Art. No. 71074

Indian Journal of Agricultural Sciences **88** (2): 00–00, February 2018/Article

Technology gap, constraint analysis and improved production technologies for yield enhancement of barley (*Hordeum vulgare*) and chickpea (*Cicer arietinum*) under arid conditions of Rajasthan

RAJ SINGH[1], ATUL DOGRA[2], ASHUTOSH SARKAR[3], ANURAG SAXENA[4] and BHAGWAN SINGH[5]

South Asia and China Regional Program, ICARDA, New Delhi 110 012

Received: 14 June 2017; Accepted: 25 September 2017

ABSTRACT

Agriculture is the mainstay of livelihood in arid region of Rajasthan and improvement in the agricultural productivity is one of the most important strategies to reduce poverty, ensuring food and livelihood security in the region. Moreover, the region is highly prone to recurrent drought owing to its harsh and frequent climatic aberrations. Consequently, limit the scope of sustainable crop production and encourage the degradation of natural resources. Therefore, majority of farming community is engaged in subsistence farming due lack of adequate resources and because of poor and instable crop production, socio-economic status of the farmers is very poor. This has necessitated improvement in agricultural production by imposing improved production technologies. Barley (*Hordeum vulgare* L.) and chickpea (*Cicer arietinum* L.) are the most important food grain crops grown during rainy season under conserved moisture or limited irrigation condition of the region, but average productivity of both the crops is very low. In addition to unfavourable climatic conditions, use of traditional practices is also important factor responsible for low yield. The present study was therefore conducted in five villages of three districts of arid region of Rajasthan during 2013-14 and 2014-15 to understand socio-economic profile of the farmers and also to study the effect of improved production technologies on the yield and economics of barley and chickpea. The results revealed that majority of the respondents (37.93%) had middle level of education and 55.17% of total respondents belong to medium farm size category. None of the respondents has used improved production technologies as per the recommendations for the cultivation of barley and chickpea crops, indicating 100% adoption gap. Further, all the respondents (100%) possessed low price of crop produce as major constraint followed by lack of marketing facility (96.55%), non-availability of improved seed (89.65%), high cost of cultivation (81.03%) and lack of effective extension agencies (81.03%). The grain yield of barley and chickpea showed remarkable improvement due to adoption of improved production technologies. Increase in the grain yield of barley and chickpea recorded by 19.37 to 24.83% and 28.63 to 38.07% respectively, over farmer's practice. Increase in net return was obtained up to 43.78% due to improved production technologies of barley and 50.11% with improved production technologies of chickpea. However, socio-economic status and livelihood of the farmers can be improved due to the adoption of improved production technologies of crops in arid region of Rajasthan.

Key words: Arid region, Barley, Chickpea, Improved production technology, Low yield, Traditional cultivation practices,

Arid region covers almost 12 percent of the total geographical area of the country. It extends over an area of 38.7 million ha, out of which 31.7 mha lies in hot and 7.0 mha in cold arid region. Among all the states, Rajasthan accounts maximum area under hot arid (62%) followed by Gujarat (20%), Punjab and Haryana (7%) and southern part of the country (11%). In Rajasthan, Arid region is spread over in 12 districts, accounting for 59.2% of total cultivated area of the state. About 90% area of the region is rainfed, which is highly vulnerable to extreme climatic conditions, like low and erratic rainfall (100-450 mm/annum), extreme temperatures (often >45°C in peak of summer), high wind velocity (>30 km/hr) and high potential evapo-transpiration (1500-2000 mm/annum). Besides, harsh climatic conditions, soils of the region are coarse textured, poor in organic matter, available N and P (Tripathi and Kumar 2000) and have low water holding capacity. Furthermore, traditional methods of cultivation like use of

