

Analysis of Factors Influencing the Adoption of Technological Innovations among Farmers in South Kalimantan

ABSTRACT - Adoption of agricultural technology innovations in South Kalimantan, particularly on swamp land, remains suboptimal despite various dissemination programs. This study identifies internal and external factors influencing farmers' technology adoption, including the institutional capacity of agricultural extension. It uses a literature review with a descriptive qualitative approach. Secondary data were collected through Google Scholar, Garuda, ResearchGate, and Statistics Indonesia publications, screened using inclusion and exclusion criteria, and analyzed through content analysis. The results show that adoption is influenced by internal factors (age, education, farming experience, capital, and land size) and external factors (innovation attributes, extension access, farmer groups, institutional networks, digital information access, local culture, and extension institutional capacity). Extension worker-to-farmer-group ratios in Banjar and Barito Kuala reach 1:23 and 1:28, above the ideal 1:15. Adoption is determined by both farmer characteristics and institutional capacity. Strengthening extension workers, farmer groups, and digital media is recommended, along with further quantitative research.

ABSTRAK - Adopsi inovasi teknologi pertanian di Kalimantan Selatan, khususnya lahan rawa, belum optimal meskipun berbagai program diseminasi telah dilaksanakan. Kajian ini bertujuan mengidentifikasi faktor internal dan eksternal yang memengaruhi adopsi inovasi teknologi oleh petani, termasuk kapasitas kelembagaan penyuluhan. Metode yang digunakan adalah studi kepustakaan dengan pendekatan deskriptif kualitatif. Data sekunder dikumpulkan melalui Google Scholar, Garuda, ResearchGate, dan publikasi BPS, diseleksi dengan kriteria inklusi dan eksklusi, lalu dianalisis dengan analisis isi. Hasil menunjukkan bahwa adopsi dipengaruhi faktor internal (umur, pendidikan, pengalaman bertani, permodalan, dan luas lahan) serta faktor eksternal (atribut inovasi, akses penyuluhan, kelompok tani, jejaring kelembagaan, akses informasi digital, budaya lokal, dan kapasitas kelembagaan penyuluhan). Rasio penyuluh terhadap kelompok tani di Kabupaten Banjar dan Barito Kuala mencapai 1:23 dan 1:28, di atas rasio ideal 1:15. Adopsi inovasi ditentukan oleh karakteristik petani dan kapasitas kelembagaan. Disarankan penguatan penyuluh, kelompok tani, dan media digital, serta penelitian kuantitatif lanjutan.

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INTRODUCTION

South Kalimantan is one of the major food-producing regions on the island of Kalimantan, with a rice harvested area of approximately 240,644 hectares in 2024, representing a 12.30% increase compared with 2023, and milled dry grain production of 979,359 tons, an increase of 11.86% (BPS Kabupaten Barito Kuala, 2024). The 2023 Agricultural Census recorded 463,299 agricultural households in South Kalimantan, comprising a total of 488,487 agricultural holdings (BPS Provinsi Kalimantan Selatan, 2023), most of which are located on tidal swamp and lowland swamp areas with specific agroecosystem characteristics. These land characteristics require the application of location-specific technology packages to sustainably improve farming productivity. Therefore, increases in production can only be sustained if technological innovations that are appropriate to the agroecosystem are genuinely accepted and adopted by farmers.

However, evidence from South Kalimantan indicates that innovation adoption remains suboptimal. Rina and Koesrini (2016) found that the adoption of Inpara varieties in lowland swamp areas of Tapin and North Hulu Sungai Regencies remained low, despite farmers having relatively high levels of knowledge (68.3%) and favorable attitudes (72.9%). Irpansyah et al. (2017) reported that the adoption rate of peanut cultivation technology in Banjar Regency was 66.13%, which was categorized as moderate and remained suboptimal. A similar condition has been observed in Central Kalimantan, a neighboring province with comparable swamp agroecosystem characteristics. A literature review by Feronika et al. (2023) concluded that farmers' adoption of technological innovations in the region remained low, with most farming households (73%) not participating in any technology adoption activities, primarily due to limited knowledge and skills, restricted access to technology, financial constraints, gender roles, and local cultural values. This situation persists despite the long-standing implementation of various agricultural technology dissemination programs, such as the Integrated Crop Management Field School (SL-PTT) and the Rural Agribusiness Development Program (PUAP), across rice-producing centers in Indonesia, including swamp areas of Kalimantan. Imani et al. (2022), who examined farmers' perceptions and adoption levels of Integrated Crop Management (PTT) innovations for lowland rice in West Lampung Regency, also found that the adoption of PTT technology components among farmers remained uneven.

