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Impact of Soil Health Card on Urea Fertilizer Usage and Crop Yield in Haryana

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HIGHLIGHTS

- Farmers partially implement the recommendations of soil health card.
- Adoption of soil health card recommendations leads to a reduction in urea fertilizer usage.
- Reduction in usage of urea under soil health card recommendations does not result in lower crop yields.
- Adoption of soil health card recommendations does not cause financial loss.

ARTICLE INFO

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ABSTRACT

Soil health is crucial for sustaining agricultural productivity. This study evaluates the impact of the Soil Health Card (SHC) scheme on fertilizer usage and crop yield in Haryana. Using primary data obtained from farm-level survey conducted utilizing a pre-tested semi-structured schedule in 2024–25, the research compares urea application and crop productivity between SHC adopters and non-adopters. The impact of SHC adoption on urea usage and yield varies across crops. The findings indicate that while SHC-adopting farmers apply urea at levels below conventional practices, they still exceed recommended doses. SHC adoption leads to a statistically significant reduction in urea usage, without compromising crop yields. An economic analysis reveals that paddy and wheat farmers benefit from both cost savings and increased yield. The study underscores the potential of SHC in promoting balanced fertilizer usage while maintaining crop yield. The novel findings support the need for implementation of tailored nutrient management strategies to safeguard soil health.

INTRODUCTION

Agriculture in Haryana predominantly relies on chemical fertilizers. The fertilizer consumption pattern has undergone considerable transformation during recent past across the regions (Shah et al., 2025). Fertilizer usage in the state is skewed towards urea (Aryal et al., 2021). One of the main drivers of excessive nitrogen fertilizer use is the perceived potential for higher crop yields (Reddy et al., 2024). However, maintaining soil health is critical for sustaining agricultural productivity in the long-run (Sheoran et al., 2024). The imbalanced use of chemical fertilizers has contributed to soil degradation, declining yields, and environmental concerns in the state (Mandal, 2024). Additionally, reducing chemical fertilizer usage has a notable positive externality by improving public health (Ai et al., 2024). Consequently, it is crucial to facilitate farmers for prudent use of chemical fertilizers. Governments are expected to incentivize such beneficial externalities. To this end, the Government of India (GOI) launched the Soil Health Card (SHC) Scheme in 2015. The initiative aims to promote judicious fertilizer use by providing farmers with a scientific assessment of soil health, enabling informed decisions on fertilizer application. Haryana has actively implemented the SHC scheme to improve agricultural sustainability (Ohlan et al., 2025).

Given the state's intensive cropping patterns and high fertilizer consumption, evaluating the SHC's impact on fertilizer usage and crop yield is essential. Regarding existing literature, it has been

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observed that a few studies have assessed the impact of SHC on fertilizer consumption pattern and farming profitability concerning mainly Uttar Pradesh (Sahay et al., 2019; Singh et al., 2023). Besides, the previous studies considered a very limited number of crops, mainly wheat and paddy. Most of these relevant studies pointed out the losses in crop yield due to existing excess use of nitrogen fertilizer. However, there is a lack of a compressive and systematic assessment of economic impact of SHC in the context of Haryana. Additionally, previous research has focused mainly on SHC adopters, overlooking a comparative analysis with non-adopters (Chouhan et al., 2017). Since fertilizer usage varies across states in India, it is essential to examine the impact of SHC across different regions using a comprehensive approach.

The objective of this study is to investigate impact of soil health card on urea fertilizer application and yields of major crops grown in Haryana. In this process, the study answers three research questions: Does the adoption of SHC influence urea fertilizer usage? Does SHC adoption lead to yield decline across different crops? and Does SHC adoption reduce economic benefits compared to non-adopters? By comparing urea usage and yield outcomes between SHC adopters and non-adopters, this research provides empirical insights into the scheme's economic impact. In this way, the findings contribute to the broader discourse on sustainable agricultural practices and policy interventions aimed at enhancing farm productivity while preserving soil health.