[1]Principal Scientist (email: rajsingh@iari.res.in), Division of Agronomy, Indian Agricultural Research Institute, New Delhi. [2]Socio-economist (email: a.dogra@cgiar.org), [3]Regional Coordinator and Food Legume Breeder (email: a.sarker@cgiar.org). South Asia and China Regional Program, ICARDA, New Delhi. [4]Principal Scientist (email: anurag.saxena@icar.gov.in), Division of Integrated Land Use Management and Farming Systems, [5]Principal Scientist (email: bhagwan.singh@icar.gov.in), Division of Transfer of Technology, Training and Production Economics, Central Arid Zone Research Institute (CAZRI), Jodhpur 342 003

non-descript seed with little or no use of external inputs, mixed cropping and sowing of crops with broadcast methods further deteriorates the situation. Moreover, diverse problems with socio-economic and infrastructural backwardness do not allow the farmers to invest more on the use of improved production technologies. Therefore, low input-low risk-low yield concept is still prevailing in the region (Faroda *et al.* 2007), consequently adoption rate of improved production technologies in the region is very poor (Saha *et al*. 2009). Crop production is the main source of livelihood as it provides 59-71% of total agricultural income, while livestock rearing contributes 28-42% to total income of farmers in the region (Anonymous, 2007). But arable cropping has been considered as a subsistent rather than commercial activity, as it is not stable because of complex and multifarious problems i.e. environmental, technological and socio-economic. Under such conditions adoption of improved production technologies can play vital role to enhance yield and achieving stability in crop production.

Crop production in arid region largely depends upon water availability, water requirement of the crop and duration of the crop. Therefore, selection of a suitable crop and its variety is of paramount importance to realize desirable yield level from the limited available water. Chickpea and barley are having wider adaptability in the region because of low water requirement and adaptations under the agro-climatic conditions of the region. Chickpea is grown on 8.37 lakh ha in the region, with the production of 5.71 lakh tonnes and productivity of 682 kg/ha contributes 62.7% to the total chickpea production of the state. Rajasthan stands second rank after Madhya Pradesh in the country with respect to area and production of chickpea in the country. Barley is also one of the important cereal crop, which is cultivated in an area of 1.74 lakh ha with a total production of 5.38 lakh tonnes and productivity of 3083 kg/ha, and shared 55.9% in the total barley production of the state (Directorate of Agriculture 2014-15). The average productivity of both the crops is much lower than the potentiality (1800 kg/ha) of chickpea (Khan and Singh, 2005) and 3990 kg/ha of barley (Singh *et al*. 2013) at farmers environment in the region. Low adoption of high yielding varieties and improved production technologies is one of the important constraints that are responsible for low productivity of crops (Dhaka 2015, and Raj *et al.* 2013). The wide gap between average yield of crops obtained at experimental farm and at farmer's field can be narrowed with the adoption of improved varieties and cultivation practices (Kumar 2013, Poonia and Pithia 2011). Adoption of the improved production technologies largely depends upon the socio-economic status of the farmers (Ghosh *et al*. 2005), which needs to be addressed to bridge the extension gap. Therefore, present study was conducted to assess the socio-economic profile of the respondents, identifying technological gaps and constraints; and also to study the effect of improved production technologies on productivity and profitability of barley and chickpea under arid regions of Rajasthan.

MATERIALS AND METHODS

The study was carried out during *rabi* seasons of 2013-14 and 204-15 at the farmers' fields in five villages of Jaisalmer (Didu and Sankaria), Jodhpur (Mansagar and Govindpura) and Barmer (Dhok) districts of Rajasthan. All the three district (Jodhpur, Jaisalmer and Barmers) lies between 25^0 and 27^0 N latitude and 70^0 and 72^0 E longitude, while elevation varies between 225 to 235m above the mean sea–level. The average annual rainfall during the study period of Jodhpur, Jaisalmer and Barmer district was 366, 188 and 267 mm, respectively, of which, more than 80% rain was received during July-September. Soil of adopted villages was sandy loam, having pH from 7.4 to 8.1, low in organic carbon (0.24-0.30%), available nitrogen (123 to 132 kg/ha), available phosphorus (11.8 to 13.1 kg/ha) and high in available potassium (228 to 272 kg/ha). Total 58 farmers (34 for barley and 24 for chickpea during each year) across all 5 villages of 3 districts were selected with the help of village head man and considering farmer's interest in cultivation of barley and chickpea. In total 116 farmers were targeted to study the effect of improved production technologies having 0.33 ha at each location. Improved production technologies comprises 3 interventions (high yielding varieties RD 2660 and RD 2786, seed treatment with chloropyrifos insecticide and 100% RDF through 80 kg N+50 kg P_2O_5/ha) for barley and high yielding varieties CSJK 6 and CSJK 21, seed treatment with *Trichoderma viride* at 6 g/kg seed and 100% recommended dose of fertilizers (20 kg N+40 kg P_2O_5/ha) for chickpea were compared with farmer's practice. Treated seed of chickpea with Trichoderma viride was sown in the second fortnight of October at seeding rate of 70 kg/ha at 45 cm row to row spacing and full dose of recommended nitrogen and phosphorus were applied as basal dose. One interculture with hand-hoe was given at 30 days after sowing (DAS) and three irrigations; at vegetative growth, pre-flowering and at pod formation stage were given by using sprinkler irrigation method.

