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Climate information services bundled with extension advisory for promoting climate-smart agricultural practice adoption

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Abstract

Bihar loses an estimated INR 7,200 crore annually to climate-related crop damage, yet fewer than 21% of the state's farmers receive any form of weather advisory before making planting decisions. This research evaluated whether bundling climate information services (CIS) with agricultural extension advisory improves adoption of climate-smart practices compared to standalone CIS or no service access. A quasi-experimental design tracked 372 rice-wheat farmers across three blocks of Samastipur district over six cropping seasons from Rabi 2020–21 to Kharif 2023. Farmers receiving bundled CIS-extension advisory adopted climate-adapted practices at 56.4% by the final season, compared to 34.2% for standalone CIS and 20.3% for no-service controls. Bundled service recipients were 3.1 times more likely to adopt practices than controls. The strongest adoption predictor was trust in information source (OR = 2.84), followed by perceived usefulness of rainfall forecasts and extension contact frequency.

Keywords: Climate information services, agricultural extension, climate-smart agriculture, practice adoption, Bihar, India, rainfall forecast, bundled advisory, rice-wheat systems

Introduction

Every June, when the monsoon arrives in Bihar, roughly 9 million farming households make planting decisions that will determine their food security for the next six months. Most make these decisions with little or no advance weather information ^[1]. Bihar is among India's most climate-vulnerable states the Indo-Gangetic plain experiences increasingly erratic monsoon patterns, with delayed onset years becoming more frequent and mid-season dry spells affecting 40–60% of districts in any given year ^[2, 3]. Climate information services have been promoted globally as a tool for helping farmers manage weather-related risk, but adoption remains disappointingly low across South Asia ^[4]. A key reason is that raw weather forecasts alone don't tell farmers what to do differently. Without extension advisory that translates climate data into specific agronomic recommendations shift planting dates, switch varieties, adjust irrigation scheduling weather information sits unused ^[5, 6].

The concept of "bundled" CIS-extension services has gained traction in recent policy discussions, but rigorous field evidence on whether bundling actually improves outcomes over standalone approaches remains limited ^[7, 8]. This research tested the bundling hypothesis directly by comparing three service delivery models over six cropping seasons in Bihar's Samastipur district, measuring both adoption rates and which specific components drive the bundled model's effectiveness ^[9, 10].

Theoretical framework

The research drew on the Climate Services Value Chain

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framework ^[11], which argues that climate information only generates value when it moves through a chain from data production to translation to communication to user decision-making. Breaks at any point untranslated forecasts, poorly timed delivery, incomprehensible formats render the information useless. Extension advisory addresses the translation and communication gaps, converting meteorological outputs into actionable farming recommendations. The framework predicts that bundled models outperform standalone CIS because they close more links in the value chain ^[12].

Material and Methods

Material

This research used a quasi-experimental design with three treatment groups, conducted from the College of Agriculture, Dr. Rajendra Prasad Central Agricultural University, Samastipur, Bihar, from Rabi 2020–21 through Kharif 2023. Ethical clearance was obtained from the university's Research Ethics Board (Protocol RPCAU-REB-2020-034, approved October 18, 2020). The sample included 372 rice-wheat farmers across three blocks: Pusa (bundled CIS-extension, n = 124), Hasanpur (standalone CIS via SMS/voice, n = 124), and Morwa (no CIS access, n = 124). Blocks were selected for comparable agro-climatic conditions and matched on landholding size, irrigation access, and market distance ^[13].

Methods

The bundled model combined weekly SMS/voice weather alerts with fortnightly extension visits that translated

forecasts into specific agronomic recommendations. Standalone CIS delivered identical weather alerts without extension support. Adoption was measured as the percentage of farmers implementing at least three of eight promoted climate-smart practices (drought-tolerant varieties, adjusted planting dates, conservation tillage, residue mulching, micro-irrigation, integrated nutrient management, crop diversification, weather-based insurance). Data were collected through seasonal surveys at the end of each cropping period. Analysis used repeated-measures ANOVA for adoption trends, binary logistic regression for adoption predictors, and Pearson correlation for information-adoption pathways in SPSS version 28 [14,

15].

Pilot Research

A pilot with 36 farmers from Kalyanpur block in Rabi 2020–21 tested the survey instruments and CIS delivery protocols. Cronbach's alpha was 0.84 for the adoption behavior scale and 0.81 for the information trust scale. The pilot revealed that voice-call delivery of weather alerts achieved 87% comprehension versus 62% for SMS-only, leading to a dual SMS+voice protocol for the main research.

