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Assessment of *Kisan Sarathi* in influencing farmers' knowledge on *rabi* crop practices: A difference-in-difference approach

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ABSTRACT

Digital extension platforms have emerged as an important means of strengthening last-mile information delivery in Indian agriculture. *Kisan Sarathi*, a multimodal and interactive ICT-based advisory system, provides personalised, location-specific recommendations to farmers through Krishi Vigyan Kendras. However, empirical evidence on its effectiveness in enhancing farmers' knowledge remains limited. The present study conducted during 2024–25, evaluated the contribution of *Kisan Sarathi* advisories in improving farmers' knowledge of winter (*rabi*) crop practices using a Difference-in-Difference (DID) approach. Uttar Pradesh was selected purposively due to its high registration on *Kisan Sarathi* and extensive area under major *rabi* crops. A total of 300 farmers were surveyed from three districts selected through a stratified two-stage sampling method, comprising equal numbers of users and non-users. A standardised knowledge test was developed through item collection, expert validation, and item analysis, yielding 17 items that were used for pre- and post-intervention assessments. The DID regression model with cluster-robust standard errors was applied to isolate the causal effect of the advisories. The results showed a significant rise in knowledge scores among *Kisan Sarathi* users compared to non-users, with the post-intervention experimental group coefficient confirming a strong positive effect. Model diagnostics indicated robustness and moderate explanatory power. The findings demonstrated that *Kisan Sarathi* substantially enhanced farmers' knowledge by delivering timely, and need-based advisories. The study concluded that digital extension platforms like *Kisan Sarathi* can play a significant role in bridging information gaps and improving informed decision-making in agriculture, reinforcing their importance in future extension strategies.

Keywords: Agro-advisory services, Digital extension platform, ICT, *Kisan Sarathi*, Knowledge test

Agriculture is increasingly embedded within a dynamic global landscape characterised by rapid technological innovation, demographic transitions, evolving consumption patterns, and deepening market interdependence (Suvedi and Kaplowitz 2016). Within this milieu, the generation, dissemination, and effective utilisation of context-specific agricultural knowledge particularly among small and marginal farmers remain fundamental to sustaining livelihoods and enhancing sectoral resilience (Glendenning and Ficarelli 2012). Despite continued policy emphasis, agricultural growth is often constrained by uneven innovation diffusion and limited access to timely, actionable information. Agricultural Extension and Advisory Services (EAS) thus constitute a vital institutional mechanism for bridging the research-practice divide (Saravanan 2012).

The philosophy of extension has progressively shifted from linear, top-down models of technology transfer toward participatory and 'extension-plus' frameworks that prioritise facilitation, capacity building, and collaborative engagement (Swanson 2009, Oladele 2015). However, public extension systems in India continue to face structural bottlenecks, including inadequate manpower, weak institutional convergence, and limited localisation of advisories (Sulaiman *et al.* 2005, Feder *et al.* 2013). The extension service provider-to-farm holding ratio of 1:1162 substantially exceeded the recommended 1:750 (Sumanth *et al.* 2020), illustrating persistent outreach gaps. The NSSO (2005) further documented that nearly 60% of farmers lacked access to modern agricultural information, underscoring systemic deficiencies in knowledge delivery.

In response, the integration of Information and

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Communication Technologies (ICTs) has emerged as a scalable and cost-effective strategy for strengthening last-mile advisory services (Paudel *et al.* 2018). Evidence from Ghana, Malawi, and India indicates that ICT-enabled platforms enhance farmers' decision-making, adoption behaviour, and income outcomes (Reddy and Ankaiah 2005, Maja and Ayano 2021). Building upon earlier digital initiatives such as e-Sagu and Warna Wired Village (Saravanan 2008), ICAR launched *Kisan Sarathi*, a multilingual digital platform delivering personalised, location-specific advisories through the Krishi Vigyan Kendra (KVK) network. The present study adopted a Difference-in-Difference (DID) approach to rigorously estimate the causal impact of *Kisan Sarathi* on farmers' knowledge of *rabi* crops.