Barley was sown in the second fortnight of November using 100 kg seed/ha in rows at a spacing of 25 cm. Before sowing, seed was treated with chlorpyrifos @ 2 ml/kg seed. The crop was fertilized with 80 kg N + 50 kg P_2O_5/ha. Half dose of nitrogen (40 kg/ha) and full dose of phosphorus (50 kg/ha) was applied as basal through urea and diammonium phosphate, while remaining nitrogen (40 kg/ha) was top-dressed in 2 equal splits, viz. at 25 and 45 days after sowing. Crop was irrigated with sprinkler irrigation method at 25, 60, 90 and at 110 days after sowing using 60 mm water per irrigation. Farmers sown non-descript variety without use of any external inputs in the case of chickpea and with the use of inadequate amount of nitrogen (23 kg nitrogen/ha) by few farmers in case of barley crop under farmer's practice. Economics was worked out on the basis of prevailing market prices of inputs and outputs. A structured interview schedule was developed to collect data from the respondents and personal interview, and group discussion were also made to collect the information for the analysis of adoption gap, socio-economic profile and constraints experienced by the respondents during the cultivation of barley and chickpea crops. Grain yield of both the crops were determined by considering the mean of all the location and was converted into kg/ha. Technology gap, extension gap and technological index were computed by using following formula as suggested by Samui *et al.* (2000).

Extension gap = Demonstrated yield-Farmer's practice yield

Technology gap = Potential yield- Demonstrated yield

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

RESULTS AND DISCUSSION

Personnel and socio-economic profile

Data on the socio-economic profile of the respondents presented in Table 1 indicated that majority of the respondents (46.55%) selected for the study belong to medium age group (25 to 50 years) followed by 36.2% from old age group (51-75 years). However, minimum respondents (10.34%) belong to young age group (18-25 years), indicating more involvement of old respondents in farming compared to younger farmers. This is affecting the adoption of improved technologies as older farmers are tend to be slow in the adoption of latest improved production technologies. Moreover, poor access and low level of knowledge force to be less receptive to older farmers towards adoption of improved production technologies. Among all the respondents, nearly 80% acquired education between primary to matriculate level, while 10.34% farmers were found illiterate. Furthermore, it was interested to note that only 10.34 % respondents have education from senior secondary to graduation level, showing the less involvement of higher educated farmers in agriculture, hence affect the adoption of the improved technologies. Education status assumes to affect adoption of improved technologies significantly. Farmers possessed higher education adopt new innovations rapidly and also use modern inputs more efficiently throughout the adoption process (Feder *et al*. 1985).

