Current Journal of Applied Science and Technology

40(8): 22-31, 2021; Article no.CJAST.67812
ISSN: 2457-1024
(Past name: British Journal of Applied Science & Technology, Past ISSN: 2231-0843, NLM ID: 101664541)

Impact of Constraints, Technological Gaps and Improved Production Practices on Yield and Economics of Greengram in Arid Regions

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Authors' contributions

This work was carried out in collaboration among all authors. Author RS designed the study, recorded the observations and wrote the first draft of the manuscript and managed the literature searches. Author OP managed the analysis of the study and finalizing the draft of the manuscript. Author SK contributed in designing the study, developing the schedule and analyzing the economics. Author MK assisted in recording the observations and compiling the data. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/CJAST/2021/v40i831336
Editor(s):
(1) Dr. Michael Ignatius Ferreira, Research and Technology Development Services, South Africa.
(2) Dr. Alessandro Buccolieri, Università del Salento, Italy.
Reviewers:
(1) Sonali Pandey, Banasthali Vidyapith, India.
(2) Mohinder Singh, SGT University, India.
Complete Peer review History: http://www.sdiarticle4.com/review-history/67812

Original Research Article

Received 25 February 2021
Accepted 01 May 2021
Published 06 May 2021

ABSTRACT

Low adoption of improved crop production technologies has been an important factor in reducing the income, increasing poverty and reducing socio-economic status of the farmers in the arid region. Greengram is one of the important pulse crop mainly grown during *kharif* season in rainfed conditions of Rajasthan. Apart from harsh agro-climatic and poor edaphic factors, non- adoption of innovative production technologies is one of the utmost important amenable factors for low yield in the region. Over a period of time, a number of improved crop production technologies have been developed, but due to many constraints and low adoption, full potential of the technologies could not be exploited. As a result, a large gap exists between potential yield and actual yield. There is a need

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to address various issues and factors, which helps to limit the crop productivity. The present study conducted at the farmer's field in Jodhpur district of Rajasthan indicated that most of the respondents stated that low returns from crop production, high cost of inputs, lack of knowledge and processing industry were the major constraints and technological index varied between 44 to 48%. The results of the study also showed gaps in the use of high-yielding varieties, recommended doses of fertilizers and plant protection measures in greengram. Demonstration of high yielding varieties of greengram (RMG 62 and RMG 268), recommended dose of fertilizers (20 kg N+50 kg P_2O_5/ha) and plant protection measures (metasystox 750 ml/ha) considerably increased seed yield, net returns, B: C ratio and additionally income over farmer's practice. Use of high yielding variety (RMG 62), recommended dose of fertilizers and plant protection measures increased seed yield and net returns by 42.5 and 63.8%, respectively over farmer's practice. The study suggests that addressing the socio-economic issues and constraints that affect the adoption of improved production technologies are paramount. In addition, there is a need for knowledge extension of better production technologies to achieve higher yield and economic returns by greengram cultivation in the arid region.

Keywords: Arid region; greengram; constraints; extension gap; technology index; improved production technologies.

1. INTRODUCTION

The arid region in India constitutes about 12% (38.7 million hectares) of the total geographical area of India, with 31.7 and 7.03 million hectares in the hot and cold arid region, respectively. The state of Rajasthan, India, occupies the highest area under arid zone (62%) followed by Gujarat (20%), Punjab and Haryana (7%) and remaining (11%) in southern part of the country [1]. The arid region of Rajasthan is characterized by low and erratic rainfall (100–500 mm), extremes of temperature (up to 50^0C), high wind velocity (40–60 km /hr) and high potential evaporation (1500–200 mm/year), consequently, moisture stress, frequent drought and partially or complete failure of crop production [2]. Crop production in the arid region encounters both bio-biological and socio-economic constraints that force farmers to adopt subsistence farming based on low input - low risk - low yield concept, which sustains the livelihood of the family of farmers hardly enough to keep. Therefore due to many agro-climatic, technological and socio-economic constraints, it is rarely expected that the pace of change of modern agriculture can improve without much efforts.

