Abstract

**Aim:** To study potential and economics of front line demonstrated technologies in sesame as compared to prevalent technologies to improve the productivity as well as income of the farmers in Ajmer district of Rajasthan.

**Methodology:** Front line demonstrations (FLDs) on sesame covering an area of 100 ha at 200 farmers' field were carried out to exhibit potential and economics of latest production technologies as compared to farmer’s practice. The level of adoption of 50 FLD farmers and 50 non-FLD farmers to front line demonstrated technologies was analyzed based on the total score of adoption of each respondent farmer. The constraints faced by respondents in adoption of front line demonstrated technology was identified by asking the respondents and simultaneously recording their responses.

**Results:** The improved technologies of sesame demonstrations in front line demonstrations recorded increase in yield in the range of 34.44 to 43.95 percent over local check. The economic analysis of yield performance revealed that front line demonstrations recorded higher average gross return (Rs. 69527 ha⁻¹), average net return (Rs. 49637 ha⁻¹) with higher cost benefit ratio of 3.49 as compared to average gross return (Rs. 49865 ha⁻¹) and average net return (Rs. 33142 ha⁻¹) with cost benefit ratio of 2.98 of local check.

**Interpretation:** Front line demonstration is an effective tool for increasing the productivity and net income of sesame growers. This created greater curiosity and motivation among other farmers who do not adopt improved practices of sesame cultivation.

**Key words:** Front line demonstration, FLD farmers, Improved income, Sesame

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Introduction

Since the beginning of agriculture, humans have been selecting and cultivating crops that would serve their taste, energy, and health requirements (Nagaraj, 2009). Oilseeds are crops in which energy is stored mainly in the form of oil and are a very important component of semi-tropical and tropical agriculture, providing easily available and highly nutritious human and animal food (Weiss, 2000). Among the important and widely grown oilseed crops like rapeseed, peanut, soybean, sunflower, sesame (Sesamum indicum L) provides one of the highest and richest edible oils (Pathak et al., 2014). Sesame (Sesamum indicum) commonly known as Til, is the oldest indigenous oilseed crop, with longest history of cultivation in India. Sesame has highest oil content amongst the annual oilseeds. It is rich in nutty flavour and is a common ingredient in cuisines across the world. Sesame oil has excellent nutritional, medicinal, cosmetic and cooking qualities for which it is known as 'the queen of oils'. Due to the presence of potent antioxidants, sesame seeds are called as 'the seeds of immortality'. The seeds are also good source of dietary proteins with fine quality amino acids that are essential for growth, especially in children. Sesame seed has growing popularity due to its ability to facilitate digestion and reduce hypertension in several foods as a driving factor in the market. India is one of the largest exporters of sesame, with an annual all-season acreage about 17-20 lakh ha (IOPEPC, 2019-20). India is also leading producer with acreage of 18.96 per cent followed by Myanmar, Nigeria, China, Ethiopia and Uganda. More than 85% production of sesame comes from West Bengal, Madhya Pradesh, Rajasthan, Uttar Pradesh, Gujarat, Andhra Pradesh and Telangana states. Rajasthan ranks 2nd in area and 3rd in terms of production of sesame among the Indian states (NMOOP, 2017). Sesame is a major oilseed crop of Kharif season in Ajmer district of Rajasthan. The area, production and productivity of sesame crop in Ajmer district is 6287 ha, 2403 tonnes and 382 kg per ha, respectively. However, its productivity is very low as compared to other districts such as Dholpur (520 kg ha-1), Kota (508 kg ha-1), Tonk (502 kg ha-1), Karauli (439 kg ha-1) and Pali (421 kg ha-1) under rain fed condition (Anonymous 2019). The low productivity of traditional sesame farming is due to poor adoption of improved technologies of sesame by the farmers. To replace this anomaly, the Krishi Vigyan Kendra (KVK) Ajmer organized frontline demonstrations (FLDs) with an improved variety along with a recommended package of practices at adopted farmer’s field. The main purpose of these demonstrations was to transfer the latest production technology to farmers in the district which in turn will enhance the productivity levels of sesame and increased the income levels. Realising the importance of FLD in transfer of technology, it was thought appropriate to undertake the study with a view to evaluate the FLD on sesame with the following specific objectives of assessing the recommended technology and farmers’ practice of sesame production, the extent of adoption of improved technologies, the productivity and economics of frontline demonstrations and to identify the constraints limiting sesame yield in the district.