Individual farmer characteristics constitute one of the determinants of technological adoption capacity. Puspitasari et al. (2025) quantitatively demonstrated among millennial farmers in Brebes Regency that agricultural technology adoption and formal education levels had positive and significant effects on farming household food security, whereas land size had no significant effect. These findings indicate that technological adoption capacity and human capital may be more influential than landholding size alone. Faried et al. (2024), through a case study of millennial farmers, also demonstrated that younger generations of farmers play an important role in adopting technology to improve farming productivity. At the same time, the ageing of the agricultural workforce represents a structural challenge. Hasyiyati (2025) empirically demonstrated that the ageing farmer phenomenon has a negative and significant effect on national rice productivity, while increases in formal education alone may not necessarily have a significant impact without an appropriate skill match with technological requirements in the field. These findings further underscore the importance of examining the determinants of innovation adoption beyond formal education to include farmers' demographic characteristics.

In addition to individual characteristics, external factors in the form of community networks and



extension services also determine the success of innovation dissemination. Setiawan et al. (2023), in their study of the development patterns of the agro-village innovation system in Banjar City, South Kalimantan, emphasized the importance of strengthening local community networks as a medium for disseminating agribusiness information and technology. Amrullah et al. (2023), studying small-scale farmers in Indonesia, demonstrated that access to agricultural extension services had positive and significant effects on both technology adoption and farm income. This finding is relevant to South Kalimantan, as Prahesti et al. (2020) showed that the performance of agricultural extension workers in empowering farming communities in Banjar Regency was categorized as moderate, at 78.57%. A recent study by Sapitri et al. (2025) in Banjar and Barito Kuala Regencies also found that the ratios of extension workers to farmer groups were 1:23 and 1:28, respectively, considerably higher than the ideal ratio of 1:15, while the use of digital media by extension workers remained limited to 30–35%. These conditions indicate that the issue of agricultural technology innovation adoption in South Kalimantan does not originate solely from individual farmer characteristics but also from the institutional capacity of agricultural extension services as a key intermediary between sources of innovation and end users.

These pieces of evidence are dispersed across commodities, regions, and types of innovation, and many studies examine internal farmer factors separately from the institutional capacity of agricultural extension services. Therefore, a synthesis is needed that places internal and external factors, including the institutional capacity of agricultural extension services, within a single framework for the South Kalimantan context, drawing on the innovation diffusion framework as applied by Feronika et al. (2023). The added value of this study lies in categorizing the determinants of adoption into internal and external factors and formulating their implications for agribusiness communication strategies. Agribusiness communication plays a strategic role in bridging sources of technological innovation with farmers as end users. As students and Agents of Change, understanding the factors that influence the adoption of technological innovations provides an important foundation for designing targeted communication and extension strategies.

The objectives of this study are to: (1) identify the internal and external factors influencing the adoption of agricultural technological innovations among farmers in South Kalimantan based on evidence from previous studies; (2) identify the institutional capacity of agricultural extension services as part of the external factors influencing the effectiveness of agribusiness communication in the region; and (3) formulate implications for agribusiness communication strategies and the role of students as Agents of Change in accelerating the adoption of technological innovations in the region.

RESEARCH METHODS

This study employed a descriptive qualitative approach through a literature review of secondary data. This approach follows the common practice of qualitative research based on literature reviews, as applied by Feronika et al. (2023) in Central Kalimantan. Primary data were not collected due to time and geographical coverage constraints, while empirical evidence on innovation adoption in South Kalimantan is dispersed across commodities, regencies, and academic disciplines and therefore requires prior synthesis. The object of the study was the internal and external factors influencing the adoption of agricultural technological innovations among farmers in South Kalimantan, including the institutional capacity of agricultural extension services. The literature search was conducted in September 2026.



