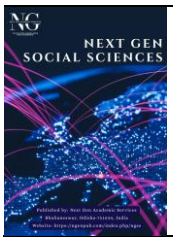

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Research Article

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Technical Efficiency of Improved and Local Varieties of Lentil (*Lens Culinaris* L.) Used by Farmers

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ABSTRACT

This study measured the technical efficiency of improved and local lentil varieties. The principal focus of the research was a comparative study of improved and local lentil varieties, with technical efficiency levels measured. For this study, the Bundi district of Rajasthan was selected purposively. A multistage sampling method was used to select the respondents. A total of 120 farmers were selected as the study's sample respondents. The result shows that the majority of the improved variety growers (48.33 per cent) were concentrated between 0.60 and 0.70. While in the case of the existing variety growers, they were (40.83 per cent) followed by 29.16 per cent and 36.66per cent of improved and local variety growers between technical efficiency categories 0.50-0.60, respectively, and 19.16 per cent of improved and 12.50 per cent of local variety growers had the highest level of technical efficiency between 0.70-0.80. This suggests that, in terms of technology, farms in the enhanced group are more productive than those in the local seed variety system.

1. INTRODUCTION

For the inhabitants of Rajasthan, pulse crops are vital. As an inexpensive source of protein, it is essential to the Rajasthani diet. Rajasthan grows eight different types of pulses, including cowpea, chickpea, pigeon pea, mungbean, blackgram, lentil, and field pea. One of the most widely grown pulse crops is lentil (Lens culinaris L.), also referred to as "masur." It is referred to as "poor man's meat" because it has a higher protein content than any other agricultural product and a nutritional value closer to that of animal flesh. A winter staple in temperate and subtropical regions is the lentil. As a legume, lentils are naturally restorative, and their seeds have an average protein content of 25.7%, about three times more than grains. Knowing the economic profitability of lentil production at the farm level is crucial, as although the area under cultivation in Rajasthan is decreasing, it has recently increased significantly and is currently average. In 2021–2022, 4,497.1 thousand tonnes of pulses were produced in Rajasthan, covering 6,339.6 thousand hectares (RBI Statistics, 2022). Due to changes in the weather and climate, Rajasthan has seen significant variations in the acreage and yield of pulse crops. Inappropriate weed management is also a cause of crop loss and yield variation due to severe weed infestation (Mahapatra et al., 2023). It has been noted that pulse production doubles compared to the usual level in years with excellent weather. Pulse

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prices have fallen due to market excess. Increased production does not result in higher income for producers. There are still a lot of unanswered questions regarding how to reduce the lentil yield gap at different levels, such as the district, state, and farmer levels, as well as the possibility of improved lentil varieties, which could only be achieved by improving the sensitivity and responsiveness of the state agricultural extension systems (Dubey et. al., 2018). Improved technology was disseminated mainly through built-in events such as field days and capacity-building programs (Singh et al., 2016), while the technology gap and technology index peaked in 2010–11, the maximum extension gap for the shown variety was observed in 2011–12 (Singh et al., 2017). And there are very few studies conducted related to this study. In this paper, we measured technical efficiency as the ratio of a production unit's actual to prospective output.

Since the traits and capacity for production vary greatly, the two primary classifications of lentil seed variants are the subject of the analysis. Smallholder farmers, who produce little and allocate input resources inefficiently, dominate the agricultural sector in Bundi. Economic theory states that the primary objective of micro-level agricultural production is to maximise profit by properly allocating input resources and timing plantings with optimal plant populations (Tickoo et al., 2005). This can be accomplished by either minimising the cost of resources required to produce a certain level of output or by optimising output from a given set of inputs. Value addition to crop output across all aspects will boost exports and generate demand (Tickoo et al., 2005).

Morris et al. (1999) assert that seed has the greatest potential to influence productivity of any input utilised in agricultural production. Therefore, productivity rises and other inputs are transformed into output more efficiently if farmers are able to obtain the appropriate seed kinds. Smallholder lentil producers primarily use farmer-owned seeds alongside their traditional crop production methods. In addition to being poor-yielding and late-maturing, these types are typically susceptible to pests and diseases, such as MSV, drought, and severe weather. Growing local lentil varieties can be less expensive and require less effort, according to Wiredu et al. (2010). Expanding the land area planted for agricultural production is typically necessary to increase crop outputs of such kinds. Again, to support scientists' efforts to increase productivity and bring greater rice fallows under the cultivation of pulses, sufficient institutional support and policy from the government is essential (Pooniya et. al., 2015), and appropriate marketing channels also must be created to dispose of their produce quickly and get a fair price (Rout et. al., 2023). However, given the growing competition for agricultural land for other infrastructure projects, such as human settlements brought on by population growth and urbanisation, this could not be a viable path in the long run.

