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Construction of an Index to Assess the Awareness of Horticultural Farmers towards e-Extension Services

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HIGHLIGHTS

- A scientifically validated, index was developed to assess horticultural farmers' awareness among e-extension services.
- The index captures three core domains: general awareness about e-extension, awareness of public e-extension services, and awareness of private e-extension services.
- A rigorous item development process, expert validation (n = 70), and statistical screening (RW ≥ 0.80; MRS ≥ OMRS) resulted in 48 high-quality statements.
- The index demonstrates excellent reliability (Cronbach's alpha = 0.951), confirming its suitability for large-scale field assessment.
- The tool provides a robust framework for examine the awareness level, and evaluation in horticultural systems.

ARTICLE INFO

Keywords: e-Extension services, Information and Communication Technologies (ICTs), Horticultural farmers, Awareness index and Digital advisory systems.

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ABSTRACT

The rapid expansion of Information and Communication Technologies (ICTs) has reshaped agricultural extension, offering scalable pathways for disseminating timely, location-specific information to farmers. Horticulture crops are highly perishable in nature and decision-making time-sensitive; the effectiveness of e-extension systems depends strongly on farmers' awareness and understanding of digital advisories. This present study, conducted during 2025, aimed to construct a scientifically valid and reliable index to measure the awareness of horticultural farmers towards e-extension services. Based on an extensive literature review, expert consultations and field insights, 112 statements were initially generated across three conceptual domains: general awareness about e-extension, awareness of public e-extension services, and awareness of private e-extension services. Following rigorous screening using Edward's criteria and relevancy testing by 70 experts, 48 statements met the established criteria of Relevancy Weightage (≥0.80) and Mean Relevancy Score (≥ OMRS = 2.44). The index was validated through field administration among 60 horticultural farmers in non-sampled areas. Reliability analysis indicated excellent internal consistency (Cronbach's alpha = 0.951) and strong split-half reliability (Spearman-Brown coefficient = 0.936). The validated index provides a robust measurement framework to assess awareness gaps and strengthen ICT-enabled advisory systems, thereby enhancing the accessibility, effectiveness, and impact of e-extension services in the horticultural sector.

INTRODUCTION

Over recent decades, the expansion of Information and Communication Technologies (ICTs) has transformed agricultural extension, creating new pathways for farmers to access expert knowledge and digital resources that enhance farm management, reduce production costs, and improve productivity (Paliwal et al.,

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2025; Singh et al., 2025). e-Extension services, enabled through diverse ICT tools, provide timely and location-specific information on soil health, pest and disease management, climate risks, and input use (Shukla et al., 2022; Singh et al., 2023; Singh et al., 2024; Shukla et al., 2024). This transformation is particularly critical in horticulture, where highly perishable crops demand immediate and precise decision-making to minimise post-harvest losses. In India, the substantial horticultural farming population and the limited availability of extension personnel render traditional face-to-face advisory services insufficient. Consequently, e-extension has emerged as a scalable alternative to bridge information gaps and improve farmers' access to expert advisories (Shukla et al., 2024). International evidence reinforces these benefits. Quaye et al. (2019) demonstrated that e-extension significantly enhanced yields and reduced production costs in Ghana, while Baig et al. (2022) reported improved knowledge and adoption of climate-smart practices among Pakistani farmers. Within India, Abdullahi et al. (2021) highlighted ICT infrastructure as a key determinant of farmers' engagement with digital advisories.

Despite these advantages, many rural farmers still face barriers such as low digital literacy, socio-economic constraints, and limited trust in ICT-based information (Singh et al., 2024; Paliwal et al., 2025). Horticulture remains a vital component of India's agricultural economy, contributing substantially to income and employment. The country's diverse agro-climatic conditions support extensive cultivation of fruits, vegetables, tubers, and medicinal plants, which increasingly serve as profitable alternatives to staple crops. Uttar Pradesh, in particular, provides favourable conditions for horticultural production and is home to a large number of small and marginal farmers who are highly dependent on this sector (Kumar et al., 2019).