MATERIALS AND METHODS

Sampling design: Uttar Pradesh was selected purposively for the study owing to its prominence in Indian agriculture. As of April 2025, it recorded the highest number of registered farmers on the *Kisan Sarathi* (Fig. 1), making it an ideal state to capture diverse user experiences and advisory utilisation patterns. In addition, since the study focused specifically on *rabi* crop practices, Uttar Pradesh was a logical choice because it also has the largest area and production under major *rabi* crops such as wheat, mustard, and gram. This combination of high farmer registration and agricultural significance ensured that the sample would meaningfully represent active users of agro-advisories and offer rich insights into the platform's performance.

The selection of respondents from Uttar Pradesh was undertaken using a stratified two-stage sampling design to ensure both diversity and representation of high-engagement areas. In the first stage, districts were stratified based on the number of farmers registered under *Kisan Sarathi*. The top ten districts with the highest number of registered farmers namely Pratapgarh, Sultanpur, Agra, Kushinagar, Bahraich, Sitapur, Mathura, Amroha, Pilibhit, and Bulandshahr were identified through purposive selection. This stratification ensured that the sampling frame was concentrated in areas with substantial platform penetration and active farmer participation. Subsequently, three districts were randomly selected from this pre-stratified group to maintain statistical rigour while preserving representation from high-engagement regions. This process resulted in the final selection of Agra (215,647 registered farmers), Mathura (153,021), and Amroha districts (125,718). In the second stage, a simple random sampling procedure was employed within each selected district. From each district, 50 registered (user) farmers and 50 non-registered (non-user) farmers were selected, ensuring equal representation of treatment and comparison groups. The final sample thus comprised 300 respondents (150 users and 150 non-users). This stratified two-stage approach ensured methodological robustness by balancing purposive stratification with random selection, thereby enhancing both representativeness and comparability across user and non-user groups.

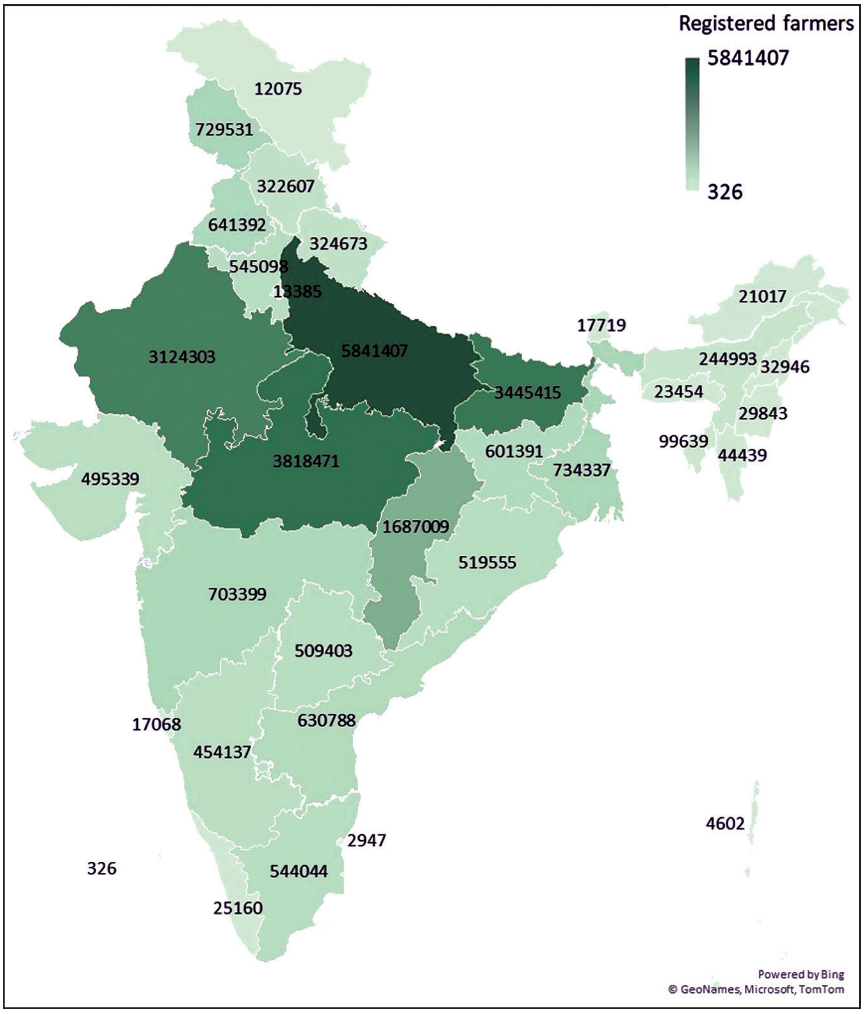

Fig. 1 Distribution of registered farmers of *Kisan Sarathi* across the 34 Indian states and UTs.

