**Cluster frontline demonstration: A sustainable approach for production and productivity enhancement of mustard in semi-arid ecology of Rajasthan**

**Abstract** –Mustard cultivated both rainfed as well as irrigated condition in Jaipur district of Rajasthan. It is a main oilseed crop of district. Krishi Vigyan Kendra (KVK), Jaipur-1 carried out 120 cluster front line demonstrations (CFLDs) at farmers field with an area of 60 ha. during *rabi* 2022-23 and 2023-24. Each demonstration size was 0.5 ha during the study period. Both the demonstration years covered six villages with two blocks of Jaipur district. Comparisons were performed between recommended and farmer practices. The yield gap, extension gap analysis, technology index, and technology gap were calculated for the purpose of interpreting the study's findings. The outcomes of two years demonstration indicated that the average yield under demonstration practice was 22.66 q /ha as compared to 18.56 q /ha in farmer practices (FP). The percent of increase in yield ranged from 23.58 to 20.56 percent and average percent yield was 22.07 % higher over farmer practices (FP). The average extension gap and technology gap were recorded 4.10 q/ha and 1.35 q/ha, respectively. The technology index was also recorded 5.61 %. The economics of demonstrations showed the positive effects of CFLDs over the farmer’s practices (FP). The highest average gross return was (Rs. 125,716/ha), net return (Rs. 97,866/ha) with B: C ratio (4.52) as compared to farmer practice.

**K e y w o r d s:** CFLDs, Mustard, Farmer Practice (FP) Yield and Benefit cost ratio.

**Introduction:**

Being an oilseed crop, mustard is significantly contributing in oilseed economy of India. In terms of total production of rapeseed mustard, India leads the world. Due to an enormous discrepancy between supply and demand, Indian government annually import vegetable oil of millions of rupees. Import dependency made oilseed production and productivity enhancement, is a key priority of Indian government. (Layek et al., 2021). Among the major oilseed crops grown each year, groundnut and rapeseed mustard account for over two thirds of production and are the main drivers of India's edible oil sector. Indian Mustard (*Brassica juncea* L.) is cold season edible oilseed *rabi* crop predominantly cultivated in north west and central states viz., Rajasthan, Haryana, Punjab, Madhya Pradesh, Gujrat and eastern parts (Bihar and Assam) of India (Khan et al., 2020). Rajasthan is the leading state in India with 3.97 million ha area and 5.83 million tons production (Anon, 2023). Jaipur is one amongst the leading districts of mustard in the State accounting about 3.89% area and 3.10% production during 2022-23 (Anon, 2022). The productivity of rapeseed-mustard in the district is 1360 kg/ha 2022-23 which is lower than the state average productivity of 1705 kg/ha. Suitability of mustard cultivation in both rainfed and irrigated condition make it first choice of rabi oilseed crops among marginal and small farmer. Additionally attractive market price of crop support rural economy of farming community. Mustard growing areas of district less adoption of high yielding varieties, improved package of practices and lack of suitable plant protection measures found as major extension gap which is negatively impacts the productivity of mustard in the mustard producing area. Among the insect- pests, diseases and weeds also considered major biotic factors for lower yield of the crop.

Indian mustard's is principally grown for edible oil and additionally leaves, seeds, and stem are consumed. Young plant leaves are used as green vegetables, in salads, or blended with other salad greens. Seed waste is used in livestock feed and fertilizers (Khan et al., 2022). Protein content in Indian mustard seed is nearly about 28-36% with ample amount of nutritive value and additionally it contains 38-57% erucic acid, 5-13% linoleic acid, and approximately 27% oleic acid. Additionally, they are excellent carriers of antioxidant vitamins A, D, E, and K. Indian mustard oil is indispensable culinary part of north Indian kitchen (Dekhane et al., 2024).