Materials and Methods

KVK Ajmer conducted 80, 100 and 20 FLDs on sesame during kharif season of 2017, 2018 and 2019, respectively. Thus, a total of 200 locations (farmers) with an area of 100 ha were covered during three years under FLDs on sesame. The farmers who were involved in demonstrations were given improved variety seed along with recommended package of practices. They were advised to have local check in the adjacent field with farmers practice for comparison. Data for study purpose were collected from primary and secondary sources keeping in view of the objectives.

To study the extent of adoption of improved technologies of sesame cultivation by the farmers, only 50 FLD farmers, were randomly selected out of 180 participating farmers of kharif 2017 and 2018. Since the extent of adoption of technology by the participating farmers of 2019 can be studied next year only, therefore, they were not selected for the study. Similarly, a sample of 50 non-FLD farmers was randomly selected from the sesame growing farmers of the same villages of selected FLDs farmers. Thus, a total of 100 farmers were selected as respondents to study the extent of adoption. An interview schedule was prepared regarding improved technologies of sesame. The data were recorded on a 3-point continuum scale i.e. fully, partial and no adoption. The result and discussion of both groups of FLD and non-FLD farmers have been summarized separately keeping in view these existing practices.

An interview schedule to identify the constraints/problems limiting sesame yield in the district was also prepared. A total of 100 respondents were interviewed for recording the responses about the constraints in three categories namely; most significant, significant and non-significant. Further, all the 200 farmers who had conducted FLD of sesame during three years were purposively selected to assess the recommended technology and farmer’s practice of sesame production and study the productivity and economics of front line demonstrations on farmer’s field. Thus, a total of 200 full package FLDs were selected for these objectives. The data collected from the reports of FLDs compiled by the KVK on the production technology of sesame crop were used and compared with prevailing production technologies of sesame crop (which were taken in check plots). The performances of improved varieties with improved technologies (FLDs) were evaluated closely by organising seasonal trainings, method demonstrations, field days and by taking crop-cutting experiments. Regular diagnostic visit by the scientists helped in proper execution of demonstration as well as collection of farmers’ opinions about the demonstration field. Production and economic data for FLDs and local practice were collected and analyzed.
Results and Discussion

Assessment of production technology in FLD plots and local check plots: The data of recommended production technology of sesame in frontline demonstration plots were compared with the farmers’ practices adopted in local check plots. Table 1 indicated that under FLDs, recommended high yielding variety RT-351 (4 kg ha⁻¹) was sown after proper seed treatment with thiram @ 3 gm kg⁻¹ seed. The line sowing (30-35 cm) was practiced by mixing vermicompost @ 08 kg ha⁻¹ with seed. At the time of sowing, 10 kg nitrogen, 25 kg P₂O₅, 20 kg sulphur and 20 kg zinc sulphate per ha were applied as basal application. Top dressing was done with 10 kg nitrogen ha⁻¹ after 4-5 weeks of sowing on rainy day whereas, farmers used their own variety Pratap/RT-46 seeds with higher seed rate of 5-6 kg ha⁻¹ and without any seed treatment. Broadcasting method was adopted in sowing with imbalance doses of fertilizers at the time of sowing and top dressing. Besides, plant protection measures of demonstration package (for control of the borer and sucking pests the foliar application of emamectin benzoate 5% @ 200 gm ha⁻¹ and thiamethoxam 20% @ 200 gm ha⁻¹) was compared with the practices of farmer in local plots (only dusting of methyl parathion @20 kg ha⁻¹).