The data sources consisted of scientific journal articles and national seminar proceedings as well as international journal articles in the fields of agricultural extension, agricultural socioeconomics, and agribusiness, along with official publications from Statistics Indonesia (Badan Pusat Statistik, BPS). These sources were primarily published within the last ten years. Several older studies were retained because they provided direct evidence from swamp areas in South Kalimantan. The literature search was conducted through Google Scholar, Garuda (Garda Rujukan Digital), and ResearchGate using the keywords “agricultural technology innovation adoption,” “farmer technology adoption in South Kalimantan,” “lowland swamp areas,” “extension institutional capacity,” and “farmer socioeconomic factors.”

The literature selection employed inclusion and exclusion criteria. Studies were included if they: (a) examined the level or determinants of agricultural innovation or technology adoption at the farmer level, including the institutional capacity of agricultural extension services supporting such adoption; (b) were conducted in South Kalimantan as direct evidence, or in other regions of Indonesia, particularly areas with swamp agroecosystems, as comparative evidence; and (c) were accessible in full text. Studies were excluded if they did not contain empirical data or findings, originated from sources whose validity could not be verified, or addressed contexts that were not relevant to agricultural technology innovation adoption at the farmer level. The studies that met the selection criteria were then categorized according to location, commodity or type of innovation, and variables examined.

The data were analyzed using descriptive qualitative content analysis in four stages. First, the variables reported to influence adoption were deductively categorized based on the innovation diffusion theory framework into internal factors (farmer characteristics) and external factors (innovation attributes, extension services and institutions, farmer groups, and communication and digital accessibility). Second, a narrative synthesis was conducted by recording the direction of the findings (positive, negative, non-significant, or descriptive) and the type of evidence (quantitative surveys, qualitative studies, or official statistics). Third, the secondary data were processed descriptively using percentages derived from reported frequencies (e.g., the distribution of respondent characteristics and digital literacy indicators) and percentage-point differences between indicators, which are presented in Table 1 and Figure 1. Fourth, the categorized findings were summarized in Table 2 and a conceptual framework (Figure 2) to formulate implications for agribusiness communication strategies. Data validity was maintained through triangulation across different types of evidence and a clear distinction between direct evidence from South Kalimantan and comparative evidence from other regions.

RESULTS AND DISCUSSION

1. Overview of Agricultural Technology Adoption in South Kalimantan

Most agricultural land in South Kalimantan consists of tidal swamp and lowland swamp areas that require location-specific cultivation technologies. In a comparable agroecosystem, namely Central Kalimantan, Feronika et al. (2023) found that most farming households (73%) had not participated in any technology adoption activities. This finding is relevant as comparative evidence for South Kalimantan because the two provinces share similar socio-agroecological characteristics. At the technology-component level, Imani et al. (2022), in their study of Integrated Crop Management (PTT) implementation for lowland



rice in West Lampung, showed that technology components requiring higher input costs tended to be adopted more slowly than simpler and less costly components. Heriaty and Triasni (2021), in their study of Integrated Crop Management for lowland rice in Soppeng Regency, South Sulawesi, also reported that the adoption of technology components occurred gradually and remained incomplete. These findings indicate that innovation adoption tends to be gradual across various rice-producing regions in Indonesia.

A similar pattern can be observed in other types of innovations. Setiawan et al. (2023) noted that the development of the agro-village innovation system in Banjar City still requires stronger community networks and local institutions to facilitate more equitable dissemination of agribusiness technologies and information among farmers. This condition indicates that adoption challenges extend across commodities and types of innovation, including both cultivation technologies and institutional and digital innovations. Therefore, agribusiness communication strategies need to be integrated rather than focused on a single type of innovation. The role of agricultural extension services as an intermediary between sources of innovation and farmers is illustrated in Figure 1.



Figure 1. Agricultural extension as part of technology adoption among farmers

Data obtained directly from South Kalimantan further reinforce this overall picture. Noorginayuwati and Anwar (2015), in their study of rice farmers in middle tidal swamp areas of South Hulu Sungai and North Hulu Sungai Regencies, found that the adoption of Integrated Crop Management (PTT) components among both participants and non-participants in the PTT Field School (SL-PTT) was categorized as moderate, with mean scores of 23.98 and 21.15, respectively, out of a maximum score of 33. The components with the highest adoption levels were quality seeds and improved varieties, whereas balanced fertilization and the *jajar legowo* planting system were adopted more slowly because farmers considered them more complicated and requiring greater capital and precision. The same study showed that technology-component adoption was significantly correlated with farm productivity ($r_s = 0.82$) and the intensity of field extension services ($r_s = 0.81$), while SL-PTT participants achieved rice productivity 26.07% higher than non-participants. This evidence indicates that the intensity of extension support, rather than farmers' individual characteristics alone, contributes to determining the success of technology adoption in the swamp areas of South Kalimantan.

