



International Journal of Research in Agronomy

E-ISSN: 2618-0618
P-ISSN: 2618-060X
© Agronomy
NAAS Rating (2026): 5.20
www.agronomyjournals.com
2026; SP-9(2): 148-151
Received: 24-12-2025
Accepted: 28-01-2026

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Gender concerns in the application of digital tools for empowering women farmers: An empirical analysis

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DOI: <https://www.doi.org/10.33545/2618060X.2026.v9.i2Sb.4941>

Abstract

Digital technologies are increasingly transforming agricultural extension, market access, and service delivery systems. However, the effective utilization of digital tools by rural women farmers remains constrained by multiple gender-specific barriers. The present study examined the ranking of gender concerns in digital tool usage among women farmers in Nalgonda district of Telangana. An ex-post facto research design was adopted, and data were collected from 240 rural women farmers using a structured interview schedule. The identified constraints were prioritized using the Garrett Ranking Technique to determine their relative severity.

The results revealed that limited digital literacy and skills emerged as the most severe concern (76.5), followed by lack of ownership of mobile phones/smartphones (71.2) and high cost of digital devices and internet services (68.4). Language barriers (64.8), time constraints due to household and farm workload (61.7) and limited access to digital training (58.2) were also significant factors. Poor network connectivity, socio-cultural restrictions, lack of women-centric digital design and limited family support were comparatively less severe but continue to influence digital participation.

The findings indicate that gender-based digital exclusion is primarily driven by capability gaps, limited access to technology, affordability challenges, and institutional inadequacies. Strengthening digital literacy, ensuring women's independent access to affordable devices, promoting localized and user-friendly content, and enhancing extension support mechanisms are essential to bridge the gender digital divide. Addressing these concerns is crucial for empowering women farmers and promoting inclusive and sustainable agricultural development.

Keywords: Digital tools, women farmers, gender concerns, Garrett ranking technique, women empowerment, inclusive agriculture

Introduction

Digital transformation is rapidly reshaping agricultural systems worldwide. The expansion of mobile phones, internet connectivity, digital advisory platforms, and e-marketing systems has significantly altered agricultural extension, service delivery, and market integration processes. In India, initiatives such as Digital India and e-NAM have accelerated the integration of digital technologies into agriculture, aiming to improve farmers' access to real-time weather information, market intelligence, crop advisories, financial services, and government schemes. These interventions are expected to enhance farm productivity, reduce transaction costs, and strengthen decision-making capacity at the farm level.

Despite these advancements, the benefits of digital agriculture are not equally distributed across gender groups. Women constitute a significant share of the agricultural workforce in India, particularly in crop production, livestock management, and post-harvest operations. However, their access to productive resources, extension services, and institutional support remains comparatively limited. The Food and Agriculture Organization (2023) ^[2] reported that structural gender inequalities in agrifood systems restrict women's access to education, information, technology, and decision-making power, thereby limiting their ability to benefit from innovation-driven agricultural growth.

The emergence of digital technologies presents new opportunities for women's empowerment, yet it also risks widening existing disparities if gender-specific constraints are not addressed. The persistent "gender digital divide" reflects unequal access to mobile devices, internet

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connectivity, digital skills, and online services. According to the GSMA (2024) ^[4], women in low- and middle-income countries are significantly less likely than men to own smartphones or access mobile internet, with affordability, digital literacy gaps, and socio-cultural norms being major barriers. These constraints are particularly pronounced in rural areas, where women's access to technology is often mediated by household power relations and resource control.

Limited digital literacy and skills have been widely recognized as primary determinants of digital exclusion. Studies by Manzoor *et al.* (2025) ^[6] indicate that capability gaps—such as lack of familiarity with smartphone functions, online applications, and digital safety practices—significantly reduce adoption and sustained use of digital agricultural technologies. Similarly, Adithyan *et al.* (2025) ^[1] observed that insufficient exposure to structured digital training programmes and mentoring support limits women farmers' confidence and engagement with digital platforms.

