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A COMPARATIVE ANALYSIS OF FARMERS' TRUST AND PERCEPTUAL HEURISTICS FOR ONLINE AGRICULTURAL INFORMATION VERSUS TRADITIONAL EXTENSION AGENTS IN PUNJAB

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ABSTRACT

This study investigates farmers' trust and the use of perceptual heuristics in evaluating online agricultural information (OAI) versus traditional extension agents (TEA) in Punjab, Pakistan. A cross-sectional survey of 300 farmers assessed trust across nine dimensions, including accuracy, timeliness, relevance, ease of understanding, comprehensiveness, trustworthiness, accessibility, feedback, and perceived usefulness, using a five-point Likert scale. Results from paired sample t-tests indicated that farmers consistently rated OAI higher than TEA, e.g., accuracy of information (OAI: 4.25 ± 0.70; TEA: 3.40 ± 0.85; $t = 17.45$, $p < 0.001$) and accessibility (OAI: 4.05 ± 0.76; TEA: 3.15 ± 0.92; $t = 15.80$, $p < 0.001$). Heuristics evaluation revealed that availability, representativeness, and familiarity cues were stronger for OAI (e.g., availability: 4.55 ± 0.60) while authority was higher for TEA (4.45 ± 0.63). Multiple linear regression identified significant predictors of trust and heuristic use, including education ($\beta = 0.22$, $p < 0.001$), access to extension services ($\beta = 0.26$, $p < 0.001$), and mobile literacy ($\beta = 0.16$, $p = 0.002$). The findings highlight the complementary roles of digital platforms and traditional agents, suggesting that blended approaches integrating ICT tools and extension services can enhance information credibility, adoption of innovations, and sustainable agricultural practices. This study provides evidence for policymakers, extension organizations, and digital developers to optimize knowledge dissemination strategies in rural contexts.

***Keywords*:** Farmers' trust, Perceptual heuristics, Online agricultural information, Extension agents, Digital agriculture, Pakistan, and ICT adoption

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1. INTRODUCTION

Agriculture continues to be the backbone of the rural economy in the world since it enables people to have food, employment and economic stability. Like every other field, the agricultural sector is also rapidly transforming with technological advancements, changing lifestyles, and the impacts of climate change. So, farmers have to cope with these changes by staying informed about innovations and the latest developments. In order to make informed decisions, adopt better practices, and become more productive, farmers must have access to quality, timely and actionable agricultural information. Historically, agricultural extension agents were the most significant means of knowledge and technical advice transfer, as well as of bringing research and innovation into farmers' fields (Raya et al., 2021). The traditional extension services have been relying on the physical contacts, visiting the farms, demonstrations, and group training to educate the farmers on how to manage their crops, how to control pests, how to irrigate their farms and how to market their crops. Such a form of interaction provides the opportunity to guide the individual and quickly clarify any doubts, thereby creating trust and credibility in the information presented (Zhou et al., 2022).

The distribution of agricultural information has changed over the past few years with the proliferation of digital technologies. Farmers can access real-time information on market prices, weather, pests, and emerging farming techniques via mobile phones, social media, SMS notifications, and online agricultural portals (Jurnal Desa, 2022). Digital platforms have the potential to reach more people, to reduce the asymmetry of information, as well as allow farmers to make independent decisions. Regardless of these merits, however, there is yet no standardized digital

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application of information in agriculture. There are rising concerns with the credibility, accuracy, and applicability of online information sources, similar to information disseminated through traditional extension agents (Hair et al., 2019).

Another important aspect that often influences farmers' decisions regarding information sources is trust, which involves a belief in the competence, reliability, and goodwill of the information provider (Jamil et al., 2023). Farmers rely on information from agricultural experts and other credible sources, which shapes their trust and their willingness to adopt new practices. Today, with the predominance of online and social media-based information, farmers may have difficulty deciding which information to take and which one not to. Online sources have features and a range of criteria, including the familiarity of the platform with which the agent is associated, user comments, and followers, through which one can evaluate the credibility (Hamadal and Adil, 2019). However, the ability to judge information vastly depends upon the socio-economic attributes of the farmers, their level of education, and their digital literacy, as well as their prior exposure to online information, which may have a moderating effect on their trust in digital information.

