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Pulses Yield Gap Minimization: Consequences of CFLD-Pulses in India

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ABSTRACT

The present study is the analysis of large scale data (31949 ha area and 79873 farmers) generated through the CFLD on pulses across the major pulses growing states under the ICAR-ATARIs of Kanpur, Jodhpur, Pune, Jabalpur, Kolkata, Guwahati, Hyderabad, Bangalore and Patna. The present analysis represented the pulse crops of *kharif* (pigeon pea-5556 ha, black gram-6067 ha and green gram-2689 ha), *rabi* (chickpea-8376 ha, lentil-3747 ha and field pea-1890 ha) and summer (green gram-3624 ha) seasons. The average performance data of CFLD were obtained for the above states during the cropping seasons of 2016-17 and 2017-18. Thus, CFLD data were analyzed from across minimum of 13 states (green gram) and maximum of 19 states (black gram). The major variables analyzed were average yield obtained from the check plots and demonstrations plots. These yields were computed for yield advantages and also compared with the reported district level, state level, National level yields and the potential yields of the respective crops in the given states (data procured from secondary sources for the year 2017-18). Accordingly the yield gaps and yield gap minimized at various levels were analyzed using appropriate methods and their degree of variation was also computed for the seasons and crops.

INTRODUCTION

India has the lion's share of growing the largest varieties of pulses in the world contributing about 38 per cent (area) and 33 per cent (production) followed by Canada, China, Myanmar and Brazil. In India, it is considered as "A poor man's meat" being the cheapest and concentrated source of dietary amino acids and protein demand of vegetarian population. Pulse crops are considered as the wonderful gift of nature as they have an ability to fix the atmospheric nitrogen (N_2), thereby helping in N cycling within the ecosystem. Major pulse-producing states in India are Madhya Pradesh, Maharashtra, Uttar Pradesh, Rajasthan, Andhra Pradesh, Karnataka, Gujarat, Chhattisgarh, and Bihar, and the major pulse crops in India are chickpea (*Cicer arietenum*, or garbanzo bean),pigeon pea (*Cajanus cajan*, also known as 'arhar' or 'tur' or red gram), green gram (*Vigna radiata*, the mung bean), black gram (*V. mungo*, or 'urad'), lentil (*Lens culinaris* subsp. *culinaris*), and field pea (*Pisum sativum*, or green pea).The area, production, and productivity of pulses tend to fluctuate. Kumar (1998) projected the national demand for pulses at 30.9 Mt (million tonnes); Mittal (2006) put it at 42.5 Mt by 2020; and the Indian Institute of Pulses Research (IIPR 2011) in its *Vision 2030* document, at 32 Mt by 2030. Mittal (2006) suggested that to meet the growing demand, domestic production (supply) of pulses should grow annually at 6.5 per cent; IIPR (2011) put the figure at 4.2 per cent; and Reddy et al., (2013), at only 3.35 per cent. These estimates are greatly affected by the differences in yield and even more so by the gap between the observed average yield and potentially attainable yield. Yield gaps are expressed as the difference between potential yield and the average yield obtained by farmers over a given area or a given span of years (Evans, 1993; Van Ittersum et al., 2013). The techniques of analysing yield gaps for major crops on regional and global scales and in different contexts have improved over time (Poonia & Pithia, 2011). A further complication is that the yields

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farmers actually obtain vary greatly over time and space, and reliable, long-term yield data are scarce.

With the objective to demonstrate the production potential of improved pulses varieties and also to bridge the yield gap, the Government of India has initiated the National Food Security Mission having a target of raising total pulse production by 4 Mt by the end of the 12th Five-Year Plan, i.e. by 2016-17. And it was to meet this target that the Government of India launched a fresh initiative, namely Cluster Front Line Demonstrations (CFLDs) on Pulses, from the *rabi* season of 2015-16 as part of the food security mission and entrusted the responsibility to the Division of Agricultural Extension of ICAR, the Indian Council of Agricultural Research. The division enlisted 638 centres, the *Krishi Vigyan Kendras* across 29 states in the country

The paper aims at analyzing the large scale data emanated from CFLD pulses across various states of India for the parameters like yield gap and yield gap minimized because of CFLD-P interventions.

