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Yield Gap Analysis of Black Gram under front Line Demonstration Program in Western Uttar Pradesh

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

This research endeavors to conduct a comprehensive yield gap analysis on black gram cultivation in Western Uttar Pradesh. The productivity and yield potential of urd crops in Western Uttar Pradesh face certain challenges due to various technological gaps and the limited adoption of

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advanced agricultural practices. In order to bridge these gaps and enhance the agricultural extension services, a Frontline Demonstration (FLD) program has been initiated. The study relies on data sourced from the annual reports published by SVP University of Agriculture and Technology, Meerut, ATARI Zone III to compile a comprehensive list of Key Variables of Success (KVSs) pertinent to FLDs on black gram. The performance evaluation provides nuanced insights into the strengths and areas for improvement in technology dissemination and adoption among farmers associated with these KVKs. The findings underscore the need for targeted enhancements to bridge the gaps between demonstrated and potential yields, fostering sustainable agricultural advancements in these regions.

Keywords: Agricultural practices; frontline demonstration; sustainable agricultural advancements; cropping system.

1. INTRODUCTION

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 [1] and pulses like urad (black gram) are vital constituents of the Indian cropping system. However, the productivity and yield potential of urad crops in Western Uttar Pradesh face certain challenges due to various technological gaps and the limited adoption of advanced agricultural practices. In order to bridge these gaps and enhance the agricultural extension services, a Frontline Demonstration (FLD) program has been initiated.

The FLD on urad crop in Western Uttar Pradesh aims to address the existing technological disparities by introducing and showcasing modern and innovative farming techniques, improved varieties, and best agronomic practices to farmers in the region. The initiative primarily focuses on narrowing the gap between the existing conventional methods and the latest agricultural technologies.The productivity of blackgram per unit area could be increased by adopting improved package of practices in a systematic manner along with high yielding varieties [2].

This demonstration serves as a platform where farmers can observe, learn, and comprehend the practical application of advanced farming methodologies directly in their own fields. By providing hands-on experience and exposure to new and efficient agricultural practices, the program aims to increase the awareness and adoption of modern techniques among farmers [3].

The demonstration not only emphasizes enhancing crop productivity but also focuses on sustainable practices, including efficient water management, integrated pest management, soil health improvement, and the utilization of quality seeds and fertilizers. Additionally, the FLD program encourages the use of cost-effective and eco-friendly approaches to minimize input costs while maximizing yields [4].

Through the collaborative efforts of agricultural experts, extension workers, and local farmers, the Frontline Demonstration on urad crop in Western Uttar Pradesh aims to not only boost the production and income of farmers but also contribute towards the overall development and advancement of the agricultural sector in the region. This initiative stands as a beacon of agricultural progress, aiming to empower farmers with the necessary knowledge and skills to transform their farming practices and livelihoods [5].

2. METHODOLOGY

This research endeavors to conduct a comprehensive yield gap analysis on black gram cultivation in Western Uttar Pradesh. The study relies on data sourced from the annual reports published by SVP University of Agriculture and Technology, Meerut, ATARI Zone III to compile a comprehensive list of Key Variables of Success (KVSs) pertinent to Frontline Demonstrations (FLDs) on black gram. The selection criteria for the Krishi Vigyan Kendras (KVKs) involved in the study included a three-year (2019-20, 2020-21 and 2021-22) track record of conducting FLD programs specifically on Urd crop, leading to the selection of KVKs in Budaun, Bijnor, Muzaffarnagar, Meerut, and Shahjahanpur for comparative analysis [6].

The research methodology encompasses a dual-pronged approach, focusing on the assessment of extension and technological gaps across the selected KVKs. Across three consecutive years (2020-21, 2021-22, and 2022-23), the five chosen Krishi Vigyan Kendras (KVKs) collectively conducted 690 Frontline Demonstrations (FLDs) on black gram, covering a combined area of 267 hectares on farmers' fields. The extension gap analysis involves gathering and evaluating data concerning the extension activities conducted by each KVK. This includes an in-depth examination of training sessions, demonstrations, farmer engagement initiatives, and the dissemination of knowledge regarding improved black gram cultivation practices. The effectiveness of these extension activities in narrowing the gap between the potential or ideal yield and the actual yield achieved by farmers within their respective regions will be assessed and compared across the KVKs [7].

Concurrently, the technological gap analysis aims to identify, analyze, and compare the technological interventions recommended and promoted by each KVK for black gram cultivation. The study will evaluate the level of adoption and implementation of these technologies by farmers actively participating in the FLD programs. The analysis will specifically focus on discerning disparities between the recommended technologies and the actual farming practices employed by farmers, thereby highlighting the existing technological gaps.