Further, farmers use perceptual heuristics (mental shortcuts) to make complex judgments, as they have plenty of information about many variables in farming practices. Heuristics also influence individuals' evaluations regarding information reliability, relevance, and risk (Rosmalah et al., 2023). For example, a farmer can trust information on pest management because it was discussed in peer networks (availability heuristic) or because it was given by an expert who could be regarded as a specialist in agriculture (authority heuristic). Digital (and traditional) extension agents can elicit different heuristics that affect the perceived credibility of their recommendations. The manner in which farmers apply this heuristic plays a crucial role in the development of an effective knowledge dissemination intervention, especially when the problem of misinformation or conflicting instructions is common (Gansser and Reich, 2021).

There is an increasing trend of studies on digital agricultural misinformation in academia; however, most of the literature focuses on either the tendencies of digital information adoption or its effectiveness in behavioral change among farmers. Studies are available on farmers' trust and perceptions of available information (Wibowo and Haryanto, 2020). However, few studies have focused on the cognitive processes and heuristics that underlie how farmers appraise information sources. To fill these gaps, this study investigates how farmers evaluate and trust agricultural information from online sources compared to traditional extension agents**,** focusing on both overall trust levels and the use of perceptual heuristics in credibility assessment. As digital technologies increasingly supplement conventional extension systems, understanding farmers' perceptions of these sources is critical for improving information dissemination and adoption of best practices (Yang et al., 2024; Chakraborty et al., 2021).

Specifically, it examines: (i) the level of trust that farmers have in the online information and the traditional extension, (ii) heuristics that farmers use to determine the validity of information, and (iii) the socio-demographic, institutional, and technological factors that influence farmers' perceptions in evaluating information. The deeper understanding of trust and perception processes in agricultural information systems provided by this study can be used to build a more powerful and robust knowledge ecosystem capable of supporting sustainable agricultural development and rural livelihoods.

2. MATERIALS AND METHODS

2.1. Research design

The quantitative and cross-sectional research design was used in this study. A cross-sectional survey design was chosen because it allows data to be collected at a single point in time and to statistically analyze correlations among trust, heuristic use, and explanatory variables (Purwanto and Loisa, 2020).

2.2. Study population

The target population consisted of rural farmers aged 18–60 years who were actively engaged in crop or livestock production and had exposure to both online agricultural information sources (mobile apps, websites, SMS alerts, and social media) and traditional extension services (field visits, farmer workshops, and meetings). The study area was Punjab, from which three randomly selected districts were Multan, Faisalabad and Bahawalpur as shown in Fig 1.

On a random basis, 10 villages were selected from each district, and 10 farmers were selected from each village, for a total of 300 respondents.

2.3. Research tool

Data were collected using a structured, closed-ended questionnaire divided into four sections: demographic and socio-economic characteristics, trust assessment, heuristic evaluation, and institutional/technological factors. Trust

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in online and extension-provided information was measured using a five-point Likert scale (1 = very low trust, 5 = very high trust). Heuristics were assessed through four perceptual cues: availability, representative, authority, and familiarity, on a five-point Likert scale. Institutional and technological factors included access to ICT tools, mobile literacy, internet connectivity, training exposure, and frequency of extension interactions.

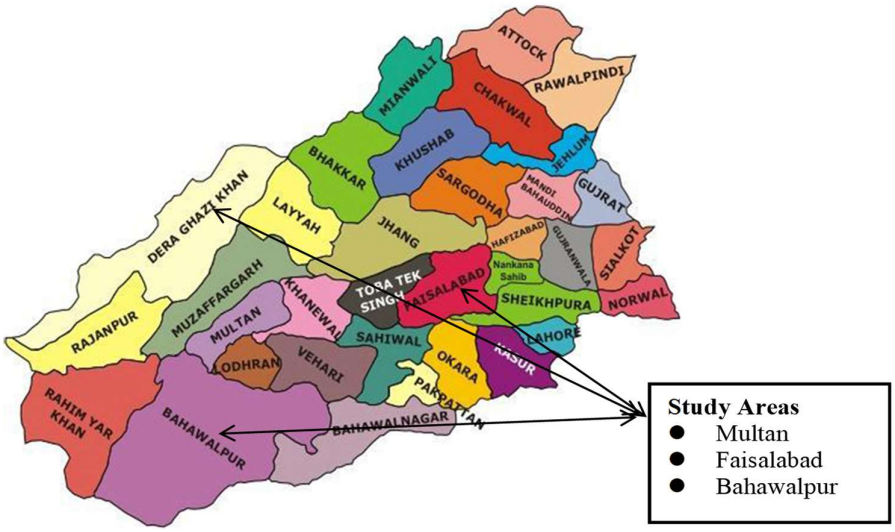

Figure 1: Study area.