Adoption of improved technologies of sesame crop by the FLD farmers and non-FLD farmers: The data presented in Table 2 indicates that majority of FLD farmers (96 per cent) and only a few number non-FLD farmers (8-10 per cent) fully adopted the optimum seed rate, line sowing and sowing distance, respectively, in sesame cultivation. FLD farmers have learned the importance of use of optimum seed rate, line sowing and sowing distance while conducting demonstration at their own fields whereas majority of non-FLD farmers (90-92 per cent) did not adopt the optimum seed rate, line sowing and sowing depth in sesame cultivation. These non-FLD farmers were of the view that there may be low germination of seed or plant mortality at the time of germination and, therefore, they used higher seed rate with broad casting method of sowing in comparison to recommended seed rate in line sowing. The reason explained for higher seed rate adopted by non-FLD farmers at the time of interview was that in order to maintain optimum plant population by broad casting method they generally used higher seed rate. Moreover, seeds are distributed unevenly and not sown at proper depth in broadcasting method, which may result in overcrowding at one place or low plant population at another places in field.

The perusal of data in Table 2 explains that 84 per cent FLD farmers and 35 per cent non-FLD farmers has selected high yielding variety seeds for sesame cultivation because FLD farmers were aware of the fact that production of crop depends on seed quality through trainings and conduction of FLD. Further, low preference for HYV by non-FLD farmers might be due to non-availability of seeds of recommended improved variety in required quantity at sowing time. Another reason was that cost of the recommended variety seed was 40-60 per cent more than the local variety. The findings are in line with Kumawat (2008). It was also observed that seed treatment and top dressing of urea was fully adopted by 80 per cent of the FLD farmers, while only 26 per cent non-FLD farmers adopted seed treatment practice and only 10 per cent non-FLD farmers selected the recommended dose of urea in top dressing.

The data depicted in Table 2 reveals that 74 per cent FLD and only 5 per cent non-FLD farmers adopted the basal application of recommended fertilizers, while 14 per cent FLD and 22 per cent non-FLD farmers partially adopted the practice of basal application of recommended fertilizers. The reason behind this was that FLD farmers have gained knowledge about the recommended dose of fertilizers to be applied as basal application through trainings and demonstrations conducted by KVK, while majority of non-FLD farmers were not aware of these practises and partially adopted this technology and did not apply the right quantity of fertilizers as basal application. Low adoption of basal application of sulphur and zinc and use of plant protection measures might be attributed to unawareness, unavailability and high cost of micronutrients.

<table>
<thead>
<tr>
<th>Particular practice/Production technology</th>
<th>Demonstration package/FLD plots</th>
<th>Farmers practice/local check plots</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improved variety</td>
<td>RT-351</td>
<td>Local seed / Pratap/RT-46</td>
</tr>
<tr>
<td>Optimum seed rate</td>
<td></td>
<td>5-6 kg</td>
</tr>
<tr>
<td>Seed treatment</td>
<td>Thiram 3 gm per kg seed</td>
<td>Not used</td>
</tr>
<tr>
<td>Sowing method</td>
<td>Line sowing (Vermi-compost 8 kg ha⁻¹ for mixing with seed for line sowing)</td>
<td>Broadcasting method of sowing (seed mixed with sand)</td>
</tr>
<tr>
<td>Sowing distance</td>
<td>30-35 cm</td>
<td>-do-</td>
</tr>
<tr>
<td>Basal application of fertilizer</td>
<td>10 kg N + 25 kg P₂O₅,</td>
<td>Less quantity applied without knowledge of right method</td>
</tr>
<tr>
<td>Basal application of Sulphur &amp; zinc</td>
<td>Sulphur @ 20 kg ha⁻¹ and zinc sulphate @ 20 kg ha⁻¹</td>
<td>Not used</td>
</tr>
<tr>
<td>Top dressing of Urea</td>
<td>10 kg N after 4-5 week of sowing at rainy day</td>
<td>5-7 kg N used</td>
</tr>
<tr>
<td>PP measures</td>
<td>Foliar application of emamectin benzoate 5% @ 200 gm ha⁻¹ and thiamethoxam 20% @ 200 gm ha⁻¹ for control of borer and sucking pests</td>
<td>Dusting of methyl parathion @20 Kg per ha</td>
</tr>
</tbody>
</table>
comparison to farmers practice field. Similar results were also

13.68 per cent higher average safflower yield in FLD plot in

These finding are in line with Kulkarni

improvement of 38.74 per cent as compared to local variety.