Table 1 Socio-economic profile of the respondents (N=116)

Particulars	Category	Frequency	Percentage
Age (Years)	18-25	12	10.34
	25-50	54	46.55
	50-75	42	36.20
	Above 75	08	6.90
Education	Illiterate	12	10.34
	Primary	28	24.14
	Middle	44	37.93
	Matriculate	20	17.24
	Senior secondary	08	6.90
	Graduate	04	3.45
	Post graduate		-
Size of land holdings (ha)	Up to 2	36	31.03
	2 - 4	64	55.17
	Above 4	16	13.79
Farming experience (in years)	Up to 10 years	18	15.52
	11 to 20 years	34	29.31
	21 to 30 years	40	34.48
	More than 30 years	24	20.69
Resources availability	Irrigation facility	56	48.27
	Tractor	46	39.65
	Sowing & threshing	68	58.62
	implements	72	62.07
Linkage with extension agencies	Frequently	16	13.79
	Occasionally	26	22.41
	Never	74	63.80

The information further revealed that maximum respondents belonged to medium category, as 55.17 % farmers have 2 to 4 ha cultivated land followed by 31.03% under small and marginal category with 1-2 ha land holding. The minimum number of respondents belonged to large category (13.79%) having above 4 ha cultivated land, indicating more land fragmentation due to rapid increase in the population, which is causing significant decrease in profit efficiency compared to unfragmented farms in the country (Manjutha *et al*. 2013). Data pertaining to experience in farming exerted that a large proportion (34.48%) of the respondents had experience in farming from 21 to 30 years followed by 29.31% respondents, who had farming experience of 11 to 20 years. Only 15.52 % respondents accounted for least farming experience (up to 10 years). Result clearly showed that maximum respondents had long farming experience, but this was owing to the engagement of old farmers since long time in the farming. Data collected on the resources owned by the farmers revealed that 48.27% respondents had irrigation facility, while remaining were dependent on hiring of irrigation facility from neighbours, else, fully depended on rain. Further, only 39.65% respondents owned tractor, but 58.62% respondents had sowing devices, indicating hiring of tractors is prevailing in the region to perform agricultural activities. Poor linkage with the extension agencies was noticed during the interaction, as 63.80% respondents never had linkage with extension agencies. Poor linkage with extension agencies could be one of the important factors responsible for low adoption of improved production technologies. Singh (2002) also mentioned that innovative technologies and good practices translate to increased yields and improved food security, only when they are properly shared with farmers.

Adoption gap analysis

Adoption gap was computed following the procedure of 3 gaps, i.e. full (No adoption), partial (partially adoption of technology) and no gap (fully adoption of technology by all respondents). Adoption gap analysis presented in Table 2 revealed that all the respondents never used high yielding variety seed and treated seed before sowing in the case of chickpea and barley, indicating nil extent of adoption of high yielding variety and seed treatment technologies and thereby full gap exists with regard to the adoption of improved production technology. While, use of high yielding varieties in conjunction with seed treatments positively influences the yield and monetary benefit. Data depicted in Table 2 further revealed that all the respondents had given two ploughing to prepare field for the sowing of both the crops (barley and chickpea), hence no gap exists in field preparation. This was due to the reason that farmers are traditionally aware about the advantage of well-prepared land to ensure good germination, retaining soil moisture for long time and reducing weed infestation. No respondent applied recommended dose of fertilizers in both the crops and full gap was noticed in the application of recommended dose of fertilizers. Further, full gap was observed in fertilizer application in chickpea, as no respondent ever applied fertilizer in chickpea, but few respondents applied low dose of nitrogen in barley. Lack of the knowledge and poor access to fertilizer procurement could be possible reason for low adoption of fertilizer application. Other agronomical practices like sowing method, irrigation number and method, weed management and insect management were partially adopted by the respondents. Partially gap in the adoption of irrigation number could be ascribed due to use of much water through surface irrigation method, while the availability of groundwater is limited in the arid ecosystems, consequently limited irrigations were applied in both the crops. Therefore, concentrated efforts are needed to popularize pressurized irrigation method like sprinkler and drip irrigation to maximize the irrigation use efficiency. With regard to plant protection measures, nobody is applying pesticides in barley crop; as a result full gap exists in managing insect and diseases in barley. It was noted that some of the farmers used insecticide to control insect infestation in chickpea and partially gap exist in pesticide adoption, while maximum yield loss occurred in chickpea due severe insect and disease infestation. Sharma *et al*. (2012) also reported high gap in the adoption of improved production technologies of *rabi* crops. Chouhan (2012) also reported low adoption of improved production technologies of chickpea crop and because of that average yield of chickpea is very low in Rajasthan. Adoption gap