2.4. Data collection and analysis

Data collection was conducted through face-to-face interviews by trained enumerators to accommodate varying literacy and digital literacy levels. Completed questionnaires were checked daily for completeness and consistency before entry into SPSS Version 26 for analysis. Descriptive statistics, including means, standard deviations, frequencies, and percentages, were used to summarize trust levels, heuristic usage, and demographic characteristics. Paired-samples t-tests were used to compare trust levels for online versus extension agents' provided information.

$$t = \frac{\bar{D}}{S_D\sqrt{n}}$$

Where:

- $\bar{D}$ = mean of the differences between paired observations ($Di=X_{1i}-X_{2i}$)
- S_D = standard deviation of the differences
- n = number of paired observations

The difference for each pair is calculated as:

$D_i = X_{1i}-X_{2i}, \quad i = 1, 2, \ldots, n$

Then, the mean of differences**:**

$$\bar{D} = \frac{\sum_{i=1}^{n} D_i}{n}$$

And the standard deviation of differences**:**

$$S_D = \sqrt{\frac{\sum_{i=1}^{n} (D_i - \bar{D})}{n-1}}$$

Finally, the calculated t-value is compared with the critical t-value from the t-distribution table at n−1n-1n−1 degrees of freedom to determine significance.

Exploratory factor analysis (EFA) was conducted to identify underlying heuristic patterns. To examine the influence of socio-demographic, institutional, and technological factors on trust and heuristic use, multiple linear regression was applied using the model:

$Y=\beta 0+\beta 1X1+\beta 2X2+\cdots+\beta nXn+\varepsilon$

Where Y represents the dependent variable (trust or heuristic usage), X1...Xn represents independent variables

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including age, education, income, farm size, access to ICT, extension contact, and internet connectivity, β0 is the intercept, β1...βn are regression coefficients, and ε is the error term.

3. RESULTS AND DISCUSSION

3.1. Trust level of farmers

Table 1 presents a comparison of the levels of trust that farmers place in Traditional Extension Agents (TEA) versus Online Agricultural Information (OAI) across nine key dimensions. Results show that the farmers placed more trust in OAI than in TEA across all trust indicators. The average of OAI and TEA in the dimensions of accuracy of information and timeliness of advice was 4.25 and 3.40, respectively. Other ratings also showed strong trust in OAI, such as ease of understanding, local context, and perceived usefulness. All the differences are significant ($p < 0.001$). This shows that farmers seek online sources of agricultural information more than online traditional extension services. The results are consistent with the existing studies, which affirm that digital agricultural systems and online information systems are seen as more accessible, timely, and reliable among the farmers. Whereas traditional extension lacks experienced agents and timely services and faces logistical issues (Abate et al., 2020; Alotaibi et al., 2020; Suadnya et al., 2021).

Table 1: Comparative Levels of Trust Farmers Place in Online Agricultural Information versus Traditional Extension Agents (n = 300)

Trust Dimension	TEA Mean ± SD	OAI Mean ± SD	t-value	Df	p-value
Accuracy of information	3.40 ± 0.85	4.25 ± 0.70	17.45	299	<0.001**
Timeliness of advice	3.35 ± 0.88	4.10 ± 0.75	14.90	299	<0.001**
Relevance to local context	3.30 ± 0.90	4.05 ± 0.78	14.50	299	<0.001**
Ease of understanding	3.50 ± 0.82	4.15 ± 0.72	13.70	299	<0.001**
Comprehensiveness of information	3.35 ± 0.85	4.05 ± 0.71	14.30	299	<0.001**
Trustworthiness	3.25 ± 0.89	4.10 ± 0.74	15.00	299	<0.001**
Accessibility	3.15 ± 0.92	4.05 ± 0.76	15.80	299	<0.001**
Feedback	3.20 ± 0.88	4.00 ± 0.78	14.20	299	<0.001**
Perceived Usefulness	3.30 ± 0.87	4.15 ± 0.70	16.20	299	<0.001**

Notes:

- df = degrees of freedom; n = 300.
- **p < 0.001 indicates a statistically significant difference.