METHODOLOGY

The present study draws on data from eleven major Indian zones in each of which the Agriculture Technology Application Research Institute (ATARIs) of the ICAR has a presence, namely in Kanpur, Uttar Pradesh; Jodhpur, Rajasthan; Pune, Maharashtra; Jabalpur, Madhya Pradesh; Kolkata, West Bengal; Guwahati, Assam; Hyderabad, Andhra Pradesh; Bengaluru, Karnataka; Ludhiana, Punjab; and Patna, Bihar. The seasons and the crops were *kharif*, or the rainy season, typically from June to September (pigeon pea-14 states, black gram-19 states, and green gram-13 states); *rabi*, or the winter season, roughly from October to March (chickpea-15 states, lentil-13 states, and field pea-10 states); and summer, typically April and May (green gram-13 states). The data from CFLDs plots were obtained for the above states on all the crops and the three cropping seasons that made up two crop years viz., 2016-17 to 2017-18. The data were, thus, drawn from at least 13 states (for green gram) to as many as 19 (for black gram). The major variables were the average yields obtained from check plots (which served as control plots) and from CFLD plots, and the differences between the two were compared to the district- and state-level yields and to the potential yields of the respective crops in different states growing those crops (data from secondary sources for 2017/18). The crucial values were the yield gaps (the differences between potential yield, which is taken as the maximum attainable yield set by the crop scientists, yields obtained in demonstration plots, and yields obtained by farmers), and yield gap minimized (the difference between the yield gap and the yield advantage in absolute as well as percentage terms). These values were estimated for different spatial scales (Dubey et al., 2018) for all the crops across the three seasons. The major variables used in the study included; Yield gap and Yield gap minimized as suggested by Rimal & Kumar (2015) and Dubey et al., (2018).

The data were subjected to both descriptive and inferential statistics. The descriptive statistics utilized were average, percent and range. The inferential statistics used were Coefficient of Variation (CV) to draw the meaningful implications. The analyzed data were presented in tabular as well graphical form.

