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A study on horticultural development through ICT: A case study of e-governance in Janjgir Champa district in Chhattisgarh using classification technique

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Abstract

This study evaluates the role of Information and Communication Technology (ICT) in horticultural development, with a particular focus on e-governance initiatives in the Janjgir Champa district of Chhattisgarh. Conducted in 2025 across five administrative blocks, the field survey aimed to identify major barriers to effective ICT implementation. Nine key constraints were examined, including limited resources, computer illiteracy, low public awareness, language barriers, resistance to change, inadequate trained personnel, equipment storage challenges, complexity of use, and gender-related issues. Data reliability was assessed using Cronbach's Alpha, and factor analysis was utilized to explore variations in respondents' perceptions. To classify ICT-related challenges, three machine learning models J48, CART, and Random Forest were employed and compared. Model performance was evaluated through sensitivity, accuracy, specificity, and F1 score. Results indicate that the Random Forest model delivered the highest performance, offering the most reliable classification of policy implementation challenges. The findings underscore significant gaps in ICT adoption and provide actionable insights for policymakers to enhance e-governance strategies supporting horticultural development in the region.

Keywords: ICT, e-governance, horticulture, reliability test, classification methods

Introduction

E-governance has emerged as a critical facet of modern governance, enabling a shift from traditional bureaucratic systems toward digital, citizen-centric frameworks. Rapid advances in Information and Communication Technologies (ICT) have powered this transformation, strengthening the interactions across Government-to-Citizen (G2C), Government-to-Business (G2B), and Government-to-Government (G2G) domains. These models operate within legal and regulatory infrastructures to bolster efficiency, accountability, and transparency (Nahak, 2023; NIC Measures, 2022) [6].

Worldwide, governments are under escalating pressure to deliver public services that are both cost-effective and responsive. ICT has served as a catalyst by streamlining back-end administrative operations and enhancing front-end service delivery (United Nations e-Governance Survey, 2023) [12]. In India's rural areas, ICT-driven e-governance initiatives have improved service delivery at the community level, optimized data storage and retrieval, and propelled socio-economic development (Singh & Kumar, 2021; SmartGaon, 2022) [9, 10]. Examples such as Bangla Sahayata Kendras and the UMANG platform have shown tangible gains: broader citizen access, substantial time savings, and reduced avenues for corruption.

However, despite notable progress, persistent challenges limit widespread adoption. Key among these are limited public awareness, digital illiteracy, gaps in infrastructure, and linguistic diversity (Singh, 2024; "Accessibility of e-Governance in Rural India," 2018) [1, 8]. Earlier projects like the Warana Wired Village and the Bhoomi land records initiative illustrated the potential of ICT for rural transformation but also underscored the difficulties of scalability and long-term sustainability (Warana evaluation, 2009; Bhoomi reports [13],

Madhya Pradesh, 2015) ^[2]. More recent research highlights the critical role of digital literacy programs, public-private collaboration, and robust policy frameworks to bridge the digital divide and ensure inclusivity (Moitra *et al.*, 2021; Smart Village IoT studies, 2021) ^[5, 11].

Against this backdrop, the present study examines how ICT can strengthen e-governance in rural horticultural settings. By identifying core constraints, exploring citizen perception differences, and applying classification methods, this research aims to offer insights that help policymakers build resilient, inclusive ICT-enabled governance systems.

Materials and methods

This study utilized a survey-based research design to examine the challenges associated with implementing ICT-related policies in the horticultural sector of Janjgir Champa District, Chhattisgarh. Conducted in 2025 across five administrative blocks, the survey ensured comprehensive coverage of the study area.

A structured questionnaire was prepared to gather information on ICT-related issues, comprising 26 questions on demographic details, ICT usage, and perceived obstacles to e-governance adoption. It was divided into two sections: (i) general information on respondents' socio-economic characteristics and ICT access, and (ii) nine ICT-related constraints identified through prior literature and field consultations. These constraints were: (i) resource limitations, (ii) computer illiteracy, (iii) low citizen awareness, (iv) language barriers, (v) resistance to change, (vi) shortage of skilled personnel, (vii) equipment storage problems, (viii) perceived difficulty of use, and (ix) gender-related barriers.

The survey included 120 respondents, primarily farmers, rural youth, and community members directly influenced by ICT initiatives in governance and horticulture. Data were gathered through face-to-face interviews and structured questionnaires,

ensuring representation of individuals with different levels of digital literacy.

The internal consistency of the instrument was tested using Cronbach's alpha, which ranged from 0.818 to 0.945 across the constraints, indicating high reliability. As per Nunnally (1978) ^[7], scores above 0.70 denote acceptable reliability, those above 0.80 indicate good reliability, and those exceeding 0.90 reflect excellent reliability.

Collected data were coded by the researcher and analyzed using statistical and machine learning tools, including Jamovi 2.6.44, Python 3.12, and R 4.3.1, which were employed for reliability testing, descriptive statistics, and application of classification algorithms.