Affordability and device ownership also play a crucial role. The International Telecommunication Union (2023) ^[5] emphasized that cost of smartphones and recurring internet expenses remain substantial barriers for rural women, particularly those with limited independent income. Shared-phone arrangements within households often restrict women's autonomy, privacy, and continuity in accessing agricultural advisories and digital financial services.

Language and content design further influence digital participation. The World Economic Forum (2024) ^[8] highlighted that digital agricultural platforms frequently fail to accommodate women's literacy levels, local language preferences, and time constraints. Gender-responsive design—including voice-based advisories, visual content, and localized interfaces—is essential to ensure inclusivity.

Additionally, women's "time poverty" resulting from unpaid household responsibilities and farm labour significantly affects their engagement with digital tools. The Food and Agriculture Organization (2023) ^[2] emphasized that unequal care burdens reduce women's participation in training programmes, extension activities, and innovation adoption. Socio-cultural norms, mobility restrictions, and limited family support further compound these challenges (Saha *et al.*, 2024) ^[7].

Telangana state has made notable progress in digital governance and agricultural modernization; however, disparities in women's digital participation persist at the grassroots level. In districts such as Nalgonda, women farmers actively contribute to

agriculture but face multiple structural and institutional barriers in accessing digital resources. Empirical assessment of these gender concerns is necessary to design targeted and inclusive extension strategies.

In this context, the present study aims to analyze and rank the gender concerns associated with the use of digital tools among women farmers in Nalgonda district of Telangana. By employing the Garrett Ranking Technique, the study seeks to identify the most severe constraints limiting digital participation and to provide evidence-based recommendations for bridging the gender digital divide. Addressing these concerns is crucial for promoting inclusive digital agriculture and empowering women farmers within sustainable agrifood systems.

Methodology

An Ex-post facto research design was adopted for the study. The State of Telangana was chosen since the researcher was familiar with local language and culture. The study was conducted in the Nalgonda district with a total of 120 farmers participating.

The Henry Garrett Ranking Technique was employed to assess and prioritize the gender concerns influencing the use of digital tools among women farmers. This method enables systematic ranking of multiple constraints based on respondents' perceived severity. Under this technique, each respondent was asked to rank the identified gender concerns according to the magnitude of the problem experienced by them.

The ranks assigned by the respondents were converted into percent positions using the following formula:

$$\text{Percent position} = 100 (\text{Rij} - 0.5) / \text{Nj}$$

Where, Rij = Rank given for the *i*th variable by *j*th respondents
Nj = Number of variables ranked by *j*th respondents

The percentage position of each rank obtained was converted into scores by referring to the table given by Henry Garrett. Then for each gender concern, the scores of individual respondents were added together and divided by the total number of respondents for whom the scores were added. The mean scores for all the gender concern were calculated and ranked accordingly and inferences were drawn.

Results and Discussion

The prioritized gender concerns are presented in Table 1. Higher mean scores indicate higher perceived severity.

Table 1: Garrett Ranking of Gender Concerns in Digital Tool Usage (N=240)

Rank	Gender Concern	Mean Garrett Score
1	Limited digital literacy and skills	76.5
2	Lack of ownership of mobile phones/smartphones	71.2
3	High cost of digital devices and internet services	68.4
4	Language barriers and difficulty in understanding content	64.8
5	Time constraints due to household/farm workload	61.7
6	Limited access to training on digital tools	58.2
7	Poor network and internet connectivity	54.6
8	Socio-cultural restrictions on women's use of technology	52.1
9	Digital tools not designed according to women's needs	49.8
10	Lack of support from family members	46.5

Limited digital literacy and skills emerged as the most severe concern (Rank 1; Mean Garrett Score: 76.5). This may be because many women farmers have had fewer opportunities for formal education, limited exposure to smartphones beyond basic calling, and less confidence in navigating menus, apps, links,

forms, and security settings. In many villages, digital learning happens informally through peers or family members; when such support is absent, women tend to avoid using unfamiliar functions due to fear of "making mistakes," losing money/data, or damaging the device. Further, most agricultural advisories

increasingly require skills such as reading messages, searching videos, joining groups, using location settings, or interpreting visuals—skills that develop only with repeated practice. This interpretation is consistent with evidence that capability barriers (skills, knowledge and awareness) strongly influence digital agriculture adoption and sustained use in LMIC contexts (Manzoor *et al.*, 2025) ^[6]. Evidence from women farmers' groups also indicates that limited training opportunities and weak mentoring support can keep digital literacy low even when devices are available (Adithyan *et al.*, 2025) ^[1].

