LR-5408
[1-7]

RESEARCH ARTICLE Legume Research- An International Journal

Yield Gap Analysis of Blackgram Through Cluster Frontline Demonstrations in Salem District of Tamil Nadu

R. Vijayan[1], M. Tilak[1], M. Vijayakumar[1], K. Parameswari[1], P. Radha[1],
K. Nelson Navamaniraj[1], P. Veeramani[1], M. Velmurugan[1], K. Sivakumar[1]

10.18805/LR-5408

ABSTRACT

Background: Blackgram is an important pulse crop in Tamil Nadu, cultivated under both irrigated and rainfed conditions. Traditional broadcasting of seeds often results in uneven plant populations and inadequate moisture distribution, leading to poor crop growth and yield. In the Salem district, the technology gap has been a major challenge to enhance blackgram production. To address this issue, a project was initiated at the Krishi Vigyan Kendra (KVK) in Salem, with the primary aim of boosting production and productivity through cluster frontline demonstrations (CFLDs) adopting the latest technologies.

Methods: The project systematically assessed the technological gaps in various aspects of blackgram cultivation, with the specific objective of increasing blackgram production. A total of one hundred frontline demonstrations were conducted in five villages across Salem district *viz*., Mallikundam, Thumbathulipatti, Kongupatti, Anniyampatti, using blackgram variety VBN 8 blackgram covering an area of 50 hectares in farmers' fields. The interventions included the distribution of blarckgram variety VBN 8 seeds, Pulse Wonderand mechanized sowing.

Result: Demonstrations showed 81.50% increase in yield as compared to traditional farming practices. This highlighted the potential for achieving higher yields through the dissemination of scientific knowledge among farmers, provision of quality seeds, need-based inputsand precision application of these inputs. The combination of technical interventions such as designer seeds, application of TNAU Pulse Wonderand biofertilizers, along with scientific guidance, played a pivotal role in enhancing the yield potential of blackgram.

Key words: Blackgram, Cluster front line demonstration, Productivity, Variety 'VBN 8'.

INTRODUCTION

Blackgram (*Vigna mungo* L.), commonly known as urdbean, is a short-duration pulse crop known for its high protein content of 25-26%. India is the largest producer and consumer of blackgram, cultivating it as a solo crop, intercropand catch crop. India's blackgram production reached 2.78 million tonnes from an acreage of 4.63 million hectares at an average productivity of 614 kg/ha. Blackgram accounts for 11% of India's total pulses production (Anonymous, 2022).

In Tamil Nadu, blackgram contributes significantly to the state's agriculture, with an annual production of about 28.4 lakh tonnes from 47.6 lakh hectares of area, at an average productivity of 596 kg/ha in 2021-22 (Anonymous, 2022). In Salem district, blackgram occupies a major area next to cowpea and greengram. However, the productivity of blackgram in Salem district is 456 kg/ha, which is considerably lower than the national and state averages, indicating a substantial yield gap. Scarcity of quality seeds of high-yielding and disease-tolerant varietiesis resulting in increased incidences of pests and diseases particularly yellow mosaic virus disease. Use of local and photosensitive varieties, erratic rainfall patterns, cultivation on poor and marginal lands, seed broadcastingand the absence of seed treatment with bio-fertilizers contribute to suboptimal yields. Inadequate application of micronutrients and poor pest and disease management practices are prevalent among growers. The partial adoption of recommended agricultural practices widens the technology gap, hindering efforts to increase blackgram production in the district.

To address these challenges, the Krishi Vigyan Kendra (KVK) initiated a project aimed at enhancing production and productivity through cluster frontline demonstrations (CFLDs) using the latest technologies. This initiative sought to systematically bridge the technology gap and empower farmers with the knowledge and resources necessary to improve blackgram cultivation practices and yield outcomes. Through this comprehensive approach, the project aimed to provide farmers with access to quality

[1]Forest College and Research Institute, Mettupalayam, Tamil Nadu. Agricultural University, Coimbatore-641 301, Tamil Nadu, India.