Greengram [*Vigna radiata* (L.) Wilczek] is one of the important short duration pulse crops grown in very diverse agro-climatic conditions during *Kharif, summer* and *rabi* season in the country. In arid and semi-arid regions of the country, it is mostly grown in rainfed conditions during *kharif* season as sole and intercrops. It is cultivated in an area of 4.41 million ha with total production of 2.30 million ton and productivity of 0.52 ton/ha in the country. Rajasthan contributes about 50% to the total greengram production of the country, with a total production of 1.22 million tons from an area of 2.46 million hectares and productivity 500 kg/ha. The arid region accounts for about 82% of the total greengram production in the state [3] But the average yield of greengram (404 kg/ha) in the region is far below than the potentiality of improved varieties of greengram like 'RMG 62' (1232 kg/ha) and 'RMG 268' (1180 kg/ha) in arid region [4]. Apart from adverse agro-climatic, edaphic and socio-economic constraints, growing through traditional methods is one of the important reasons responsible for the low productivity of greengram in the arid region [5]. However, due to physiological and morphological characteristics, greengram can persist under moisture stress conditions, but to achieve a quantum jump in productivity long duration (90–100 days) traditional land races need to be replaced by high yielding short duration (60-70 days) varieties to avoid the effect of terminal drought on crop yields. Several genotypes like RMG 62, RMG-344, RMG-492, and RMG-268 are available which mature within 60–65 days and produce more seed and straw yields than traditional land races [6,7]. Despite of development of many improved production technologies, many technological and socio-economical factors create barriers in the adoption of new technologies, resulting in fewer adoptions and higher yield gaps between the yield at research station and farmers' fields [8]. In addition, the socio-economic status of farmers plays an important role in adopting improved production technologies [9].

Field demonstrations have been the cornerstone of diffusing improved agricultural technologies among the farmers since the inception of the Community Development Program in 1952. Field demonstration when well planned, designed and implemented, allow beneficiaries to share and see the benefits of technologies among others, as well as to interact with scientists, extension personnel, and other related researchers engaged in research and developmental activities [10] In addition, demonstrations help farmers to learn about improved agricultural technologies and encourage farmers for speedy adoption. Therefore, to increase the production of pulses and to reduce the gaps between the yield obtained at the research station and the farmer's field, it is necessary to adopt improved production technologies like improved varieties and cultivation practices [11,12]. But there is a need to analyze the factors that affect productivity, educate farmers to get more yield from crop production, and develop effective strategies for adopting improved production technologies for sustainable crop production in arid regions. Hence, the present study was undertaken to find out the constraints, technological gap and impact of improved production technologies on the yield and economics of greengram in arid regions of Rajasthan.

2. METHODOLOGY

Field studies were carried out during *Kharif* seasons of 2012-13 and 2013-14 at the farmers' fields in Utamber village. The village is located at 55 km distance towards west from district headquarters Jodhpur. It lies at 26^0 24'N latitude, 73^0 02'E longitude and 273 m above mean sea-level. According to the 2011 census, the total population of the village was 2515 and the total number of households was 429. The total geographical area of the village is about 5800 ha, of which about 18% area is being irrigated with tube wells. The climate of the village is arid with hot summers (air temperature up to 48^0C) and low, and erratic rainfall (average rainfall 320 mm/yr), 80% of which is received through the south-west monsoon during July-September. The soil of the adopted village was sandy in texture with 81% sand, neutral in pH (7.4), low in organic carbon (0.16%), available nitrogen (127 kg/ha), medium in available phosphorus (11.2 kg/ha) and high in available potassium (287 kg/ha). An interview schedule was developed to collect the information and personal interview technique and was used for data collection. The data related to different aspects were collected through structured schedule with the help of personal interview. Thus, a total number of 76 farmers were interviewed to assess the socio-economic profiles, constraints faced by the respondents, and adoption gap between technological interventions and farmer's practices. Calculation of different parameters like extension gap, technology gap, technology index and additional return were worked out as suggested by [13,14].