2. Materials and Methods

The present investigation was undertaken to measure technical efficiency and the yield gap to develop a strategy for the selected lentil cultivation technology. Besides this, the study also focused on revealing the relationship between the profile characteristics of lentil growers and their technical efficiency and yield gap under selected production technology, and finally, an attempt was made to analyse the constraints and elicit suggestions from lentil growers. A thorough analysis of each farmer's technical efficiency is required to determine their capacity to produce the maximum crop with a given level of inputs under current circumstances and technology. The difference between the farm's actual output and its ideal output for a given input bundle is reflected in technical efficiency.

$$TEi = (Yi^*)/Yi = 1/\theta i = 0 \leq TE \leq 1$$

where Y*i is the observed outputs and Yi is the greatest (optimal) output that can be achieved.

3. Result and Discussion

3.1. Technical efficiency levels of improved as well as local varieties of lentil used by farmers

A thorough analysis of each farmer's technical efficiency is required to determine their capacity to produce the maximum crop with a given level of inputs under current circumstances and technology. Economic theory states that the primary objective of micro-level agricultural production is to maximise profit by allocating input resources as efficiently as possible. This can be accomplished by either minimising the cost of resources required to produce a certain level of output or by optimising output from a given set of inputs. Again, the technical efficiency of individual farmers was measured using a schedule prepared for the study. Table 1, as well as Figure 1, show the distribution of technical efficiency levels for the sample and the efficiency comparison between local and improved lentil varieties.

The frequency distribution shows that the majority of the improved variety growers (48.33per cent) were concentrated between 0.60 and 0.70. While

in the case of the existing variety growers, they were (40.83 per cent) followed by 29.16 per cent and 36.66per cent of improved and local variety growers between technical efficiency categories 0.50-0.60, respectively, and 19.16 per cent of improved and 12.50 per cent of local variety growers had the highest level of technical efficiency between 0.70-0.80. There were fewer farmers (3.33 per cent) in the improved variety category than in the existing variety category (10 per cent), with technical efficiency between 0.40 and 0.50.

Table 1. Frequency distribution of the lentil producers' technical efficiencies

Levels	Improved variety (Kota Masoor-1)		Local variety (IPL-316)	
	Frequency	Per cent	Frequency	Per cent
0.40-0.50	4	3.33	12	10.00
0.50 - 0.60	35	29.16	44	36.66
0.60 – 0.70	58	48.33	49	40.84
0.70 - 80	23	19.16	15	12.50
Total	**120**	**100.00**	**120**	**100.00**