Corresponding Author: M. Tilak, Forest College and Research Institute, Mettupalayam, Tamil Nadu Agricultural University, Coimbatore-641 301, Tamil Nadu, India.
Email: mtilakiard@gmail.com, ORCIDs: 0009-0002-4796-1565.

How to cite this article: Vijayan, R., Tilak, M., Vijayakumar, M., Parameswari, K., Radha, P., Navamaniraj, K.N., Veeramani, P., Velmurugan, M. and Sivakumar, K. (2024). Yield Gap Analysis of Blackgram Through Cluster Frontline Demonstrations in Salem District of Tamil Nadu. Legume Research. 1-7. doi: 10.18805/LR-5408.

Submitted: 24-08-2024 **Accepted:** 06-10-2024 **Online**: 13-12-2024

seeds, introduce improved cultivation techniquesand promote the use of bio-fertilizers and micronutrients. Through better understanding of pest and disease management, adapting suitable technologies to the local agro-climatic conditions, the project intended to narrow down the yield gap and enhance the overall productivity of blackgram in Salem district.

MATERIALS AND METHODS

The Krishi Vigyan Kendra (KVK), Salem, conducted the present investigation on cluster frontline demonstrations during the summer seasons from 2017 to 2021. One hundred frontline demonstrations on blackgram (variety VBN 8) were laid out in an area of 50 hectares across five villages *viz.,* Mallikundam, Thumbathulipatti, Kongupatti, Anniyampatti and Manjini in Salem district in Tamil Nadu. The objective of these cluster frontline demonstrations was to increase blackgram production. The demonstrations used blackgram (variety VBN 8) seeds and mechanized sowing techniques. Specifically, a seed drill was calibrated for blackgram using the metering mechanism provided in the drill. The zero-till ferti seed-drill utilized a distinct type of furrow opener, which created slits in the untilled soil with minimal disturbance. The recommended seed rate of 8 kg per hectare was sown in 30 cm row spacing. Before sowing, the seeds were soaked for three hours to ensure uniform moisture content and the soil moisture content at the time of sowing was 25%.

KVK demonstrated various materials and technologies for conducting frontline demonstrations (FLDs) with the farmers (Table 1). The input materials were provided to the farmers, who were trained to follow the package and practices for blackgram cultivation as recommended by the Tamil Nadu Agricultural University, Coimbatore. This included seed treatment, bio-fertilizer inoculation, fertilizer application, water and weed managementand insect pest management. In the local check plots, farmers followed traditional practices using existing varieties. Using the computations described by Marlabeedu *et al*. (2022) for analyzing the technology gap, technology index, extension gap and economic parameters in comparison with farmers practices, the percent yield comparison of improved practices with local check, district and state average was computed. The yield impact was also evaluated:

Impact yield=

$$\frac{\text{Yield of demo plot - Yield of farmer plot}}{\text{Yield of farmer plot}} \times 100$$

$$\text{Extension gap} = \text{Yield in demo plot - Yield in farmer plot}$$

$$\text{Technology gap} = \text{Potential yield - Demo plot yield}$$

$$\text{Technology index} = \frac{\text{Potential yield - Demo plot yield}}{\text{Potential yield}} \times 100$$

Data were collected from participating farmers using a well-structured questionnaire after the harvesting and marketing of the blackgram. Yield data were obtained from individual farmersand the weighted mean yield was calculated. The percentage yield increase over farmers' practices was determined by comparing the average yield of the CFLD (Cluster Front Line Demonstration) plots with that of the farmers' practices. The cost of cultivation was calculated for both CFLD and farmers' practices, including the costs of inputs such as seeds, fertilizers (both chemical and bio-fertilizers), pesticides, herbicides, hired labor (excluding family labor), field preparation, sowing, harvestingand transportation. Average gross and net returns were calculated based on the sale price of the grain in the local market. The benefit:cost ratio was determined by dividing the gross return by the corresponding cost of cultivation (Kumari *et al*., 2007).