However, the labour-intensive nature and perishability of horticultural crops necessitate timely and accurate information on climate, irrigation, soil, and input management, reinforcing the need for robust e-extension systems. The proliferation of ICT-based agro-advisory tools including SMS alerts, mobile applications, and digital platforms has reshaped knowledge dissemination and facilitated more responsive decision-making (Paliwal & Kumari, 2023). Nonetheless, the effectiveness of these advisories largely depends on farmers' awareness, perceptions of usefulness, ease of use, and trust in digital information. To address these gaps, the present study focuses on constructing a scientifically validated index to assess the awareness of horticultural farmers towards e-extension services. The index will strengthen the methodological base for evaluating ICT-enabled advisory systems and contribute to improving their design, targeting, and effectiveness for advancing smallholder horticulture in India (Abate et al., 2023).

METHODLOGY

The present study, conducted in 2025, aimed to develop an index for measuring the awareness level of horticultural farmers towards e-extension services. A comprehensive review of literature, including research papers, journals, magazines, thesis, books, and expert inputs, was carried out to identify suitable dimensions for index development. Accordingly, three major dimensions of awareness were conceptualised: "general awareness about e-extension", "awareness of public e-extension services", and "awareness of private e-extension services". Statements for each dimension were collected from diverse sources such as discussions with scientists, service providers, extension personnel, agricultural officers, KVK experts, and horticultural farmers. Initially, 112 statements were framed under the three dimensions and screened using Edward's 14-point criteria propounded by Edward (1957). After scrutiny, 83 statements were retained, comprising 21 under general awareness about e-extension, 37 under awareness of public e-extension services, and 25 under awareness of private e-extension services. To assess relevancy, both Google Forms and printed schedules were sent to 150 judges. Each statement was evaluated on a three-point continuum: Most Relevant (3), Relevant (2), and Least Relevant (1). Relevancy Weightage (RW), Mean Relevancy Score (MRS), and Overall Mean Relevancy Score (OMRS) were calculated to determine statement appropriateness. Following criteria similar to Prasad et al. (2016) and Roy et al. (2022), statements with RW $\geq$0.80 and MRS greater than OMRS (2.44) were retained. The formulas used for these calculations are as follows:

$$RW = \frac{MRR \times 3 + RR \times 2 + LRR \times 1}{MPS}$$

MPS (Maximum Possible Score) = No. of Judges × 3 = 70 × 3 = 210

$$MRS = \frac{MRR \times 3 + RR \times 2 + LRR \times 1}{\text{Number of Judges}}$$

$$OMRS = \frac{\text{Sum of obtained Relevancy Score}}{\text{No. of Judges} \times \text{No. of Statements}}$$

RW – Relevancy Weightage, MRR – Most Relevant Response, RR – Relevant Response, LRR – Least Relevant Response, MRS – Mean Relevancy Score, OMRS – Overall Mean Relevancy Score.

Based on this analysis, 48 statements were finalized, while 35 were rejected for not meeting the selection criteria. An interview schedule containing the selected statements was developed for field administration in a non-sampled area. Responses were recorded on a two-point continuum ("Yes" = 1 and "No" = 0). Finally, data were collected from 60 randomly selected horticultural farmers to assess the reliability and validity of the developed index. This systematic procedure ensured the development of a scientifically valid and reliable instrument for measuring the awareness level of horticultural farmers toward e-extension services.

RESULTS

Domain selection and its operationalisation

The construction of an awareness index to measure "Awareness of Horticultural Farmers towards e-Extension Services" began with the identification of key dimensions, including general awareness about e-extension, awareness of public e-extension services, and awareness of private e-extension services. General awareness about e-extension refers to the extent to which

horticultural farmers possess basic knowledge, recognition, and understanding of the existence, purpose, and usefulness of Information and Communication Technology–based agricultural advisory services. This includes awareness of various digital platforms, web portals, mobile applications, social media channels, and online information systems that deliver agricultural information, training, and problem-solving support. Public e-extension services related to the ICT-based agricultural information and advisory services provided, managed, or supported by government departments, public institutions, universities, and state/national agricultural organisations. These services are delivered through official digital platforms such as government web portals, mobile applications, SMS services, call centres, and social media channels operated by public agencies, with the objective of disseminating scientific information, schemes, and support to farmers. Private e-extension services include the ICT-enabled agricultural information, advisory, input support, and knowledge dissemination services provided by private companies like agri-tech firms, NGOs, producer organizations, and commercial platforms. These services are delivered through privately managed digital platforms such as mobile applications, web portals, subscription-based advisory systems, corporate call centres, SMS alerts, and social media channels, primarily aimed at supporting farmers with timely advisories, product information services, and decision-making support, often with a commercial component. Each of these dimensions consisted of a substantial number of statements to ensure that the index value could be standardized across varying domains.