METHODOLOGY

This study analyzed the impact of implementing SHC recommendations on urea fertilizer usage and crop yield. To achieve its objective, the current study used an exploratory-cum-descriptive research design. It employed a mixed-method approach, integrating primary survey data on urea usage and crop yield with secondary data on minimum support prices and urea prices. The study included six major crops cultivated in the state. A pre-tested semi structured questionnaire was used to collect primary data through face-to-face quantitative surveys with individual farmers. A farm-level field survey was conducted in six districts, each specializing in a different crop: Karnal (wheat), Yamunanagar (sugarcane), Rewari (mustard), Kurukshetra (paddy), Sirsa (cotton), and Mahendragarh (bajra) during 2024–25.

To ensure adequate representation, the Cochran sampling formula (Potapov et al., 2022) was utilized, yielding a representative sample of 396 farmers at a 95 per cent confidence level with a 5% margin of error. Information on SHC adopters in select districts were gathered from soil health testing laboratories. A purposive sampling technique was used to determine survey locations, selecting one block with a high concentration of SHC adopting farmers from each select district. Three villages were then chosen from each selected block using the same method. Within each village, a list of SHC adopting farmers was compiled, from which 11 farmers were randomly selected. To mitigate the impact of soil fertility variations, cropping pattern and irrigation facilities on fertilizer use, an additional 11 farmers were randomly chosen for the control group from neighboring fields based on a separate list. Participation of farmers was voluntary, and their informed consent was obtained before the interviews.

The data on minimum support prices (MSP) of various crops under reference were taken from Agricultural Statistics at a Glance, annual publication of Ministry of Agriculture & Farmers' Welfare, Government of India. The data on urea price were obtained from Fertiliser Statistics, an annual publication of Fertiliser Association of India, Government of India. The mean comparison independent samples t-test was used to compare the per-acre urea fertilizer usage by SHC adopters and non-adopters (Khanna & Kaur, 2023). The economic analysis was conducted by comparing differences in per acre cost of urea and yield of crops under reference obtained by SHC adopters and non-adopters. The value of various crops was estimated based on their MSP, while the cost of urea was calculated at its retail market price (Ohlan, 2021).

RESULTS

Urea fertilizer usage vis-a-vis recommended dose

Table 1 presents the pattern of urea fertilizer usage, measured in terms of the estimated average quantity of SHC recommended and actual doses used by soil test farmers for major crops grown in Haryana. A review of data presented in Table 1 shows that farmers holding soil health cards apply a significantly higher quantity of urea than the recommended doses for all crops studied. For paddy, the recommended dose of urea for soil test farmers was 98 kg per acre, whereas they applied 110 kg per acre—an increase of 12.24 per cent. Similarly, for wheat, farmers used 10 kg per acre more urea than the recommended level. For mustard, sugarcane, bajra, and cotton, the application of urea exceeded the recommended levels by 8.70, 6.25, 5.26 and 6.25 per cent, respectively.

Table 1. Recommended and Actual Use of Urea Fertilizer in Haryana (kg/acre)

Crop	Recommended A	Actual B	Difference C = B-A	Percentage Gap D = (C÷A) ×100
Paddy	98	110	12	12.24
Wheat	95	105	10	10.53
Mustard	23	25	2	8.70
Sugarcane	160	170	10	6.25
Bajra	19	20	1	5.26
Cotton	80	85	5	6.25

Note: N= 198

Impact of SHC on urea fertilizer usage

It is pertinent to examine the impact of the SHC scheme on fertilizer usage. Table 2 presents the estimates for the use of urea fertilizer by control group farmers and soil test farmers of crops under study. The results of the mean comparison test (t-test) for the difference in average urea usage between treatment and control group farmers are statistically significant at the 1% level. This indicates that the adoption of SHC significantly reduces urea usage. Specifically, the impact of SHC adoption was found to be most pronounced in the cultivation of bajra, where urea usage declined by 20 per cent. Mustard cultivation followed closely, with a 16.67 per cent reduction in urea usage. In absolute terms, soil test farmers used 110 kg and 105 kg of urea per acre for paddy and wheat cultivation, respectively, whereas the control group farmers applied

Table 2. Use of Urea Fertilizer in Cultivation of Various Crops in Haryana (kg/acre)

Crop	Control Farmers A	Soil Test Farmers B	Difference C = B-A	Percentage D = (C÷A)×100	t-value
Paddy	125	110	-15	-12.00	9.66*
Wheat	120	105	-15	-12.50	9.21*
Mustard	30	25	-5	-16.67	12.2*
Sugarcane	180	170	-10	-5.56	14.72*
Bajra	25	20	-5	-20.00	15.06*
Cotton	90	85	-5	-5.56	8.08*

Note: * = Mean comparison independent samples t-test value is significant at 1% level.

