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The model of organic fertilizer adoption in urban farming to support environmentally friendly agriculture in Pekanbaru City, Riau Province, Indonesia

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ABSTRACT
This study examines farmer characteristics, urban farming profiles, levels of organic fertilizer adoption, and the factors influencing its adoption in Pekanbaru City. The degradation of agricultural land in Indonesia, including Pekanbaru, is primarily attributed to excessive chemical fertilizers, which compromise soil fertility and endanger food security. Although interest in organic farming is growing, its adoption remains limited due to inadequate government support, market challenges, and farmers' dependence on chemical fertilizers for immediate results. Using a survey method targeting vegetable farmers who have used organic fertilizers for at least one year, the data were analyzed with Partial Least Square (PLS) modeling. The findings indicate that farmers, predominantly male (72.09%) with low educational attainment, face challenges such as limited land availability. Although farmers hold positive perceptions of organic fertilizers, especially chicken manure, they prefer chemical fertilizers due to their immediate impact. Moreover, agricultural extension services and government support for organic fertilizer adoption are deemed insufficient. The decision to adopt organic fertilizers is significantly influenced by land size, the performance of agricultural extension workers, and marketing strategies. To improve adoption rates, it is imperative to enhance agricultural extension services, optimize government support, and establish accessible marketing strategies, thereby promoting sustainable urban agriculture in Pekanbaru.

Contribution/Originality: This research is original as it examines organic fertilizer adoption in Pekanbaru's urban agriculture, integrating social, economic, and environmental aspects. This study is different from others because it focuses on local factors like policy potential and urban community awareness. It also looks at the specifics of sustainable urban agriculture in Pekanbaru, which other studies have missed.

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1. INTRODUCTION
Indonesia has significant agricultural potential, crucial in increasing farmers' incomes, ensuring food and nutrition security, creating job opportunities, and contributing to the nation's foreign exchange. This potential is supported by several comparative advantages, such as (i) the availability of land resources for developing organic agricultural systems

and (ii) technologies that support organic agriculture, including compost production, no-till farming, biological pesticides, and more.

However, the environmental conditions, particularly agricultural land, have deteriorated over the past few decades. According to Chaniago (Idris, 2022) approximately 72% of Indonesia's agricultural land is currently "sick" due to the depletion of organic matter, primarily caused by excessive use of chemical fertilizers. In the 1960s, Indonesian soils were fertile with high organic content, which made chemical fertilizers highly effective. However, the gradual shift away from organic fertilizers in favor of the convenience of chemical fertilizers has led to soil degradation. Similarly, Yusuf et al. (2023) explained that nearly 69% of agricultural land in Indonesia has been severely degraded due to excessive use of chemical substances. The damage to agricultural land and the environment is caused by pollution from agrochemical materials, such as chemical fertilizers and pesticides. These conditions make Indonesia's food security vulnerable to the impacts of climate change, which is expected to become increasingly critical by 2050.

The fertilizer usage pattern among rice farmers in Indonesia is predominantly inorganic. According to the 2023 Agricultural Census, 86.41% of farmers use inorganic fertilizers, 13.5% use a balanced mix of organic and inorganic fertilizers, and only 0.07% rely solely on organic fertilizers. This figure reflects a preference for inorganic fertilizers due to their practicality and availability. However, excessive use of inorganic fertilizers, particularly nitrogen (N) fertilizers, will deplete soil fertility and exacerbate climate change. It is estimated that only 50% of the nitrogen applied is absorbed by the soil, with the remainder released into the atmosphere (Yani, Juliansyah, Puteh, & Anwar, 2022).

Commonly used chemical fertilizers, such as urea and TSP, are expensive, especially after the government removed subsidies. Distribution delays often cause shortages, leading to high prices and increased production costs. However, organic fertilizers offer advantages over inorganic alternatives, particularly regarding human health and environmental sustainability. The growing awareness of healthy living has brought attention to the dangers of synthetic chemicals, particularly inorganic fertilizers, which remain a cornerstone of modern agriculture. This awareness sparked increased interest in organic farming among producers and consumers. Consumers are increasingly favoring food products that are safe, nutritious, and environmentally friendly, which is fueling demand for organic products. The global trend toward eco-conscious, healthy lifestyles has led to the institutionalization of standards that require agricultural products to meet food safety, nutritional content, and eco-labeling criteria.

Despite government initiatives to promote organic farming, such as the "Go Organic 2010" program, progress has been slow due to market constraints, low farmer interest, lack of understanding of organic products, burdensome certification processes for small farmers, and challenges in farmer organizations and business partnerships.

Nevertheless, interest in organic farming continues to grow. This trend is expected to positively influence the development of organic agriculture in Pekanbaru City, the capital of Riau Province. Pekanbaru, with a population of over 1.2 million and an area of 632.3 km^2, is a significant producer of vegetables. Main crops include spinach, large chili peppers, cayenne peppers, Chinese cabbage, cucumbers, and water spinach, with specific crops being dominant in different sub-districts.