Table 2 Adoption gap between technological interventions and farmer's practices in barley and chickpea cultivation

Particulars	Crop					
	Barley			Chickpea		
	Technological intervention	Traditional practices	Gap	Technological intervention	Traditional practices	Gap
Variety	RD 2660, RD 2786	Local variety	(0) Full gap	RSG 963, CSJK 6, RSGK 6, CSJK 21	Local variety	(0) Full gap
Field preparation	Two ploughing	Two ploughing	(116) No gap	Two ploughing	Two ploughing	(116) No gap
Sowing method	Line sowing	Broadcasting/ line sowing	(54) Partial gap	Line sowing/line sowing	Broadcasting	(29) Partial gap
Seed treatment	Treated seed	No seed treatment	(0) Full gap	Treated seed	No seed treatment	(0) Full gap
Fertilizer quantity	100 kg N+ 60 kg P_2O_5/ha	FYM once in 3-4 years and sometimes top dressing of 50 kg urea/ha	(36) Partial gap	20 kg N+40 kg P_2O_5/ha	No use of fertilizer	(0) Full gap
Weed management	Pendimethalin 1.0 kg/ha (PE)+one HW at 30 DAS	No weed control or sometimes one HW	(28) partial gap	Pendimethalin 1.0 kg ai/ha (PE)+one HW at 30 DAS	One hand weeding	(76) Partial gap
Irrigation method	Four irrigation with sprinkler method	Three to four irrigation with surface irrigation method	(61) Partial gap	Three irrigation with sprinkler method	Two or one irrigation with surface irrigation method	(68) Partial gap
Plant protection	Use of pesticides as per insect & disease infestation	No use of pesticides	(0) Full gap	Use of pesticides as per insect & disease infestation	Occasionally use of pesticides	(58) Partial gap

between improved production technologies and farmer's practices can be narrowed by educating and motivating farmers about the improved production technologies.

Constraints analysis

It is inferred from Table 3 that respondents have faced a number of constraints, which were responsible for low adoption and productivity of the barley and chickpea crops in arid region. All the constraints were classified into six categories; namely, (i) personal, (ii) economic, (iii) social, (iv) technological, (v) physical, and (vi) marketing. Among all the constraints, low price of produce was identified as a major constraint, which was perceived by 100% respondents followed by lack of proper marketing facilities (96.55%). Both the constraints are leading to low adoption of improved production technologies, hence low crop productivity at farm level. Therefore, suitable marketing mechanism is pre-requisite to give proper reward or return to the efforts being made by the farmers (Kumar and Sindhu 2014). Other important constraints like non availability of improved seed, lack of effective extension agencies and high cost of cultivation were perceived by more than 80% of respondents. Besides the above, lack of training, advice from neighbours, and non-availability of ICT facilities were perceived by 70-80% respondents as important constraint, as a result farmer's knowledge is very poor about improved production technologies, which affects the adoption of the improved production technologies. This implies the need of strong extension systems and organization of capacity building programs to create awareness among the farmers about improved production technologies to enable them to narrow the gap between improved production technologies and farmer's practice.

Table 3 Major constraints faced by respondents (N=116)

Particulars	Frequency	(%)	Rank
I. *Personal*			
Lack of knowledge	82	72.41	6
Lack of resources	60	51.72	15
Lack of motivational factors	52	44.83	16
Lack of time	44	37.93	17
Less educated			
Poor linkage with extension agencies	92	79.31	5
II. *Economic*			
High cost of cultivation	94	81.03	4
Non availability of credit	60	51.72	14
Poor economic condition	98	84.48	3
III. *Social*			
Lack of technical advice from neighbours	46	74.14	7
Non availability of ICT facilities	82	70.69	9
Unavailability of loan due to poor social and economic status			
Lack of interest of young generation in agricultural activities	62	53.44	13
IV. *Technological*			
Lack of effective extension agencies	94	81.03	4
Non availability of improved seed	104	89.65	3
Lack of training about improved production technologies	88	75.86	5
V. *Physical*			
Scarcity of quality irrigation water	58	50	15
Poor transportation facilities	68	58.62	12
Non availability of implements	60	51.72	14
Non availability of adequate irrigation facility	70	60.34	11
Small land holding	74	63.79	10
Poor storage facility	84	72.41	8
VI. *Marketing constraints*			
Lack of proper marketing facility	112	96.55	2
Low price of produce	116	100	1

