Research Article

Indian Journal of Extension Education
Vol. 62, No. 4 (October–December), 2026, (168-173)

ISSN 0537-1996 (Print)
ISSN 2454-552X (Online)

Strengthening ICT-Based Agricultural Extension through Human Capacity and Institutional Support in West Java

Yoyon Haryanto*, Fita Dwi Untari and Siti Syamsiah

Polytechnic of Agricultural Development Bogor, Ministry of Agriculture, Bogor, West Java, Indonesia
*Corresponding author email id: yoyonharyanto@gmail.com

HIGHLIGHTS

- Extension-worker competence and cosmopolitanism strengthened ICT-enabled advisory services.
- Institutional, infrastructure, and regulatory support reinforced Agricultural Extension Centre performance.
- Conventional methods alone did not improve digital extension implementation.
- Hybrid advisory strategies can combine digital reach with trusted face-to-face facilitation.

ARTICLE INFO

Keywords: Advisory services, Digital communication, Extension workers, Organisational readiness, Rural information systems, Technology adoption.

https://doi.org/10.48165/IJEE.2026.62424

Citation: Haryanto, Y., Untari, F. D., & Syamsiah, S. (2026). Strengthening ICT-Based Agricultural Extension through Human Capacity and Institutional Support in West Java. *Indian Journal of Extension Education*, *62*(4), 168-173. https://doi.org/10.48165/IJEE.2026.62424

Reviewed by: Dr. Brajendra Singh Meena (bmeena65@gmail.com); Dr. Basavaprabhu Jirli (bjirli@cmdr.ac.in); Dr. Kamini Bisht (bishtkamini@gmail.com)

ABSTRACT

Agricultural Extension Centers connect farmers with information, innovation, consultation, and institutional networks. This study analysed the human and institutional factors associated with centre performance and information and communication technology-based agricultural extension in West Java. The study was conducted from May to November 2022 in Subang and Cianjur Regencies. Survey data from 156 extension workers and farmers were complemented by interviews, observations, and document review. Descriptive statistics and partial least squares structural equation modelling were applied. The centres performed strongly as information, development-movement, learning, agribusiness-consultation, and partnership-networking hubs. Digital-extension adoption capacity and sustainability were also rated highly. Positive path coefficients were observed from respondent characteristics to centre performance (0.257) and digital extension (0.293), and from extension support to the same outcomes (0.326 and 0.319, respectively). Extension methods had a negligible coefficient for digital extension (-0.008). Cosmopolitanism, extension-worker competence, infrastructure, institutional support, and regulations were prominent indicators. The findings show that digital advisory services are supported by capable personnel, enabling institutions, reliable infrastructure, and hybrid strategies that combine digital communication with face-to-face facilitation.

INTRODUCTION

Agricultural extension increasingly operates through digital and face-to-face channels that connect farmers with production knowledge, markets, climate information, and institutional services. Information and communication technology (ICT) can accelerate the delivery of timely advice, widen geographical coverage, and support more responsive decision-making. However, technology alone does not create effective advisory services. Extension-worker competence, information-seeking behaviour, organisational support, infrastructure, and regulations determine whether digital tools become embedded in routine practice. Recent evidence shows that farmers' acceptance of ICT-based advisory services depends on usefulness, trust, accessibility, responsiveness, and personalisation (Paliwal et al., 2026), while extension personnel need differentiated skills in digital communication, document management, troubleshooting, cybersecurity, and emerging applications (Sahoo et al., 2025).

Received 21-08-2026; Accepted 14-09-2026

Indonesia institutionalised this transformation through the Strategic Command for Agricultural Development, which positioned Agricultural Extension Centers at sub-district level as operational hubs for data, learning, consultation, development programmes, and partnerships. The centers were expected to use ICT to coordinate local agricultural development and link farmers with innovation systems. Their effectiveness is especially important in West Java, where farmers continue to rely strongly on extension workers as trusted information intermediaries. Evidence from the province also indicates that advisory services and livelihood resources strengthen farmers' resilience through capacity-building pathways rather than information delivery alone (Azhari et al., 2025), while global research mapping confirms the growing integration of agricultural extension within climate-resilience scholarship (Azhari et al., 2026).