Based on these issues, this study aims to analyze:

1. The characteristics of farmers, agricultural extension workers, and the profile of urban farming in Pekanbaru City.
2. Characteristics of organic fertilizer innovation, the performance of agricultural extension, government support, marketing strategies, and the level of adoption of organic fertilizer in urban agriculture in Pekanbaru City.
3. Factors influencing the use of organic fertilizers in urban farming in Pekanbaru City.
4. Efforts to enhance the adoption of organic fertilizers in urban farming in Pekanbaru City.

1.1. Organic Fertilizers and Their Benefits

Organic fertilizers refer to all organic materials derived from plants and animals that can decompose into nutrients accessible to plants. According to Ministry of Agriculture Regulation No. 2/Pert/Hk.060/2/2006 on Organic Fertilizers and Soil Amendments, organic fertilizers are primarily or entirely composed of organic materials from plants and animals that have undergone a processing method. They can be solid or liquid and supply organic matter that improves the soil's physical, chemical, and biological properties. This definition emphasizes the carbon content of organic fertilizers, distinguishing them from inorganic fertilizers. Khan, Aleinikovienė, and Butkevičienė (2024) states that organic fertilization utilizes natural resources to enhance soil quality. Maula (2023) organic fertilizers made from natural materials, including livestock waste, are essential in sustainable agriculture as they enhance soil fertility and maintain ecosystem balance. Patunah and Pradani (2024) play a key role as one of the main components in achieving sustainable farming. Ardianto and Iskandar (2022) agricultural ecology theory highlights the importance of using organic materials to improve soil quality and ensure long-term sustainability.

According to Saraswati (2012) the benefits of using environmentally friendly fertilizers, such as biofertilizers, include enhancing fertilization efficiency, improving crop yields sustainably, increasing soil fertility and health, and promoting plant health. Several studies on the economic impact of organic fertilizers, particularly on rice crops, include the following findings: Muchlis (2010) discovered that applying 200 kg/ha of biofertilizers could reduce inorganic fertilizer usage by 50%. Setyawan (2013) explained that combining straw incorporation, organic fertilizers, and biofertilizers can reduce NPK fertilizer dosage by up to 50% without compromising crop yields. This strategy demonstrates that biofertilizers and organic fertilizers can enhance fertilization efficiency. Siswanto (2014) found that applying organic fertilizers increased the efficiency of N, P, and K fertilizers. According to Regulation No. 40/2007 from the Ministry of Agriculture, using organic and inorganic fertilizers together can make the soil more fertile and make using inorganic fertilizers more effective (Saraswati, 2012).

1.2. Innovation and the Theory of Innovation Adoption

Rogers (2003) defines innovation as an idea, practice, or object perceived as new by an individual or group of adopters. The first use or discovery of an idea that determines its novelty. The key extrinsic characteristics of innovation include: (1) Relative Advantage: The degree to which an innovation offers benefits over existing technology, whether technical, economic, non-economic, or socio-cultural; (2) Compatibility: The alignment of the innovation with local environmental factors, including physical, socio-cultural, political, and economic aspects; (3) Complexity: The degree of difficulty in understanding and using the innovation compared to its predecessor; (4) Trialability: The ease with which an innovation can be tested or experimented with; and (5) Observability: The extent to which the results of an innovation are visible to others. On the other hand, Azzahra et al. (2022) state that this innovation can also contribute to rural economic development by creating job opportunities in the agricultural sector and waste management.

Adoption is the process of accepting an innovation, leading to changes in an individual's knowledge (cognitive), attitude (affective), and skills (psychomotor) after being introduced to the innovation (Mardikanto, 2009). Traditional dominant models of innovation adoption often overlook the role of emotions, even though this aspect is relevant in consumer decision-making (Valor, Antonetti, & Crisafulli, 2022) Farmers can benefit from innovations as they help reduce production costs, simplify tasks, and increase yields (Gandasari, Diena, & Larassati, 2020). According to Rizki, Suwarsinah, and Priatna (2019) government support positively impacts innovation adoption. Meanwhile, Ober (2020) highlights that the successful implementation of innovation is a crucial contemporary issue for the smooth operation of businesses, industries, and socio-economic environments.

2. RESEARCH METHOD

2.1. Location and Duration of the Study

This research was conducted using a survey method in Pekanbaru City, selected for its potential in urban farming and horticulture development and its vulnerability to using inorganic fertilizers. Due to limited land availability, farmers often use the land intensively without allowing it to rest. They prefer chemical fertilizers because of their quick response time, even though these fertilizers can cause long-term harm to the soil and the environment. The study was conducted over 10 months, from July 2023 to May 2024.

