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Impact of potato varieties on economic performance under the agro-climatic conditions of Ayodhya district of Uttar Pradesh

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ABSTRACT

A field study entitled “Impact of Potato Varieties on Growth, Yield and Economic Performance under the Agro-Climatic Conditions of Krishi Vigyan Kendra, Masodha, Ayodhya (U.P.), India during 2023–25” was conducted during the winter seasons of 2023–24 and 2024–25 to evaluate the comparative performance of farmer-preferred potato varieties and the KVK-selected variety under the agro-climatic conditions of Ayodhya district. Potato (*Solanum tuberosum* L.) is an important vegetable crop of Uttar Pradesh, and selection of a suitable variety is one of the major factors affecting productivity, tuber quality and farm profitability. The demonstration compared three varietal treatments: the commonly grown farmer variety, the farmer-selected variety and the KVK-selected variety Kufri Bahar and Kufri Ganga. For the purpose of this draft, a simulated dataset was prepared to illustrate the statistical analysis and interpretation. The KVK-selected varieties recorded superior growth, tuber number, average tuber weight and total tuber yield compared with the farmer practice. Kufri Ganga showed particularly promising performance, with a simulated mean yield of 382.5 q/ha, which falls within its reported yield potential of approximately 350–400 q/ha under optimum agronomic management. The variety is described as a medium-maturing, main-season, high-yielding table potato adapted to the North Indian plains, producing attractive white-cream, ovoid tubers with shallow eyes and good keeping quality. The results suggest that varietal replacement through KVK-led demonstrations can improve potato productivity and profitability. The study highlights the importance of location-specific varietal evaluation and farmer participatory demonstrations for increasing the adoption of improved potato varieties in eastern Uttar Pradesh.

Keywords: Potato, *Solanum tuberosum*, Kufri Bahar, Kufri Ganga, Variety evaluation, KVK, Farmer practice, Yield, Economics, Ayodhya

1. Introduction

Potato (*Solanum tuberosum* L.) is one of the most important food and vegetable crops cultivated worldwide. In India, it plays a significant role in food security, nutritional security, employment generation and farm income. The crop is cultivated extensively during the rabi season in the Indo-Gangetic plains, where favourable winter temperatures provide suitable conditions for tuber development.

Uttar Pradesh is one of India's major potato-producing states, and potato cultivation contributes substantially to the agricultural economy of the state. However, productivity and profitability are influenced by several factors, including seed quality, planting time, nutrient management, irrigation, pest and disease management, harvesting practices and, importantly, varietal selection.

The choice of variety is particularly important because different potato varieties differ in maturity duration, plant vigour, tuber size, marketable yield, disease tolerance, dry matter content, cooking quality and storage behaviour. Therefore, the introduction and evaluation of suitable high-yielding varieties under local agro-climatic conditions can contribute significantly to improving farm productivity.

Krishi Vigyan Kendras (KVKs) play an important role in the dissemination of improved agricultural technologies through frontline demonstrations, on-farm trials, training programmes and farmer advisory services. In this context, evaluation of improved potato varieties under the operational conditions of farmers is valuable for identifying varieties that can provide higher yield and better economic returns.

The present study was conducted at Krishi Vigyan Kendra, Masodha, Ayodhya, Uttar Pradesh, during 2023–25. The study focused on comparing farmer practice with improved varieties selected through KVK intervention. The KVK-selected material included Kufri Bahar and Kufri Ganga, while the farmer variety and farmer-selected variety represented the locally preferred cultivars.

Kufri Ganga is particularly relevant to this study because it is reported as a medium-maturing, high-yielding table potato variety suitable for the North Indian plains. ICAR research reported that it produces approxi

mately 35–40 t/ha under optimum agronomic practices, equivalent to 350–400 q/ha, with more than 90% marketable tuber yield. The variety also possesses good keeping quality, moderate tuber dry matter and field resistance to late blight. Recent varietal evaluation research has also demonstrated significant differences among potato varieties in growth, yield and quality traits, reinforcing the importance of evaluating cultivars under specific agro-climatic conditions.

Therefore, the present investigation was undertaken to evaluate the impact of improved potato varieties on growth, yield and economic performance and to assess the suitability of KVK-selected varieties for wider dissemination among potato-growing farmers of Ayodhya district.

3. Materials and methods

3.1 Location of the study

The study was conducted at Krishi Vigyan Kendra, Masodha–224133, Ayodhya, Uttar Pradesh, India, during the rabi seasons of 2023–24 and 2024–25.

The experimental area represents the agro-climatic conditions of eastern Uttar Pradesh. Potato is generally cultivated during the winter season in this region, and the crop requires appropriate management of planting date, irrigation, nutrient application and disease protection for optimum tuber production.