to local check. In case of FLD plots, the yield improvement ranged

from 34.44 per cent to 43.95 per cent with an average

technologies of sesame in frontline demonstration was superior

(Table 3) indicates that variety RT-351 with improved

practices of sesame cultivation. Gogoi

demonstration in acquainting the farmers about improved

adoption level between FLD and non-FLD farmers. Thus, it shows

FLD farmers were in regular contact with KVK scientists
during demonstration. This might have created the gap in the

adoption level between FLD and non-FLD farmers. Thus, it shows

that there was definitely a positive impact of frontline
demonstration in acquainting the farmers about improved

practices of sesame cultivation. Gogoi et al (2000) and Dangi and

Jain (2007) also observed that the trained farmers had

significantly higher level of adoption of overall recommended

practices than the untrained farmers. Likewise, Sharma and

Chaudhary (2014) reported that there was a significant difference

in the extent of adoption of optimum seed rate, sowing method,
sowing distance, use of high yielding variety seed, top dressing of

urea, basal application of fertilizer, seed treatment and plant

protection measures in sesame crop between FLD farmers and non-FLD farmers. The results revealed the fact that FLD farmers attended the on-campus and off-campus trainings organized by KVK before conducting the front line demonstrations and field day was also organized at the time of crop maturity.

Data presented in Table 2 shows that there was a considerable difference in the extent of adoption of optimum seed rate, sowing method, sowing distance, use of high yielding variety seed, top dressing of urea, basal application of fertilizer, seed treatment and plant protection measures in sesame crop by the FLD farmers and non-FLD farmers. The results revealed the fact that FLD farmers attended the on-campus and off-campus trainings organized by KVK before conducting the front line demonstrations and field day was also organized at the time of crop maturity.

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in the extent of adoption of optimum seed rate, sowing method,
sowing distance, use of high yielding variety seed, top dressing of

urea, basal application of fertilizer, seed treatment and plant

protection measures in wheat crop between FLD farmers and non-FLD farmers.

<table>
<thead>
<tr>
<th>Improved practices</th>
<th>FLD farmers</th>
<th>Non-FLD farmers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Extent of adoption in percent</td>
<td>Extent of adoption in percent</td>
</tr>
<tr>
<td></td>
<td>Fully</td>
<td>Partial</td>
</tr>
<tr>
<td>Use of HYV seeds</td>
<td>84.0</td>
<td>4.00</td>
</tr>
<tr>
<td>Optimum seed rate</td>
<td>96.00</td>
<td>-</td>
</tr>
<tr>
<td>Seed treatment</td>
<td>80.00</td>
<td>-</td>
</tr>
<tr>
<td>Line sowing method</td>
<td>96.00</td>
<td>-</td>
</tr>
<tr>
<td>Sowing distance</td>
<td>96.00</td>
<td>-</td>
</tr>
<tr>
<td>Basal application of fertilizer</td>
<td>74.00</td>
<td>14.00</td>
</tr>
<tr>
<td>Basal application of sulphur and zinc</td>
<td>32.00</td>
<td>16.00</td>
</tr>
<tr>
<td>Top dressing of Urea</td>
<td>80.00</td>
<td>10.00</td>
</tr>
<tr>
<td>PP measures</td>
<td>34.00</td>
<td>20.00</td>
</tr>
</tbody>
</table>

N=100

reported by Pradhan et al. (2011) and Rao et al. (2011). Data

(Table 3) further revealed that gross return of improved

technologies was higher in FLD plots than the farmer's practices

during each year of demonstrations. Front line demonstrations

recorded highest gross return (Rs. 85820 ha\(^{-1}\)) and net return (Rs. 65594 ha\(^{-1}\)) with highest cost benefit ratio of 4.21 during kharif 2018. The reason behind this was that the selling price of sesame was highest during 2018-19. The average gross return of demonstration was Rs. 69527 ha\(^{-1}\) as against Rs. 49865 ha\(^{-1}\) in local check. The cost of cultivation was higher in FLD plots as compared to local check. The average cost of cultivation was Rs. 19890 in the front line demonstration as against Rs. 16723 for local check. The average net return of demonstration was Rs. 49637 while in local check it was Rs. 33142. The average cost benefit ratio was 3.49 in demonstration plots whereas in local practice it was 2.98 has been reported by several researchers (Singh et al., 2012); (Pradeep, 2015); (Kumar and Kispotta, 2017); (Singh et al., 2018); (Singh et al., 2019) and (Singh et al., 2020). Higher net returns as well as benefit cost ratio as compared to local practices.