The principle that "Seeing is believing" stimulates farmers in general, making frontline demonstration (FLD) one of the most effective extension strategies. Demonstrating off recently developed crop production and protection technologies and their management techniques in farmers' fields across various agroclimatic zones and agricultural scenarios is the primary goal of FLDs. Scientists must research the elements that contribute to increased crop production, as well as field constraints of production, in order to gather production data and feedback information while demonstrating the technologies in farmers' fields. CFLDs on mustard coupled with integrated crop management tactics had been demonstrated with the aim of the increased productivity and production potential of district under semi-arid ecology.

**Materials and Methods**

The study under investigation was conducted by the KVK Jaipur-1 under the direction of ICAR-Agricultural Technology Application Research Institute, Jodhpur during *rabi* season from 2022-23 to 2023-24 at the farmers’ fields of different six villages namely Udaipuria, Lasadiya, Paldi, Sirsya, Srisawaijaisingpura and Gogiyawas in Chaksu and Phagi bloks of Jaipur district under semi-arid ecology of Rajasthan. A total number of 120 demonstrations which have, 0.5 ha area each, total 60 ha. area was conducted during two consecutive years. Beneficiary farmers were selected by conducted group meeting and trained them to adopt recent improved production technology of mustard production. The soil type of selected villages was sandy loam to loamy sand in texture. In general, soils of the area under study are sandy loam to loamy sand in texture. In cluster frontline demonstration of mustard using high yielding variety DRMR 2015-17 (Radhika) during demonstration years. Mustard was sown between the third and fourth weeks of October and harvested during February to March. Seeds were sowed in rows 45 cm apart using a seed drill and set at 2-3 cm depth. However, the practices adopted by farmers in general used local or readily available seed varieties, seed rate 5-6 kg/ha, no seed treatment, sowing from the last week of October to the first week of November, and no use of fertilizer pattern to underdose application; they simply use urea and DAP, no sulphur application or less application of sulphur, no weed, and plant health measures followed (Table 1).

**Table No. 1: Comparison between farmers practice (FP) and technologies demonstrated in the CFLDs of mustard**

|  |  |  |  |
| --- | --- | --- | --- |
| **Sr. No.** | **Technology intervention** | **FP** | **Recommended Practices** |
| 1 | Adopted Variety | Existing/ Old local varieties | DRMR-IJ-31, RH-725 and DRMR 2015-17 |
| 2 | Seed rate (kg/ha) | 5-6 | 4 |
| 3 | Seed treatment (ST) practice | Not following ST | Metalaxyl 35% SD @ 6 gm/kg seed |
| 4 | Application of Bio - fertilizers | Not following | PSB culture @ 5 ml/kg seed |
| 5 | Integrated Nutrient management | NPS - 40:20:00 kg per ha | NPS - 60:40:20 kg per ha |
| 6. | Weed management practice | Hand Weeding | Pendimethalin @ 0.75 kg/ha as PE or hand weeding at 30 DAS |
| 7 | Plant Health management | Improper use of insecticides for Aphid management | Aphid management by topical application of Imidacloprid 17.8 SL @ 0.4 ml/lit |
| 8 | Technical guidance | Nil | Time to time |

Gap assessment in technology adoption was carried out by group discussion with selected farmers before starting CFLDs programme. Starting from seed sowing to harvesting KVK researchers regularly monitored CFLDs fields and control field (farmer’s field). Feedbacks were gathered from beneficiary farmers for further improvement of programme. Additionally, KVK researchers organized field days pod maturation stage of crops. Samui et al., (2000) formulae were employed to estimate extension gap, The technology gap and technology index.