Impact of improved production technologies on yield and economics

Barley: Use of improved production technologies that included high yielding variety (RD 2786) of barley, seed treatment with chlorpyrifos and application of 100% RDF (*80 kg N + 50 kg* P_2O_5*/ha)* resulted in 43.78 % higher grain yield over farmer's practices (Table 4). Other high yielding variety RD 2660 in conjunction with seed treatment and 100% RDF also resulted in 19.37% increase in grain yield than farmer's practice. In fact, crop yield is a complex entity which depends on the complementary effects of many crop production components like variety, nutrients, water management, and plant protection measures. Significant increase in the grain yield might be attributed to favourable effect of high yielding variety, seed treatment and 100% RDF on the growth, yield attributes and yield of barley compared to farmer's practice. The economic analysis indicated that net returns, benefit: cost ratio and economic efficiency were also markedly influenced by improved production technologies as compared to farmer's practice. Highest increase in net returns (43.78%), benefit: cost ratio (14.46%) and economic efficiency (54.84%) was observed with variety RD 2786 along with seed treatment and 100% RDF followed by variety RD 2660 in conjunction with seed treatment and 100% RDF. This could be ascribed to the high yield potential of varieties and effect of favourable growth environment provided by seed treatment and 100% RDF. Similar findings were also reported by Sharma and Sharma (2014).

Chickpea: The data on grain yield and economics (Table 4) indicate that use of high yielding varieties of chickpea, CSJK 6 and CSJK 21 grown along with improved production technologies like seed treatment with *Trichoderma viride* and 100% RDF (20 kg N+40 kg P_2O_5/ha) recorded 38.07 and 28.63%, respectively, higher seed yield over farmer's practice. This increase in seed yield might be attributed to

Table 4 Yield of barley and chickpea as influenced by the package of practices

Technology	Average grain yield (kg/ha)	Yield increased over FP (%)	Cost of cultivation (₹/ha)	Gross return (₹/ha)	Net return (₹/ha)	Benefit: cost ratio	Increase in net returns over FP (%)	Economic efficiency (₹ ha/day)
Barley								
RD 2660 with seed treatment and 100% RDF	3605	19.37	28400	52931	24531	0.86	30.13	188.7
RD 2786 with seed treatment and 100% RDF	3770	24.83	28400	55503	27103	0.95	43.78	208.48
Farmer's practice with Local variety	3020		22830	41680	18850	0.83	0	134.64
Chickpea								
Var. CSJK 21 with seed treatment and 100% RDF	1267	28.63	30360	73047	42,687	1.41	34.97	316.20
Var. CSJK 6 with seed treatment and 100% RDF	1360	38.07	30360	77,836	47,476	1.56	50.11	351.67
Farmer's practice	985		22650	54278	31628	1.40	0	222.73

the genetic potential of improved varieties, control of dry root rot disease due to seed treatment and optimum supply of nutrients. Poonia and Pithia (2011) and Ramakrishna *el al.* (2005) also reported significant increase in grain yield of chickpea due to improved production technologies (high yielding varieties, seed treatment and 100 RDF) as compared to farmer's practices. Economic evaluation revealed that highest increase in net returns (50.11%), benefit: cost ratio (1.56) and economic efficiency (Rs 351.67/ha/day) was fetched by variety CSJK 6 in association with seed treatment and 100% RDF over farmer's practices (Table 4). Use of variety CSJK 21 along with seed treatment and 100% RDF also showed 34.97% increase in net returns over farmer's practices. However, this technology also showed increase in benefit: cost ratio and economic use efficiency over farmer's practice. The lowest net returns (₹ 22650/ha), benefit: cost ratio (1.40) and economic efficiency (₹ 222.73/ha/day) were obtained with farmer's practice. The net returns, benefit: cost ratio and economic efficiency appeared very high owing to production of grain yield due to use of improved production technologies compared to farmer's practice.