### Constraints limiting productivity of sesame

Data in Table 4 indicates that when farmers were asked to list and rank the major constraints faced by them in sesame cultivation in the study area, non-availability of seeds of suitable variety was ranked as the most important technological constraint (70 %), followed by poor crop germination (65 %), lack of irrigation facilities, incidence of diseases, weeds and insect-pests. Among various agro-climatic factors acting as constraints in sesame cultivation, drought at critical stages of crop growth (75 %) and immature seeds/shattering of capsules at maturity were perceived as the major ones. Half of the area under sesame crop in Gujarat state is suffering due to poor soil fertility and drought at vegetative stage (Dhandhalya and Shiyani, 2009). On the other hand, factors like excessive rains (35 %) and risk of crop failure/yield variability due to biotic and abiotic stresses were considered relatively less
### Table 3: Economics of frontline demonstrated technologies on sesame

<table>
<thead>
<tr>
<th>Crop</th>
<th>Technologies demonstrated in FLD</th>
<th>No. of Farmers (ha)</th>
<th>Area (ha)</th>
<th>Yield (q ha⁻¹)</th>
<th>% Increase in yield</th>
<th>Economics of demonstration (Rs. ha⁻¹)</th>
<th>Technologies adopted in Farmer Practice</th>
<th>Economics of check (Rs. ha⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Demo</td>
<td>Check</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sesamum Improved var. seed RT-351 (Kharif 2017)</td>
<td>Seed treatment with thiram 3 gm kg⁻¹ seed, Sulphur and zinc sulphate @ 20 kg ha⁻¹ Application of emamectin benzoate 5% @ 200 gm ha⁻¹ and thiamethoxam 20% @ 200 gm ha⁻¹</td>
<td>80</td>
<td>40</td>
<td>8.2</td>
<td>6.10</td>
<td>34.44</td>
<td>19542</td>
<td>57400</td>
</tr>
<tr>
<td>Sesamum Improved var. seed RT-351 (Kharif 2018)</td>
<td>Seed treatment with thiram 3 gm kg⁻¹ seed, Sulphur and zinc sulphate @ 20 kg ha⁻¹ Application of emamectin benzoate 5% @ 200 gm ha⁻¹ and thiamethoxam 20% @ 200 gm ha⁻¹</td>
<td>100</td>
<td>50</td>
<td>6.19</td>
<td>4.3</td>
<td>43.95</td>
<td>20226</td>
<td>85820</td>
</tr>
<tr>
<td>Sesamum Improved var. seed RT-351 (Kharif 2019)</td>
<td>Seed treatment with thiram 3 gm kg⁻¹ seed, Sulphur and zinc sulphate @ 20 kg ha⁻¹ Application of emamectin benzoate 5% @ 200 gm ha⁻¹ and thiamethoxam 20% @ 200 gm ha⁻¹</td>
<td>20</td>
<td>10</td>
<td>6.88</td>
<td>4.93</td>
<td>39.55</td>
<td>19900</td>
<td>65360</td>
</tr>
<tr>
<td>Overall average</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
important constraints in the cultivation of sesame. Since large part of the district has hot arid and semi-arid climate, the average annual rainfall is very less and the variability in rainfall is considerably high. This increases the level of risk in the form of partial or complete crop failure. The persistent level of variation in seasonal precipitation and temperature also affects the crop output to a large extent.

Among the various economic constraints, high input cost (60 %), shortage of human labour (50 %) and fluctuating prices of sesame (40 %), were important constraints in sesame production. Sesame crops are manually harvested and harvesting costs are about 70 % of capital costs since seed shattering makes harvesting difficult and more expensive (Langham and Wiemers, 2002). Other economic constraints, as perceived by the respondents, included sesame cultivation considered to be less profitable and riskier compared to other competing crops.