**Results and Discussion:**

To evaluate the yield at farmers' fields, CFLDs were performed on mustard. Table 1 unequivocally demonstrated the advantageous effects of CFLDs over FP and the increased mustard production in the demonstration area as a result of the adoption of varieties with superior yields, treatments of seeds, timely sowing, balanced fertilizer dosages, weed control, etc. The highest yield of mustard was 22.85 q/ha and 22.46 q/ha during 2022-23 and 2023-2024, respectively under cluster front line demonstrations however, under farmer’s practices the yield was 18.49 q/ha and 18.63 q/ha during respective years. The maximum mustard yield was 22.85 q/ha recorded in *rabi*-2022-23 and minimum mustard yield was 22.46 q/ha recorded in *rabi*-2023-24. The two years average yield of mustard under cluster front line demonstrations was 22.66 q/ ha in comparison to 18.56 q/ ha over existing farmer’s practices (FP). The higher seed yield of mustard recorded under demonstrations was due to integrated crop management practices like such as use of improved or high yielding variety, seed treatment, optimum seed rate, timely sowing, line sowing, balanced application of fertilizers along with sulphur, weed management and plant protection measures. These results were also supported by Kumar *et al.,* (2019), Singh and Tetarwal (2022), Yadav *et al.,* (2023), Yadav and Khan (2024),

Meena et al. (2011) reported that a 23.32 percent enhancement in overall production in advance production technologies was recorded as compare to farmers practices, however soybean productivity was enhanced by 32.26% due to research emanated production technologies (Bhatnagar, 2009). The yield increased by 22.07 percent higher than farmer practices (FP) and ranged from 23.28 percent to 20.56 percent over the two years of demonstrations under our study. Also reported by Singh *et al.,* (2023) yield increase 22.20 percent in mustard crop through adoption of improved technologies over farmers practices.

**Extension gap:**

An extension gap is a parameter to know the yield differences between the demonstrated technology and farmer's practice and recorded data depicted in table 2. The extension gap ranging ranged from 4.36 q/ha to 3.83 q/ ha during the period of study advocate the necessity of creating awareness among farmers for adoption of latest improved mustard production technologies to boost production scenario. The average extension gap was recorded 4.10 q/ha during both the demonstration years. The higher extension gap was 4.36 q/ha in *rabi* 2022-23 and the lower extension gap was 3.83 q/ha in *rabi* 2023-24. This worrying tendency of the accelerating extension gap will be changed as farmers employ modern high yielding varieties more and more. Eventually, farmers will become disillusioned and stop using the old types because of the new technologies. The similar findings also reported by Patel *et al.,* (2013), Singh *et al.,* (2019) Yadav *et al.,* (2023) and Yadav and Khan (2024).

**Technology gap:**

The discrepancy between potential and demonstration yields is known as the technological gap. Data presented (Table-2) indicated that the technology gap was between 1.15 q/ha to 1.54 q/ha during *rabi* 2022-23 and 2023-24, respectively. The maximum technology gap 1.54 q/ha was observed during *rabi* 2023-24 and the minimum technology gap 1.15 q/ha was observed during *rabi* 2022-23. The overall average technology gap 1.35 q/ha was observed during both the years. The reported disparity in technology could be attributed to variations in weather and soil fertility status. The current study's results are consistent with those of Yadav and Khan (2024) and Katare et al. (2011).

**Technology Index:**

Table 2 displays the technology index data. The viability of the advanced technology in the farmer's field is shown by the technology index. Technology's proved feasibility increases with a lower technology index value (Sagar and Chandra, 2004). The technology index varied from 4.79 to 6.42 per cent during the study years. The higher technology index 6.42 percent was found during *rabi* 2023-24. The lower technology index 4.79 percent was found during *rabi* 2022-23. The average of two years of the demonstrations technology index 5.61 percent was recorded. The greater disparity in the technology index in some regions related to the research period may be explained by variations in soil fertility, weather, irrigation water availability, and crop pest and insect attack. Yadav and Khan (2024) and Kumar et al. (2018) have reported similar results. **Economics:**