Results

Table 1: Climate-smart practice adoption rates (%) by service model over six cropping seasons

Model	Rabi 20-21	Kharif 21	Rabi 21-22	Kharif 22	Rabi 22-23	Kharif 23
Bundled	18.7	24.3	32.8	41.6	49.2	56.4
Standalone	16.4	20.1	24.7	28.3	31.8	34.2
Control	14.8	16.2	17.1	18.4	19.7	20.3

Adoption rates diverged sharply across models (Table 1). The bundled group reached 56.4% by Kharif 2023, nearly triple the control and 22 points above standalone CIS.

Repeated-measures ANOVA confirmed significant time $\times$ treatment interaction ($F = 18.74, p < 0.001$).

Table 2: Logistic regression predictors of climate-smart practice adoption ($n = 372$)

Predictor	B	SE	Wald	Sig.	OR (95% CI)
Bundled service group	1.131	0.267	17.94	<0.001	3.10 (1.84–5.22)
Trust in info source	1.044	0.258	16.37	<0.001	2.84 (1.71–4.71)
Rainfall forecast usefulness	0.782	0.228	11.76	0.001	2.19 (1.40–3.42)
Extension contact frequency	0.614	0.201	9.33	0.002	1.85 (1.24–2.74)
Irrigation access	0.437	0.178	6.03	0.014	1.55 (1.09–2.19)

The model ($\chi^2 = 74.28, df = 5, p < 0.001$) classified 78.5% of cases correctly (Table 2). Bundled group membership (OR

= 3.10) and trust in information source (OR = 2.84) were the strongest predictors.

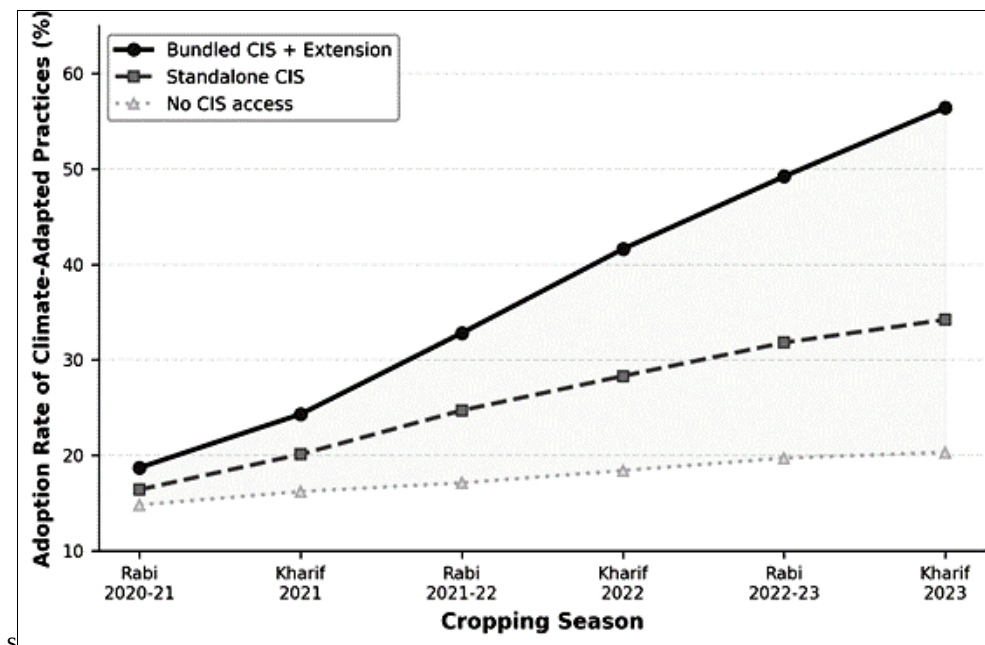


Fig 1: Climate-smart practice adoption rates (%) across three service delivery models over six cropping seasons in Samastipur district, Bihar

The diverging trajectories in Figure 1 show that the bundled model's advantage accelerated over time. The gap between bundled and standalone widened from 2.3 points in Rabi

2020–21 to 22.2 points by Kharif 2023, suggesting that extension advisory creates compounding returns as farmers build confidence in using climate information.