125 kg and 120 kg per acre, respectively. SHC adopters used 15 kg per acre less urea in the cultivation of paddy and wheat. Additionally, SHC-adopting farmers reduced urea use in the cultivation of sugarcane and cotton by 5.56 per cent.

Impact of SHC on crop yield

To evaluate the economic impact of SHC adoption, it is essential to assess the effect of reduced urea usage on crop yield. Table 3 compares the crop yields of control farmers with those of soil test-based fertilizer application farmers. The yield levels of paddy and wheat for control group farmers were 1689 kg/acre and 2042 kg/acre, respectively, while the corresponding figures for soil test farmers were 1691 kg/acre and 2043 kg/acre. The yield attained by SHC adopters was slightly higher than that of control group farmers by 2 kg/acre for paddy and 1 kg/acre for wheat. For the remaining crops, the yield differences between control and soil test farmers were also minimal, ranging from 1 kg/acre for mustard to 3 kg/acre for sugarcane. In sum, there is no considerable yield loss due to less application of urea.

Table 3. Yield of Various Crops in Haryana (kg/acre)

Crop	Control Farmers A	Soil Test Farmers B	Difference C = B-A
Paddy	1689	1691	2
Wheat	2042	2043	1
Mustard	785	784	-1
Sugarcane	33045	33042	-3
Bajra	996	994	-2
Cotton (Lint)	184	182	-2

Comparative economic analysis

Table 4 presents the economic analysis of the impact of SHC adoption by considering the reduction in urea costs, changes in the value of crop output, and the resulting net profit or loss (Rs/acre) across six major crops in Haryana. SHC adoption led to a reduction in urea costs by Rs. 80.7/acre for both paddy and wheat. At the same time, the value of output increased by Rs. 46/acre for paddy and Rs. 23/acre for wheat. This resulted in a net profit of Rs. 126.7/acre for paddy and Rs. 103.7/acre for wheat.

A mixed impact was observed in case of cultivation of sugarcane. Farmers saved Rs. 53.8/acre in urea costs but experienced a decline of Rs. 12/acre in output value. Despite this, they achieved a net profit of Rs. 41.8/acre. Although SHC adoption reduced urea costs by Rs. 26.9/acre for mustard, bajra, and cotton, the value of output declined by Rs. 57/acre for mustard, Rs. 53/acre for bajra, and Rs. 142/acre for cotton. Consequently, slight net losses were recorded at Rs. 30.1/acre for mustard, Rs. 26.1/acre for bajra, and Rs. 115/acre for cotton.

Table 4. Economic Impact of SHC in Haryana (Rs/acre)

Crop	Reduction in Cost of Urea A	Change in Value of Output B	Net gain/ Loss C = A+B
Paddy	80.7	46	126.7
Wheat	80.7	23	103.7
Mustard	26.9	-57	-30.1
Sugarcane	53.8	-12	41.8
Bajra	26.9	-53	-26.1
Cotton	26.9	-142	-115

DISCUSSION

The comparative analysis revealed that the actual usage of urea in all crops under reference was higher than their recommended levels, ranging from 5.26 per cent to 12.24 per cent. This indicates a strong tendency among farmers to rely on conventional fertilization practices, possibly due to ingrained habits or misconceptions about optimal nutrient application. This finding aligns with Patel et al., (2023), who observed similar behavior among cereal cultivators in Bihar, where farmers did not fully adhere to tailored fertilizer recommendations despite adopting SHC practices. Similar trends have been reported by Grover et al., (2016), who found that farmers in Punjab and Uttar Pradesh often overuse urea due to a lack of awareness about balanced nutrient management and the perceived immediate benefits of nitrogen-based fertilizers.