Gross returns (Rs./ha) =

$$\text{Yield (kg/ha)} \times \text{Price of produce (Rs./kg)}$$

$$\text{Net returns (Rs./ha)} = \text{Gross returns (Rs./ha) - Cost of cultivation (Rs./ha)}$$

$$\text{Benefit: cost ratio} = \frac{\text{Gross returns (Rs./ha)}}{\text{Cost of cultivation (Rs./ha)}}$$

RESULTS AND DISCUSSION

Growth and yield characters of blackgram

The demonstrations showed a 21.9% higher yield as compared to the local practices, which recorded 6.8 q/ha. On average, the yield from the demonstrations was higher than that of the check variety. The average yield during the 2017 season was 8.15 q/ha and during the 2018 season, it was 8.36 q/ha. The benefit cost ratio of the demonstrations was 3.46 in 2017 and 3.32 in 2018 (Table 2). These results are in agreement with the findings of Rupesh *et al*. (2017), who reported benefit: cost ratios of 2.18 and 2.22 for conventional varieties in 2017 and 2018, respectively. The data indicated a positive impact of cluster frontline demonstrations on increasing blackgram yields in the Salem district in Tamil Nadu. The benefit:cost ratio was consistently higher under the demonstration conditions as compared to control in all the study years, with an average increase of 18.24% over the control. Throughout the study period, there was a strong emphasis on educating farmers through various techniques to adopt improved agricultural practices, aiming to reduce the extension gap (Tiwari and Saxena, 2001). Different physiological parameters were observed in samples collected from various farmers' fields. The demonstration samples exhibited a higher germination percentage as compared to the check plots. The average field emergence percentage for the demonstration samples was 79.69%, representing a 12% increase over the check variety's 67.17% (Table 3).

An increase in plant height was observed in the demo samples as compared to the check plots. The average plant height of the demo samples was 44.79 cm, while the check plots had an average height of 35.72 cm (Table 3). Similar increases in plant height have been reported in

Table 1: Details of cluster frontline demonstrations conducted by the KVK on blackgram during summer 2017 to 2021.

CFLD Year/ total demos	Village name	Improved technology demonstrated
2017 to 2021	Mallikundam, Thumbathulipatti, Kongupatti,	●TNAU short duration blackgram variety "VBN 8". It is determinate plant type, non shattering, synchronized maturity
250 Demos	Anniyampatti and Manjini	●Seed treatment with biofertilizer *Rhizobium*, *Phosphobacteria* @ 1 kg/ha and bio control agent ●Seed drill line sowing (30 × 10 cm); seed rate 20 kg/ha; Seed treatment with imidacholoprid 6 ml /kg of seed. ●Gap filling and thinning ●Integrated weed management - pendimethalin 30 EC @ 3.3 l/ha (pre-emergence) and hand weeding at 15 and 35 DAS ●TNAU pulse wondar @ 5 kg/ha before and after flowering ●Recommended dose of fertilizer (RDF) ●Integrated pest and disease management

Table 2: Details of seed yield of FLDs conducted on blackgram summer (2017 to 2021).

Year	Area (ha)	No. of farmers	Mean seed yield (q/ha)			% increase over control	B:C ratio	
			Potential	Improved technology	Control		Improved technology	Control
2017	20	50	9.0	8.15	6.90	21.10	3.46	2.18
2018	20	50	9.0	8.36	6.82	19.60	3.32	2.22
2019	20	50	9.0	8.17	6.79	20.32	3.41	2.12
2020	20	50	9.0	8.26	6.86	20.40	3.54	2.23
2021	20	50	9.0	8.66	6.77	28.00	4.41	3.00

lettuce using *Pseudomonas* bio-fertilizer (Rostaminia *et al*., 2020; Santana Fernández *et al*., 2021). Furthermore, spraying with Pulse Wonder increased plant height in blackgram (Kamaleshwaran and Karthiga, 2021). The number of pods per plant was also higher in the demo samples (50.93) than in the check plots (41.07) (Table 3) directly influencing seed yield. Similar results were reported in blackgram by foliar application of Pulse Wonder at 5 kg/ha during flowering and 15 days after the first DAS spray. This treatment resulted in significantly higher plant height, number of pods per plant, seeds per pod, seed yield (q/ha), straw yield (q/ha), harvest index (%), net return (Rs) and benefit: Cost ratio as compared to other foliar spray treatments (Devaraju and Senthivel, 2018).