Table 1 summarizes the indicators of technology adoption, extension capacity, and farmer profiles from the studies conducted in South Kalimantan that were reviewed.

Indicator	Value	Location and Sample	Source
A. Innovation Adoption Level			
Adoption of Inpara varieties (lowland swamp areas)	Low; knowledge 68.3% (high); attitude 72.9% (agree)	Tapin & North Hulu Sungai; <i>n</i> = 60	Rina & Koesrini (2016)
Adoption of peanut cultivation technology	66.13% (moderate)	Belangian Village, Banjar Regency	Irpansyah <i>et al.</i> (2017)
B. Agricultural Extension Capacity			
Extension worker performance in farmer empowerment	78.57% (moderate)	Banjar Regency; 30 extension workers and 30 farmer group leaders	Prahesti <i>et al.</i> (2019)
Extension worker-to-farmer group ratio	1:23 (Banjar); 1:28 (Barito Kuala)	Banjar & Barito Kuala	Sapitri <i>et al.</i> (2025)
BPPs with programs based on farmers' needs	60% (Banjar); 50% (Barito Kuala)	Banjar & Barito Kuala	Sapitri <i>et al.</i> (2025)
BPPs with adequate official vehicles	35–40%	Banjar & Barito Kuala	Sapitri <i>et al.</i> (2025)
BPPs using WhatsApp Groups (passively)	70%	Banjar & Barito Kuala	Sapitri <i>et al.</i> (2025)
C. Farmer Profile			
Farmers with elementary school education	62–68%	Banjar & Barito Kuala	Sapitri <i>et al.</i> (2025)
Farmers aged >50 years	55–60%	Banjar & Barito Kuala	Sapitri <i>et al.</i> (2025)
Respondents aged ≥41 years (41–50 years: 16; >50 years: 8)	66.7% (24 of 36)	Karang Indah Village, Barito Kuala	Processed from Forqan <i>et al.</i> (2024)
Respondents with elementary school education or no formal schooling (10 + 5)	41.7% (15 of 36)	Karang Indah Village, Barito Kuala	Processed from Forqan <i>et al.</i> (2024)
Respondents engaged in farming for >15 years	58.3% (21 of 36)	Karang Indah Village, Barito Kuala	Forqan <i>et al.</i> (2024)

Table 1. Indicators of Adoption, Extension Capacity, and Farmer Profiles from Studies in South Kalimantan

Note: HSU = North Hulu Sungai; BPP = Agricultural Extension Center. Source: Synthesis of the literature review and processing of secondary data (2026).



Table 1 shows three things. First, the adoption level is in the low to moderate category, and good knowledge and attitudes do not automatically result in adoption. Second, extension capacity is limited, as indicated by the performance of extension workers being only in the moderate category, the non-ideal ratio of extension workers to farmer groups, and limitations in facilities and the use of digital media. Third, the farmer profile is dominated by older age and low education, both in the data from Sapitri et al. (2025) and in the survey data from Karang Indah Village processed from Forqan et al. (2024).

2. Internal Factors Influencing the Adoption of Technological Innovations

Individual farmer characteristics are important determinants in decision-making regarding innovation adoption. First, the level of formal education is positively associated with technological adoption capacity. Puspitasari et al. (2025) quantitatively demonstrated that formal education had a positive and significant effect on farming household food security through increased technological adoption capacity. This finding is consistent with Setiyowati et al. (2022), who showed that farmer characteristics, including education, influenced farmers' knowledge of introduced cultivation innovations. The profile of farmers in South Kalimantan indicates limited human capital. Sapitri et al. (2025) reported that farmers in Banjar and Barito Kuala Regencies were dominated by elementary school graduates (62–68%) and those aged over 50 years (55–60%). Survey data from Karang Indah Village, Barito Kuala, processed from the frequency distribution of Forqan et al. (2024), show a similar pattern: 66.7% of respondents were aged 41 years or older, 41.7% had elementary school education or no formal schooling, and 58.3% had been farming for more than 15 years (Table 1).