Methodology: To assess the effectiveness of the advisory services provided through *Kisan Sarathi*, an experimental study was conducted during 2024–25 involving two groups, viz. Experimental group (user farmers), registered under *Kisan Sarathi* and Control group (non-user farmers), non-registered under *Kisan Sarathi*. A knowledge test, comprising multiple-choice questions based on the advisories provided by *Kisan Sarathi*, was developed and administered to measure the effect. Steps followed in developing the knowledge test are as follows:

Step 1 (*Item collection*): The first step in developing a knowledge test involves the collection of relevant items. For this study, advisories provided to farmers during the *rabi* season in 2023-2024 were listed in consultation with KVK professionals. A total of 38 items were selected based on the following criteria: promoting thinking and practicality, rather than rote memorisation, differentiating between well-informed and poorly informed farmers, and ensuring the questions have a suitable level of difficulty. The items covered a range of topics such as crop production practices, fertiliser application, pest management, feeding practices for dairy cows, etc.

Step 2 (*Item selection*): Once the items were collected, a total of 40 experts, including scientists from different research institutions, were consulted to check the relevance of each item. Relevancy was tested using the following formulae:

$$\text{Relevancy weightage} = \frac{(\text{Most relevant} \times 3) + (\text{Relevant} \times 2) + (\text{Not relevant} \times 1)}{\text{Maximum possible score}}$$

$$\text{Mean relevancy score} = \frac{(\text{Most relevant} \times 3) + (\text{Relevant} \times 2) + (\text{Not relevant} \times 1)}{\text{Number of judges}}$$

Items with a relevancy weightage greater than 0.80 and a mean relevancy score greater than 2.5 were selected, resulting in a total of 28 items being retained for further analysis.

Step 3 (Item analysis): The tests conducted for item analysis are mentioned hereunder:

a. *Difficulty index*:This measures the degree of complexity of an item, ensuring that the questions are neither too easy nor too difficult. Items with a difficulty index between 20 and 80 were considered for inclusion in the final test (Table 1). It was calculated using the formula:

$$P = \frac{NC}{N} \times 100$$

Where NC, Number of respondents giving correct answer; N, Total number of respondents.

b. *Discrimination index*: This determines whether a question can differentiate between well-informed and poorly informed respondents. Items with discrimination index above 0.3 were selected for the final knowledge test (Table 1). It was calculated using the formula:

$$E^{1/3} = \frac{(S1 + S2) - (S5 + S6)}{N/3}$$

Where S1, S2, S5 and S6 are the frequencies of correct answers in the high-score groups (G1 and G2) and low-score groups (G5 and G6), respectively; N, Total number of respondents.

c. *Point-biserial correlation*: This statistic is also used in item analysis to measure the correlation between the item and the overall test score. A significant point-biserial correlation indicates that the item effectively discriminates between those with higher and lower overall scores, thus ensuring the quality of the test items.The item analysis yielded a total of 17 items for administering the final knowledge test (Table 1).

Thereafter, the DID approach was employed to estimate the causal effect of *Kisan Sarathi* advisories by comparing the change in knowledge levels over time between the experimental (user) and control (non-user) groups. This approach is particularly appropriate for this study as it controls unobserved time-invariant differences between user and non-user groups, thereby enabling a more robust estimation of the causal impact of *Kisan Sarathi* advisories compared to simple before-after or cross-sectional comparisons. The method facilitates assessment of whether access to advisories leads to measurable improvements in farmers' knowledge levels; comparison of differential changes between user and non-user groups over time, and generation of insights for strengthening ICT-based extension models for more effective and inclusive information dissemination.