Lack of ownership of mobile phones/smartphones ranked second (Rank 2; 71.2). This likely reflects gendered patterns of asset ownership and control within households, where phones are commonly owned by male members and women's access is mediated by availability, permissions, and competing usage needs. Shared-phone arrangements reduce women's "anytime access" to advisories, limit privacy (especially in calling helplines, joining groups, or using financial apps), and discourage regular engagement with learning content. Women may also avoid using a shared phone for agricultural purposes if they anticipate criticism about "unnecessary phone use" or if the device is prioritized for men's work and social communication. Extension evidence from India notes that women's technology use is shaped by social norms, mobility restrictions, limited control over resources, and financial constraints, reinforcing the rural gender digital divide (Saha *et al.*, 2024) ^[7]. Global monitoring similarly highlights persistent gender gaps in mobile internet and smartphone adoption, which aligns with the structural nature of device ownership constraints (GSMA, 2024) ^[4].

High cost of digital devices and internet services ranked third (Rank 3; 68.4). This can be explained by the combined burden of upfront smartphone costs (purchase/repair) and recurring costs (data recharges), which may be difficult for women who have limited independent income or restricted decision-making power over household spending. Even when households can afford a phone, the perceived risk of damage, theft, or repair costs may discourage allocating a device to women. Additionally, many advisory formats videos, voice notes, app updates—consume significant data, making continued use costly. GSMA (2024) ^[4] identifies affordability as a key barrier to mobile internet adoption and highlights how cost constraints interact with gender gaps. In line with this, research on women farmers' digital literacy constraints also reports that internet cost is a major practical barrier limiting regular digital engagement (Adithyan *et al.*, 2025) ^[1].

Language barriers and difficulty in understanding content ranked fourth (Rank 4; 64.8). This is likely because many digital tools and advisories are designed using dominant languages or formal terminology, while women farmers may be more comfortable with local language communication and oral/visual learning modes. When app interfaces, alerts, or scheme guidelines are not in Telugu (or use complex words), women may depend on others to interpret content, reducing autonomy and timely decision-making. Language challenges are often amplified when content is text-heavy, assumes literacy, or lacks clear visuals and context-specific examples. Gender-inclusive agritech frameworks emphasize that product design must align with women's realities—language, literacy, trusted channels, and usability—otherwise adoption remains limited (WEF, 2024).

Time constraints due to household and farm workload ranked fifth (Rank 5; 61.7). This can be attributed to women's "time poverty" arising from the dual responsibility of unpaid care work (cooking, childcare, elder care) alongside farm and allied

activities (weeding, harvesting support, livestock care, fodder collection). Because digital learning and app use require uninterrupted time—watching videos, attending trainings, reading messages—women may not be able to engage consistently, especially during peak agricultural seasons. Even when information is available, acting on it (visiting markets, attending meetings, contacting extension staff) may require mobility and time flexibility that women often lack. FAO (2023) ^[2] highlights that unequal burdens of unpaid work and structural gender inequality constrain women's participation and benefits in agrifood systems, including access to innovations and services.

Limited access to training on digital tools ranked sixth (Rank 6; 58.2), suggesting institutional gaps in outreach and capacity building for women. Many training programs in rural areas are either infrequent, not targeted to women, scheduled at times inconvenient for them, or delivered in mixed settings where women may participate less actively due to social norms. Moreover, one-time trainings without follow-up often fail to convert exposure into competence; women require repeated practice, troubleshooting support, and confidence-building. Evidence from women farmers' groups indicates that limited training opportunities and weak mentoring significantly constrain digital literacy and continued use (Adithyan *et al.*, 2025) ^[1]. This also aligns with broader adoption research showing that institutional support and human capacity are major determinants of digital technology uptake in agriculture (Manzoor *et al.*, 2025) ^[6].

