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Analysis of yield gaps in black gram (*Vigna mungo*) in district Bilaspur of Himachal Pradesh

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Abstract

Black gram (*V. mungo)* is one of the important pulse crops in India which plays an important role in supplementing the income of small and marginal farmers. Non adoption of improved varieties and recommended practices is one of the reasons for low productivity in this crop. Improved technological package was compared with that of farmers' practice in the Bilaspur district of Himachal Pradesh during *kharif* 2006 to 2009. The results revealed that the use of improved variety, line sowing and balanced application of fertilizers under the improved practice increased seed yield of mash by 34.1 to 81.6% over farmer practice. Improved technological package gave 33.7% higher gross return and 70.4% higher net return over the prevalent practice of the farmers. The average additional cost and additional net return of INR 3003 and INR 10715 were recorded from 2006 to 2009. Incremental benefit cost ratio (IBCR) ranged from 3.10 to 4.64 with an average value of 3.55. The water use efficiency has also been increased by using the improved agricultural technologies in the demonstrations.

Key words: Technology gap, extension gap, technology index, Black Gram.

Food legumes are the vital source of protein. These crops contain high amounts of protein, macro and micronutrients (Ca, P, K, Fe and Zn), vitamins, fibre and carbohydrates for balanced nutrition. They are rich in lysine and essential amino acids which are found only at low levels in cereal proteins (Mohmoud, 2009). Black gram (*V. mungo)* is an important food legume widely consumed in India. It also plays an important role in sustainable agriculture enriching the soil through biological nitrogen fixation. It is mostly grown in Madhya Pradesh, Maharashtra, Tamil Nadu, Uttar Pradesh, Rajasthan and Gujarat during rainy season, where as in Andhra Pradesh and West Bengal in winter (rabi) season (Ram *et al.,* 2010). On account of its short duration, photosensitivity and dense crop canopy it assumes special significance in crop intensification, diversification and conservation of natural resources and sustainability of production system (Katiyar and Dixit, 2010). In the recent past CSKHPKV came up with worthwhile production technologies. However, such technological benefits are not yet harnessed by the state farmers.

Therefore, yield level at farmers field is quite low than that is achieved in experimental farms and demonstration plots. Therefore, the present investigation was carried out to estimate the yield gaps in black gram for having planning for better research and extension.

Material and Methods

Improved technology package (Table 1) was compared with farmers' practice of growing mash in all the three blocks of Bilaspur district during *kharif* 2006-2009. In total, 120 trials were conducted on the farmer's field. The gross plot size was 400 m^2. Yield data for the improved practice as well as from farmers' practice were recorded at the time of threshing and analyzed to draw the inferences. The season-wise detail of sowing and harvesting has been given in Table 2.

The technology gap, extension gap and technology index were estimated using the following formulae (Kadian *et al*., 1997, Samui *et al*., 2000 and Dwivedi *et al*., 2014):

Technology gap = Potential yield (P) – Demonstration plot yield (D)

Extension gap = Demonstration plot yield – Farmer's plot yield

$$\text{Technology index (\%)} = \frac{(P - D)}{Pi} \times 100$$

The potential yield refers to that maximum reported at the time of release of the variety. Cost of cultivation of black gram (*V. mungo)* includes cost of inputs like seed, fertilizers, pesticides etc. purchased by the farmers (in farmers practice) and supplied to him (in improved practice) as well as hired labour, sowing charges by bullocks/tractor and post harvest operation charges paid by the farmers. The farmers' family labour was not taken into consideration in the present study. The gross and net returns were worked out accordingly by taking cost of cultivation and price of grain and byproduct. Additional costs include expenditure on improved technological inputs over farmers' practice. Similarly, the incremental benefit-cost ratio (IBCR) was worked out as a ratio of additional net returns and corresponding additional cost of cultivation (Kumari *et al.,* 2007).

The seasonal water use (Et) was computed from profile water contribution (CS), effective rainfall (ER) and irrigation water applied (I) using the equation: Et = CS + ER + I. Since, the trials were conducted in wide area under varying agro-ecological conditions, the profile water contribution (CS) was not taken into consideration. Similarly, the crops were grown under rainfed farming conditions only. Thus, effective rainfall was considered as seasonal water use in the present study by taking into account the respective crop growth period of each demonstration and the water use efficiency was worked out accordingly (Table 2). The rainfall data were taken from 'Agro-meteorological Observatory' of Pulse Research Sub Station, Berthin Distt. Bilaspur (H.P.) which is situated in the centre of the district.