To implement the DID estimation, pre-test and post-test assessments were conducted for both the groups. At the baseline (t_0), knowledge levels of the experimental and control groups were measured as Y_0 and Y_0', respectively. Following the intervention period (t_1), the post-test knowledge levels were recorded as Y_1 for the experimental group and Y_1' for the control group. The change in knowledge within the experimental group was computed as $\Delta X = (Y_1 - Y_0)$, while the corresponding change in the control group was estimated as $\Delta X' = (Y_1' - Y_0')$. The net effect attributable to *Kisan Sarathi* advisories was then derived as the difference between these two changes, expressed as:

$$\text{Impact of } \textit{Kisan Sarathi} = (Y_1 - Y_0) - (Y_1' - Y_0') = \Delta X - \Delta X'$$

This formulation isolates the programme effect by subtracting the change that would have occurred in the absence of the intervention, as reflected in the control group. By doing so, the DID framework strengthens causal inference and provides a more reliable estimation of the platform's impact on farmers' knowledge levels.

A key assumption of the DID approach is the parallel trend assumption, which requires that, in the absence of the intervention, the treatment and control groups would have followed similar trends over time. In the present study, only one pre-intervention observation was available, which limits the ability to statistically test this assumption. However, efforts were made to ensure comparability between the groups through the sampling design, including selection from similar agro-ecological contexts and balanced representation of user and non-user farmers. Moreover, the absence of statistically significant differences in baseline knowledge levels between the two groups further supports the plausibility of the parallel trend assumption.

RESULTS AND DISCUSSION

A DID regression model with cluster-robust standard

Table 1 List of items selected for knowledge test

Sl. no.	Items	Difficulty index (%)	Discrimination index	Point bi-serial
1	Which of the following benefits is associated with feeding Napier grass to dairy cows?	35.00	0.65	0.645**
2	Integrated Pest Management (IPM) focuses on?	55.00	0.3	0.334**
3	What is the recommended dose of phosphorus (P) per hectare for wheat cultivation?	38.33	0.45	0.416**
4	What is the recommended practice to prevent restlessness in livestock when feeding green fodder?	53.33	0.35	0.310*
5	Which insect is a common pest affecting barley?	31.67	0.25	0.274*
6	What is the optimal sowing time of mustard?	78.33	0.4	0.341**
7	Which nutrient deficiency symptom in wheat often appears as yellowing of the older/lower leaves starting from the tips?	30.00	0.2	0.262*
8	What is the main reason of applying Sulphur (S) in the cultivation of *rabi* crops?	55.00	0.55	0.448**
9	What is the recommended feeding schedule for milch animals?	48.33	0.35	0.270*
10	Which wheat variety is widely cultivated in UP for its high yield and resistance to rust?	31.67	0.6	0.549**
11	What is the recommended method to control aphid pests in mustard crops?	30.00	0.45	0.496**
12	What is the primary insect pest that damages the grains of stored wheat?	43.33	0.55	0.401**
13	Which of the following practices is recommended while storing potato tubers and potato seeds?	33.33	0.65	0.551**
14	If mustard plants show stunted growth and purpling of leaves, which nutrient is likely deficient?	43.33	0.6	0.523**
15	What are typical symptoms of mustard stem rot disease?	56.67	0.3	0.263*
16	What is the recommended method to overcome deficiency in milk production of dairy animals due to low temperatures?	48.33	0.65	0.545**
17	What is the primary purpose of a soil health card?	46.67	0.85	0.706**

**Significant at p-value<0.01; *p-value<0.05.

errors (Table 2) was applied to assess the effect of *Kisan Sarathi* advisories on farmers' knowledge levels. In pre-intervention scores, the baseline knowledge score of the experimental group (exp_pre) was higher than that of the control group's post-intervention score (con_post) which served as the reference category, but the difference was not statistically significant (p = 0.175). The control group's pre-intervention score (con_pre) was slightly, but significantly lower compared to the reference category. In post-intervention scores, the experimental group (exp_post) showed a significant increase (coefficient = 4.36, p<0.001) than the control group, confirming a strong positive effect of *Kisan Sarathi* advisories on knowledge acquisition among farmers.