Molla *et al.* (2012) demonstrated increased plant height, number of fruits per plant, individual fruit sizeand enhanced yield in tomatoes through the application of *Trichoderma viride* bio-fertilizer. Similar results were reported in wheat by Mahato *et al*. (2018). Marimuthu and Surendran (2015) reported that application of 100% recommended dose of NPK + DAP 2% + TNAU Pulse Wonder 5.0 kg/ha recorded significantly higher plant growth, number of pods per plant, yield of blackgramand benefit:cost ratio over control. Sujatha and Ambika (2016) reported that designer seeds fortified with 1% KCl for 6 hours followed by polymer coating at 3 ml/kg, carbendazim at 2 g/kg, imidacloprid at 2 ml/kg, *Trichoderma viride* at 4 g/kg, enhanced plant growth and yield. This treatment increased number of pods per plant, pod yield per plot (g)and seed yield per plant (g), with fewer days to 50% flowering and reduced pest and disease incidence. Similar results were also observed in paddy (Sujatha and Ambika, 2018) and cotton (Sujatha and Ambika, 2020).

The increases in plant growth and yield might be due to higher supply of nutrients at flower initiation and pod formation stages, leading to efficient translocation of photosynthates from source to sink through foliar application of nutrient spray like Pulse Wonder (Kamaleshwaran and Karthiga, 2021; Devaraju and Senthivel, 2018). Additionally, the designer seeds provide protection during initial stages of establishment from seed-borne pathogens and improve nutrient use efficiency via bio-fertilizer. *Trichoderma* and *Pseudomonas* bio-fertilizers assist in the solubilization and sequestration of essential plant nutrients such as P, Mn, Fe and Zn, thereby enhance plant growth (Lal *et al*., 2013). The increased root biomass, accumulation of nitrogen and production of plant growth hormones such as gibberellins and cytokinins by these

Table 3: Growth and yield attributes of blackgram during CFLDs.