- Extension gap = Demonstration yield - Farmers' practice yield
- Technology gap= Potential yield - Demonstration yield
- Technology index (%) ={(Potential yield-demonstrated yield) /Potential yield} X100
- Additional returns = Demonstration returns - Farmers' practice returns

Out of the 76 farmers interviewed, 15 farmers, including small, medium and large categories, were selected to study the impact of improved production technologies on greengram yields and monetary benefits. Improved production technologies like high yielding varieties (RMG 62 and 268), nutrient management (20 kg N and 50 kg P_2O_5/ha) and plant protection measures (metasystox 750 ml/ha) were compared with farmer's practices. Field demonstrations were held at an area of 0.50 acres at each location. Greengram was sown using 15 kg of seed/ha during the first fortnight of July at 45 cm row to row spacing in rainfed conditions. Crop was fertilized with 20 kg N+50 kg P_2O_5/ha and metasystox was applied at 40 days after sowing mixing with 400 litre water/ha. As regards to the farmer's practice, all the farmers used only their traditional seed as input and none of farmers used any external inputs (Fertilizers and pesticides). One hand weeding was performed at 30 days after sowing for managing weeds and crop was harvested in second fortnight of September in both the years, whereas farmer's variety was harvested in the first fortnight of October. Economic analysis was worked out considering the prevailing market price of input and outputs.

3. RESULTS AND DISCUSSION

3.1 Socio-economic Status of the Respondents

The study of the socio-economic status of farmers is extremely important to understand the behaviour, attitudes, resources and level of adoption of farmers. It is evident from Table 1 that highest number of farmers (47.37%) belonged to the age group of 31 to 45 years followed by 31.58% in the age group of below 30 years, indicating that majority of the farmers were of middle age and younger age group. It was also noted that 21.05% of the farmers belonged to the old age group (more than 45 years), but the participation in farming of experienced farmers over 20 years was minimal (13.5%). Age assumes special importance in adopting improved techniques as it significantly impacts decision-making ability. As age progresses, decision-making ability and risk-taking power begin to decrease. Among all the respondents, only 7.60% farmers were illiterate, while majority of the farmers (42.10%) had primary level (5^{th} pass) of education. In addition, 23.68% of the farmers possessed education up to high school level and recorded the second highest number of farmers who had education up to high school level and 5.26% farmers had education up to graduation level and above. Age and education status of the household head are the important variables among the demographic and socio-economic factors that determine the adoption behavior of improved production technologies of the farmers [15]. Further, it was interested to note that the joint family system is still dominating in the rural areas. Largest numbers of respondents (36.84%) were living in joint families followed by supplementary core families (31.58%). About 23.68% of the farmers lived in a core family, but none of the respondents lived as a single member family. Living in a joint family or higher number of family members provides an opportunity to share field activities, complete field activities well on time, help connect with society and increase knowledge, resulting in more adoption of improved production technologies. In a study it was reported that more number of family members assures the availability of labour, which provides an opportunity to adopt improved production technologies [16].

Data on operational land holding size showed that maximum number of farmers (34.21%) belonged to small holding category, followed by medium land holding category (26.32%). Lowest numbers of farmers (7.89%) were belonged to large operational holdings category, who owned more than 10 hectares of land. This indicates that size of operational land holdings is decreasing. This may be due to fragmentation of land by an ever-increasing population. It was observed that highest percentage of farmers (28.94%) had the longest experience (15–20 years) in farming, followed by 23.68% farmers with 10–15 years of experience. The lowest number of farmers had more than 20 years of experience in farming. Of the total respondents, 47.36% never had contact with extension agencies, while 36.84% had occasional contact, but 15.78% farmers have regular contact with extension agencies.