The coefficient plot (Fig. 2) visually represented the magnitude and direction of the estimated effects from the DID regression model for panel data. Each point represented the estimated coefficient, while the horizontal lines indicated the 95% confidence intervals (CI). Coefficients with CI crossing zero indicated that their effects were not statistically significant, whereas those with confidence intervals not crossing zero suggested a significant effect. The coefficient for exp_post was large and positive, with its confidence interval not crossing zero, indicating a statistically significant positive effect of *Kisan Sarathi* advisories on farmers' knowledge levels. The coefficient for exp_pre was moderately positive, indicating that the experimental group initially had slightly higher knowledge levels than the reference category (con_post). However, the confidence interval crossed zero, suggesting that this effect was not statistically significant. This was consistent with expectations, as both groups were anticipated to be comparable before the intervention. On the other hand, the coefficient for con_pre was negative and statistically significant, indicating that farmers in the control group had slightly lower knowledge scores before the intervention, compared to the con_post (reference category). The confidence interval did not cross zero, confirming the statistical significance of this finding. Several factors could explain this result, including the natural learning effect, baseline variation in knowledge levels, which led to an increase in control group's post

Table 2 Effect of *Kisan Sarathi* advisories on farmers' knowledge levels

Groups	Panel data variables	Coefficient values	Std. errors	Interpretation
Experimental group before intervention	exp_pre	0.500	0.353	This coefficient represents the difference in knowledge scores between the experimental and control groups before the intervention. It is not significant.
Experimental group after intervention	exp_post	4.360***	0.386	Coefficient for experimental group after the intervention. Strong positive effect of the intervention.
Control group before intervention	con_pre	-0.313***	0.081	Coefficient shows difference in scores for the control group before the intervention. Indicates a small but significant decrease in scores for the control group in the pre-intervention period.
Control group after intervention	con_post	-	-	Variable is being used as a reference category.

Residual Std. Error: 3.186 (*df* = 596); R^2: 0.260; F Statistic: 69.881*** (*df* = 3; 596).

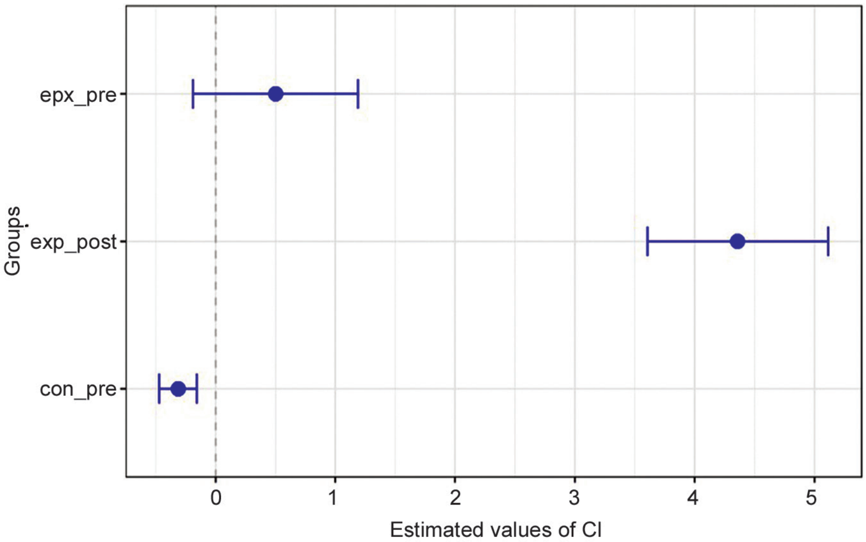

Fig. 2 Coefficient plot of the DID regression model with cluster-robust standard errors. exp_pre, Experimental group before intervention; exp_post, Experimental group after intervention; con_pre, Control group before intervention.

knowledge and pointed towards its utility as a resource in agricultural EAS. The findings of the knowledge test highlighted the significant effect of *Kisan Sarathi* as an advisory platform in enhancing farmers' knowledge. The DID regression model revealed a substantial improvement in knowledge scores among the experimental group, underscoring the platform's role in addressing knowledge gaps and providing valuable information to farmers.

These results aligned with Reddy (2017), who reported a positive and significant impact of mobile phone-based agro-advisory services like e-Kapas on cotton farmers' knowledge levels. By delivering relevant, straightforward, and need-

scores compared to its pre scores, though this increase was smaller than that observed for the experimental group post-intervention. The variable con_post was automatically dropped from the model to avoid redundancy, as it served as the reference category in the DID regression. The findings from the cluster-robust regression model confirmed that *Kisan Sarathi* advisories significantly enhanced farmers' knowledge levels. Since these estimates corrected for potential biases in standard regression models, they provided stronger evidence of the intervention's effectiveness in improving knowledge dissemination as an extension and advisory system.