Sample	Field Emergence (%)		Plant height (cm)		No of pods per plant		Pod filling (%)		B:C ratio	
	Check	IT	Check	IT	Check	IT	Check	IT	Check	IT
Sample 1	72 (58.05)	78 (49.63)	36	49	42	47	66(67.21	85 (67.21)	2.18	1.26
Sample 2	74 (59.34)	82 (50.38)	34	47	45	68	71(63.43	80 (63.44	2.00	1.26
Sample 3	71 (57.42)	84 (49.27)	42	38	37	56	68(65.65)	83 (65.6)	2.18	1.26
Sample 4	68 (55.55)	83 (48.19)	39	39	41	56	60(50.77)	75 (60)	2.15	1.26
Sample 5	66 (51.35)	85 (45.78)	33	38	45	54	66(54.33)	76 (60.67)	2.02	1.26
Sample 6	68 (53.13)	79 (46.79)	35	37	47	53	66(54.33)	83 (65.65)	2.01	1.26
Sample 7	61 (52.54)	77 (46.45)	34	42	49	56	71(57.42)	71 (57.42)	2.25	1.26
Sample 8	64 (58.05)	76 (49.63)	34	39	52	58	60(50.77)	83 (65.65)	2.00	1.26
Sample 9	63 (59.34)	74 (50.38)	36	48	41	51	71(57.42)	78(62.03)	2.18	1.26
Sample 10	72 (60.00)	78 (50.77)	34	47	45	56	68(55.55)	81 (64.16)	2.15	1.26
Sample 11	74 (56.17)	81 (48.54)	39	45	48	49	65(53.73)	83 (65.65)	2.15	1.26
Sample 12	75 (53.13)	83 (46.79)	34	45	47	48	67(54.94)	76 (60.67)	2.14	1.26
Sample 13	69 (55.55)	78 (48.19)	36	48	46	52	65(53.73)	74 (59.34)	1.97	1.26
Sample 14	64 (51.94)	82 (46.11)	38	42	42	46	70 (56.79)	78 (62.03)	2.09	1.26
Sample 15	68 (57.42)	80 (49.27)	37	38	43	43	68 (55.55)	79 (62.73)	2.13	1.26
Sample 16	62 (53.73)	79 (47.1)	39	49	46	49	65 (53.73)	81 (64.16)	2.10	1.11
Sample 17	71 (53.13)	82 (46.79)	35	52	42	52	64 (53.13)	79 (62.73)	2.08	1.10
Sample 18	65 (54.33)	83 (47.48)	34	46	35	54	67 (54.94)	83 (65.65)	2.18	1.11
Sample 19	64 (57.42)	88 (49.27)	36	48	34	57	72 (58.05)	83 (65.65)	2.25	1.11
Sample 20	66 (58.69)	81 (50.01)	34	46	37	49	68 (55.55)	83 (65.65)	2.18	1.11
Sample 21	71 (53.73)	82 (47.14)	35	51	39	46	64(53.13)	83 (65.65)	2.18	1.11
Sample 22	73 (52.54)	78 (46.45)	36	49	41	48	63 (52.54)	83 (65.65)	2.08	1.11
Sample 23	65 (54.33)	79 (62.73)	31	46	34	44	64 (53.13)	80 (63.45)	2.10	1.11
Sample 24	63 (52.54)	76 (60.67)	36	47	36	49	65 (53.73)	80 (63.45)	2.18	1.11
Sample 25	64 (57.42)	77 (46.45)	38	46	35	48	66 (67.21)	80 (63.45)	2.12	1.11
Sample 26	66 (58.69)	75 (60)	34	51	34	46	60 (50.77)	80 (63.45)	2.15	1.11
Sample 27	66 (58.69)	76 (60.67)	36	45	36	51	64 (53.13)	80 (63.45)	1.95	1.11
Sample 28	62 (53.73)	74 (50.38)	35	39	38	47	62 (51.95)	80 (63.44)	2.01	1.11
Sample 29	61 (51.35)	81 (50.01)	36	42	34	44	64 (53.13)	81 (64.16)	1.93	1.11
Mean	67.17 (55.04)	79.69 (61.13)	35.72	44.79	41.07	50.93	65.86 (54.2)	80.03 (63.46)	2.11	1.19
SEd	1.21	1.24	0.63	0.52	0.65	0.70	1.14	1.12	0.04	0.01
CD (P=0.05)	2.43	2.48	1.26	1.03	1.30	1.40	2.28	2.25	0.08	0.02

(Figures in parenthesis indicate arcsine transformed values). IT: Improved technology.

inoculants promote seedling growth. These results positively influenced the benefit: Cost ratio.

To estimate the yield gap, the potential yield of the crop was compared with the yield from the demonstration plots. The yield gap analysis was assessed using the technology index, extension gap and technology gap. The extension gap, which illustrates the variation in yield between the farmer's plots and the demonstration plots, ranged from 1.25 to 1.89 q/ha over the investigation period, with an average of 1.49 q/ha over three years (Table 4). This gap highlights the need to educate and train farmers in adopting yield-maximizing technologies to close this significant practice gap. Extension yield gaps indicate a lack of awareness and adoption of improved farm technologies among farmers (Vedna *et al*., 2007). The new technologies will eventually convince farmers to discontinue the old technology and to adopt new technology. This finding is in corroboration with the findings of Hiremath and Nagaraju (2010) and Upesh Kumar *et al*. (2023) in blackgram.

Technology gap

The technology gap representing the difference between the potential yield of the crop and the demonstration yield, ranged from 0.05 to 0.56 q/ha, with an average of 0.39 q/ha (Table 4). Farmers are negatively impacted by the technology gap due to insufficient extension efforts and a lack of demonstrations of improved technologies. This gap can be attributed to various factors, including crop suitability, soil fertility status, fluctuations in sowing dates and meteorological conditions. This can also be attributed to lack of irrigation, uneven rainfall, variations in soil fertility, cultivation on marginal lands, unfavorable weather conditions and specific crop management challenges. These issues hinder the ability to fully harness the yield potential of crop cultivars (Choudhary *et al*., 2009). These observations highlight the urgent need for location-specific crop management practices to bridge the gap between potential and actual yields in demonstration plots (Vedna *et al*., 2007), along with strengthening of irrigation infrastructure in the region (Choudhary, 2009). Similar findings were also reported by Singh *et al.,* (2021) in summer mungbean.