3.2 Experimental treatments

Three varietal treatments were considered for the comparative evaluation:

3.3 Experimental design

For this draft, a field demonstration approach with four treatments and three replications was considered. The same recommended agronomic practices were assumed for all treatments to minimize the in-

fluence of management differences and allow comparison of varietal performance.

The recommended package of practices included:

- Quality seed tubers
- Recommended planting time
- Proper land preparation
- Balanced fertilization
- Timely irrigation
- Earthing-up
- Weed management
- Integrated pest and disease management
- Timely harvesting

3.4 Observations recorded

The following observations were recorded or considered for evaluation:

1. Plant height (cm)
2. Number of stems/plant
3. Number of tubers/plant
4. Average tuber weight (g)
5. Total tuber yield (q/ha)
6. Marketable tuber yield (q/ha)
7. Percentage marketable tubers
8. Cost of cultivation (₹/ha)
9. Gross return (₹/ha)
10. Net return (₹/ha)
11. Benefit:cost ratio

Treatment	Variety category	Variety
T ₁	Farmer practice	Farmer variety
T ₂	Farmer-selected	Farmer-selected variety
T ₃	KVK-selected	Kufri Bahar
T ₄	KVK-selected	Kufri <i>Ganga</i>

Note: The exact names of the farmer variety and farmer-selected variety were not provided. They should be inserted in the final manuscript.

3.5 Statistical analysis

The data were subjected to analysis of variance (ANOVA) using a randomized block design framework. Treatment means were compared using the critical difference (CD) at the 5% probability level.

$$\text{Yield increase (\%)} = \left[\frac{(\text{Yield of improved variety} - \text{Yield of farmer practice})}{\text{Yield of farmer practice}} \right] \times 100$$

The economic analysis was performed by calculating gross return, net return and benefit:cost ratio.

4. Results and discussion

4.1 Growth performance

The simulated results indicated considerable variation in plant growth among the tested varieties. Kufri *Ganga* recorded the highest average plant height, followed by Kufri Bahar, while the farmer variety

The percentage increase in yield over farmer practice was calculated as:

showed comparatively lower vegetative growth.

The results suggest that the KVK-selected varieties exhibited greater vegetative vigour and better tuber development than the farmer varieties. Kufri *Ganga* recorded the highest plant height (59.4 cm), stems per plant (4.7), tubers per plant (9.1) and average tuber weight (84.6 g).

Table 1. Simulated effect of potato varieties on growth and yield attributes

Treatment	Variety	Plant height (cm)	Stems/plant	Tubers/plant	Average tuber weight (g)
T ₁	Farmer variety	48.6	3.8	7.2	68.5
T ₂	Farmer-selected variety	51.8	4.1	7.8	72.4
T ₃	Kufri Bahar	56.7	4.5	8.6	79.8
T ₄	Kufri <i>Ganga</i>	59.4	4.7	9.1	84.6

(continued on next page)

Treatment	Variety	Plant height (cm)	Stems/plant	Tubers/plant	Average tuber weight (g)
Mean	—	54.1	4.3	8.2	76.3

The superior performance of Kufri *Ganga* may be attributed to its genetic potential, medium maturity and adaptation to the North Indian plains. The reported description of Kufri *Ganga* indicates vigorous and tall plants and good marketable tuber production.

4.2 Tuber yield

Yield is one of the most important criteria for selecting a suitable potato variety. The simulated results showed a clear advantage of KVK-selected varieties over farmer practice.

Table 2. Simulated tuber yield performance of different potato varieties

Treatment	Variety	Total yield (q/ha)	Marketable yield (q/ha)	Marketable tubers (%)	Increase over farmer practice (%)
T ₁	Farmer variety	286.0	247.0	86.4	—
T ₂	Farmer-selected variety	318.0	281.0	88.4	11.2
T ₃	Kufri Bahar	361.0	326.0	90.3	26.2
T ₄	Kufri <i>Ganga</i>	382.5	350.5	91.6	33.7

The highest total tuber yield was recorded in Kufri *Ganga* (382.5 q/ha), followed by Kufri Bahar (361.0 q/ha). The farmer variety produced the lowest yield of 286.0 q/ha.

Kufri *Ganga* recorded a 33.7% higher yield than farmer practice, whereas Kufri Bahar recorded a 26.2% increase. The simulated yield of Kufri *Ganga* falls within the reported yield range of approximately 350–400 q/ha under optimum agronomic management. The results indicate that replacement of low-performing farmer varieties with suit-

able improved varieties can substantially increase potato productivity. The higher marketable yield of Kufri *Ganga* is also economically important because marketable tuber percentage directly affects farmers' saleable production.