Additionally, the methodology includes the development of a Technology Index formula. This index will be formulated based on the extent of adoption and implementation of recommended technologies by the farmers associated with each KVK. Subsequently, the Technology Index will be computed for each KVK using the collected data, providing a quantifiable measure of the adoption rate of recommended practices and technologies [8].

Statistical tools and methods, encompassing averages, percentages, will be employed to analyze the data gathered on extension gaps, technological gaps, and the Technology Index for the selected KVKs. The outcomes of this analysis will provide valuable insights into the efficacy of each KVK in mitigating gaps and fostering technology adoption among farmers.

The extension gap, technology gap along with technology index were worked out (Samui *et al*., 2000) as given below:

Technology gap = Potential yield – Demonstration yield

Extension gap = Demonstration yield – Farmers yield

Technology index = {(Potential yield – Demonstration yield)/ Potential yield} x 100

3. RESULTS AND DISCUSSION

3.1 Conclusion Based on KVKs' Performance (2020-2022)

3.1.1 Number of farmers engaged

Across the three-year span, a pattern of farmer engagement emerged within the selected Krishi Vigyan Kendras (KVKs). In Budaun, farmer involvement increased from 25 to 50 participants from 2020 to 2022, culminating in a total engagement of 100 farmers over the period. Bijnor consistently exhibited significant participation, with a total of 175 engaged farmers, demonstrating steadfast involvement throughout the three years. MZB_II in Muzaffarnagar experienced fluctuating participation, initially engaging 73 farmers, which later declined to 33, yet overall maintained substantial engagement. Meerut showcased a steady rise in farmer participation, escalating from 25 to 75 farmers, accumulating 150 engaged farmers over the three years. Shahjahanpur upheld consistent engagement, involving 100 farmers throughout the three-year duration. The overall trend indicated an increase in engagement across all KVKs, ascending from 198 to 283 farmers between 2020 and 2022, reflecting a positive and upward trajectory in farmer participation within the FLD programs.

3.1.2 Area under cultivation (in hectares)

In terms of cultivated land area, distinctive patterns were observed among the selected Krishi Vigyan Kendras (KVKs) engaged in black gram cultivation. Budaun showcased a steady increase in cultivated land, advancing from 40 to 111.2 hectares between 2020 and 2022, summing up to a total cultivation area of 100 hectares. Conversely, Bijnor emerged as the leading contributor, cultivating the highest area totaling 267 hectares, displaying a consistent annual increase in cultivated land. MZB_II in Muzaffarnagar experienced fluctuations in

cultivation area, declining from 21.8 to 11.2 hectares in 2022, yet contributing to a total of 57 hectares. Meerut displayed an expansion in cultivation area, increasing from 10 to 30 hectares annually and accumulating a total of 60 hectares over the period. Shahjahanpur maintained a stable cultivated land area of 40 hectares across the three-year span. Overall, the data illustrated an increasing trend in the area under cultivation, ascending from 71.8 to 111.2 hectares between 2020 and 2022 across the KVKs, signifying an overall growth trend in cultivated land within the FLD programs.

1. **Farmer Engagement:** Overall, there was a positive trend in farmer engagement across the KVKs, with varying levels of consistency.
2. **Cultivation Area:** The total cultivated area increased steadily, signifying an expansion in agricultural activities promoted by the KVKs.
3. **Variation in Participation:** Some KVKs showed fluctuations in farmer participation and cultivated area, possibly due to varying local factors or program modifications.

The data indicates encouraging trends in farmer involvement and expanded cultivation areas across the KVKs, laying groundwork for potential growth and agricultural development in the region.

3.2 Yield Gap Analysis

In evaluating the performance of Krishi Vigyan Kendras (KVKs) engaged in black gram Front Line Demonstration in Budaun I, Bijnor, Shahjahanpur, Meerut, and Muzaffarnagar over the years 2020-21, 2021-22, and 2022-23, distinctive patterns in farmer engagement and yield outcomes surfaced. There was a significant increase in yield observed in demonstration plot over farmers practice. It was observed that potential yield can be achieved by imparting scientific knowledge to the farmers, providing the quality need based inputs and proper application of inputs. In Budaun I, for instance, the initial engagement of 25 farmers on 10 hectares yielded 9.5 quintals per hectare, with subsequent fluctuations in engagement and yield, with an increase in yield of 26.45 per cent in 2021-22. The extension gap varied from 12 to 15 quintals, while the technology gap fluctuated between 24.28 and 25 quintals, showcasing inconsistencies in addressing yield disparities due to extension and technological factors. The rising technology index from 0.28 to 0.41 suggests an encouraging trend in technology adoption among farmers in Budaun I.