RESULTS AND DISCUSSION

Analysis of yield gaps

The widest yield gap was in lentil with respect to its national-level yield (1.45 t/ha), which was slightly lower than that of field pea (1.55 t/ha) and higher than that of chickpea (1.16 t/ha) (Table 1). The *kharif* pulses showed smaller yield gaps at all levels. The yield gap in percentage terms showed a similar pattern. In *kharif* pulses, the variation in yield gap (Figure 1) for the check plots and state-level yields was high for pigeon pea (36% and 38%, respectively) and black gram (35% and 38%) and especially so for *kharif* green gram (45% and 32%) and the least for *rabi* lentil (10.5% and 9%) and field pea (12% and 18%). Singh et al., (2016) had also reported that there was yield gap in lentil to the extent of 15.0–22.5 per cent in selected lentil-growing states, namely Bihar, Madhya Pradesh, Uttar Pradesh, and West Bengal. With reference to Uttar Pradesh, Dubey et al., (2018) also reported the absolute yield gap in lentil to be 0.99–1.51 t/ha, and the current findings confirm that report. Potential yield is still the great challenge to be achieved for pulses in India as indicated by the wider gap with respect to the reported yield at all level i.e. state, national and farmers' yield. Results have shown better picture when trials' yields were compared, the yield gap was observed highest only for *kharif* (180.48%) and summer (106.33%) green gram for reported state yield and for other crops, the gaps were lowest (22.78%) for lentil to as high as 82.05 per cent for pigeon pea for state and national level reported yield. With respect to check plots, the gap was still lower ranging from 23.06 per cent (lentil) to 50.23 per cent for summer green gram. The result has manifold implications. Large scale (space) on-farm demonstrations, if repeated longitudinally (over time) may improve the reported state level and ultimately the national level yields of different pulses in India. Secondly, the yield gap of check plot (farmers' level yield) of different pulses could be further minimized if the assessed and appropriate varieties are disseminated in space and time. Mondal (2011) also quantified the yield gap in rice in different Asian countries including India and estimated it to varies from as low as 3.38 per cent in China to as high as 50.00 per cent in Thailand. India stood a reasonable and manageable level of yield gap (27.78%) in rice which is at lower level when compared with pulses (38.57%). Likewise from the Bundelkhand region of Uttar Pradesh, Sah et al., (2021) reported that there was greater stability in pulses area in the region which may be attributed to the scale based application of modern technologies. Kumbhare et al., (2014) compared pulses with cereals in term of yield gaps of pulses with cereals and found higher gap in pulses whereas Nain et al., (2014) viewed adoption gap as the determinant of instability in pulse production. In mustard and sesame, the CFLD helped to reduce to the extension gap and technology gaps significantly (Singh et al., 2019). A study from Bihar pointed out that yield gap-II i.e. demonstration plot yield and farmer's field yield for all the pulse crops were recorded as 36.33% in pigeon pea, 24.38 per cent in chickpea, 23.40 per cent in lentil and 49.39 per cent in green gram (Kumari et al., 2020). Three years ago also, almost similar extent of yield gap in pulses were reported from Maharashtra and Madhya Pradesh states by Gireesh et al., (2017); Nain et al., (2015) across the major pulse growing states.

Table 1. Yield gap (tonnes per hectare) in pulse crops across seasons and pulse-growing states in India

No.	Crop	Data scale and range	Absolute yield gap (t/ha) between recorded and potential yields			Yield gap as a percentage of potential and trials' yield		
			State average	National average	Average from check plots	State average	National average	Average from check plots
Kharif (rainy season)								
1	Pigeon pea [19][a]	19 states	1.045±0.399 (0.854)[b]	1.221±0.463 (0.779)	0.952±0.333 (0.984)	125.41 {66.27}[c]	179.82 {82.05}	101.27 {44.30}
		Range	0.390–1.568	0.521–1.721	0.510–1.459			
2	Black gram [10.66]	21 States	0.511±0.196 (0.556)	0.440 ±0.137 (0.627)	0.486±0.173 (0.580)	97.18 {53.05}	70.12 {35.72}	87.51 {46.72}
		Range	0.185–0.704	0.273–0.573	0.327–0.715			
3	Green gram [10.66]	23 states	0.614±0.196 (0.333)	0.528±0.103 (0.515)	0.403±0.180 (0.698)	187.56 {180.48}	113.10 {81.35}	78.70 {33.81}
		Range	0.569–9.78	0.485–0.685	0.145–0.588			
Rabi (winter) season								
1	Chickpea [20.63]	21 states	1.171±0.218 (0.893)	1.157±0.066 (0.907)	0.886±0.369 (1.177)	151.01 {82.89}	129.29 {71.33}	93.87 {32.03}
		Range	0.500–1.751	0.553–1.401	0.549–1.412			
2	Field pea [25.00]	17 states	1.255±0.244 (1.254)	1.559± 0.011 (0.941)	1.2.44±0.159 (1.255)	108.89 {37.10}	165.67 {81.04}	102.39 {36.01}
		Range	1.010–1.500	–	1.085–1.404			
3	Lentil [21.50]	19 states	1.280±0.121 (0.869)	1.450±0.086 (0.700)	1.282±0.143 (0.867)	157.83 {22.78}	207.15 {52.42}	159.05 {23.06}
		Range	1.095–1.400	1.300–1.500	1.448–1.075			
Summer season								
1	Green gram [12.00]	13 states	0.741±0.156 (0.458)	0.688±0.00 (0.515)	0.571±0.124 (0.629)	190.06 {106.33}	133.01 {83.49}	99.32 {50.23)
		Range	0.490–0.903	–	0.411–0.758			