Poor network and internet connectivity ranked seventh (Rank 7; 54.6). This may be because many villages still experience unstable signals, low bandwidth, or frequent power interruptions, making it difficult to stream advisory videos, download apps, or maintain consistent access to platform updates. When connectivity is unreliable, women may lose interest in digital tools due to repeated "failed attempts," and households may prioritize data use for other purposes. Connectivity problems also reduce trust—farmers may not rely on advisories that arrive late or cannot be accessed during critical decision windows. Determinants of digital adoption in LMIC agriculture consistently include infrastructure and connectivity as key enabling conditions (Manzoor *et al.*, 2025) ^[6].

Socio-cultural restrictions (Rank 8; 52.1), lack of women-centric digital design (Rank 9; 49.8), and limited family support (Rank 10; 46.5) were ranked relatively lower but remain meaningful constraints. Lower ranking may indicate that women perceive practical barriers (skills, ownership, cost) as more immediate than social barriers; however, socio-cultural norms often operate in the background by shaping whether women can own phones, attend trainings, or use devices freely. Gatekeeping by family members can restrict phone use, discourage participation in online groups, or limit travel to digital service points. Additionally, when digital tools are not designed around women's roles (livestock, post-harvest, household nutrition) and constraints (low literacy, limited time, privacy needs), women may not see them as relevant, lowering motivation to adopt. Extension scholarship notes that norms, mobility restrictions, and control over resources continue to shape women's digital engagement (Saha *et al.*, 2024) ^[7]. The WEF's gender-inclusive agritech framework similarly stresses that inclusion depends on designing products and delivery systems that match women's contexts and provide trusted human support alongside technology (WEF, 2024).

Strategies for Enhancing Digital Empowerment of Women Farmers

Strengthening digital literacy among women farmers should be the foremost priority. Regular, hands-on training programmes must be organized at the village level through Krishi Vigyan Kendras (KVKs), extension departments, Self-Help Groups (SHGs), and Farmer Producer Organizations (FPOs). These trainings should focus on basic smartphone operations, use of agricultural apps, participation in digital advisory groups, online safety, and digital financial transactions. Repeated practice sessions and local peer mentors or “digital champions” can help build confidence and sustained engagement.

Improving women’s access to smartphones and affordable internet services is equally important. Government and development agencies can introduce subsidized smartphone schemes, installment-based purchase options, or community digital resource centers managed by SHGs. Collaboration with telecom providers to offer low-cost data plans tailored for rural women farmers can further reduce affordability barriers. Offline or low-bandwidth digital solutions should be promoted in areas with poor connectivity.

Content design must be gender-responsive and user-friendly. Digital platforms should provide local-language (Telugu) interfaces, voice-based advisories, and visual or video content suitable for varying literacy levels. Information should also reflect women’s roles in agriculture, such as livestock management, post-harvest activities, kitchen gardens, and agri-entrepreneurship.

Institutional support systems should be strengthened to ensure continuous guidance. Extension workers must actively include women farmers in digital advisory networks and conduct follow-up visits to reinforce learning. Integrating digital literacy components into ongoing agricultural development programmes will promote long-term sustainability.

Finally, community sensitization initiatives involving family members and local leaders can help reduce socio-cultural barriers and encourage supportive environments for women’s technology use. Collectively, these strategies can enhance women’s digital inclusion and contribute to more equitable and resilient agricultural development.

Conclusion

The study reveals that gender concerns in the use of digital tools among women farmers are primarily related to capability gaps, limited access to devices, and affordability constraints rather than unwillingness to adopt technology. Limited digital literacy emerged as the most severe constraint, followed by lack of smartphone ownership and high cost of devices and internet services. These findings indicate that women’s effective participation in digital agriculture depends largely on their skills, independent access to technology, and financial capacity.

Language barriers, time constraints due to household responsibilities, and limited training opportunities further restrict digital engagement. Although socio-cultural restrictions and connectivity issues were ranked lower, they continue to influence women’s digital participation indirectly.

Overall, bridging the gender digital divide requires improving digital literacy, enhancing women’s access to affordable devices and internet services, and strengthening institutional support systems. Gender-responsive digital initiatives are essential for promoting inclusive agricultural development and empowering women farmers.

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