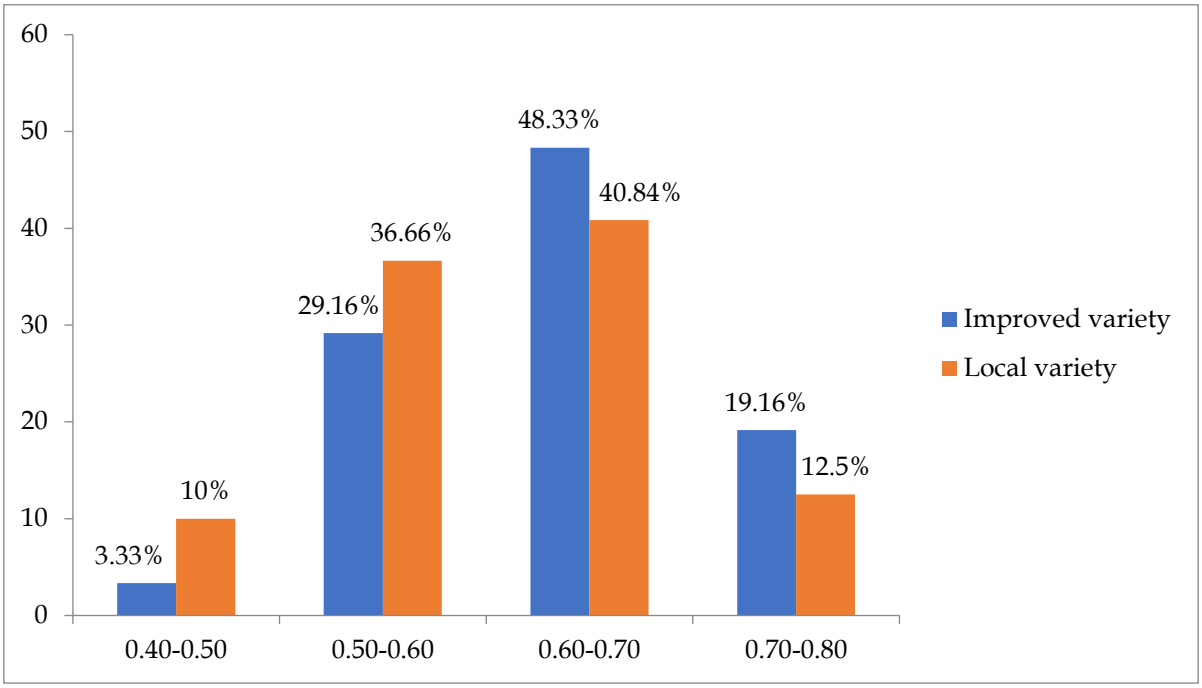

Figure 1. Frequency distribution of the lentil producers' technical efficiencies

Farms in the enhanced group are more productive than those in the local seed variety system. Given that the enhanced lentil varieties come with a comprehensive package that includes other cultural practices and suggested fertiliser application volumes and times, this could be due to the timely and accurate application of these fertilisers. To catch up with their counterparts who grow enhanced varieties, current seed variety farmers should be encouraged to learn more about input management techniques. They might also be urged to practise using recently enhanced lentil seed varieties, along with the cultural packages that accompany them, to boost their use of other variable inputs and achieve notable output gains. Similarly, adopters of the high-yielding variety had slightly higher technical efficiency (0.65) than non-adopters (0.63), according to Matin et al. (2018). Most producers (54.4%) had technical efficiency levels below 70 per cent, followed by those between 91 and 100 per cent (18.5%), according to the technical efficiency level of the various producer types. More farmers (71.4%) with technical efficiency levels below 70 per cent were local variety practitioners, followed by those with levels between 71 and 80 per cent (16.7%). However, a greater proportion of farmers (53.1%) who used high-yielding varieties had technical efficiency levels below 70 per cent, followed by those between 91 and 100 per cent. Likewise, Swetha et al. (2019) observed that not every black gramme grower in the study region was technically proficient. The study found that the average technical efficiency of black gram farmers was 67%, with 33% able to increase their efficiency. The findings of this study have been parallel to the findings of Shyamsundari et al. (2019), Abera (2018), Youssef et al. (2017), Miah et al. (2014), and Faisal (2011).

Table 2. Descriptive statistics of respondent farmers (n=120)

Technical efficiency	Improved variety	Local variety
Mean	0.63	0.58
Minimum	0.48	0.44
Maximum	0.74	0.68
SD±	0.06	0.05

The mean technical efficiency of improved variety growers and existing variety growers were 0.63 and 0.58, respectively. This indicates that, considering their current input usage and the varietal technology at their disposal, lentil farmers typically produce between 63% and 58% of their total production. In other words, due to inefficient resource usage and subpar agronomic methods, lentil farms are losing between 37% and 42% of their maximum potential output. In contrast, the top-performing farmer produces 74% of the output for the local group and 68% for the enhanced group. The minimum technical efficiency was 0.48 for improved variety growers and 0.44 for local variety growers. The farmers in the study area who are the least and most technically efficient differ greatly. The results (Tables 1 and 2) indicated that the lentil farmers (improved variety growers) were better than the local variety growers with respect to all measures.

3.3. Association between Technical efficiency of respondents & selected independent variables

The association between the technical efficiency of lentil cultivation and selected independent variables, namely, age, educational status, size of land holding, annual Income of family, farming experience, mass media utilisation, social participation, extension contact, innovativeness, and risk orientation. The rank correlation coefficient was used to calculate these variables, as shown in Table 3.

Table 3's findings showed that this hypothesis was rejected, as the chi-square values exceeded the critical values. As a result, it was determined that while certain individual influences might not be statistically significant, the combined effect of the ten variables is significant. The majority of the socioeconomic factors analysed for their effects on technical efficiency were found to be significant. Age, education, agricultural experience, use of mass media, social interaction, extension contact, risk-taking, and inventiveness, for example, all either decrease or enhance technical inefficiency. This suggested that age has a beneficial effect on TE; efficiency effects would rise by 0.529% for every 1% increase in age. This also showed that the technical efficiency and productivity of producing lentils increased with the age of the farmer. The positive education indicator shows that technical efficiency rises with education level; this link is noticeable at the 5% level. This implied that technical efficiency increased with farmers' knowledge of proper farming practices and resource utilisation.