Extension and technological gap and technological index analysis

Barley: Data pertaining extension gap, technological gap and technological index are depicted in Table 5 showed that variety RD 2786 in conjunction with seed treatment and 100% RDF resulted in highest extension gap (750 kg/ha), lowest technology gap (220 kg/ha) and technological index (5.51%) followed by due to use of variety RD 2260 along with seed treatment and 100% RDF, while farmer's practice resulted in highest technology gap (970 kg/ha) and technological index (24.31%).

This shows tremendous scope of increasing crop productivity through adoption of improved production technologies and recommended package of practices with due consideration of agro-climatic condition, soil fertility and other factors. Lower difference in technological index due to both improved varieties coupled with seed treatment and 100% RDF compared to farmer's practice exhibits almost similar feasibility of adoption of both improved

Table 5 Effect of improved production technologies on extension gap, technology gap and technological index

Technology	Average grain yield (kg/ha)	Extension gap (Kg/ha)	Techno-logical gap (kg/ha)	Techno-logical index (%)
Barley				
RD 2660 with seed treatment and 100% RDF	3605	585	385	9.64
RD 2786 with seed treatment and 100% RDF	3770	750	220	5.51
Farmer's practice with Local variety	3020		970	24.31
C.D (P=0.05)	307			
Chickpea				
Var. CSJK 21 with seed treatment and 100% RDF	1267	282	533	29.61
Var. CSJK 6 with seed treatment and 100% RDF	1360	375	440	24.44
Farmer's practice	985		815	45.28
CD (P=0.05)	262			

Technology gap and technological index worked out considering 3990kg/ha and 1800 kg/ha potential grain yield of barley and chickpea, respectively.

varieties along with seed treatment and 100% RDF, which can be demonstrated at the farmer's field. Rai *et al* (2012) also reported similar findings.

Chickpea: The extension gap computed due to difference between the use of improved production technologies and farmer's yield was 375 kg/ha with the use of variety CJSK 6 and 282 kg/ha with variety CSJK 21 both treated with *Trichoderma viride* and fertilized with 100% RDF over farmer's practice . Therefore concentrate efforts are required to educate and motivate farmers to ensure the adoption of improved production technologies to minimize extension gap. Technological gap is the output of difference between potential yield and demonstration yield. It was 440 kg/ha for CJSK 6 followed by 533 kg/ha by CJSK 21 along with improved technologies compared to 815 with farmer's practice. Increase in technology gap could be ascribed to variability in soil fertility, agro-climatic condition and use of cultivation practices at the farmer's field. Technological index indicates the level of feasibility of demonstrated technology at farmer's field. Lowest value (24.44%) of technological index was observed with CSJK 6 along with seed treatment and 100% RDF followed by 29.61% with CSJK 21 in conjunction with seed treatment and 100% RDF. However, highest technological index (45. 28%) was noticed with farmer's practice. This Indicates better performance and more feasibility of adoption of improved production technologies of chickpea. Similar findings were also reported by Thakral and Bhatnagar (2002) in chickpea.

Based on the study, it can be concluded that huge gap exists in terms of technological knowledge at farmer's level, which could be one of the major reason for low adoption and productivity of crops in the arid region. Low price of produces, poor market facility, non-availability of quality seed and lack of effective extension agencies are the major constraints. Use of improved production technologies like high yielding variety of barley (RD 2786 and 2660) and Chickpea (CSJK 6 and CSJK 21) in conjunction with seed treatment and 100% recommended dose of fertilizers showed significant increase in grain yield and monetary benefit. Therefore improved production technologies need to be popularize among the farmers for obtaining high yield and monetary benefit for sustaining livelihood of the farmers in arid region of Rajasthan.

ACKNOWLEDGEMENT

We are thankful to CGIAR Research Program on Dryland Systems for financial support in Rajasthan under South Asia activities. Also we acknowledge the farmers efforts in taking up this project and sparing their time to give valuable information.

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