Second, age and farmer regeneration also play a role. Hasyati (2025) found that the ageing of the agricultural workforce (ageing farmers) had a negative and significant effect on national rice productivity, because older farmers are generally more cautious and less willing to take risks when trying new technologies. Formal education also does not necessarily have a significant effect without a match between skills and technological needs in the field. In Barito Kuala, Rusydi et al. (2026), studying floating rice farmers in Sampurna Village, Jejangkit District, found significant relationships between formal and non-formal education and perceptions of technology, as well as between age and farming experience and such perceptions. Age was negatively associated with farmers' perceptions of floating rice technology. On the other hand, Faried et al. (2024) showed that millennial farmers play a role in adopting technology to improve farm productivity, with capital support being one of their needs. Young farmers are therefore an important target of agribusiness communication, and the messages conveyed need to emphasize practical skills, not only formal education. It should be noted that most of this evidence comes from outside South Kalimantan or measures perceptions rather than adoption, and therefore needs to be further tested in the local context.

Third, capital conditions are a recurring structural constraint. Feronika et al. (2023) identified financial constraints as one of the main barriers to adoption among farming households in Central Kalimantan, consistent with Faried et al. (2024), who emphasized the importance of capital support and resource capacity for millennial farmers. Fourth, the influence of cultivated land size varies. Sirajuddin (2021) found that land size was strongly correlated with farmers' positions in the decision-making stages of the *jajar legowo* innovation, whereas Puspitasari et al. (2025) found that land size did not have a significant effect compared with technology adoption and formal education. Saleh et al. (2024), through logistic regression on the adoption of precision agricultural technology in tropical agroecological areas, found that education, income,



access to capital or credit, and active participation in farmer groups significantly influenced adoption decisions, whereas land size did not. This difference indicates that the influence of land size is context-dependent and needs to be examined together with institutional factors and commodity characteristics. The consistency of findings across regions also confirms that farmers' human resource capacity and capital are more important in determining adoption readiness than landholding size alone, including in the context of swamp areas in South Kalimantan.

3. External Factors Influencing the Adoption of Technological Innovations

Institutional factors and the external environment also play important roles in the adoption process. Setiawan et al. (2023) emphasized that strengthening community networks and locally based innovation systems, such as the development of agro-villages in Banjar City, provides an important medium for disseminating agribusiness technology information to farmers. Innovation attributes also influence the speed of adoption. Sirajuddin (2021) found that farmers' perceptions of the compatibility, complexity, and observability of innovations were strongly correlated with the stages of adoption decisions, consistent with the principles of diffusion of innovation theory that innovations perceived as simple and whose results are easy to observe tend to be adopted more rapidly.

As an illustration, Noorginayuwati and Anwar (2015) noted that farmers in the lowland swamp areas of South Kalimantan tended to delay adopting the *jajar legowo* planting system because it was considered complicated and difficult to implement on small plots, although it had been technically proven to increase yields through the border-row effect and facilitate the control of pests, diseases, and weeds. This case shows that perceptions of innovation complexity, as found by Sirajuddin (2021), clearly influence the speed of implementation of technology components in the field, so agribusiness communication strategies need to include demonstration plots (demplots) as visual learning media that simplify technical messages. Rina and Koesrini (2016) showed another aspect, namely that innovations must compete with varieties already familiar to farmers. Both findings support the need for demonstration plots under actual field conditions.

Information accessibility and the sociocultural context are also relevant external factors. The review by Feronika et al. (2023) in Central Kalimantan identified limited access to technology, local cultural values, and gender roles in farming households as structural barriers to adoption. These barriers are relevant to South Kalimantan because of the similarities in the social-agroecological characteristics of the two provinces, and they emphasize that agribusiness communication strategies need to consider not only the technical aspects of innovation but also the sociocultural context of its recipients.