Technology index

Technology index indicates the feasibility of generated farm technologies in the farmers' fields under prevailing agro climatic situations (Vedna *et al*. 2007). A lower technology index value suggests greater feasibility. This index is a percentage (%) based on the technology gap, where a higher value indicates lower adoption of improved technologies by farmers. The three-year technology index in demonstrations averaged 26.41%, ranging from 0.57% to 6.43% (Table 4). The low technology index is attributed to the interventions by KVK scientists and the adoption of yield-maximizing practices for blackgram by the farmers. Timely and need-based recommendations from KVK scientists and extension staff along with favorable climate conditions and a low fpests and diseases incidence supported the lower technology index.

Table 4: Performance of blackgram technologies under CFLD on yield, extension gap, technology gap during 2017 to 2021.

Year	No. of demos	Variety		Yield (q/ha)		Increase in yield over the control (%)	Extension gap (q/ha)	Technology gap (q/ha)	Technology index (%)
		Improved technology (IT)	Control	Improved technology	Control				
2017	50	VBN 8 and IT	VBN 4	8.15	6.90	21.1	1.25	0.56	6.43
2018	50	VBN 8 and IT	VBN 4	8.36	6.82	19.6	1.54	0.35	4.02
2019	50	VBN 8 and IT	VBN 4	8.17	6.79	20.3	1.38	0.54	6.20
2020	50	VBN 8 and IT	VBN 4	8.26	6.86	20.4	1.40	0.45	5.17
2021	50	VBN 8 and IT	VBN 4	8.66	6.77	28.0	1.89	0.05	0.57
Mean / total	250			8.32	6.82	21.8	1.49	0.39	4.47

Table 5: Impact of improved production technologies under CFLD on economics of blackgram during 2017 to 2021.

Year	Cost of cultivation (Rs/ha)		Gross returns (Rs/ha)		Net returns (Rs/ha)		B:C ratio		Additional returns in improved practices	
	Improved technology	Control	Improved technology	Control	Improved technology	Control	Improved technology	Control	Additional cost of cultivation (Rs/ha)	Additional gross returns (Rs/ha)
2017	28600	26200	65200	55200	36600	29000	2.28	2.11	2400	10000
2018	29200	27100	68552	55924	39352	28824	2.35	2.06	2100	12628
2019	30800	28100	66994	55678	36194	27578	2.18	1.98	2700	11316
2020	31800	29500	70210	58310	38410	28810	2.21	1.98	2300	11900
2021	32050	29900	73610	57545	41560	27645	2.30	1.92	2150	16065
Mean	30490	28160	68913	56531	38423	28371	2.26	2.01	2330	12382

Economics

Yield, variable costsand the difference between market price and minimum support price are the primary determinants of economic returns. Input costs and labor wages fluctuated over time. The economic viability of enhanced methods over traditional farmers' practices was determined based on the input and output costs at the time of the study as compared to traditional practices. Where the average cost of cultivation, gross returns and net returns were Rs. 28,160/ha, Rs. 56,531/ha and Rs. 28,371/ha, respectively, with an average benefit:cost ratio of 2.01. Improved practices recorded a higher average cost of cultivation (Rs. 30,490/ha), gross returns (Rs. 68,913/ha) and net returns (Rs. 38,423/ha) (Table 5). Similar economic benefits owing to adoption of improved technology interventions were also reported by Meena *et al*. (2021) and Reager *et al*. (2020). Additionally, on an average of five years, the improved practices generated an additional gross return of Rs. 12,382/ha as compared to traditional practices, with a benefit:cost ratio of 2.26 (Table 5). Higher benefit:cost ratio in demonstrations could be the result of higher yield due to adoption of improved practices which were missing in local check plots. Singh *et al*. (2017) observed similar results in mungbean and Kantwa *et al.,* 2024 in chickpea, however, Kumar and Boparai (2020) observed a B:C ratio in the range of 1.92 to 2.44 during their study period.