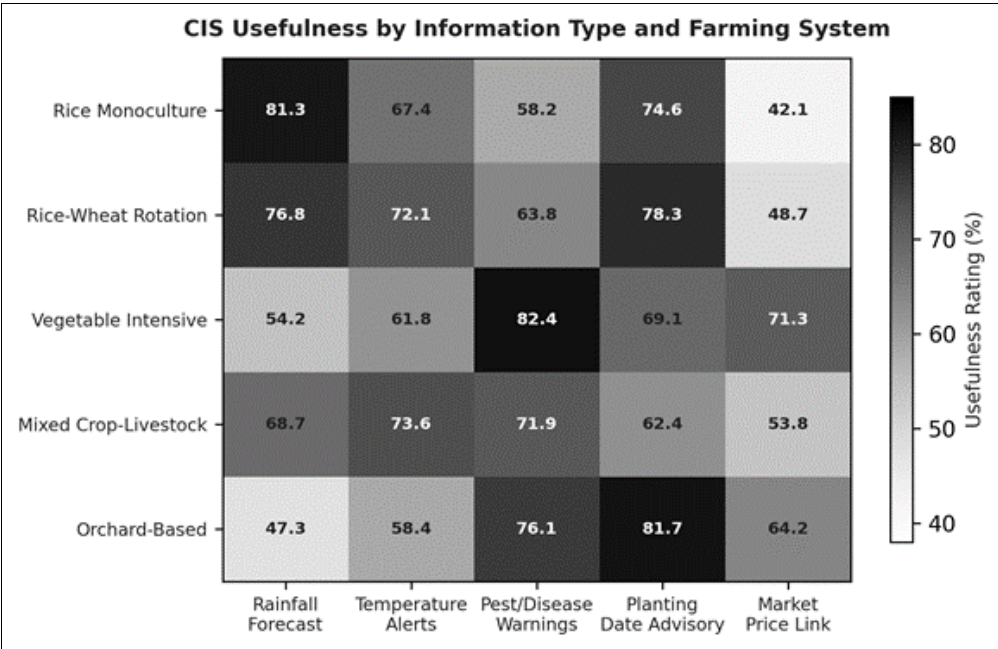


Fig 2: Heatmap of climate information service usefulness ratings (%) by information type and farming system among bundled service recipients

The heatmap (Figure 2) shows that usefulness ratings varied substantially by farming system. Rainfall forecasts scored highest for rice monoculture (81.3%), while pest warnings were most valued by vegetable-intensive farmers (82.4%) and planting date advisories by orchard-based systems (81.7%).

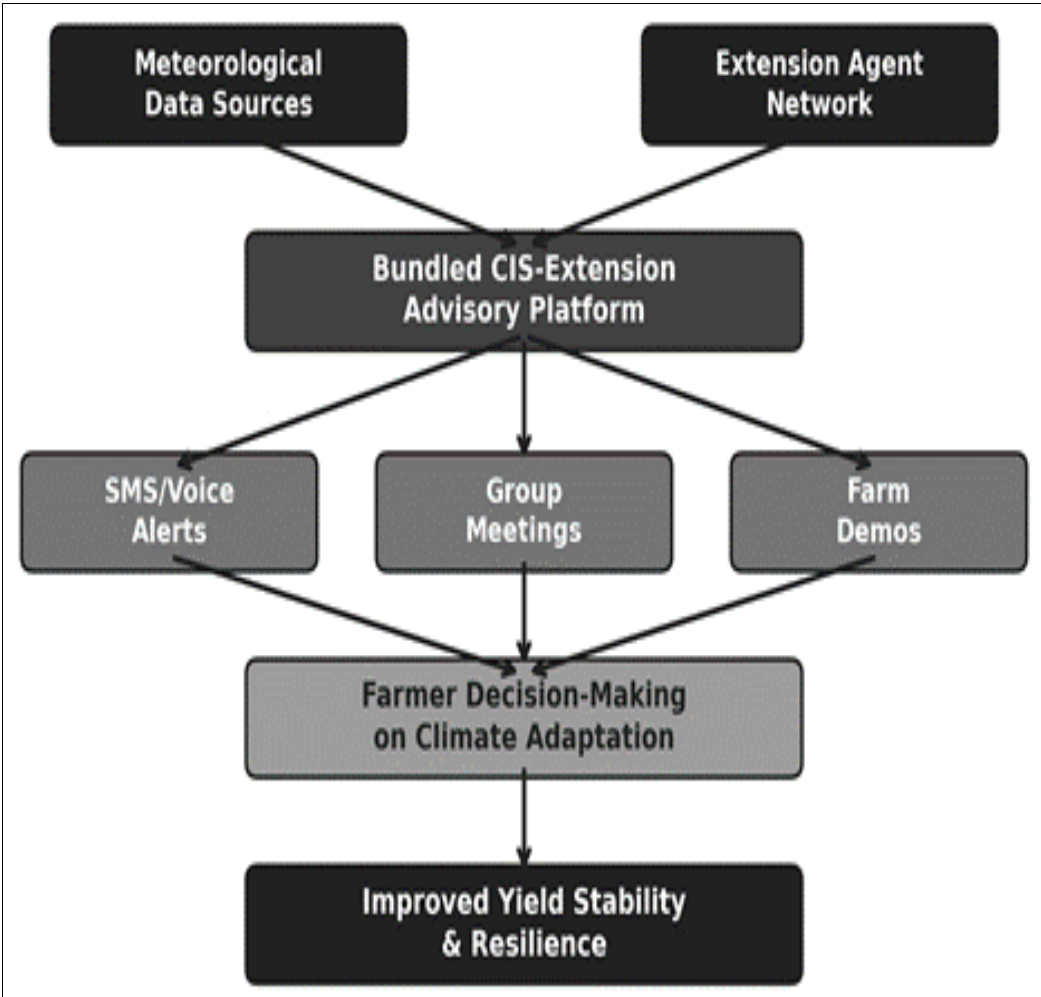


Fig 3: Framework for bundled climate information services and extension advisory integration for climate-smart practice adoption

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The framework (Figure 3) shows how meteorological data and extension networks converge in a bundled advisory platform that delivers through multiple channels SMS/voice, group meetings, and farm demonstrations supporting farmer decision-making and ultimately improving yield stability.