4. Institutional Capacity of Extension Services, Farmer Groups, and Access to Extension Services

Amrullah et al. (2023) showed that access to agricultural extension services had positive and significant effects on technology adoption and farm income among small-scale farmers in Indonesia. This finding shows that extension is not only an information channel but also supports farmers' decisions to implement technology. Saleh et al. (2024) found that active participation in farmer groups significantly influenced decisions to adopt precision agricultural technology. In the context of South Kalimantan, Prahesti et al. (2020) found that the performance of agricultural extension workers in Banjar Regency was in the moderate category (78.57%), while Sapitri et al. (2025) reported an extension worker-to-farmer group ratio of 1:23 in Banjar Regency and 1:28 in Barito Kuala, as well as the use of digital media by extension workers



remaining at around 30–35 percent. Thus, extension capacity, farmer group involvement, and the use of digital channels need to be viewed as an interconnected series of agribusiness communication that complements one another.

5. Communication and Digital Literacy

Digital channels have the potential to overcome limitations in interpersonal communication channels, but the readiness of farmers and extension workers remains low. The study by Forqan et al. (2024) focused on digital marketing, but its indicators can be used as proxies for farmers' digital readiness. In Karang Indah Village, Barito Kuala, 62% of farmers were unfamiliar with the concept of digital marketing, only 33% had used digital platforms (particularly WhatsApp and Facebook), and only 19% had participated in digital training (Figure 2). The authors concluded that digital adoption was constrained by knowledge, digital skills, and access to technology.

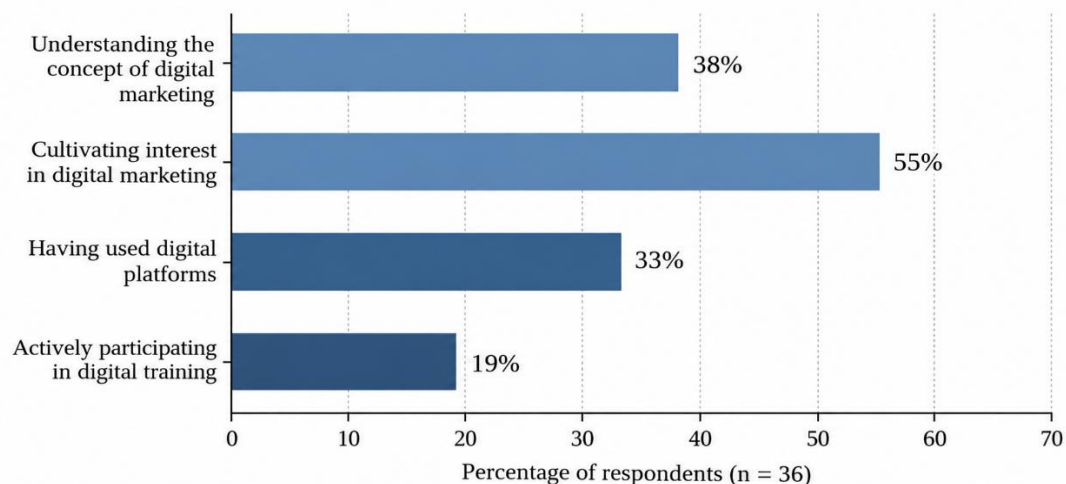


Figure 2. Indicators of Digital Literacy and Digital Utilization among Rice Farmers in Karang Indah Village, Barito Kuala (n = 36). Source: Forqan et al. (2024)

There is a gap between perception and practice: 55% of farmers considered digital marketing important, but only 33% used it, representing a difference of 22 percentage points (processed from Forqan et al., 2024). A total of 75% of user farmers perceived an increase in income, suggesting that the barriers appear to lie in initial capacity and support rather than in the absence of tangible benefits. This figure should be interpreted cautiously because the user group consisted of only about 12 people (33% of 36 respondents).

On the extension worker side, WhatsApp Groups have been used in 70% of the BPPs examined; however, their use remains passive, limited to information dissemination without interaction, and Sapitri et al. (2025) suggested that the digitalization of extension services should be developed gradually alongside improvements in digital literacy. Sugihono et al. (2024) viewed social media and smartphones as both opportunities and challenges for extension services, while Sirajuddin and Kamba (2021) reported that farmers perceived information and communication technology (ICT) as relatively easy to use. Channels that are



already familiar to farmers can serve as a starting point, provided that they are accompanied by training and two-way interaction.