3.2. Heuristics Evaluation

In order to gain more insight into how farmers determine the credibility of the information available on agriculture, Table 2 presents a study of the perceptual heuristics used by both traditional extension agents (TEA) and the agricultural information available on the Internet (OAI). The perceptual heuristics include availability, representativeness, authority, and familiarity, which enable one to make decisions about the credibility and reliability of information without conducting analysis and evaluation (Sirajuddin and Kamba, 2021; Sawitri et al., 2020).

Table 2: Heuristics Evaluation: Assessment of Perceptual Cues in Evaluating the Credibility of Traditional Extension Agents and Online Agricultural Information (n = 300)

Heuristic	Traditional Extension Agents (Mean ± SD)	Online Agricultural Information (Mean ± SD)
Availability Cue	4.30 ± 0.68	4.55 ± 0.60
Representativeness Cue	4.15 ± 0.72	4.40 ± 0.65
Authority Cue	4.45 ± 0.63	3.85 ± 0.80
Familiarity Cue	4.10 ± 0.75	4.50 ± 0.62

Notes:

- Availability Cue: Trust based on how readily the information comes to mind or how frequently it is encountered.
- Representativeness Cue: Trust based on similarity to known or typical examples.
- Authority Cue: Trust based on perceived expertise or official status of the source.
- Familiarity Cue: Trust based on prior exposure or comfort with the source.

The results indicate that, in the case of availability and representativeness cues, the farmers rated online information higher (Availability: 4.55 ± 0.60; Representativeness: 4.40 ± 0.65) than the information provided by extension agents (Availability: 4.30 ± 0.68; Representativeness: 4.15 ± 0.72). Similarly, the familiarity cue was higher for online information (4.50 ± 0.62) than for extension agents (4.10 ± 0.75), indicating that farmers are more comfortable and accustomed to seeking information from online platforms. On the other hand, the authority cue occupied a superior position in the ranking for traditional extension agents (4.45 +0.63) than for online sources

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(3.85 +0.80). This indicates that the authority and competency of the extension workers is well recognized by farmers (Geovani and Harsoyo, 2018). These findings show that farmers apply different heuristics depending on the information source: digital resources are valued for their accessibility, representativeness, and familiarity, whereas traditional agents are valued for their authority. This shows that internet-based and traditional extension services complement each other in shaping farmers' perceptions of information credibility (Aghasafari et al., 2020; Zhang et al., 2021; Lefebvre et al., 2020; Bazaluk et al., 2020).

3.3. Factors influencing farmers' trust in information sources and their use of perceptual heuristics

Table 3 provides the results of the multiple linear regression model that examines how socio-demographic, institutional and technological factors affect the trust that farmers have in the source of information and their use of the perceptual heuristics (availability, representativeness, authority and familiarity cues) to determine the credibility (n = 300). The comparison determined the percentages of both factors leading to the establishment of trust and heuristic reliance among farmers as essential antecedents of the adoption of farming practices (Kassem et al., 2021; Alotaibi et al., 2020).

Table 3: Multiple Linear Regression Analysis: Influence of Socio-Demographic, Institutional, and Technological Factors on Farmers' Trust and Heuristic Use (n = 300)

Predictor Variables	β (Trust)	SE (Trust)	p-value (Trust)	β (Heuristic Use)	SE (Heuristic Use)	p-value (Heuristic Use)
Socio-Demographic Factors						
Age (years)	0.11	0.04	0.012*	0.07	0.03	0.038*
Education Level (years)	0.22	0.05	<0.001**	0.19	0.04	<0.001**
Farm Experience (years)	0.09	0.04	0.028*	0.11	0.03	0.009**
Institutional Factors						
Access to Extension Services	0.26	0.06	<0.001**	0.21	0.05	<0.001**
Membership in Farmer Groups	0.17	0.05	0.003**	0.14	0.04	0.007**
Technological Factors						
Access to Online Agricultural Information	0.24	0.05	<0.001**	0.29	0.04	<0.001**
Mobile Literacy	0.14	0.05	0.011*	0.16	0.04	0.002**
Model Statistics						
R^2	0.43	–	–	0.39	–	–
Adjusted R^2	0.41	–	–	0.37	–	–
F-value	15.28	–	<0.001**	13.42	–	<0.001**