Results and Discussion

Grain yield

With the adoption of improved production technology on black gram (*V. mungo)*, the grain yield was invariably higher (791 to 998 kg ha^{-1}) than the farmers' plot (510 to 590 kg ha^{-1}) yields during all the years (Table 4) which may be attributed to the adoption of recommended agro-technologies during the study period. Sagar and Chandra (2004) and Choudhary *et al.* (2009) have also reported increase in yield by the use of recommended agro techniques.

Table 4 revealed that percent seed yield increase in black gram in improved package over farmers' plots was highest (81.6%) during *kharif* 2006 and lowest (34.1 %) during *kharif* 2009. This indicates that with the adoption of improved technology in pulses, the yield levels in pulses could be raised by 34.1 to 81.6% over the farmers' practice. The yield advantage of 36.9 to 192.0% has also been reported in earlier studies (Kumari *et al.,* 2007 and Choudhary *et al.,* 2009).

Table 1. Detail of improved package and farmers practice

Particulars	Improved package	Farmers practices (Local check)
Variety	UG-218	Local (Kathu)
Seed rate	18-20 kg/ha	30 kg/ha
Sowing method	Line sowing (30 cm x10 cm)	Broad casting
Situation	Rainfed	Rainfed
Fertilizer dose	20:40:20 (N:P:K kg/ha)	Nil
Plant protection	Need based insecticides & fungicides spray	No spray and insecticides & fungicides

Table 2. Date of sowing and harvesting

Year	Dates of sowing	Dates of harvesting
2006	25 June-07 July, 2006	22-05 October, 2006
2007	25 June-07 July, 2007	24-10 October, 2007
2008	24 June-07 July, 2008	25-10 October, 2008
2009	22 June-010 July, 2009	23-08 October, 2009

Technological gaps

The yield gaps in the present study were categorized into technological and extension gaps. The technology gap observed ranges from 202 to 409 kg ha^{-1} during the years of investigation. The highest technological gap was obtained during *kharif* 2009 (409 kg ha^{-1}) followed by 345 kg ha^{-1} during *kharif* 2008 while lowest gap was observed during *kharif* 2006 (202 kg ha^{-1}). This may be attributed to the lack of irrigation facilities, improper distribution of rainfall (Table 3), variation in soil fertility status, cultivation in the marginal lands, non congenial weather conditions and local specific crop management problems faced in order to obtain the yield potential of specific crop cultivars (Sagar and Chandra 2004; Choudhry 2013). The location specific crop management is required to bridge the gap in the potential and the demonstration yields (Kumari *et al.* 2007), besides strengthening of irrigation infrastructure in the region (Choudhry *et al.* 2009).

Extension gaps

The successful development, dissemination and adoption of improved technologies for small-holders depend on more than careful planning of research and the use of appropriate methodologies in extension. (Mishra *et al.* 2007; Choudhary 2013). The extension gap ranged from 201 to 448 kg ha^{-1} during the period of study. The higher extension gap in the present study (Table 4) indicates that there is strong need to aware and motivate the farmers which is emphasizing on need to educate farmers through various means for adoption of improved agricultural production technologies over existing local practices to minimize the extension gap. Maximum extension gap of 448 kg/ha was observed during *kharif* 2006 and lowest during 2009. Extension yield gaps are the indicators of lack of awareness for the adoption of improved farm technologies by the farmers (Kadian *et al.* 1997; Kumari *et al*. 2007; Choudhary 2013). Thus this study infers that extension functionaries of Bilaspur district have to strictly focus on dissemination of proven farm technologies in pulse production systems enhancing thereby the pulse productivity over existing.