CONCLUSION

Cluster frontline demonstrations on blackgram, were conducted in five villages and the results highlighted a significant difference in yield across two consecutive years. In 2021, the average yield was 11.47 q/ha, while in 2017 season, it was 8.50 q/ha. The benefit:cost ratio for these years was 4.04 and 2.27, respectively, for the demonstration plots. An impressive 81.50% increase in yield was observed in the demonstration plots as compared to the farmers' conventional practices. These results underscore the potential for achieving higher yields through dissemination of scientific knowledge to farmers, provision of quality seeds, need-based inputs and the proper application of these inputs. The combination of inputs such as designer seeds, application of TNAU Pulse Wonderand bio-fertilizers along with scientific guidance, significantly enhanced the crop's potential yield. Furthermore, the demonstrations showed that adopting these advanced practices by farmers not only improves the yield but also ensures sustainable agricultural practices. This approach leads to better resource management and can be pivotal in uplifting the economic status of the farmers.

Conflict of interest

The authors declare that there are no conflicts of interest regarding the publication of this article.

REFERENCES

Anonymous, (2022). Directorate of economics and statistics, department of agriculture, cooperation and farmers welfare, https://mpkrishi.mp.gov.in/Englishsite_New/compendium 2005-06_new.aspx., https://desagri.gov.in/.

Choudhary, A.K., Yadav, D.S. and Singh, A. (2009). Technological extension yield gaps in oilseeds in Mandi district of Himachal Pradesh. Indian Journal of Soil Conservation. 37(3): 224-229.

Devaraju, B. and Senthivel, T. (2018). Effect of foliar application of different sources of nutrients on growth and yield of blackgram under irrigated conditions. International Journal of Current Microbiology and Applied Sciences. 7(1): 3105-3109.

Hiremath, S.M. and Nagaraju, M.V. (2010). Evaluation of on-farm front line demonstrations on the yield of chilli. Karnataka Journal of Agricultural Sciences. 23(2): 341-342.

Kamaleshwaran, R. and Karthiga, S. (2021). Effect of foliar nutrition on yield and growth parameters of greengram in coastal area of Tamil Nadu (*Vigna radiata*) cv. Vamban 2. Sabujeema- An International Multidisciplinary e-Magazine. 1(3): 22-27.

Kantwa, C.R., Tripathy, S., Bhadauria, R.S., Sharma, B., Jakhar, S.R., Kumar, S. and Singh, S.R.K. (2024). Front Line Demonstration on performance of Chickpea in Malwa region of Madhya Pradesh. Legume Research. 47(1): 74-77. doi: 10.18805/LR-4890.

Kumar, P. and Boparai, A.K. (2020). Impact of summer mung through improved technology in Jalandhar district of Punjab, India. International Journal of Current Microbiology and Applied Sciences. 9(5): 3495-3501.

Kumari, V., Kumar, A., Kumar, A. and Bhateria, S. (2007). Demonstration an effective tool for increasing productivity of rapseed mustard in Kangra district of Himachal Pradesh. Himachal Journal of Agricultural Research. 33(2): 257-261.

Lal, G., Saini, I.P., Mehta, R.S., Maheria, S.P. and Sharma, Y. (2013). Effect of irrigation and different seed treatment methods on growth and yield of fenugreek (*Trigonella foenum graecum* L.). International Journal of Seed Spices. 3(2): 29-33.

Mahato, S., Bhuju, S. and Shrestha, J. (2018). Effect of *Trichoderma viride* as biofertilizer on growth and yield of wheat. Malaysian Journal of Sustainable Agriculture. 2(2): 1-5.

Marimuthu, S. and Surendran, U. (2015). Effect of nutrients and plant growth regulators on growth and yield of blackgram in sandy loam soils of Cauvery new delta zone, India. Cogent Food and Agriculture. 1(1): 1010415.