Conventional visits, lectures, and demonstrations continue to build trust and enable contextual problem solving, whereas digital channels increase speed and reach. Treating these modes as substitutes may therefore weaken extension quality. Digital transformation is more plausibly understood as a hybrid institutional process in which human capability and organisational conditions enable technology to complement interpersonal advisory work. Research has commonly examined digital access, extension competence, or institutional support separately, leaving limited evidence on their combined relationships with centre performance and digital extension implementation.

Subang and Cianjur Regencies offered relevant settings because their extension centres had implemented the national programme across contrasting rice and horticultural systems. The study tested whether respondent characteristics, extension methods, and extension support influenced the role of Agricultural Extension Centres and ICT-based agricultural extension. It was hypothesised that human capability and institutional support would have positive effects, while reliance on conventional methods without digital integration would not strengthen ICT-based services. The objective was to identify the most influential human and institutional factors and derive practical directions for hybrid agricultural extension in West Java.

Earlier Indonesian studies documented the importance of centre readiness and extension-worker performance in implementing the national programme (Anto & Andriansyah, 2020; Kinasih et al., 2021; Pakpahan et al., 2021). Internet use has also been associated with extension-worker performance in Cianjur (Purwatiningsih et al., 2018), while field evidence continues to show the contribution and limits of ICT within local extension practice (Prayoga, 2018; Utomo et al., 2022). More recent work places digital learning and social capital at the centre of capacity development for sustainable food systems (Sumardjo et al., 2026). Together, these studies justify examining technology use within the institutional and human system that supports it.

METHODOLOGY

An explanatory survey was conducted from May to November 2022 in Subang and Cianjur Regencies, West Java. The locations were selected purposively because all Agricultural Extension Centres had implemented the Strategic Command for Agricultural Development and represented contrasting rice and horticultural production systems. Respondents were drawn from seven centres in each regency. The final sample comprised 156 agricultural extension workers and farmers involved in centre activities. Data were collected using a structured questionnaire and were complemented by field observations, document review, and in-depth interviews with programme innovators, managers, extension workers, farmers, and other community representatives. The model included respondent characteristics, extension methods, and extension support as explanatory constructs.

Respondent characteristics captured extension-worker competence and cosmopolitanism. Extension methods represented conventional and digital approaches, while extension support covered institutional, infrastructure, and regulatory support. The two endogenous constructs were the role of Agricultural Extension Centres and ICT-based agricultural extension. Centre roles comprised data and information, agricultural development movements, learning, agribusiness consultation, and partnership networking. ICT-based extension comprised adoption capacity and sustainability. Items were rated using ordinal response scales and converted to interval data before modelling. The construct specification followed the view of extension as a facilitated learning and capacity-development process rather than one-way information transfer (Amanah, 2007).

Instrument testing was conducted with 42 respondents from six Agricultural Extension Centres in Bogor Regency. Item validity coefficients ranged from 0.343 to 0.926 and reliability coefficients from 0.661 to 0.943, supporting use of the instrument. Descriptive analysis summarised respondent access, support, institutional roles, and digital-extension performance. Partial least squares structural equation modelling was performed using SmartPLS 4 to estimate measurement loadings, path coefficients, and explained variance. The structural analysis examined the relationships of respondent characteristics, extension methods, and extension support with both endogenous constructs. Qualitative evidence was used to interpret the institutional context and the continued role of interpersonal extension. Participation was voluntary, respondents were informed about the study purpose, and responses were analysed confidentially.