Item selection process

The results presented in Table 1 demonstrate the assessment conducted by 70 judges who evaluated the relevance of the set of items. Out of the initial pool, 48 items were identified as relevant and subsequently used to collect responses from 60 farmers located in non-sampling areas. The expert feedback was gathered and analysed to calculate three key parameters: Relevancy Weightage (RW), Mean Relevancy Score (MRS), and Overall Mean Relevancy Score (OMRS). To ensure the selection of only the most relevant items, criteria were established: the Relevancy Weightage (RW) must be greater than 0.80, and the Mean Relevancy Score (MRS) must exceed the Overall Mean Relevancy Score (OMRS), which was set at 2.44. Using this process, 48 items were deemed suitable in the first stage, with these items being revised based on expert suggestions.

Relevance analysis of items

An initial pool of 112 items was identified to measure the awareness of horticultural farmers towards e-extension services. These items were subjected to a screening process using the fourteen informal criteria proposed by Edwards (1957), commonly applied in index development to ensure clarity, relevance, and the non-redundancy of items. Following this screening, 83 items were retained for further evaluation and were proposed for relevancy testing by a panel of experts. A total of 150 experts from various relevant professional backgrounds, including academicians, extension professionals, researchers, and government officials, were approached. Out of the 150 experts contacted, 70 judges, possessing the requisite subject knowledge and professional experience, responded within the stipulated timeframe of one month. The responses of these judges were systematically compiled and each statement was analysed using Microsoft Excel to determine its Relevancy Weightage (RW), Mean Relevancy Score (MRS), and Overall Mean Relevancy Score (OMRS). This rigorous analysis ensured that only items meeting both statistical and conceptual criteria were selected. Specifically, statements with a Relevancy Weightage greater than or equal to 0.80, and a Mean Relevancy Score greater than or equal to the Overall Mean Relevancy Score (OMRS), were considered suitable for inclusion (Shitu et al., 2018; Panigrahi et al., 2024; Vavilala et al., 2024; Singh et al., 2025; Shukla et al., 2026). As a result of this robust analysis, 48 statements were finalised for inclusion in the index, and their distribution across three broad categories was as follows: 14 statements under general awareness, 24 under public e-extension services, and 10 under private e-extension services.

Validity of the index

The validity of the index was established through content validity testing. Content validity was ensured by verifying that the content of individual items, as well as the full set of items, accurately represented the construct they were intended to measure. The content of the index was thoroughly reviewed through extensive literature and expert opinions related to the awareness level of horticultural farmers towards e-extension services. Given the alignment with these sources, it was assumed that the awareness index meets the criteria for content validity, confirming that it measures what it is intended to measure.

Reliability of the index

Reliability refers to the consistency of the measurement when repeated assessments are conducted. In this study, data for reliability analysis were collected through personal interviews with 60 farmers from a non-sampling area. The internal consistency of the index was assessed using the Cronbach's alpha coefficient, a widely accepted measure for reliability (Singh et al., 2025; Jagriti et al., 2026; Singh et al., 2026; Shukla et al., 2026). As shown in Table 2, the Cronbach's alpha coefficient for the overall index was found to be 0.951, indicating an excellent level of reliability for the scale. To further confirm the reliability, the split-half method was employed, with the Spearman-Brown coefficient calculated to be 0.936, which corroborates the strong consistency of the index.

The strong reliability values across both the Cronbach's alpha and the split-half methods provide confidence in the consistency and stability of the awareness index, ensuring that it can be reliably used for future assessments of horticultural farmers' awareness of e-extension services.