3.2 Constraint Analysis

Respondents considered a number of constraints that affects the adoption of improved production technologies in the arid region (Table 2). High cost of inputs, low cost of crop produce, non-existence of processing industry and lack of knowledge about seed production have been considered as the foremost constraints and ranked first among all the constraints faced by the respondents during the adoption of improved cultivation practices of greengram in arid regions. The factors deprived farmers to adopt high yielding varieties and use of other external inputs, resulting in lower yield of greengram [17]. In addition, poor marketing facilities, no or little use of external inputs due risk of crop failure, lack of technical advice to protect crop produce from insect damage during storage and lack of irrigation facilities were also observed as second and third highest important constraints, which were perceived by 93.42, 89.47, 89.47 and 89.47% of respondents, respectively. The lack of training institutes, lack of storage facilities, and non-availability of timely loans were expressed as the fourth significant constraints by 84.21% of farmers. The other problems expressed by the farmers were poor liaison between research/extension institutions and farmers, lack of transportation facilities, non availability of seed of improved varieties and other inputs, lack of knowledge about water management practices and lack of knowledge for plant protection measures. The results of the study suggest the need of developing strong strategy to deal with the problems and offer solutions for greengram producers.

3.3 Adoption Gap

It is evident from Table 3 that none of the respondents ever adopted high-yielding varieties, treated seed and recommended dose of fertilizers in greengram. The yield of greengram was severely affected due to the full gap in the adoption of the above production technologies. Thus, there is a need to increase the productivity of greengram through the adoption of improved production technologies in the arid region. It has also been observed that most farmers use less seed than the recommended rate, except for a few farmers. Similarly, limited farmers are partially adopting improved weed, water and pest management technologies, indicating the need to increase adoption levels for higher greengram production in the region.

3.4 Seed Yield, Extension Gap and Technology Index

Data depicted in Fig. 1 revealed that seed yield of greengram was considerably increased due to use of improved production technologies (variety, recommended dose of fertilizers and metasystox) compared to farmer's practices. Maximum seed yield of greengram (686 kg/ha) was obtained with variety 'RMG 62', application of recommended dose of fertilizers (20 kg N+50 kg P_2O_5/ha) and spray of metasystox at 750 ml/ha, and recorded 42.92% higher yield over farmer's practices. Further, growing of greengram variety 'RMG 268' along with application of recommended dose of fertilizers and metasystox resulted in 610 kg/ha seed yield compared to 420 kg/ha with farmers practice. The improvement in seed yield was due to the adoption of shorter-duration improved varieties, which ripen within 60–65 days, while traditional varieties take 75 to 80 days to mature. As a result crop grown with improved varieties escaped the effect of terminal drought. In addition, the recommended dose of fertilizers supplied the optimum amount of nutrients to the crop and metasystox protected the crop from yellow mosaic virus infestation. Therefore, due to the use of improved production technologies, the crop received optimal conditions for better growth, consequently higher yield [18].

Table 1. Description of socio-economic profile of the respondents (N=76)

Particulars	Category	Frequency	Percentage
Age			
Up to 30 years	Young	24	31.58
31-45 years	Middle	36	47.37
Above 45 years	Old	16	21.05
Education			
No education	Illiterate	10	7.6
5th Pass	Primary education	32	42.10
10th Pass	High school education	18	23.68
12th Pass	Senior secondary school	12	15.79
Graduate and above	Graduate and above	4	5.26
Family size			
Alone member	Single member family	0	0
2 to 4 member	Broken family	6	7.89
4 to 5 members	Nuclear family	18	23.68
5 to 6 members	Supplemented Nuclear family	24	31.58
6 and above members	Joint family	28	36.84
Operational land holding size (ha)			
Below 1.00 hectare	Marginal	8	10.53
1.00-2.00 hectare	Small	26	34.21
2.00-4.00 hectare	Medium	20	26.32
4.00-10.00 hectare	Semi-medium	16	21.05
10.00 hectare and above	Large	6	7.89
Experience in farming			
Less than 5 years	-	12	15.79
5 to 10 years	-	14	18.42
10-15 years	-	18	23.68
15-20 years	-	22	28.94
Above 20 years	-	10	13.15
Linkage with extension agencies			
Regular	-	12	15.78
Occasional	-	28	36.84
Never	-	36	47.36

Table 2. Constraints as perceived by the respondents (N=76)