RESULTS

Human readiness and extension practices

Based on Table 1, respondents averaged 46 years of age, and 37.82% had completed undergraduate education. Average work experience was 11 years. Digital access was already substantial: 92.31% had personal or family access to an internet-enabled smartphone and 77.56% had personal or family access to a computer or laptop. Extension-worker competence reached a moderate index of 69.39%. Respondents were able to manage information, understand digital-era responsibilities, anticipate barriers, and recognise the advantages of innovation, but the moderate score indicated room for more advanced facilitation and data-management skills. Information seeking was most frequent in other villages and agricultural or extension service offices, averaging four visits per month. This cosmopolitan orientation exposed extension actors to innovations and professional networks beyond their immediate work environment.

Table 1. Respondent readiness for digital extension

Indicator	Result
Mean age	46 years
Undergraduate education	37.82%
Mean work experience	11 years
Smartphone access[1]	92.31%
Computer/laptop access[1]	77.56%
Competence index	69.39% (moderate)
Information visits to villages	4 per month
Visits to extension service offices	4 per month

[1]Includes personal or family ownership

Both conventional and digital practices remained active. Farm visits were used often or always by 80.77% of respondents for technological innovation and 77.56% for facilities and infrastructure information. Social media were used often or always by 70.51% for technological innovation, 73.08% for facilities and infrastructure, and 73.71% for marketing information (Table 2). Internet sources other than social media were less consistently used. The pattern indicates an emerging hybrid system: farm visits remained central for observation, demonstration, and trust, while social media accelerated follow-up communication and information distribution. Digital channels should complement rather than displace interpersonal methods because farmer decisions frequently require local diagnosis and confidence in the adviser (Yadav et al., 2026).

Table 2. Frequent use of selected extension methods

Method	Technological innovation (%)	Marketing (%)	Facilities (%)	Inputs (%)
Farm visits	80.77	77.56	77.56	81.41
Lectures	59.62	55.13	58.98	63.46
Social media	70.51	73.71	73.08	69.23
Other internet sources	58.33	60.26	57.70	53.85

Institutional performance and enabling support

Based on Table 3, institutional, infrastructure, and regulatory support were all rated highly. The data and information centre recorded the highest mean index (98.18), followed by the agricultural development movement (96.69). Respondents associated institutional support with innovation assistance, technical and methodological training, internships, and seminars. Infrastructure included internet connectivity, operational facilities, and learning resources, while regulations provided legitimacy and direction for centre activities. The similarly high values show that digital extension was enabled by a bundle of organisational conditions rather than a single intervention.

Table 3. Extension support and centre performance indices

Dimension	High category (%)	Mean index
Institutional support	89.74	91.03
Facilities and infrastructure	78.21	88.35
Regulatory support	77.56	88.03
Data and information centre	93.59	98.18
Agricultural development movement	94.87	96.69
Learning centre	94.24	96.51
Agribusiness consultation	86.53	91.77
Partnership networking	92.31	96.58

Determinants of centre roles and ICT-based extension

The structural model explained 28.3% of the variance in the role of Agricultural Extension Centres and 30.4% in ICT-based agricultural extension. Positive coefficients were observed from respondent characteristics to centre roles (0.257) and ICT-based extension (0.293), and from extension support to centre roles (0.326) and ICT-based extension (0.319). In contrast, extension methods had a negligible negative coefficient for ICT-based extension (-0.008). The measurement model identified cosmopolitanism (0.923) and extension-worker competence (0.887) as strong indicators of respondent characteristics. Infrastructure (0.927), institutional support (0.904), and regulations (0.821) strongly represented extension support. ICT adoption capacity (0.945) and sustainability (0.934) also loaded strongly on the digital-extension construct.