[a]numbers in square brackets are average potential yields of various crops across states.
[b]numbersin parentheses are average reported yields.
[c]numbers in {} indicate the percent yield gap with respect to trials' plot yield

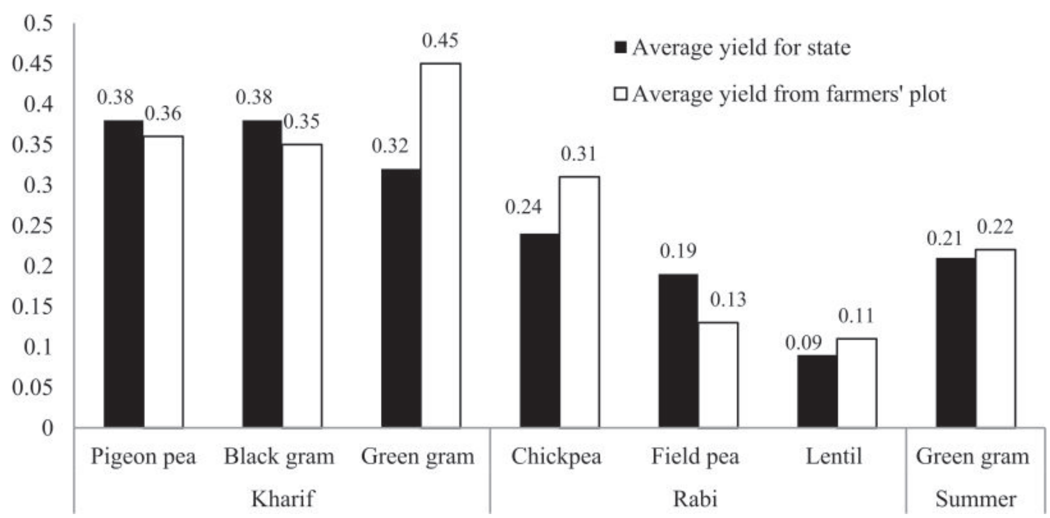

Figure 1. Variation in different categories of yield gaps in six pulse crops in India

Yield gap minimized

As discussed, the yield gap were greater for *kharif* pulses–the yield gap minimized conformed to the same pattern (Table 2), being the widest at the state-level (35.9%–85.3%) and at the national level (35.9%–79.3%) in all three seasons. At the farmers' level, the gap was the widest for green gram (79.96%) and the narrowest for field pea (37.43%, SD=8.05). It should also be noted that the variation in the yield gap minimized due to CFLDs was maximum for black gram and chickpea at the national level (about 65%), which reflects the variation in the yield advantage in those crops across states (Figure 2), probably a reflection, in turn, of the variation in terms of the relatively greater space given to the two crops in cropping systems. The least variation in the yield gap minimized was seen in field pea (10%–25%) and green gram (15%–40%) at all three levels. Literature, however, showed that researchers

Table 2. Effect of CFLD-P on yield gap minimized in pulse crops in India.

No.	Crop	Scale and range	Yield gap minimized (%) with respect to		
			State-level yield	National-level yield	Yield from check plots
Kharif (rainy) season					
1	Pigeon pea	19 states	58.61±15.11	64.51±15.77	55.21±17.64
		Range	32.00–84.62	39.34–88.48	37.04–88.24
2.	Black gram	24 states	71.31±40.77	60.55±41.55	64.19±32.88
		Range	23.41–147.57	9.77–132.23	24.08–123.91
3	Green gram	23 states	85.30±16.08	79.30±22.24	79.96±32.66
		Range	66.77–105.98	52.55–107.01	123.45–44.73
Rabi (winter) season					
1	Chickpea	21 states	49.35±51.09	50.24±48.48	68.75±89.71
		Range	81.40–132.28	64.01–132.82	3.69–345.40
2	Field pea	17 states	37.71±42.52	49.17±13.31	37.43±8.65
		Range	33.33–42.08	35.86–62.48	28.77–46.08
3	Lentil	19 states	35.91±22.41	42.00±24.32	37.48±19.86
		Range	16.93–74.00	10.54–78.33	15.54–69.77
Summer					
1	Green gram	13 States	63.60±26.29	62.77±28.61	56.49±28.63
		Range	30.59–103.61	24.82–104.38	32.06–105.26