S. No.	Constraints	Constraints faced by respondents	Percentage	Rank
1.	Socio-economic constraints			
	• Non availability of seed of improved varieties and other inputs	52	68.42	VII
	• High cost of inputs	76	100.00	I
	• No use or little use of external inputs due risk of crop failure by moisture stress	68	89.47	III
	• Low income from crop production	76	100.00	I
	• Damage due to grazing by wild animals	52	68.42	VII
	• Poor socio-economic status	41	53.95	IX
2.	Infrastructural constraints			
	• Lack of irrigation facilities	68	89.47	III
	• Non availability of credit in time	64	84.21	IV
	• Poor market facility	71	93.42	II
	• No processing industry	76	100.00	I
	• Lack of transportation facilities	63	82.89	V
	• Lack of storage facilities	67	88.16	IV
3.	Technological Constraints			
	• Lack of proper knowledge about improved varieties and other improved cultivation practices	52	68.42	VIII
	• Lack of knowledge about water management practices	61	80.26	VII
	• Lack of knowledge for plant protection measures	62	81.58	VI
	• Lack of knowledge for seed production methods	76	100.00	I
	• Lack of technical advice for protecting the crop produce from insect damage during storage	68	89.47	III
4.	Institutional Constraints			
	• Poor liaison between research/extension institutions and farmers.	57	75.00	V
	• Non availability of suitable literature.	54	71.05	VI
	• Lack of training institutions for training of the farmers	64	84.21	IV
	• Lack of co-operative societies	48	63.16	VIII

Table 3. Analysis of gap between improved production technology and farmer's practices in greengram cultivation

S.N0.	Technology	Improved practices	Farmer's practices	Gap
1.	Variety	RMG 62 and RMG 268	Local	Full gap
2.	Sowing methods	Line sowing (40cm x 10 cm)	Broadcasting/ line sowing	Partial gap
3.	Seed rate	15 kg/ha	10-12 kg/ha	Partial gap
4.	Seed treatment	Seed inoculation with Rhizobium and PSB, Carbendazim 50 WP @ 2.5 gm/kg seed/Trichoderma @ 8-10 g/kg	No seed treatment	Full gap
5.	Weed management	Pendimethalin @ 2.5 L/ha fb one manual/mechanical weeding	One manual weeding	Partial gap
6.	Nutrient management	20 kg N &50 kg P_2O_5/ha	No use of fertilizer	Full gap
7.	Pest management	Integrated pest management	Inadequate pest management	Partial gap
8.	Water management	In-situ moisture conservation through field bunding, crop establishment method and mulching	Moisture conservation only through field bunding	Partial gap

Table 4. Effect of improved cultivation practices on the yield and economics of greengram

Technology	Gross return (Rs./ha)	Cost of cultivation (Rs./ha)	Net returns (Rs./ha)	B:C ratio	Additional return over farmer's practice (Rs./ha)
variety (RMG 62)+ (20 kg N+50 kg P_2O_5/ha)+ Metasystox 750 ml/ha	30870	14239	16631	1:2.17	6481
Variety (RMG 268) +(20 kg N+50 kg P_2O_5/ha) +Metasystox 750 ml/ha	27450	14239	13211	1:1.93	3061
Farmer's practice	20250	10100	10150	1:2.00	-