DISCUSSION

The findings indicate that ICT-based agricultural extension depends not only on access to technology but also on the capacity of extension workers to convert digital resources into relevant advisory services. The positive coefficients linking respondent characteristics with both Agricultural Extension Centre roles and ICT-based extension underline the importance of competence and cosmopolitanism. Access creates opportunities for communication, whereas competence determines whether information can be verified, contextualised, and communicated effectively. This interpretation is consistent with Panda et al. (2019) and Kumar (2025), who reports that productive ICT use is associated with

Table 4. Structural model results

Relationship or indicator	Coefficient/loading	Interpretation
Characteristics → centre roles	0.257	Positive
Characteristics → ICT extension	0.293	Positive
Extension support → centre roles	0.326	Positive
Extension support → ICT extension	0.319	Positive
Extension methods → ICT extension	-0.008	Negligible negative
R^2 centre roles	0.283	Moderate explanatory value
R^2 ICT extension	0.304	Moderate explanatory value

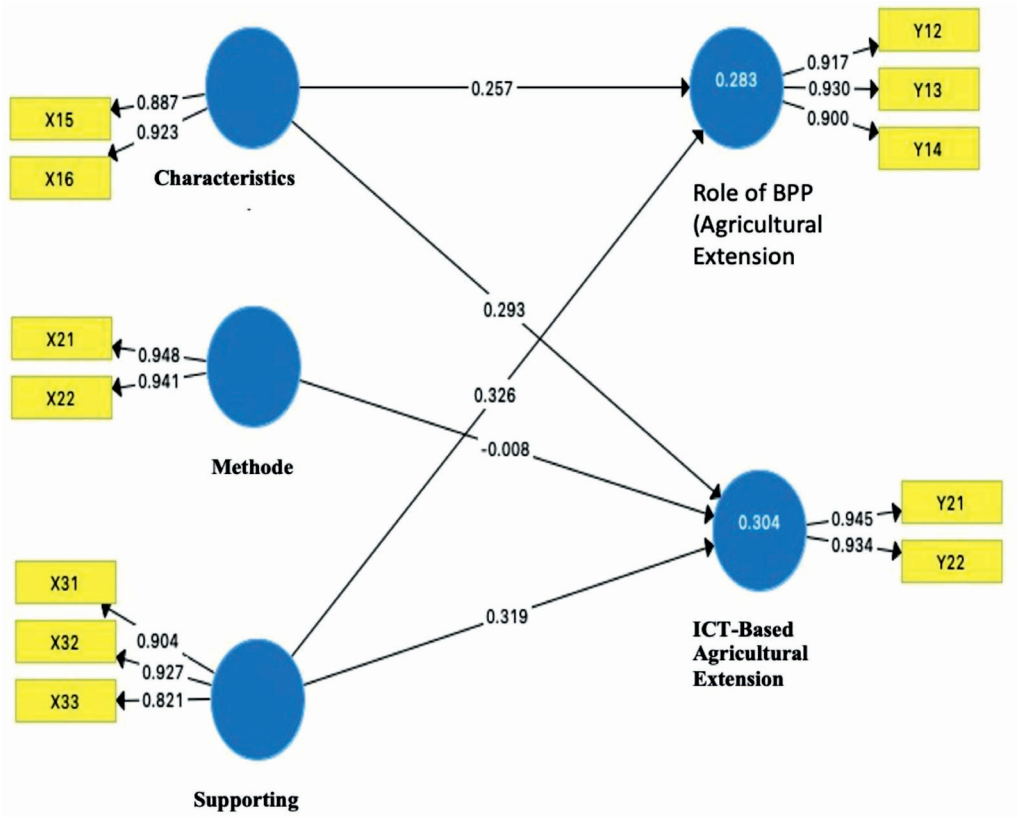

Figure 1. Structural model of ICT-based agricultural extension

education, media exposure, social participation, and extension contact. Digital competence therefore extends beyond platform operation to information verification, content development, online facilitation, data protection, and interpretation of farmer feedback (Sahoo et al., 2025). This broader capability orientation is consistent with integrative approaches to strengthening extensionists' roles in farmer empowerment (Amanah et al., 2026).

