.8) and benefit-cost ratio (2.20) were fetched under demonstrations over farmers' practice. Thus, adoption of improved technologies demonstrated has a long-term impact on crop productivity, profitability and sustainability in moth bean over farmers' practice.

Acknowledgements

The financial support to meet the expenses towards frontline demonstrations by Department of Agriculture & Farmers Welfare, Ministry of Agriculture & Farmers Welfare, Government of India under National Food Security Mission scheme through its nodal agency ICAR-Agricultural Technology Application Research Institute, Jodhpur, Rajasthan is gratefully acknowledged.

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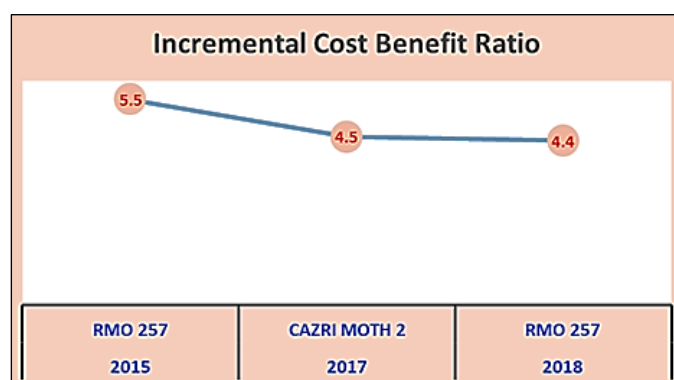


Fig 1: ICBR of moth bean demonstration in Bikaner district of Rajasthan

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