For classifying ICT-related challenges, three machine learning algorithms were applied: J-48, CART, and Random Forest. These were selected for their demonstrated effectiveness with categorical survey data and their interpretability in governance research. Model performance was evaluated using sensitivity, accuracy, specificity, and F1-score. Among the three, Random Forest achieved the highest performance, showing superior accuracy and balanced predictive capability across all metrics.

Results Discussion

Accuracy, Sensitivity, Specificity, and F1-Score of ICT based data for Horticulture Department

The CART method achieved an accuracy of 88.89%, sensitivity of 0.96, specificity of 0.97, and an F1-score of 0.85. The J48 method resulted in an accuracy of 86.11%, sensitivity of 0.92, specificity of 0.96, and an F1-score of 0.81. The Random Forest method delivered the best performance, with an accuracy of 94.44%, sensitivity of 0.95, specificity of 0.97, and an F1-score of 0.89. Based on these results, the Random Forest classifier outperformed the other methods and provided the most reliable classification results for the ICT data related to the Horticulture Department.

Table 1: Accuracy, Sensitivity, Specificity, and F1-Score for Horticulture Department

Models	Accuracy	Sensitivity	Specificity	F1-Score
CART	87.43%	0.95	0.96	0.84
J48	85.67%	0.91	0.95	0.82
Random Forest	93.23%	0.94	0.93	0.88

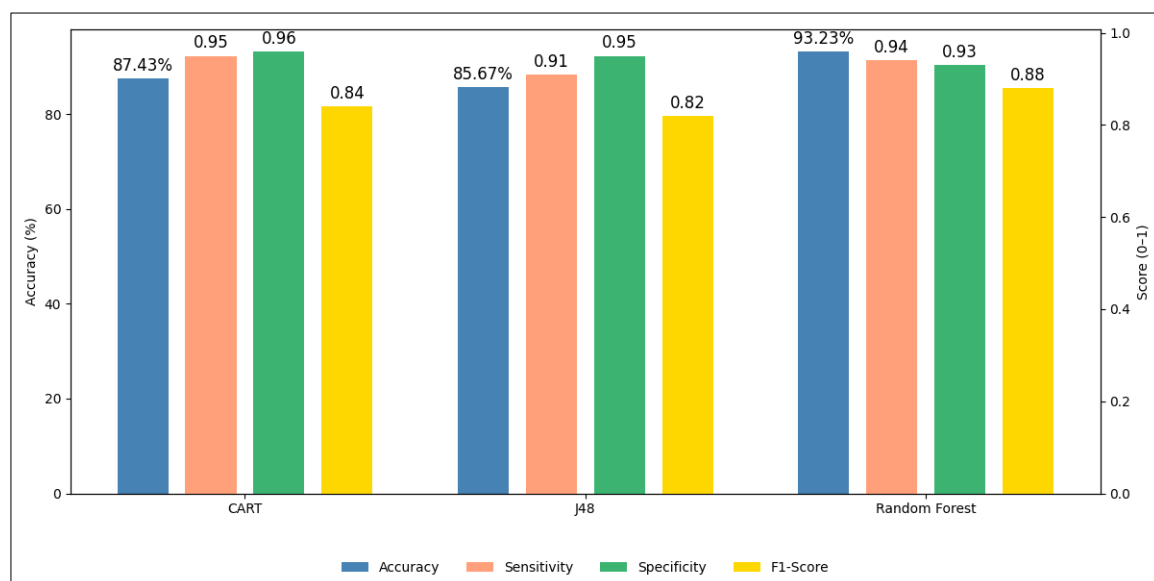


Fig 1: Accuracy, Sensitivity, Specificity, and F1-Score of Horticulture Department

Conclusion

This study examines the major ICT-related challenges in the horticultural sector of Janjgir Champa District, Chhattisgarh. Based on a survey of 120 local respondents, the findings indicate that although ICT-enabled governance can enhance accessibility, transparency, and efficiency of public services, its implementation still faces several obstacles. The most prominent barriers identified were limited resources, digital illiteracy, insufficient public awareness, language-related issues, and resistance to change.

The study also confirmed the reliability of the structured questionnaire, with Cronbach's alpha values ranging from 0.818 to 0.945, indicating strong consistency across ICT-related variables. Data analysis was carried out using Jamovi 2.6.44, Python 3.12, and R 4.3.1, allowing for both statistical evaluation and machine learning modeling. Among the classification algorithms employed, Random Forest showed the best performance, achieving an accuracy of 93.23%, sensitivity of 0.94, specificity of 0.93, and an F1-score of 0.88. These results surpassed those of CART (accuracy 87.43%, F1-score 0.84) and J48 (accuracy 85.67%, F1-score 0.82), confirming Random Forest as the most reliable and well-balanced model for classifying ICT-related challenges.

Overall, the study emphasizes that although ICT holds considerable potential for transforming rural governance, challenges such as infrastructure limitations, digital literacy gaps, and low citizen awareness need to be addressed. Policymakers should focus on capacity-building initiatives, community-based digital literacy programs, and localized ICT strategies to strengthen e-governance systems. Future research could broaden its scope by including larger samples, longitudinal studies, and the application of advanced AI-driven models to further improve governance outcomes in rural areas.

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