Cosmopolitanism connects local agricultural problems with knowledge and resources beyond the immediate community. Contacts with research institutions, universities, government agencies, private organisations, and professional networks expose extension workers to alternative practices and innovations. Digital platforms expand these opportunities through webinars, virtual demonstrations, and communities of practice. However, external information becomes useful only when it is assessed against farmers' resources, production systems, and risks. Extension centres can strengthen organisational learning by encouraging staff to evaluate and share knowledge obtained through external networks.

The continuing use of farm visits alongside social media supports a hybrid extension approach. Digital channels are appropriate for timely alerts, reminders, market information, and verified materials, whereas field interaction remains important for diagnosis, demonstration, negotiation, and complex problem-solving. The negligible coefficient linking extension methods with ICT-based extension does not show that conventional methods are ineffective. Rather, it suggests that adding digital media to existing activities does not automatically produce digital transformation. Effective hybrid extension deliberately connects field diagnosis, digital follow-up, farmer feedback, and institutional information while considering farmers' literacy, connectivity, device access, and the complexity of the agricultural problem.

The centres also show potential as local information and innovation intermediaries. Their strong information, learning, and partnership functions indicate that they perform more than administrative roles. This interpretation agrees with Azhari et al. (2025) and Syamsiah et al. (2025), who emphasise the contribution of extension, learning, and social resources to resilient farming systems. It also aligns with evidence that social transformation and institutional collaboration are central to food-system sustainability (Sumardjo et al., 2023; Godara et al., 2024; Godara et al., 2025). The comparatively lower agribusiness-consultation score, although still high, points to a gap between technical information provision and enterprise-oriented support. Agribusiness consultation requires individualised analysis of production costs, markets, financing, partnerships, and risks, together with coordination beyond the conventional extension system.

The positive coefficients for extension support confirm that digitalisation requires a supportive institutional environment comprising functioning infrastructure, organisational commitment, operational funding, technical assistance, and clear regulations. Digital farmer field schools improve knowledge when technology is integrated into facilitated learning (Kadam et al., 2026), while interactive platforms can strengthen farmer agency when they move beyond one-way information delivery (Godara et al., 2024; Yadav et al., 2026). Infrastructure may remain underused when connectivity is unreliable, training is discontinuous, or operational guidance is unclear. ICT-based extension should therefore be developed as part of the broader functions of Agricultural Extension

Centres rather than as a separate technology project (Sondarava et al., 2023). The moderate explained variance also indicates that trust, digital literacy, leadership, workload, organisational culture, farmer demand, and locally relevant content warrant examination in future longitudinal or multigroup studies.

CONCLUSION

Agricultural Extension Centres in West Java function as strong local hubs for information, learning, programme coordination, consultation, and partnerships. Their performance and the implementation of digital advisory services depend more clearly on extension-worker capability, outward information seeking, institutional support, infrastructure, and enabling regulations than on method choice alone. Conventional methods remain valuable for trust, diagnosis, and practical learning, but they need to be deliberately connected with digital communication and follow-up. Extension policy should therefore prioritise continuous digital competence development, peer learning across locations, reliable connectivity, operational support, and governance arrangements that integrate field and online services. A hybrid extension system built around capable personnel and supportive institutions offers a practical pathway for widening access without losing the interpersonal qualities that make agricultural advice credible and locally relevant.

DECLARATIONS

Ethics approval: Formal ethical clearance or institutional review board approval was not specifically required under the institutional procedures applicable to minimal-risk, non-invasive social research at the time of data collection. This institutional determination was confirmed by Bogor Agricultural Development Polytechnic in the Letter of Ethical Consideration No. 346.1/SM.220/I.8/02/2026, dated 4 February 2026. The study involved competent adult participants, did not include medical or clinical interventions, biological sampling, vulnerable populations, or highly sensitive personal data, and followed the ethical principles of the Declaration of Helsinki (1964) and its subsequent amendments insofar as they apply to non-clinical social research.

Consent to participate: Before data collection, all respondents received information about the study purpose, the voluntary nature of participation, the right to decline or withdraw without consequence, and the confidential handling of their responses. Informed consent was obtained from every participant before the questionnaire or interview, and anonymity was maintained during analysis and reporting.