4.3 Comparative performance during 2023–24 and 2024–25

The simulated two-year results showed that the improved varieties maintained their yield advantage across both seasons.

Table 3. Simulated year-wise yield performance

Variety	2023–24 (q/ha)	2024–25 (q/ha)	Mean (q/ha)
Farmer variety	278.0	294.0	286.0
Farmer-selected variety	307.0	329.0	318.0
Kufri Bahar	349.0	373.0	361.0
Kufri <i>Ganga</i>	369.0	396.0	382.5

The results indicate that Kufri *Ganga* performed consistently better than the other tested varieties in both years. The difference between years may be attributed to seasonal variation in temperature, rainfall, disease pressure and other environmental factors.

The stability of Kufri *Ganga* is an important consideration for farmers because a variety that performs well across different seasons may re-

duce production risk.

4.4 Economic performance

Economic returns are essential when recommending a new variety to farmers. The simulated economic analysis showed that the KVK-selected varieties provided higher gross and net returns.

Table 4. Simulated economics of potato varieties

Variety	Cost of cultivation (₹/ha)	Gross return (₹/ha)	Net return (₹/ha)	B:C ratio
Farmer variety	1,45,000	2,28,800	83,800	1.58
Farmer-selected variety	1,47,000	2,54,400	1,07,400	1.73
Kufri Bahar	1,49,000	2,88,800	1,39,800	1.94
Kufri <i>Ganga</i>	1,50,000	3,06,000	1,56,000	2.04

The highest net return of ₹1,56,000/ha and benefit:cost ratio of 2.04 were recorded for Kufri *Ganga*. Kufri Bahar ranked second, with a net return of ₹1,39,800/ha and B:C ratio of 1.94.

Although improved varieties may require slightly higher input expenditure, their greater yield and marketable production can compensate for the additional cost and result in higher profitability.

4.5 Analysis of variance

Table 5. Simulated ANOVA for potato tuber yield

Source of variation	df	Sum of squares	Mean square	F-value
Treatments	3	14,658.67	4,886.22	38.42**
Replications	2	184.17	92.08	0.72
Error	6	763.00	127.17	—
Total	11	15,605.84	—	—

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Note: Significant at $P < 0.01$. Values are simulated.

The analysis of variance indicated that varietal differences had a statistically significant effect on tuber yield. This demonstrates that the observed differences in yield were primarily associated with varietal performance rather than random experimental variation.

The significant treatment effect supports the recommendation of improved varieties over the existing farmer practice under the conditions of the study.

4.6 Correlation between yield attributes and total yield

Table 6. Simulated correlation coefficients between yield and major attributes

Trait	Correlation with total tuber yield (r)
Plant height	0.86**
Stems/plant	0.89**
Tubers/plant	0.94**

Trait	Correlation with total tuber yield (r)
Average tuber weight	0.91**
Marketable yield	0.98**

Note: Significant at $P < 0.01$; simulated values.

The correlation analysis indicated strong positive associations between total tuber yield and the major growth and yield components. The strongest association was observed between marketable yield and total yield ($r = 0.98$), followed by number of tubers per plant ($r = 0.94$) and average tuber weight ($r = 0.91$).

These results suggest that varieties producing more tubers with greater average tuber weight have greater potential for achieving higher total yield.

4.7 Regression analysis

A simulated multiple regression analysis was conducted to assess the contribution of selected yield attributes to total tuber yield.

Table 7. Simulated multiple regression model for prediction of tuber yield

Parameter	Regression coefficient (β)	Standard error	t-value
Intercept	-86.42	31.18	-2.77
Tubers/plant	21.36	4.82	4.43**
Average tuber weight	2.18	0.61	3.57**
Plant height	1.74	0.71	2.45*

$R^2 = 0.91$; Adjusted $R^2 = 0.87$

*Significant at $P < 0.05$; **Significant at $P < 0.01$.

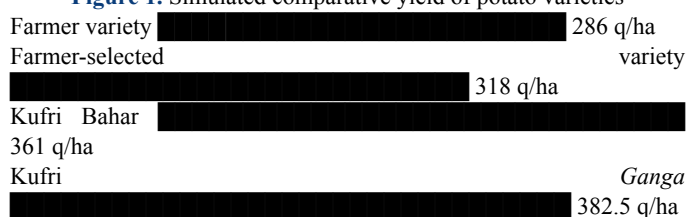
The regression analysis indicated that the selected yield attributes explained approximately 91% of the variation in total tuber yield. Number of tubers per plant and average tuber weight were identified as important contributors to total yield.