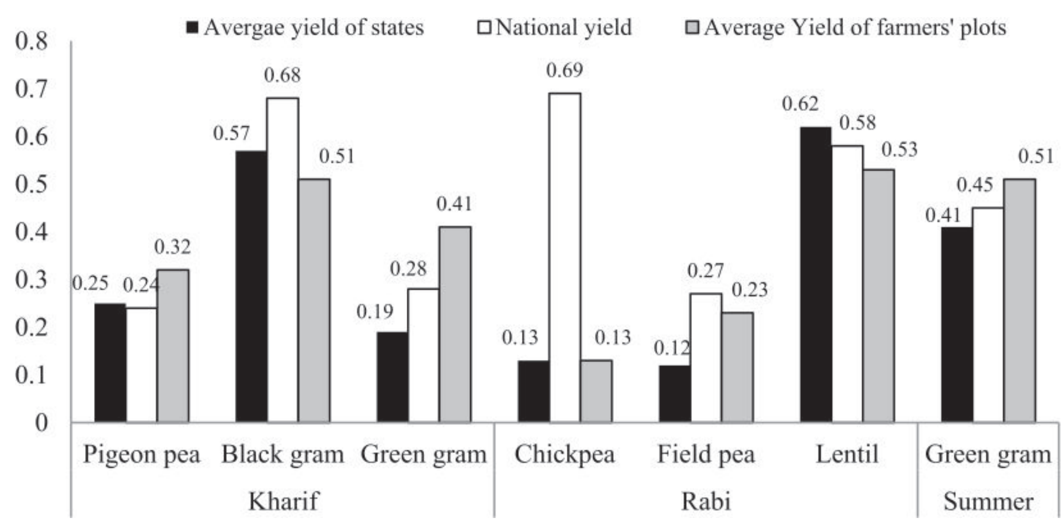

Figure 2. Variation in different categories of yield gaps minimized in six pulse crops in India

in past had mainly focussed on quantifying the yield gaps in rice, cotton, etc (Aggarwal et al., 2008) and pulses (Shrivastava et al., 2017). However, quantifying the yield gap minimization in pulses was only reported by Dubey et al., (2018). With references to paddy, the on-farm technology assessment minimized the extension gap to the extent of -0.59 to -1.21 kg/ha (Singh et al., 2020).

CONCLUSION

The investigation objectively disclosed several implications. Firstly, the scale at which these CFLDs are being conducted is sufficed for discerning the tangible impact. As a result, the average yield gain was quite encouraging and in some cases passing even the potential yields. Secondly, the cross sectional variation in the reported yield, yield gap and yield advantages across the states implicate for evolving the pulses varieties and technologies which are more unique to the given state or region. Thus, the researchable agenda for the pulses variety improvement programme is emanated. Thirdly, the focused and mission mode approach for enhancing pulses production in India not only enhanced the total pulses production, the per capita pulses availability was also increased.

REFERENCES

Aggarwal, P. K., Hebbar, K. B., & Venugopalan, M. (2008). Quantification of yield gaps in rainfed rice, wheat, cotton and mustard in India. ICRISAT. Global theme on Agro-ecosystems report # 43. Patancheru, Andhra Pradesh, India: Monograph. International Crops Research Institute for the Semi-Arid Tropics: pp 65.