Table 3: Association between Technical efficiency and independent variables

S. No.	Independent Variables	Correlation coefficient (r)
1.	Age	0.529*
2.	Education	0.019*
3.	Size of land holding	0.183*
4.	Annual Income of family	0.476NS
5.	Farming experience	0.941**
6.	Mass media utilization	0.230*
7.	Social Participation	0.348*
8.	Extension contact	0.578**
9.	Innovativeness	0.451*
10.	Risk orientation	0.296*

3.4. Factors influencing technical efficiency

Farmers who receive training or education related to beans may be able to access cutting-edge, creative production methods. Better decision-making in the production process could result, as could an increase in pioneer spirit in adopting agricultural technologies. This result is consistent with the findings of Onuwa et al. (2022). The size of land holding had a negative but significant correlation with technical efficiency among the respondents. As land size increases, farmers may be unable to manage farming activities efficiently. This indicates that smaller farms utilise inputs more effectively, making them more efficient. It means that the smaller the landholding, the more opportunities there are to increase technical efficiency. The family's annual income showed no significant correlation with the respondents' annual income or technical efficiency. Therefore, it may be concluded that the family's annual income was unrelated to the technical efficiency of the respondents in the study area. As farmers gain more knowledge and experience with the unpredictable conditions of agriculture, it is generally expected that their years of farming will increase their efficiency. This will enable them to make accurate predictions about when to sow, what inputs to use, how much to use, and when to apply them. In contrast, farmers who are relatively young or new to lentil production are likely to be less efficient,

according to the study's positive coefficient for experience. Hence, increased farming experience will also raise farmers' technical efficiency.

There was a significant correlation between mass media utilisation and the technical efficiency of the farmers in lentil cultivation. This showed that variable mass media utilisation had led farmers in the study area to increase technical efficiency or reduce inefficiency. There was a significant correlation between social participation and respondents' technical efficiency, suggesting that greater access to resources and information on improved agricultural methods is likely to be an advantage for farmers who are members of an organisation. Joining a farmers' association can facilitate information exchange on farming technologies, thereby influencing members' production practices through peer learning. This may be explained by the fact that farmers' groups can help farmers obtain production inputs at reasonable costs, better coordinate production and marketing efforts, and reduce the marketing chain by bringing small producers and markets together directly. This suggested that the extension agents' visits to farms enhance the respondents' technical proficiency. The knowledge and information farmers acquire that supplements training may be the reason for the favourable correlation between technical efficiency and the frequency of extension interactions. For instance, extension contact reduces technical inefficiency or increases technical efficiency.

The respondents' levels of technical efficiency and innovativeness were positively and significantly correlated. This is true and had filled the prior expectations because most of the farmer's primary occupation was agriculture alone, during their free time they had the tendency to search and browse for the effective use of inputs using social media and seek new information regarding improved technologies has been introduced by the government, or they would seek for the presence of availing any subsidies for crop cultivation, hence there was no surprise of correlation between the innovativeness and technical efficiency of the farmers. The farmers' technical efficiency and risk orientation were positively and significantly correlated. This implies that farmers with a favourable risk orientation towards the improved technologies would try to adopt them and increase their technical efficiency.

4. CONCLUSION

The finding regarding the technical efficiency of respondents indicated that the lentil farmers (improved variety- Kota Masoor-1) were better than the existing variety (IPL-316). The finding also revealed that the lower the yield gap index (technology index), the greater the technology's feasibility. So, the Kota Masoor-1 variety of lentil is suitable for the Bundi district of Rajasthan compared to existing varieties. The development of suitable legume technologies, their efficient demonstration and seed sector support, as well as IPM/ICM/IDM support systems, are necessary to grow legumes, increase income, and improve soil fertility, thereby enhancing the sustainability of the rice-wheat-based system. To improve lentil production and profitability, farmers in Rajasthan should have access to higher-quality, high-yielding varieties. Farmers in the Bundi district should also receive training on HYV lentil seeds. Additionally, the gap between the state's supply and demand for lentils must be closed. A crop insurance program for pulses should be introduced to offset losses from natural disasters. Growers of lentils in the state and Bundi district ought to be encouraged to embrace better lentil packaging and practices.

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Ethical Statement: This study was conducted in accordance with ethical research standards, ensuring the integrity of data collection, analysis, and reporting. Informed consent was obtained from all participants, and no harm was inflicted during the study. The research complies with relevant institutional and international ethical guidelines.

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Data availability: The data may be made available by the corresponding author upon reasonable request.

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