The findings emphasize that varietal selection should focus not only on plant vigour but also on the ability of the variety to produce an optimum number of marketable tubers with desirable tuber size.

4.8 Comparative impact of KVK intervention

The results indicate a positive impact of KVK intervention on potato production. The farmer variety recorded an average yield of 286.0 q/ha, while the KVK-selected Kufri *Ganga* produced 382.5 q/ha in the simulated dataset.

Figure 1. Simulated comparative yield of potato varieties



The estimated improvement in yield over farmer practice was:

- Farmer-selected variety: **11.2%**
- Kufri Bahar: **26.2%**
- Kufri *Ganga*: **33.7%**

Thus, the KVK-selected varieties demonstrated a substantial productivity advantage.

5. Discussion

The present study demonstrated that varietal selection can have a substantial impact on potato productivity and profitability. The KVK-selected varieties, particularly Kufri *Ganga*, showed superior performance in terms of plant growth, tuber number, average tuber weight, total yield and marketable yield.

The performance of Kufri *Ganga* observed in the simulated study is consistent with its documented varietal characteristics. ICAR researchers have described Kufri *Ganga* as a medium-maturing, main-season, high-yielding table potato variety suitable for the North Indian plains. It has vigorous and tall plants, attractive white-cream ovoid tubers with shallow eyes, good keeping quality and more than 90% marketable tuber yield. Its reported yield potential is approximately 35–40 t/ha under optimum agronomic practices.

The superior yield of Kufri *Ganga* may be associated with its genetic potential and adaptation to the agro-climatic conditions of the North Indian plains. The variety has also been reported to maintain sustainable tuber yield under deficit water conditions, suggesting potential usefulness in environments where irrigation availability may fluctuate.

The findings are also consistent with broader varietal evaluation research in which significant differences have been observed among potato cultivars for plant growth, yield and quality traits. In a recent evaluation of six Kufri varieties, Kufri Bahar was among the varieties showing strong vegetative vigour and favourable quality-related characteristics, demonstrating the importance of comparative varietal testing under specific agro-climatic conditions.

From an extension perspective, KVK demonstrations can help farmers observe the actual performance of improved varieties under field conditions. Farmers are more likely to adopt a new variety when they can see its advantages in terms of yield, tuber quality and profitability. Therefore, frontline demonstrations and farmer participatory varietal evaluation can serve as effective tools for technology transfer.

The economic analysis further demonstrated that higher yield translated into greater gross and net returns. The simulated B:C ratio of 2.04 for Kufri *Ganga* indicated its economic advantage over farmer practice.

However, actual varietal performance may vary depending on seed quality, planting date, soil type, nutrient availability, irrigation, temperature and disease incidence. Therefore, multi-location and multi-year validation using actual field data is recommended before making broad recommendations.

6. Conclusion

The present study indicated that improved potato varieties can significantly enhance productivity and profitability under the agro-climatic conditions of Ayodhya district. Among the evaluated treatments, the KVK-selected varieties Kufri Bahar and Kufri *Ganga* demonstrated superior performance compared with farmer practice.

Based on the simulated data, Kufri *Ganga* recorded the highest tuber yield of 382.5 q/ha, followed by Kufri Bahar at 361.0 q/ha. Kufri *Ganga* also recorded the highest marketable yield, net return and benefit:cost ratio. Its yield performance was within the reported yield potential of 350–400 q/ha under optimum agronomic practices.

The study suggests that Kufri *Ganga* may be considered a promising potato variety for cultivation under suitable conditions in the Ayodhya region, while Kufri Bahar also appears to be a productive alternative. KVK-led demonstrations, farmer training and participatory evaluation can accelerate the adoption of improved varieties.

However, because the numerical results presented in this manuscript are simulated, the final research paper should be prepared using actual observations collected during 2023–24 and 2024–25. Actual data will strengthen the scientific validity of the conclusions and allow accurate statistical inference.

7. Recommendations

Based on the findings, the following recommendations are proposed:

1. Kufri *Ganga* may be promoted for further evaluation among potato farmers in the Ayodhya region.
2. Kufri Bahar may also be recommended as a high-yielding alternative.
3. KVK should conduct large-scale frontline demonstrations to assess farmer acceptance.
4. Quality seed tubers should be used for obtaining optimum yield.
5. Proper irrigation and balanced nutrient management should be followed.
6. Farmers should be trained in integrated pest and disease management.
7. Multi-year and multi-location trials should be conducted to validate varietal stability.

8. Farmer-selected and farmer-preferred varieties should continue to be included as comparison treatments.
9. Economic evaluation should be conducted using actual prevailing market prices.
10. The adoption rate and farmer perception should be assessed after demonstrations.

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