Overall model performance and robustness: The R^2 value (0.260) indicated a moderate explanatory power, with an F-statistic of 69.88 (p<0.001) confirming the model's overall significance. Fig. 3 illustrated the pre- and post-intervention knowledge levels, demonstrating a steep increase in the experimental group, while the control group remained largely unchanged. It highlighted the effectiveness of advisories provided by *Kisan Sarathi* in increasing farmers'

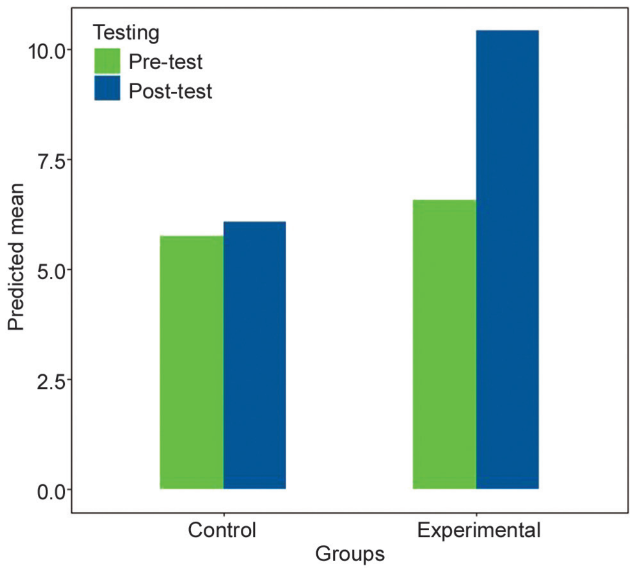

Fig. 3 Pre- and post-effect of *Kisan Sarathi* advisories on experimental and control groups.

specific information through voice messages in the local language (Telugu), e-Kapas effectively bridged information gaps and reduced information asymmetry. The findings were also consistent with the results of Mahra *et al.* (2015) and Larochelle *et al.* (2019). Similarly, *Kisan Sarathi* had shown its potential to provide timely and tailored advisories, significantly improving the knowledge levels of farmers in the experimental group.

The observed improvement in farmers' knowledge in the present study is also consistent with emerging evidence from other digital agriculture and mobile-based advisory systems. For instance, studies on Digital Green have demonstrated that video-enabled and participatory advisory approaches significantly enhanced farmers' knowledge and adoption of improved practices by improving message clarity and contextual relevance (Gandhi *et al.* 2007, Priya *et al.* 2025). Similarly, digital advisory and market platforms such as mKisan and eNAM have been shown to improve farmers' access to timely information and market intelligence, leading to better decision-making and increased awareness levels (Saini *et al.* 2023, Reddy *et al.* 2025). These findings collectively suggested that ICT-enabled advisory systems, irrespective of platform type, play a crucial role in enhancing farmers' knowledge and bridging information gaps, which is consistent with the significant knowledge gains observed among *Kisan Sarathi* users in the present study.

The findings decisively showed that *Kisan Sarathi* enhanced farmers' knowledge in a meaningful and measurable way, reaffirming the strategic value of digital platforms in strengthening India's agricultural extension landscape. The cognitive gain among users illustrates how personalised, real-time, and context-specific advisories can overcome long-standing information bottlenecks and support more informed on-farm decisions. These highlight the policy imperative for sustained investments in ICT-enabled extension models that complement public systems, deepen last-mile reach, and promote equitable access to credible knowledge. The demonstrated effectiveness further highlights the need to integrate such platforms within broader extension reforms, ensuring that digital advisories evolve into robust, scalable, and farmer-responsive mechanisms capable of supporting resilient and knowledge-driven agriculture. However, to further strengthen the mechanism, effective content management will be critical for wider adoption and improved effectiveness. Given the influx of information from diverse sources, which often creates confusion and challenges in choosing the appropriate course of action, it becomes imperative to establish a robust content management mechanism that integrates content creators (scientists and researchers from ICAR institutes, KVKs, and SAUs), content approvers (domain experts), and content customisers (KVK personnel) to ensure location-specific and contextually appropriate advisories. Nevertheless, the findings are based on selected districts of Uttar Pradesh, and therefore, their generalizability to other regions with different socio-economic and agro-ecological conditions should be interpreted with caution.

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