6. Summary of Determinant Factors of Technological Innovation Adoption

Table 2 presents a summary of the determinant factors of agricultural technological innovation adoption, including the institutional capacity of agricultural extension services, based on the synthesis of the literature review described above.

Factor Category	Identified Variables	Review Sources
Internal	Age/farmer generation (<i>ageing farmers</i>)	Hasyati (2025)
Internal	Formal education level	Puspitasari <i>et al.</i> (2025); Setiyowati <i>et al.</i> (2022); Saleh <i>et al.</i> (2024)
Internal	Capital, income, and credit access	Feronika <i>et al.</i> (2023); Faried <i>et al.</i> (2024); Saleh <i>et al.</i> (2024)
Internal	Cultivated land size	Sirajuddin (2021); Puspitasari <i>et al.</i> (2025)
External	Innovation characteristics/attributes (compatibility, complexity, observability)	Sirajuddin (2021)
External	Community networks and local innovation institutions	Setiawan <i>et al.</i> (2023)
External	Access to information and digital technology	Feronika <i>et al.</i> (2023)
External	Local cultural values and gender roles	Feronika <i>et al.</i> (2023)
Internal	Farming experience	Rusydi <i>et al.</i> (2026)
External	Access to extension services/extension intensity	Amrullah <i>et al.</i> (2023); Noorginayuwati & Anwar (2015)
External	Active participation in farmer groups	Saleh <i>et al.</i> (2024)
External	Institutional capacity of agricultural extension services	Prahesti <i>et al.</i> (2020); Sapitri <i>et al.</i> (2025)

Table 2. Summary of Determinant Factors of Agricultural Technological Innovation Adoption Based on the Literature Review

Source: Synthesis of the literature review (2026).

Table 2 contains five internal factors (age, education, capital, land size, and farming experience) and seven external factors (innovation attributes, local institutional networks, access to information and digital technology, cultural values and gender, access to extension services, farmer group activity, and institutional capacity of agricultural extension services). The interrelationships among these factors are illustrated in Figure 3.



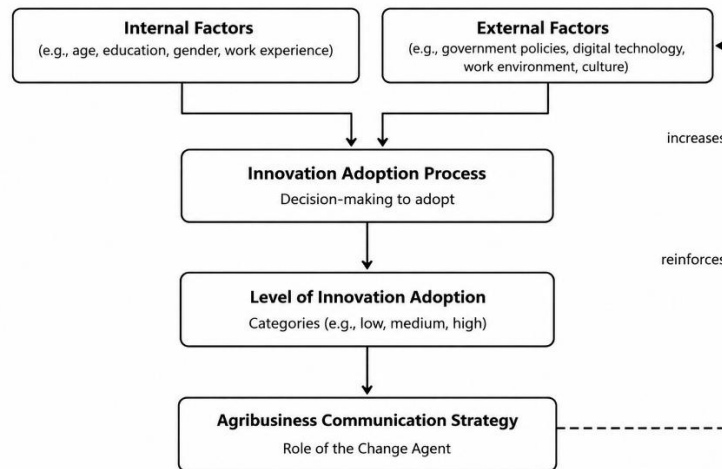


Figure 3. Conceptual Diagram of Factors Influencing the Adoption of Agricultural Technological Innovations in South Kalimantan

Figure 3 shows that internal farmer factors and external-institutional factors do not operate separately but jointly shape the decision-making process, resulting in adoption levels that vary from low to high. The dashed lines represent reciprocal relationships, indicating that agribusiness communication strategies and the role of students as Agents of Change are expected to strengthen external factors, particularly the institutional capacity of agricultural extension services and the accessibility of digital information, thereby accelerating innovation adoption in the subsequent period.

7. Implications for Agribusiness Communication Strategies and the Role of Students as Agents of Change

The findings indicate that accelerating innovation adoption in South Kalimantan cannot rely on a single approach but requires a combination of agribusiness communication strategies that simultaneously target internal and external factors. Students as Agents of Change can play five roles. First, they can serve as partners to extension workers in simplifying technical messages so that they are easily understood by farmers with varying levels of education. Second, they can promote the regeneration of young farmers through education and agribusiness entrepreneurship mentoring to address the negative effects of ageing farmers on productivity (Hasyati, 2025). Third, they can facilitate the strengthening of community networks and local institutions as nodes for disseminating technological information, in line with the findings of Setiawan et al. (2023) regarding the role of agro-village innovation systems. Fourth, they can develop and disseminate digital communication media, such as educational videos, agricultural consultation applications, and farmer group social media, to expand access to technological information, particularly in areas with limited road access and access to technological resources. Fifth, they can support the strengthening of field extension workers' capacity through collaboration with local Agricultural Extension Centers (BPPs) as volunteer technology assistants, given the limited ratio of extension workers to farmer groups in the swamp areas of South Kalimantan (Sapitri et al., 2025).