The analysis further highlighted the effectiveness of SHC in promoting judicious fertilizer use. SHC adopters demonstrated significant reductions in urea usage compared to non-adopters, with the highest reductions observed in bajra (20%) and mustard (16.67%). Paddy and wheat farmers also reduced urea usage by 12-12.5 per cent. These reductions underscore SHC's potential to improve soil health and foster more sustainable fertilizer management practices. It also emphasized that SHC-based recommendations help optimize fertilizer use, thereby enhancing nutrient use efficiency and reducing environmental degradation. These findings are consistent with those of Singh et al., (2023), who reported a 15-25 per cent reduction in urea usage among SHC adopters in Sulphur, Uttar Pradesh, leading to improved soil organic carbon levels and reduced nitrogen leaching. The low-dose urea use not only improves crop quality but also indirectly benefits public health (Das et al., 2022).

The findings suggest that conventional fertilization practices, which often involve excessive urea use, do not necessarily lead to substantial yield gains compared to soil test-based fertilizer application. The lower yields of wheat and paddy among non-adopting farmers (control group) may be attributed to lodging caused by excessive fertilizer application during final irrigation or rainstorms (Tripathi et al., 2023). The findings imply that current fertilizer practices may not be optimal in terms of nutrient application, and reducing urea usage can maintain yields at par with conventional methods. This finding lends support to Ankhila et al., (2021), who found that SHC based nitrogen application in paddy led yield gain in Andhra Pradesh.

An economic assessment of SHC adoption further highlights its benefits. Paddy and wheat farmers experienced both cost savings and increased output value, resulting in net profits of Rs. 126.7/acre and Rs. 103.7/acre, respectively. Sugarcane farmers also benefited from reduced urea costs, though they saw a slight decline in output value, still achieving a positive net return. However, the economic impact varied for mustard, bajra, and cotton farmers, who recorded small net losses due to reduced output values outweighing urea cost savings. The economic analysis presented by Panda et al. (2022) about fixed and operational cost, gross return with or without dividend and benefit cost ratio also advocates reduction of operational cost for higher dividends. These findings are in line with Grover et al., (2016), who reported that SHC adoption led to significant cost savings for paddy and wheat farmers in Punjab.

Overall, the results indicate that SHC adoption had varying economic effects across different crops in Haryana. While paddy and wheat farmers reaped significant benefits, mustard, bajra, and cotton farmers experienced minimal losses, suggesting that SHC-based fertilizer recommendations did not lead to lower financial returns. These findings emphasize the need for further extension efforts to ensure farmers fully understand and trust soil health-based fertilization practices. In sum, while SHC adoption effectively reduces excessive urea use without compromising yields, its economic impact varies across crops, highlighting the importance of tailored approaches for different agricultural contexts. Regarding the societal importance of the findings, adopting low-dose urea application practices can contribute to safer, more nutritious food and support sustainable agricultural systems, which are critical for addressing pressing public health and environmental challenges in India. The government and non-government organizations can provide incentives to farmers to reduce urea fertilizer usage in food crops (Zheng et al., 2022). The analysis of variations in the cost structure of various crops between adopters and non-adopters of SHC using a causal research design presents a promising avenue for future research.

CONCLUSION

This study analyzed the impact of the soil health card scheme on urea usage and crop yield levels in Haryana. The findings reveal that soil test farmers generally apply higher-than-recommended doses of urea across major crops. The evaluation of SHC adoption shows a statistically significant reduction in urea usage among soil test farmers compared to control group farmers, demonstrating the scheme's effectiveness in promoting judicious fertilizer application. Despite the reductions in urea application, yield levels for SHC-adopting farmers remained largely unchanged or showed marginal improvements across all crops. This suggests that excessive urea application does not necessarily translate into higher productivity and that balanced fertilization based on soil testing is sufficient for maintaining crop yields. Overall, the findings indicate that SHC adoption not caused economic losses to farmers. Moving forward, policymakers should focus on strengthening awareness programs to enlarge the adoption of SHC scheme in Haryana.

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