Results confirmed that age, education and farm experience were the predictors. Level of education was positively related to trust ($\beta = 0.22$, $p < 0.001$) and to the use of heuristics ($\beta = 0.19$, $p < 0.001$), showing that the better educated the farmers are, the better their ability to evaluate information and act on heuristic cues. The experience with a farm and age were also positively influential, albeit minimally, indicating that cognitive maturity and farm experience are among the predisposing factors (Mallick et al., 2022; NAAS, 2022). Results on institution factors showed that farmers who had better access to the extension services had more trust ($\beta = 0.26$, $p=0.001$) and more heuristic use ($\beta = 0.21$, $p=0.001$). The involvement in farmers' social groups also had a positive influence on both outcomes (trust $\beta = 0.17$, $p = 0.003$; heuristic use $\beta = 0.14$, $p = 0.007$), demonstrating the importance of social networks and peer validation to the information credibility perception (Adhiguru and Mruthyunjaya, 2020; Mallick et al., 2021).

Trust and heuristic dependence were strong predictors of the technology factors, including access to online agricultural information and mobile literacy. The more readily available digital sources are, the higher the likelihood that farmers will believe the information ($\beta = 0.24$, $p < 0.001$) and heuristic cues ($\beta = 0.29$, $p < 0.001$), which explains the greater role of ICT in agriculture. Positive relation was also exist between mobile literacy and trust (trust $\beta = 0.14$, $p = 0.011$; heuristic use $\beta = 0.16$, $p = 0.002$), showing that the familiarity with technology made farmers more flexible to obtain the information, assess it, and employ it effectively (Levendal, 2022; Soodan et al., 2023; Cimino et al., 2024).

The model explained a large proportion of the outcome variance, with R^2 of trust = 0.43 and R^2 of heuristic use = 0.39, indicating a good fit. Even F-values were significant (trust $F = 15.28$, $p < 0.001$; heuristic use $F = 13.42$, $p < 0.001$), confirming that the given predictors significantly contribute to differences in trust and heuristic use among farmers. Overall, these data show that education level, institutional support, and access to technology are among the most significant variables that determine the degree of trust in information sources and the application of heuristics in information processing among farmers. Integrating activities that have the potential to strengthen those spheres

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would increase farmers' choices and their acceptance of the proposed agricultural processes.

4. CONCLUSION

Results showed greater trust among farmers in online platforms for seeking information than in traditional extension. Paired-samples t-tests have demonstrated that the credibility of internet information has a much greater impact across the various dimensions. Multilinear regression revealed that the socio-demographic variables (education, age, and farm experience), institutional support variables (access to extension and membership in a farmer group), and technological variables (digital access and mobile literacy) played significant roles in predicting both trust and heuristic use. Farmers apply different heuristics depending on the information source: digital resources are valued for their accessibility, representativeness, and familiarity, whereas traditional agents are valued for their authority. This shows that internet-based and traditional extension services complement each other in shaping farmers' perceptions of information credibility. The policy implications of the findings for policymakers and extension organizations entail the need to implement blended solutions that integrate ICT-based solutions with traditional services and capacity-building initiatives to improve digital literacy.

Declarations

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Data Availability: The data supporting the findings of this study are available from the corresponding author upon reasonable request.

Ethics Statement: The study involving human participants was reviewed and approved by the Institute of Agricultural Extension, Education, and Rural Development, University of Agriculture, Faisalabad. All research procedures complied with relevant institutional and local ethical standards, and written informed consent was obtained from all participants before participation.

Authors' Contributions: Muhammad Saeed Shahbaz was responsible for the study conceptualization, methodology design, data collection, formal data analysis, Abdulmalek Naji Alsanhani; preparation of the original draft, and manuscript review and editing.

Generative AI Statement: The authors declare that no generative artificial intelligence tools, including DeepSeek, were used in the preparation of this manuscript.

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