The effectiveness of communication channels also needs to be considered. Referring to Rogers' diffusion of innovation theory, interpersonal channels (face-to-face extension worker–farmer interactions) tend to be more effective at the persuasion stage because they allow two-way dialogue and adjustment of messages to farmers' concerns, whereas mass media or digital media are more effective at the awareness stage because they can reach broad audiences quickly and efficiently. However, the ratio of extension workers to farmer groups in Banjar and Barito Kuala Regencies of 1:23 to 1:28 (Sapitri et al., 2025) indicates structural limitations in interpersonal channels, while the use of digital media by extension workers, which is only around 30–35 percent (Sapitri et al., 2025), indicates that the potential of digital channels has not yet been fully optimized. This condition suggests a combination of the two channels through a two-stage approach (two-step flow of communication), namely the widespread dissemination of initial information through digital media, followed by reinforcement by progressive farmers or farmer group leaders as opinion leaders who bridge information to the local community level while simultaneously reducing the burden on the limited interpersonal channels of extension workers.

For farmers and extension workers, this review is useful as a basis for targeting the most evident adoption barriers, namely limited human capital, inadequate extension capacity, and low digital literacy. For students and higher education institutions, this review provides concrete directions for mentoring activities to support technology dissemination in the swamp areas of South Kalimantan.

8. Limitations of the Review and Recommendations

This review has two limitations. First, most findings regarding internal and external factors come from areas with comparable agroecosystems (Central Kalimantan, West Lampung, Gorontalo, South Sulawesi) and do not yet fully represent conditions across all regencies or cities in South Kalimantan. Second, data on extension capacity currently cover only Banjar and Barito Kuala Regencies, so generalization to other regencies with different agroecosystems, such as dryland areas in Tanah Laut or Tabalong Regencies, should be undertaken with caution. Further quantitative research with representative samples across various regencies in South Kalimantan is needed to test the strength of the influence of each determinant factor. Extension workers and local governments are advised to prioritize increasing the number of extension personnel, improving the digital literacy of extension workers and farmers, and utilizing demonstration plots and farmer groups as means of dissemination.

CONCLUSION

This literature review shows that the adoption of agricultural technology innovations among farmers in South Kalimantan is influenced by a combination of internal and external factors. Internal factors include age or stage of farmer regeneration, formal education, farming experience, capital conditions, and cultivated land size, with the effect of land size being context-dependent. External factors include innovation attributes, access to extension services, participation in farmer groups, community networks and local innovation institutions, access to information and digital technology, local cultural values and gender roles, and the institutional capacity of agricultural extension. Adoption levels in studies from South Kalimantan, as well as in regions with comparable agroecosystems such as Central Kalimantan (Feronika et al., 2023), fall in the low to moderate range, indicating that farmers' application of technology innovations is not yet optimal.



The institutional capacity of agricultural extension in Banjar and Barito Kuala Regencies remains limited. This is reflected in an extension worker-to-farmer-group ratio that is not yet ideal, extension worker performance in the moderate category, and digital media use by extension workers that is not yet optimal. These limitations are compounded by farmers' limited human capital, namely a predominance of older age groups, low formal education, and inadequate digital literacy. Thus, the adoption problem stems not only from individual farmer characteristics but also from the capacity of the institutions that link sources of innovation with farmers.

Based on these findings, agribusiness communication strategies in South Kalimantan need to combine digital channels for raising awareness with interpersonal channels, through extension workers, farmer groups, and progressive farmers, for reinforcement. Students, as Agents of Change, can act as partners of extension workers by simplifying technical messages, mentoring young farmers, and developing easily accessible information media. Because this review relies on secondary data, the strength of the influence of each factor still needs to be tested quantitatively with representative samples across regencies in South Kalimantan.

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