Similarly, in Bijnor, consistent engagement of 50 farmers on 20 hectares in the first two years resulted in yields of 13.5 and 15.5 quintals per hectare, respectively, an increase in yield of 45.40 per cent in 2021-22. The extension gap remained constant at 15 quintals, indicating steady efforts in addressing yield differences attributed to extension services. Fluctuations in the technology gap (27.02 to 31.39 quintals) and technology index (0.05 to 0.08) suggest mixed performances in technology assimilation among farmers associated with Bijnor's KVK.

Analyzing Shahjahanpur's performance revealed consistent engagement of 25 farmers on 10 hectares, yielding 12.2 quintals per hectare in 2020-21, an increase in yield of 95.65 per cent in 2021-22, Subhash K. (2015) also find similar results in Bilaspur district of Himachal Pradesh stating 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. Fluctuations in the extension gap (14 to 16 quintals) and technology gap (54.29 to 84.14 quintals) indicate varying efforts to manage yield differences due to extension and technological factors. The technology index fluctuated from 0.06 to 0.23, highlighting inconsistencies in technology assimilation among associated farmers.

Table 1. Overall growth trend in cultivated land within the FLD programs

KVKs	2020		2021		2022		Total	
	No. of Farmers	Area (ha)	No. of Farmers	Area (ha)	No. of Farmers	Area (ha)	No. of Farmers	Area (ha)
Budaun	25	10	25	10	50	20	100	40
Bijnor	50	20	50	20	75	30	175	70
MZB_II	73	21.8	59	24	33	11.2	165	57
Meerut	25	10	50	20	75	30	150	60
Shahjahanpur	25	10	25	10	50	20	100	40
Overall	198	71.8	209	84	283	111.2	690	267

Meerut's KVK showcased discernible patterns, initially engaging 25 farmers on 10 hectares, yielding 9.6 quintals per hectare, an increase in yield of 28.79 per cent in 2020-21. Fluctuations in the extension gap (13 to 16 quintals) and technology gap (19.96 to 28.79 quintals) suggest variable efforts in addressing yield disparities due to extension and technological factors, similar results were observed by Jamwal [9] in Kathua district of Jammu and Kashmir Stating overall average technology yield gap, extension yield gap and Technology index in blackgram were 7.70q/ha, 2.25q/ha and 51.33 percent respectively. The fluctuating technology index (0.20 to 0.43) indicates varying degrees of technology adoption.

In Muzaffarnagar, fluctuations in engagement and yield outcomes were evident, an increase in yield of 22.50 per cent in 2022-23. Fluctuations in the extension gap (-1.81 to 22.50 quintals) and technology gap (-3.60 to 20.16 quintals) suggest varying success in managing yield disparities due to extension and technological factors similar findings were observed by Narendar *et al,* [10] in Nalgonda and Yadadri BhuVanagiri district of Telangana state. The technology index fluctuated from 0.22 to 0.36, indicating varying levels of technology adoption among participating farmers.

In summary, the performance evaluation provides nuanced insights into the strengths and areas for improvement in technology dissemination and adoption among farmers associated with these KVKs. The findings underscore the need for targeted enhancements to bridge the gaps between demonstrated and potential yields, fostering sustainable agricultural advancements in these regions.

The data provided in Table 2 depicts a comprehensive overview of critical metrics concerning farmer engagement, cultivation area, potential yields, percentage yield increase, demonstrated yield, extension gap, technological gap, and technology index. These metrics served as pivotal indicators in evaluating the outcomes and efficacy of Frontline Demonstration (FLD) programs targeting black gram cultivation across diverse Krishi Vigyan Kendras (KVKs) over a specific timeframe.

Each KVK exhibited variations in extension gap, technology gap, and technology index throughout the recorded years. These fluctuations played a fundamental role in assessing the effectiveness of technology dissemination and acceptance among farmers. They highlighted discrepancies between demonstrated and potential yields, attributable to extension services and technological factors.

Upon comprehensive analysis, specific KVKs displayed strengths in distinct performance metrics. When evaluating technological gaps, Shahjahanpur consistently showcased superior performance by consistently maintaining lower technological gap of 32, 15 and 18 q/ha compared to other KVKs similar results were observed by Ram and Regar [11]. This consistent trend suggests the robustness and effectiveness of the extension services in minimizing yield disparities.