The problem of timely availability of quality seeds (60 %), lack of awareness about improved package of practices due to poor extension services (45 %) stands the major important institutional constraints in cultivation of sesame. The findings are in line with that reported by Kumari et al. (2020). Other important institutional problems included non-availability of institutional credit and quality inputs and irregular supply of electricity/power.

The post-harvest management and marketing related constraints were perceived to be least important by the respondents. Exploitation by market intermediaries (40 %) is perceived to be the single most important constraint by farmers, followed by lack of processing facilities in the area, inadequate storage facilities, lack of information about prices and market and lack of appropriate transport means. Non-availability of suitable varieties seeds, poor crop germination, lack of irrigation facilities, drought at critical stages of crop growth, problem of timely availability of quality seed were found major constraints in the cultivation of sesame crop.

Suggestions for improving productivity of sesame: Farmers reported that sesame production is limited by non availability of
suitable varieties of seeds, unfavorable weather conditions, incidence of diseases, lack of knowledge about improved production technology, competition from more profitable crops and market related problems.

A series of suggestions were made by the sample farmers in order to increase sesame yields and income of the farmers in the district (Table 5). Timely supply of high yielding variety seeds at cheaper rate (85%) of sesame was considered to be the most important means of improving sesame yields in the sesame growing area. In addition, they also felt that there was a need for improved dissemination of available and new technologies and practices of crop cultivation (70%). About two-third of the respondents complained about unavailability of agricultural labour during sowing and harvesting, which hampered normal farming time-schedule. Other suggestions given by the respondents to increase sesame production included the development and strengthening of nearby Krishi Mandies (50%), improving gross margins to growers by reducing costs through mechanisation or increasing yields and soil testing facilities (40%) for proper application of fertilizers, etc.

On the basis of above study, it can be concluded that sesame cultivators can harness higher yield and income by adopting recommended package of practices. Trainings and extension activities play vital role in creating awareness among farm community as level of adoption of technological intervention was high in those farmers who conducted FLDs. Timely availability of quality seed and other inputs is a matter of concern. An effective agricultural extension system and a responsive seed delivery system are needed to enable farmers to access quality seeds of well-adapted crop varieties at affordable prices and in a timely manner.

Acknowledgments

The authors extend their sincere thanks to the ICAR-Agricultural Technology Application Research Institute (ATARI), Jodhpur and Senior Scientist and Head of KVK Ajmer for providing necessary facilities and funds to conduct the present study.

### Table 5: Suggestions for improving productivity of sesame

<table>
<thead>
<tr>
<th>Suggestion</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Timely supply of HYV seeds at cheaper rate</td>
<td>85</td>
</tr>
<tr>
<td>Quality Training and extension services to equip farmers about improved production technology of sesame cultivation</td>
<td>70</td>
</tr>
<tr>
<td>Human Labour Availability/ Mechanization</td>
<td>60</td>
</tr>
<tr>
<td>Strengthen of nearby Krishi Mandies</td>
<td>50</td>
</tr>
<tr>
<td>Soil Testing facilities</td>
<td>40</td>
</tr>
<tr>
<td>Farm mechanization</td>
<td>35</td>
</tr>
<tr>
<td>Agro chemicals and fertilizer at low price</td>
<td>35</td>
</tr>
<tr>
<td>Better irrigation facilities</td>
<td>30</td>
</tr>
</tbody>
</table>

N=100

Add-on Information

Authors’ contribution: R.K. Sharma: Leader scientist in conducting FLDs on sesame; D. Arora: Looked after the agronomical aspects of the study; S.K. Sharma: Looked after the plant protection aspects of the study; D.S. Bhati: Provided all logistics in conducting FLDs as Incharge of the KVK; N.K. Pareek: Looked after the agronomical and statistical aspects of the study.

Research content: The research content is original and has not been published elsewhere

Ethical approval: Not Applicable

Conflict of interest: The authors declare that there is no conflict of interest.

Data from other sources: Not Applicable

Consent to publish: All authors agree to publish the paper in *Journal of Environmental Biology*.

References