DISCUSIONS

The present study sought to construct a scientifically validated and reliable index to assess the awareness of horticultural farmers towards e-extension services. The findings reveal a strong methodological foundation for the instrument, supported by systematic item generation, expert validation and rigorous reliability

Table 1. The Relevancy Weightage (RW), Mean Relevancy Score (MRS), Overall Mean Relevancy Score (OMRS)

S.No.	Statement	RW	MRS
	General Awareness about e-extension		
1	I am aware about e-Extension	0.86	2.57
2	I know about e-Extension is useful for me	0.87	2.60
3	I know about the ICT tools and techniques	0.88	2.63
4	I am aware about internet based mobile phone applications	0.87	2.61
5	I am aware of some websites for farmers	0.82	2.46
6	I am aware of the some web-portal for farmers	0.81	2.44
7	I am aware of other digital platforms like- social media	0.84	2.51
8	I know about the digital platform for agriculture farmers	0.82	2.46
9	I am aware about Google assistance	0.83	2.50
10	I am aware about Google Lens	0.83	2.49
11	I am aware about OTP	0.83	2.50
12	I know about OTP do not share anyone	0.85	2.56
13	I am aware about YouTube	0.91	2.74
14	I am aware about Play Store, used for downloading mobile app	0.92	2.77
	Awareness of public e-extension services		
15	I know that public e-extension services may supplement/complement traditional extension agent/services	0.93	2.79
16	I know about the Krishi Vigyan Kendra located in our district	0.90	2.71
17	I am aware about KVK web portal	0.87	2.61
18	I heard about Kisan Call Centre	0.80	2.40
19	I know Kisan Call Centre can be contacted by dialling a toll-free number-(1800 180 1551)	0.90	2.69
20	I know Kisan Call Centre is available from 6:00 am to 10:00 pm on all seven days of the week	0.85	2.56
21	I know about online training programme	0.80	2.41
22	I am aware about online training programme for cutting, budding and grafting for horticulture crop	0.95	2.86
23	I am aware about DD Kisan channel	0.96	2.89
24	I know DD Kisan channel gives free of cost agriculture related information on my television	0.93	2.80
25	I know DD Kisan channel share seasonal crop basis information	0.91	2.73
26	I know DD Kisan channel provides information related to scientific orientation farming	0.87	2.60
27	I am aware about e-Newspaper	0.82	2.46
28	I am aware about e-NAM (e-National Agriculture Market)	0.89	2.66
29	I know under e-NAM farmers sell our products	0.87	2.61
30	I know about how can get recent market price through e-NAM	0.87	2.61
31	I receive agricultural information in WhatsApp Group	0.87	2.60
32	I know about the scheme and services provided online by the Department of Horticulture and Food Processing (like- MIDH, SCSP, RKVY, etc.)	0.85	2.54
33	I have the Damini App on my phone	0.83	2.50
34	I have the Meghdoot App on my phone	0.91	2.73
35	I am aware about District Agro-Met Unit (DAMU)	0.87	2.60
36	I am aware about Kisan Sarathi Portal	0.87	2.60
37	I am aware about Pradhan Mantri Fasal Bima Yojana	0.81	2.44
38	I am aware about PM Kisan Samman Nidhi	0.80	2.41
	Awareness of private e-extension services		
39	I am aware about amazon app	0.82	2.46
40	I know amazon app to purchase seeds, insecticides, pesticides etc.	0.80	2.41
41	I know Flipkart Online Shopping App sales of different agricultural inputs	0.85	2.56
42	I know YouTube channel has different video content (like- success story, new technology, and new varieties) for farmers	0.81	2.44
43	I am aware about Plantix App	0.85	2.54
44	I know Plantix App, it is identification of plant disease and gives plant cure guidance	0.80	2.40
45	I am aware about DeHaat App	0.89	2.67
46	I am aware about BigHaat App	0.88	2.64
47	I am aware about AgroStar App	0.82	2.46
48	I am aware about weed manager app	0.81	2.43

*Criteria for statement selection= RW>0.80, MRS>OMRS, *OMRS = 2.44

Table 2. Reliability Statistics of Index

Cronbach's Alpha	Part 1	Value	.902
		N of Items	24[a]
	Part 2	Value	.914
		N of Items	24[b]
	Total N of Items		48
	For whole index		.951
Correlation Between Forms			.881
Spearman-Brown Coefficient	Equal Length		.936
	Unequal Length		.936
Guttman Split-Half Coefficient			.936

a. The items are: S1, S2, S3, S4, S5, S6, S7, S8, S9, S10, S11, S12, S13, S14, S15, S16, S17, S18, S19, S20, S21, S22, S23, S24.
b. The items are: S25, S26, S27, S28, S29, S30, S31, S32, S33, S34, S35, S36, S37, S38, S39, S40, S41, S42, S43, S44, S45, S46, S47, S48.

testing. The results underscore both the robustness of the index and the increasing relevance of ICT-enabled agricultural advisory systems in the horticultural sector.