Data availability statement: The de-identified data supporting the findings of this study are available from the corresponding author upon reasonable request. Public release is restricted to protect participant confidentiality.

Conflict of interest: The authors declare no commercial, financial, or non-financial conflicts of interest related to this study.

Acknowledgements: The authors acknowledge the Polytechnic of Agricultural Development Bogor, the Agricultural Extension and Agricultural Human Resources Development Agency, the Ministry of Agriculture of the Republic of Indonesia, participating Agricultural Extension Centres in Subang and Cianjur Regencies, and all respondents.

REFERENCES

Amanah, S. (2007). Makna penyuluhan dan transformasi perilaku manusia. *Jurnal Penyuluhan*, *3*(1), 63–67. https://doi.org/10.25015/penyuluhan.v3i1.2152

Amanah, S., Syamsiah, S., Azhari, R., Snider, A., McNamara, P., & Bhushan, B. (2026). Enhancing extensionists' capabilities in female farmers' groups empowerment: An integrative approach. *Indian Journal of Extension Education*, *62*(3), 97–104. https://doi.org/10.48165/IJEE.2026.62316

Anto, A., & Andriansyah. (2020). Analisa tingkat pengetahuan penyuluh terhadap program Kostratani di Provinsi Kalimantan Tengah. *Prosiding Seminar Nasional Pembangunan dan Pendidikan Vokasi Pertanian*, *1*(1), 40–48. https://doi.org/10.47687/snppvp.v1i1.124

Azhari, R., Amanah, S., Fatchiya, A., & Kinseng, R. A. (2025). The influence of agricultural extension services and livelihood capitals on farmers' climate resilience in West Java, Indonesia: A structural equation modelling approach. *Journal of Natural Resources and Environmental Management*, *15*(5), 904–923. https://doi.org/10.29244/jpsl.15.5.904

Azhari, R., Firmansyah, A., Shaliza, F., & Syamsiah, S. (2026). Mapping global research on farmers' climate resilience and agricultural extension: A bibliometric analysis. *Indian Journal of Extension Education*, *62*(4), 68–83. https://doi.org/10.48165/IJEE.2026.62410

Godara S., Bana R. S., Godara S., Bishnoi, S., Nain M. S., Parsad R., & Marwaha S. (2024). Data-driven insights for agricultural extension services in Rajasthan: A study of kisan call center queries, *Indian Journal of Extension Education*, 60(1), 53-58. https://doi.org/10.48165/IJEE.2024.60110.

Godara, S., Bana, R. S., Marwaha, S., Parsad, R., Nain, M. S., Sahu, S., Mehta, A., Singh, D., & Kumar, R. (2024). Uncovering farmers' information need through kisan call centre data analytics of Haryana state. *Indian Journal of Extension Education*, *60*(4), 59-66. https://doi.org/10.48165/IJEE.2024.60411.

Kadam, K. R., Ahire, M. C., Dhadwad, M. B., & Dahatonde, A. S. (2026). Effect of soybean digital farmer field school on knowledge levels of respondents in Maharashtra. *Indian Journal of Extension Education*, *62*(1), 27–31. https://doi.org/10.48165/IJEE.2026.62105

Kinasih, T. S., Widiyanto, & Suminah. (2021). Kinerja penyuluh pertanian dalam pelaksanaan program Komando Strategis Pembangunan Pertanian (Kostratani) di Kabupaten Sragen. *Agrica Ekstensia*, *15*(2), 111–117. https://doi.org/10.55127/ae.v15i2.98

Kumar, S. (2025). Determining the knowledge level and accessibility of major ICT tools by farmers in Madhya Pradesh. *Indian Journal of Extension Education*, *61*(4), 101–105. https://doi.org/10.48165/IJEE.2025.61417