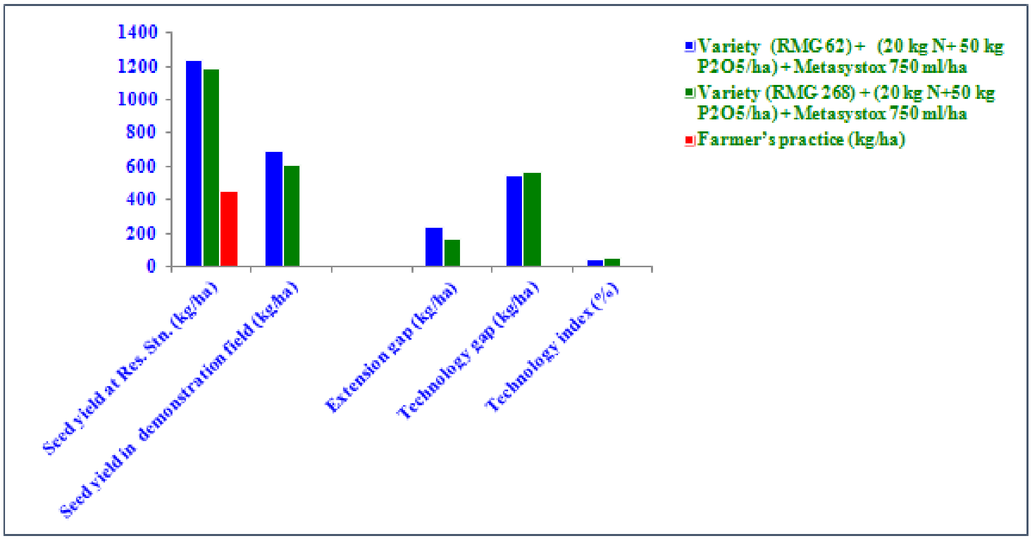

Fig. 1. Effect of improved production technologies on seed yield, gap and technology index

The highest extension gap of 236 kg/ha was recorded owing to the growing of greengram variety 'RMG 62' alongwith application of recommended dose of fertilizers and metasystox. Further, an expansion gap of 160 kg/ha was recorded due to the use of variety RMG 268, recommended dose of fertilizers and metasystox application compared to farmer's practice. This indicates huge scope of extension activities and need of capacity building of the farmers to bridge the gap between demonstration yield and farmer practice in arid region [19]. Furthermore, a wide technology gap (546 to 570 kg/ha) was recorded between the yield obtained at research station and field demonstration conducted at the farmer's field. This also affected technology index, which varies between 44.31 to 48.30%. The technology gap and the high value of the technology index reflect the feasibility of developing technologies in farmers' participation mode.

3.5 Effect on Economics

Net returns, B: C ratio and additional returns over farmer's practice were significantly affected by the use of improved production technologies (Table 4). Growing of variety 'RMG 62' along with the application of recommended dose of fertilizers (20 kg N+50 kg P_2O_5/ha) and plant protection measures (metasystox 750 ml/ha) fetched highest net returns (Rs.16631/ha) and B: C ratio (1:2.17). As a result, additional net returns (Rs.6481/ha) was also maximum over farmer's practice. Growing of other high yielding variety 'RMG 268' along with the application of 20 kg N+50 kg P_2O_5/ha and metasystox 750 ml/ha provided a net return of Rs.1321/ha and B:C ratio of 1:1.93. It also provided additional net returns of Rs.3061/ha compared to farmer's practice. Increase of net returns and B:C ratio might be attributed to the better growth and yield production due to growing of high yielding varieties, application of recommended dose of fertilizers and plant protection measures [20].

4. CONCLUSION

It is concluded that harsh climatic and edaphic conditions is a detrimental phenomenon in arid regions and cannot be eliminated. However, its impact on crop production can be reduced by adopting improved production technologies, building farmers capacity, developing robust research programs in participatory mode, increasing farmers' access to better production technologies and assuring higher prices of crop produce. It is observed that most of the farmers were of middle-age group and had education up to 5th standard. High cost of inputs, low price of crop produces and lack of knowledge were identified as major constraints which severely affected adoption of improved production technologies. Also, none of the farmers used the seed of high yielding varieties, treated seeds and recommended dose of fertilizers in greengram, consequently very low yield of this crop in the arid region. Adoption of improved production technologies such as high yielding varieties

(RMG 62 and RMG 268), recommended dose of fertilizers (20 kg N+50 kg P_2O_5/ha) and plant protection measures (metasystox 750 ml/ha) found effective to increase greengram yield by 42.92 to 45.24% and additional return by Rs.3061 to 6481/ha over farmer's practice in the arid region of Rajasthan.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sdiarticle4.com/review-history/67812