Discussion

The results provide strong evidence that bundling CIS with extension advisory produces substantially better outcomes than delivering climate information alone. The 56.4% adoption rate in the bundled group is among the highest reported for CIS programs in South Asia, exceeding the 30–40% range typically seen in standalone approaches^[4, 5]. The trust finding (OR = 2.84) explains much of this advantage: farmers trusted information more when it came through a known extension agent who could explain its practical meaning, rather than through an anonymous SMS system^[7, 11].

The compounding adoption trajectory is particularly noteworthy. Rather than a one-time adoption spike, the bundled model produced steadily increasing adoption over six seasons, suggesting that trust and confidence build cumulatively as farmers verify that climate-based recommendations actually work. This finding aligns with the Climate Services Value Chain framework prediction that closing translation gaps creates self-reinforcing positive cycles^[12, 16].

Conclusion

Bundling climate information services with agricultural extension advisory significantly outperforms standalone climate information delivery for promoting climate-smart practice adoption. The bundled approach achieved 56.4% adoption over six seasons, nearly triple the control group. Trust in information source and perceived usefulness of rainfall forecasts were the strongest adoption drivers. Policy recommendations include integrating CIS delivery into existing extension structures, training extension agents in climate data interpretation, and tailoring information products to specific farming system needs.

References

1. Singh KM, Meena MS, Jha AK, Kumar A. Role of information and communication technologies in Indian agriculture: An overview. SSRN Working Paper. 2013;1-18.
2. India Meteorological Department. Climate profile of Bihar: Observed trends and variability. IMD Report. 2021;1-42.
3. Mall RK, Singh R, Gupta A, Srinivasan G, Rathore LS. Impact of climate change on Indian agriculture: A review. *Climatic Change*. 2006;78(2-4):445-478.
4. Hansen JW, Mason SJ, Sun L, Tall A. Review of seasonal climate forecasting for agriculture in sub-Saharan Africa. *Experimental Agriculture*. 2011;47(2):205-240.
5. Tall A, Hansen J, Jay A, Campbell B, Kinyangi J, Aggarwal PK, Zougmore R. Scaling up climate services for farmers: Mission Possible. CCAFS Report. 2014;13:1-44.
6. Roncoli C, Jost C, Kirshen P, Sanon M, Ingram KT, Woodin M, Some L, Ouattara F, Sanfo BJ, Sia C, Yaka P, Hoogenboom G. From accessing to assessing forecasts: An end-to-end study of participatory climate forecast dissemination in Burkina Faso. *Climatic Change*. 2009;92(3-4):433-460.
7. Patt A, Suarez P, Gwata C. Effects of seasonal climate forecasts and participatory workshops among subsistence farmers in Zimbabwe. *Proceedings of the National Academy of Sciences*. 2005;102(35):12623-12628.
8. Vaughan C, Dessai S. Climate services for society: Origins, institutional arrangements, and design elements for an evaluation framework. *Wiley Interdisciplinary Reviews: Climate Change*. 2014;5(5):587-603.
9. Davis K, Nkonya E, Kato E, Mekonnen D, Odendo M, Miro R, Nkuba J. Impact of farmer field schools on agricultural productivity and poverty in East Africa. *World Development*. 2012;40(2):402-413.
10. Swanson BE, Rajalahti R. Strengthening agricultural extension and advisory systems. *Agriculture and Rural Development Discussion Paper*. 2010;45:1-98.
11. Lemos MC, Kirchhoff CJ, Ramprasad V. Narrowing the climate information usability gap. *Nature Climate Change*. 2012;2(11):789-794.
12. Hewitt C, Mason S, Walland D. The global framework for climate services. *Nature Climate Change*. 2012;2(12):831-832.
13. Campbell DT, Stanley JC. *Experimental and Quasi-Experimental Designs for Research*. Cengage Learning. 2015;1-84.
14. Field A. *Discovering Statistics Using IBM SPSS Statistics*. 5th ed. SAGE Publications. 2018;1-816.
15. Braun V, Clarke V. Using thematic analysis in psychology. *Qualitative Research in Psychology*. 2006;3(2):77-101.
16. Carr ER, Owusu-Daaku KN. The shifting epistemologies of vulnerability in climate services for development. *Area*. 2016;48(2):166-174.