Technology index

Black gram is the major component of existing pulse production systems in the Bilaspur district in terms acreage and production (Anonymous 2009) and is under cultivation with the farmers as pure or mixed crop since many years**.** Technology index indicates the feasibility of the evolved technology in the farmers' fields under existing agro climatic variations (Kumari *et al.* 2007; Choudhary *et al.* 2013). Lower the value of technology index, higher is

Table 3. Rainfall (mm) during the cropping season

Month	Year			
	2006	2007	2008	2009
July	289.0	387.4	246.2	399.4
August	380.0	390.2	375.6	340.6
September	198.8	17.2	64.6	172.6
October	27.6	2.0	22.6	4.0
Total	895.4	796.8	709	916.6

the feasibility of the improved technology. Technology index varied from 16.8 to 34.1% in different years of study. The lowest technology index 16.8% was recorded during *kharif* 2006 followed in increasing order by 25.8% during 2008, 30.4% during 2007 and 34.1% during *kharif* 2009, respectively. This indicate that a strong gap exist between the generated technology at the research institution and disseminated at the farmer`s field (Kadian *et al*. 1997, Vaghasia *et al*. 2005 and Kumari *et al*. 2007). But the introduction of HYV's and demonstration of improved technology followed by intensive awareness campaign will eventually lead to adoption of generated technology among farmers of the district to accelerate the crop diversification, crop intensification and productivity enhancement in the black gram (*V. mungo)*.

Economic analysis

The gross and net returns in improved practice were highest during kharif 2006 with an average value of INR 39920 and INR 31670/ha, respectively. While, in farmer practice highest gross and net returns recorded were INR 29500/- and INR 18000/-, repectively. The IBCR ranges from 3.10 to 4.64 (Table 5). Enhanced monetary returns as well as IBCR through improved farm technology have also been reported by various workers (Kumari *et al*., 2007; Choudhry *et al.* 2009; Choudhary *et al.* 2013). Overall economic analysis highlights that use of improved technology and its adoption in black gram (*V. mungo)* had substantially enhanced the farm gains over farmer's practice which indicated that use of farm technology can greatly improve the livelihood and profitability of the farming community of Bilaspur district.

Water use and water use efficiency

The total seasonal water use during the crop growth period in black gram (*V. mungo)* varied from 709.0 to 916.6 mm (Table 4). Water use efficiency (WUE) varied from 0.86 to 1.21 kg ha-mm^{-1} in the improved practice and 0.61 to 0.77 kg ha^{-1} mm in farmers plots. From the data, it was evident that use of improved technology has greatly enhanced the water use efficiency of black gram (*V. mungo)* as compared to farmers' field plots, though the crop water use was same under both the conditions (Table 3). This can be attributed to improved crop yields of black gram (*V. mungo)* in the improved practice because of better crop management and plant nutrition (Choudhary *et al.* 2006; 2009), resulting in higher water use efficiency with the same amount of seasonal water use. Overall, water use efficiency in improved plot was higher than that of farmer's plots.

Table 4. Yield of black gram affected by improved practices over farmer practice

Year (Kharif)	No. of trials	Yield (kg/ha)		LSD (P-0.05)	Technology gap (kg ha^{-1})	Extension gap (kg ha^{-1})	Technology index (%)	Seasonal water use (mm)	WUE (Kg ha^{-1}mm^{-1})	
		IP	FP						IP	FP
2006	21	998	550	19.1	202	448	16.8	895.4	1.11	0.61
2007	42	835	510	21.0	365	325	30.4	796.8	1.05	0.64
2008	30	855	546	32.4	345	309	25.8	709.0	1.21	0.77
2009	27	791	590	46.4	409	201	34.1	916.6	0.86	0.64
Average		869	549		189	321	26.7			

IP- Improved practice and FP-Farmer Practice

It can be concluded from the study that the wide gap between potential and demonstration yield in black gram (*V. mungo)* was mainly due to technological and extension gaps. The productivity and profitability of the agricultural farm can be improved greatly under rainfed situations by adopting the improved agricultural technologies in the Bilaspur district. It was also observed that there was need to educate and motivate the farmers for adoption of improved technologies, so that marginal farmer with limited resources could improve their livelihood and diversify their farming situation.

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Table 5: Cost of cultivation, Gross return, Net return and B: C ratio of improved practices over farmer practice

Year (Kharif)	Cost of cultivation (INR)		Gross return (INR)		Net return (INR)		Additional cost (INR)	Additional net return (INR)	IBCR*
	IP	FP	IP	FP	IP	FP			
2006	8250	5070	39920	22000	31670	16930	3180	14740	4.64
2007	11572	8520	33400	20400	21828	11880	3052	9948	3.26
2008	13890	10500	38475	24570	24585	14070	3390	10500	3.10
2009	13890	11500	39550	29500	25660	18000	2390	7660	3.21
Average	11900.5	8897.5	37836.3	23161.3	25935.8	15220	3003	10715	3.55

IBCR-Incremental Benefit Cost Ratio

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