The multidimensional structure of the index, comprising general awareness, public e-extension services and private e-extension services, aligns with the evolving landscape of digital agricultural extension. The identification and operationalisation of these three domains reflect the growing diversity of information sources available to farmers, ranging from government-led portals to commercial agri-tech applications. This classification is consistent with earlier studies emphasising the need for domain-specific assessment tools to capture the heterogeneity of digital platforms in agriculture (Panigrahi et al., 2024; Vavilala et al., 2024).

The item selection process demonstrated a high degree of expert consensus. Of the initial 112 statements developed from literature reviews and field consultations, 83 items progressed through preliminary screening based on Edward's criteria (Edwards, 1957), ensuring conceptual clarity and non-redundancy. Subsequent relevancy testing by 70 judges resulted in the selection of 48 items that met the dual criteria of RW $\geq$ 0.80 and MRS $\geq$ OMRS (2.44). The strong relevancy scores observed across statements particularly those related to digital literacy (e.g., mobile applications, web portals, social media), public advisory channels (e.g., KVK portals, DD Kisan, Kisan Call Centre) and private applications (e.g., DeHaat, Plantix, BigHaat) indicate a high degree of perceived importance attached to these tools by experts.

These findings reflect broader trends in the agricultural sector, where farmers increasingly rely on ICTs for timely, location-specific information (Paliwal & Kumari, 2023; Singh et al., 2024b). The high relevance of statements related to agro-meteorological services (e.g., Meghdoot, Damini, DAMU) further highlights the growing significance of climate-related advisories, especially for horticultural crops that are highly sensitive to weather variability.

The reliability analysis provides additional support for the stability of the index. The Cronbach's alpha value of 0.951 indicates excellent internal consistency, surpassing the threshold commonly accepted in psychometric research. Furthermore, the Spearman-Brown coefficient of 0.936 reinforces the reliability of the split-half structure. These values are comparable to or exceed those reported in similar studies developing indices for behavioural or attitudinal assessment in agriculture (Kumar et al., 2015; Singh et al., 2025; Kumari, et al., 2026; Shukla et al., 2026; Singh, et al., 2026). The high reliability suggests that the instrument is robust enough for repeated administration and suitable for large-scale field application.

Overall, the findings reveal that the developed index successfully captures the multidimensional construct of awareness towards e-extension services. The inclusion of both public and private service-related items provides a holistic measurement framework, reflective of the increasingly pluralistic extension ecosystem in India. The high reliability and strong expert validation demonstrate that the index can be effectively employed by researchers, policymakers, and extension organisations to identify awareness gaps, design targeted capacity-building interventions and assess the responsiveness of farmers to digital advisory systems. Given the rising importance of ICTs in horticultural farming driven by perishability, climate sensitivity, and market volatility the availability of a validated awareness-measurement tool represents a significant contribution. By providing a standardised mechanism to quantify awareness, this index can support the optimisation of e-extension strategies, enable evidence-based policy formulation and enhance the reach and relevance of both public and private digital services.

CONCLUSION

The study successfully developed a reliable and scientifically validated index for assessing the awareness of horticultural farmers towards e-extension services. By integrating three complementary domains general awareness, public e-extension services, and private e-extension services the index offers a comprehensive and structured mechanism for evaluating farmers' engagement with digital advisory platforms. The rigorous item selection process and strong reliability coefficients confirm the robustness and applicability of the tool for large-scale research and field assessments. This index fills a critical methodological gap in ICT-based extension research and provides policymakers, researchers, and extension agencies with an evidence-based instrument to diagnose awareness levels, design targeted interventions and strengthen digital extension ecosystems. Its adoption can significantly enhance the responsiveness, inclusiveness and effectiveness of e-extension services, ultimately contributing to improved decision-making and resilience among horticultural farmers.

DECLARATION

Ethical approval and consent to participate: The informed consent was sought from the respondents.

Availability of supporting data: Supporting data are available upon request.

Competing interests: No competing interests were declared.

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The authors declare that during the preparation of this work, thoroughly reviewed, revised, and edited the content as needed. The authors take full responsibility for the final content of this publication.

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