Gross return, cost of cultivation, net return, and benefit: cost ratio were calculated using the input and output prices of commodities that were most prevalent throughout the demonstration study and are shown in Table 3. The minimum support price (MSP) and current market rates were used to estimate the economics of improved production practices under CFLDs. Over the years, there was variation in the economic returns as a function of MSP sale price and grain yield. The economics clearly indicated that the maximum gross return (Rs.124,533/ha and 126,899/ha), net return (Rs. 96,783/ha and 98,949/ha) and B: C ratio (4.49 and 4.54) recorded under cluster front line demonstrations during *rabi* 2022-23 and 2023-24, respectively. The minimum gross return (Rs.100,771/ha and 105,260/ha), net return (Rs. 75,271/ha and 79,560/ha) and B: C ratio (3.95 and 4.10) recorded under farmers practices (FP) during *rabi* 2022-23 and 2023-24, respectively. Overall economics of two years demonstration clearly showed that the highest gross return (Rs.125,716 /ha), net return (Rs. 97,866/ha) and B: C ratio (4.52) obtained in cluster front line demonstrations as against the lowest gross return (Rs.103,016 /ha), net return (Rs. 77,416 /ha) and B: C ratio (4.03) obtained in farmers practices (FP). Beneficiary farmers made greater earnings than non-beneficiaries, according to economic analysis. This suggests that combining scientific farming technology practices with farmers' active participation increased yield and economic return, which in turn encouraged other farmers to adopt the technologies being used in their fields. Previous studies by Singh et al. (2019), Singh and Tetarwal (2022), Yadav and Khan (2023), Sarma et al. (2024), and Yadav and Khan (2024) all showed comparable findings.

**Conclusion:**

CFLDs two-year results showed that it had a positive effect on mustard yield for the Jaipur district's farming community. It is determined that, in comparison to conventional methods, the average yield rises by 22.07 percent. The demonstration's economic viability was explained by a good benefit-cost ratio, which also persuaded farmers to accept the intervention. In order to greatly boost the yield potential of mustard, the project is performing cluster frontline demonstrations of established technology. The farming community's income and standard of living will rise significantly as a result. In the semi-arid ecosystem of the Jaipur district, where mustard is grown, a multifaceted approach involving non-beneficiaries is still required to increase mustard production using the newest technologies, including high-yielding varieties, balanced fertilizer application along with sulfur, and plant protection measures. There is a greater need to use extension strategies including training, field visits, and field days to spread the upgraded technology to farmers' fields.

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**Table.2 Effect of cluster front line demonstration on yield, extension gap, technology gap, technology index in mustard crop.**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Year** | **Area (ha.)** | **No. of Demo.** | **Variety** | **Yield (q/ha)** | | | **Percent increase over farmers practices** | **Extension gap (q/ ha)** | **Technology gap (q/ ha)** | **Technology index (%)** |
| **Potential** | **Demo.** | **Farmer Practices** |
| 2022-23 | 20.0 | 40 | Radhika  (DRMR-2015-17) | 24.00 | 22.85 | 18.49 | 23.58 | 4.36 | 1.15 | 4.79 |
| 2023-24 | 40.0 | 80 | Radhika  (DRMR-2015-17) | 24.00 | 22.46 | 18.63 | 20.56 | 3.83 | 1.54 | 6.42 |
| **Total** |  |  | - | - | - | - | - | - | - | - |
| **Average** | - | - | - | 24.00 | 22.66 | 18.56 | 22.07 | 4.10 | 1.35 | 5.61 |

**Demo. – Demonstration, CFLD – Cluster Frontline Demonstration, FP- Farmer Practice**

**Table.3 Economics and B:C ratio of cluster front line demonstration and farmer practices in mustard crop**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Year** | **Cost of Cultivation (Rs/ha)** | | **Gross return (Rs./ha)** | | **Net return (Rs./ha)** | | **B:C ratio** | |
| **Demo.** | **Farmer Practices** | **Demo.** | **Farmer Practices** | **Demo.** | **Farmer Practices** | **Demo.** | **Farmer Practices** |
| 2022-23 | 27,750 | 25,500 | 124,533 | 100,771 | 96,783 | 75,271 | 4.49 | 3.95 |
| 2023-24 | 27,950 | 25,700 | 126,899 | 105,260 | 98,949 | 79,560 | 4.54 | 4.10 |
| **Average** | 27,850 | 25,600 | 125,716 | 103,016 | 97,866 | 77,416 | 4.52 | 4.03 |