In terms of Extension gaps, Bijnor emerged as promising, showing the largest and consistently increasing extension gap of 49.60, 89.00, 130.50 q/ha in the consecutive years, similar findings were observed by Singh [12] in Hamirpur district of Himachal Pradesh. Such occurrences indicate commendable technology adoption or potential overestimation issues warranting deeper scrutiny.

Regarding the technology index, Budaun presented a consistent and upward trajectory across observed years i.e 0.28, 0.33 and 0.41 in the consecutive years. This consistent increase implies a positive shift in technology acceptance and adoption among farmers engaged in the FLD program.

In a holistic evaluation, Bijnor persistent success in managing highest extension gap underscores the efficacy of its extension services. Simultaneously, Sharanpur signifies potential through its display of smaller technology gaps, indicative of efficient technology adoption or potential estimation discrepancies. Additionally, Bijnor increasing technology index signifies an encouraging trend in technology acceptance among participating farmers.

This comprehensive analysis provides valuable insights into the comparative performances of different KVKs, shedding light on their respective strengths and potential areas for improvement in advancing black gram cultivation through FLD initiatives.

Table 2. Potential yields, fostering sustainable agricultural advancements

KVKs	Year	No. of Farmers	Area (ha)	Yield (q/ha)				potential yield	% Increase in yield	Total Yield (demonstrated)	Extension gap	Technological gap	Technology index
				Demo High	Low	Average	Check						
Budaun-I	2020-21	25	10	9.5	7.5	8.6	6.92	12	24.28	86.00	16.80	34.00	0.28
	2021-22	25	10	10.53	9.71	10.12	8.03	15	26.45	101.20	20.90	48.80	0.33
	2022-23	50	20	9.53	7.52	8.9	7.12	15	25.00	178.00	35.60	122.00	0.41
Bijnor	2020-21	50	20	13.5	9.47	11.66	9.18	16	27.02	233.20	49.60	86.80	0.27
	2021-22	50	20	15.5	12.5	14.25	9.8	15	45.40	285.00	89.00	15.00	0.05
	2022-23	75	30	17.5	11.25	13.86	9.51	15	31.39	415.80	130.50	34.20	0.08
Shahjhanpur	2020-21	25	10	12.2	8.2	10.8	7	14	54.29	108.00	38.00	32.00	0.23
	2021-22	25	10	14.2	9.5	13.5	6.9	15	95.65	135.00	66.00	15.00	0.10
	2022-23	50	20	16.5	11.2	15.1	8.2	16	84.14	302.00	138.00	18.00	0.06
Meerut	2020-21	25	10	9.6	8.74	9.17	7.12	16	28.79	91.70	20.50	68.30	0.43
	2021-22	50	20	11.83	9.18	10.94	9.12	14	19.96	218.80	36.40	61.20	0.22
	2022-23	75	30	12.83	8.74	10.34	8.21	13	20.60	310.20	63.90	79.80	0.20
MZN-II	2020-21	73	21.8	9.8	7.6	9.02	7.35	11.5	18.51	196.64	36.41	54.06	0.22
	2021-22	59	24	11.2	6.5	8.29	8.44	13	-1.81	198.96	-3.60	113.04	0.36
	2022-23	33	11.2	10.5	7.5	9.8	8	15	22.50	109.76	20.16	58.24	0.35

4. CONCLUSION

In conclusion, the detailed assessment of Frontline Demonstration (FLD) programs for black gram cultivation across diverse Krishi Vigyan Kendras (KVKs) has provided invaluable insights into their performance and outcomes. The comprehensive analysis of key metrics including extension gap, technology gap, and technology index shed light on the effectiveness of technology dissemination, adoption among farmers, and the overall success of these initiatives.

Shahjahanpur emerged as a standout performer, consistently exhibiting lower extension gaps compared to other KVKs, showcasing the robustness of its extension services. Meanwhile, MZN-II (Muzaffarnagar) demonstrated promise with smaller or even negative technology gaps, suggesting commendable technology adoption or potential estimation discrepancies.

Additionally, the encouraging trend observed in Budaun's increasing technology index signifies a positive shift in technology acceptance among participating farmers over time. These nuanced findings highlight the strengths and areas for potential enhancement across the KVKs, emphasizing the need for targeted improvements in extension services and technology adoption strategies.

Overall, this comprehensive evaluation not only delineates the comparative performances of various KVKs but also underscores the significance of tailored approaches in advancing black gram cultivation. The insights garnered from this analysis serve as a roadmap for refining FLD programs, guiding efforts to bridge the gaps between demonstrated and potential yields, and fostering sustainable agricultural advancements in these regions.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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