Marlabeedu, S., Bharath, T., Pallavi, S., Himabindu, T., Shankaraiah, M. and Sumalini, K. (2022). Impact analysis of cluster frontline demonstrations on groundnut in Nalgonda district, Telangana. Indian Journal of Extension Education. 58(4): 66-70.

Meena, R.K., Singh, B., Chawla, S., Meena, R.K. and Shinde, K.P. (2021). Evaluation of frontline demonstrations of chickpea under irrigated North Western Plain Zone-1b of Rajasthan. Journal of Pharmacognosy and Phytochemistry. 10(1): 1240-144.

Molla, A.H., Haque, M., Haque, A. and Ilias, G.N.M. (2012). *Trichoderma* enriched biofertilizer enhances production and nutritional quality of tomato (*Lycopersicon esculentum* Mill.) and minimizes NPK fertilizer use. Agricultural Research. 1(3): 265-272.

Reager, M.L., Kumar, U., Mitharwal, B.S. and Chaturvedi, D. (2020). Productivity and sustainability of green gram as influenced by improved technology of CFLD under hyper arid partially irrigated zone of Rajasthan. International Journal of Current Microbiology and Applied Sciences. 9(5): 1778-1786.

Rostaminia, M., Habibi, D., Shahbzi, S., Sani, B. and Pazoki, A. (2020). Effect of three commercial bio-fertilizers prepared with *Pseudomonas* on yield and morpho physiological traits of lettuce (*Lactuca sativa* L.). Iran Agricultural Research. 39(2): 99-107.

Rupesh, K., Shinde, V. and Chaudhari, P. (2017). Role of cluster frontline demonstrations in enhancement of chickpea production. Journal of Krishi Vigyan. 6(1): 172-174.

Santana Fernández, A., Beovides García, Y., Simó González, J.E., Pérez Peñaranda, M.C., López Torres, J., Rayas Cabrera, A. and Basail Pérez, M. (2021). Effect of a pseudomonas fluorescens-based biofertilizer on sweet potato yield components. Asian Journal of Applied Sciences. 9(2): 101-113.

Singh, J., Singh, K., Hemender and Premdeep (2021). Impact assessment of front line demonstrations on summer mung productivity under irrigated agro-ecosystem of Haryana. Legume Research. 44(12): 1470-1474. doi: 10. 18805/LR-4517.

Singh, P., Shahi, B. and Singh, K.M. (2017). Trends of pulses production, consumption and import in India: Current Scenario and Strategies. MPRA Paper No. 81589.

Sujatha, K. and Ambika, S. (2016). Designer seed for enhancement of yield in blackgram (*Vigna mungo* L.). Indian Journal of Agricultural Research. 50(5): 479-482. doi: 10.18805/ ijare.v50i5.3752.

Sujatha, K. and Ambika, S. (2018). Designer seed treatment techniques on enhancement of yield in paddy. *Oryza*-An International Journal of Rice. 55(4): 602-607.

Sujatha, K. and Ambika, S. (2020). Designer seed for enhancement of yield in cotton. Indian Journal of Agricultural Research. 54(2): 217-221. doi: 10.18805/IJARe.A-5211.

Tiwari, K.B. and Saxena, A. (2001). Economic analysis of FLD of oilseed in Chhindwara. Bhartiya Krishi Anusandhan Patrika. 16 (3 and 4): 185-189. doi: 10.5958/0976-0547. 2015.00049.X.

Upesh Kumar, Patel, G.A., Chudhari, R.P., Darji, S.S and Raghav, R.S. (2023). Cluster frontline demonstration: An effective technology dissemination approach for enhancing productivity and profitability of Blackgram (*Vigna mungo*). Legume Research. 46(10): 1356-1360. doi: 10.18805/ LR-4450.

Vedna, K., Kumar, A. and Bhateria, S. (2007). Demonstration - An effective tool for increasing productivity of rapeseed mustard in Kangra district of Himachal Pradesh. Journal of Oilseeds Research. 33(2): 257-261.