Dubey, S. K., Gautam, U. S., Singh A. K., Singh, A., Chahal, V. P., Singh, A. K., Singh, C., & Srivastava, A. (2018). Quantifying the yield gap minimization in lentil (Lens culinaris) under Cluster Frontline Demonstrations (CFLD) conducted in Uttar Pradesh. *Indian Journal of Agricultural Sciences, 88*(6), 851–859.

Evans, L T. (1993). Crop Evolution, Adaptation and Yield. Cambridge University Press.

Gireesh, S., Kumbhare, N. V., Nain, M. S., Kumar, P., & Gurung, B. (2019). Yield gap and constraints in production of major pulses in Madhya Pradesh and Maharashtra. *Indian Journal of Agricultural Research*, *53*, 104-107.

IIPR (2011). Vision Document for 2030, ICAR-IIPR, Kanpur, pp 67.

Kumar, P. (1998). Food demand and supply projection for India: Agricultural Economics Policy Series 98-01, Indian Agricultural Research Institute, New Delhi.

Kumari, P., Singh, K. M., & Ahmad, N. (2020). Yield Gap and its Determinants in Pulse Crops of Bihar-Facts From Plot Level Data of Cost Of Cultivation Scheme. *Multilogic in Science*, *9*(32), 455-458.

Kumbhare, N. V., Dubey, S. K., Nain, M. S., & Bahal, R. (2014). Micro analysis of yield gap and profitability in pulses and cereals. *Legume Research- An International Journal*, *37*(5), 532-536.

Mittal, S. (2006). Structural Shift in Demand for Food: India's prospects in 2020. ICRIER Working Paper. pp 42.

Mondal, M. H. (2011). Causes of yield gap and strategies for minimizing the gaps in different crops. *Bangladesh Journal of Agricultural Research, 36*(3), 469-476.

Nain, M. S., Kumbhare, N. V., Sharma, J. P., Chahal, V.P., & Bahal, R. (2015). Status, adoption gap and way forward of pulse production in India. *Indian Journal of Agricultural Science, 85*(8), 1017-1025.

Nain, M. S., Ram Bahal, Dubey, S.K., & Kumbhare, N. V. (2014). Adoption Gap as the Determinant of Instability in Indian Legume Production: Perspective and Implications. *Journal of Food Legumes*, *27*(2), 146-150.

Poonia, T. C., & Pithia, M. S. (2011). Impact of front line demonstrations of chickpea in Gujarat. *Legume Research, 34*(4), 304-307.

Reddy, A., Amarender, Bantilan, M. C. S., & Geetha Mohan. (2013). Pulses Production Scenario: Policy and Technological Options. Policy Brief 26, ICRISAT, Hyderabad, India, pp 1-7.

Rimal, N. S., & Kumar, S. (2015). Yield gap analysis of major pulses in India. *Journal of the Institute of Agriculture and Animal Science*, *33*(34), 213-219.

Sah, U., Dixit, G. P., Kumar, H., Ojha, J., Katiyar, M., Singh, V., Dubey, S. K., & Singh, N. P. (2021). Dynamics of pulse Scenario in Bundelkhand region of Uttar Pradesh: A temporal analysis. *Indian Journal of Extension Education, 57*(4), 97-103.

Singh, K. K., Singh, R. P. N., & Mishra, D. (2019). Evaluation of Front Line Demonstration of Oilseeds in Raebareli District. *Indian Journal of Extension Education, 55*(3), 49-52.

Singh, P., Singh, G., & Sodhi, G. P. S. (2020). On-farm Participatory Assessment of Short and Medium Duration Rice Genotypes in South-western Punjab. *Indian Journal of Extension Education, 56*(3), 88-94.

Van Ittersum, M. K., Cassman, K. G., Grassini, P., Wolf, J., Tittonell, P., & Hochman, Z. (2013). Yield gap analysis with local to global relevance—A review. *Field Crops Research, 143*, 4–17.