Niranjan, S., Singh, D. R., Kumar, N. R., Jha, G. K., Venkatesh, P., Nain, M. S., & Krishnakumare, B. (2023). Do information networks enhance adoption of sustainable agricultural practices? Evidence from northern dry zone of Karnataka, India. *Indian Journal of Extension Education, 59*(1), 86-91 http://doi.org/10.48165/IJEE.2023.59118

Pakpahan, T. E., Wicaksono, M., & Harahap, Q. H. (2021). Peran Balai Penyuluhan Pertanian sebagai pusat data informasi pertanian dalam mendukung program Kostratani. *Jurnal Agribisnis Terpadu*, *14*(1), 46. https://doi.org/10.33512/jat.v14i1.11458

Paliwal, H., Singh, A. K., Kumar, S., Singh, P., & Kumari, J. (2026). Scale to measure farmers' attitude towards ICT-based agro-advisory services. *Indian Journal of Extension Education*, *62*(1), 166–170. https://doi.org/10.48165/IJEE.2026.621RT05

Panda, S., Modak, S., Devi, Y. L., Das, L., Pal, P. K., & Nain, M. S. (2019). Access and usage of Information and Communication Technology (ICT) to accelerate farmers' income. *Journal of Community Mobilization and Sustainable Development, 14*(1), 200-205.

Prayoga, K. (2018). Dampak penetrasi teknologi informasi dalam transformasi sistem penyuluhan pertanian di Indonesia. *Journal of Social and Agricultural Economics*, *11*(1), 47–59. https://doi.org/10.19184/jsep.v11i3.5663

Purwatiningsih, N. A., Fatchiya, A., & Mulyandari, R. S. H. (2018). Pemanfaatan internet dalam meningkatkan kinerja penyuluh pertanian di Kabupaten Cianjur. *Jurnal Penyuluhan*, *14*(1), 79–91. https://doi.org/10.25015/penyuluhan.v14i1.17173

Sahoo, S., Parasar, D. B., & Jayasingh, D. K. (2025). Towards digitally enabled extension services: ICT training directions in coastal Odisha. *Indian Journal of Extension Education*, *61*(4), 66–71. https://doi.org/10.48165/IJEE.2025.61411

Sondarva, Y. M., Nain, M. S., Singh, R., Mishra, J. R., Singh, D. R., & Parsad, R. (2023). E-readiness assessment of national agricultural research system. *Indian Journal of Extension Education*, *59*(4), 82-85. https://doi.org/10.48165/IJEE.2023.59417.

Sumardjo, Firmansyah, A., & Dharmawan, L. (2023). Social transformation in peri-urban communities toward food sustainability and achievement of SDGs in the era of disruption. *Sustainability*, *15*(13), 10678. https://doi.org/10.3390/su151310678

Sumardjo, Firmansyah, A., Dharmawan, L., & Sadono, D. (2026). Digital learning, social capital, and ICT utilization in strengthening young farmers' capacity for sustainable food systems in Indonesia. *Frontiers in Sustainable Food Systems*, *10*, 1767016. https://doi.org/10.3389/fsufs.2026.1767016

Syamsiah, S., Firmansyah, A., & Azhari, R. (2025). Sustainability strategies of young agrosociopreneurs in supporting national food security. *BIO Web of Conferences*, *186*, 02013. https://doi.org/10.1051/bioconf/202518602013

Utomo, B. N., Dharmayanti, N. L. P. I., Sukmayandi, T., & Widjaja, E. (2022). The contribution of ICT in agricultural development in Kostratani of BPP Bojonggambir, Tasikmalaya. *International Journal of Economics, Management, Business, and Social Science*, *2*(1), 97–108. https://doi.org/10.59889/ijembis.v2i1.51

Yadav, B., Maurya, A. S., Patel, S., Kumar, R., & Kumar, A. (2026). Assessing the role of digital platforms in strengthening agricultural extension services: Advisory to empowerment. *Indian Journal of Extension Education*, *62*(2), 47–53. https://doi.org/10.48165/IJEE.2026.62208