2.2. Data Collection Methods and Sampling Techniques

The data collected comprised primary and secondary sources. Primary data was obtained through in-depth interviews and field observations. Secondary data is sourced from related institutions or data providers (trade offices, statistics bureaus, etc.). The data types and sources are outlined in Table 1.

Table 1. Types and sources of data.

Type of data	Source
Characteristics of farmers	Farmers
Urban farming profiles	Farmers
Perceptions of organic fertilizers	Farmers
Innovation decision types	Farmers
Communication channels	Farmers
Agricultural extensions' performance	Farmers
Adoption level of organic fertilizers	Farmers
Secondary data	Pekanbaru city monographic data, P2L program participant statistics, and literature studies

Farmers were randomly sampled, targeting vegetable farmers who had used organic fertilizers for at least one year. The sample size was determined based on the main vegetable production areas in Pekanbaru City (Table 2).

Table 2. Distribution of respondents by sub-district in Pekanbaru city.

Sub-district	Population	Sample
Sido Mulyo	37	12
Tenayan Raya	30	10
Marpoyan Damai	34	11
Tuah Madani	30	10
Total	253	84

2.3. Data Analysis

The characteristics of farmers, agricultural extension, and farm business profiles were analyzed using descriptive statistics. Descriptive statistical analysis uses mean, frequency distribution, graphs, and tables using the *Microsoft Office Excel 2016 computer program*. Narratives or descriptions discuss the data analyzed descriptively.

Perceptions of organic fertilizer, types of innovation decisions, communication channels, and performance of agricultural extension workers in adopting organic fertilizer innovations were analyzed using quantitative qualitative data analysis. The qualitative data is measured using an ordinal scale for each research indicator. The measurement score value uses a Likert scale, ranging from 1 to 5. After calculating the score value for each variable and sub-variable

of the study, categorization is carried out consisting of: "very good," "good," "less good," "not good," and "very bad." The range formula for categorization is: (maximum score x number of indicators) – (minimum score x number of indicators).

2.4. Number of Categories

Relationships between organic fertilizer adoption model variables were tested using Partial Least Square (PLS-Path Modelling), supported by Smart PLS Version 2 software. Outer Model Testing: Assesses the validity and reliability of indicators against latent variables. Inner Model Testing: Looks at the structural relationships between hidden variables, such as the significance of R-Square and path coefficients.

3. RESULTS AND DISCUSSION

3.1. Characteristics of Farmers

Urban farmers are farmers who farm in Pekanbaru city, with the characteristics of using narrow land that utilizes idle land in housing complexes or locations that have not been utilized for buildings or other development facilities. They cultivate crops such as cassava and horticulture through vegetables and short-lived fruits (watermelon, melon, and papaya). The characteristics of farmers studied include age, education level, farming experience, and number of family members. The characteristics of farmers can be seen in Table 3.

Table 3. Characteristics of food crop and horticultural farmers in Pekanbaru city.

No.	Description	(Number of people)	Percentage (%)
1	Gender = X1		
	a. Man	62	72.09
	b. Woman	24	27.91
2	Age (Years) = X2		
	a. 18 - 38	26	30.23
	b. 39 - 59	48	55.82
	c. 60 - 80	12	13. 95
3	Education level = X3		
	a. Not very elementary school	2	2.34
	b. Elementary school	20	23.24
	b. Junior high school	25	29 .07
	c. High school	35	40.7
	d. College	4	4.65
4	Farming experience (Years) = X5		
	a. ≤10	32	37.21
	b. 11-20	37	43.02
	c. 21-30	12	13.95
	d. ≥ 30	5	5.82
5	Number of family dependents (People) = X4		
	a. 1-3	53	61.63
	b. 4-6	30	34.88
	c. 7-10	3	3.49

3.1.1. Gender

According to the research findings (Table 1), food crop and horticulture farmers in Pekanbaru City are predominantly male, accounting for 72.09%, while female farmers make up 27.91%. This indicates that women also engage in food crop and horticulture farming in Pekanbaru City. Gender is also believed to influence the adoption of organic fertilizer innovations. Mensah, Villamor, and Vlek (2018) found that gender differences positively and significantly affect the likelihood of farmers adopting fertilizer applications. Households headed by women are more likely to adopt organic fertilizers than those led by men (Daadi & Latacz-Lohmann, 2021). However, Tufa et al. (2022) noted limited evidence regarding gender disparities in technology adoption and agricultural productivity.

3.1.2. Age

Horticultural farmers in Pekanbaru city vary from the youngest age of 18 to the oldest age of 78, with an average age of 44.91 years. However, 12 percent of farmers are over 60 years old. The productive age has a strong physique that is profitable for their farming business. Farmers of a productive age can think logically when choosing innovations that benefit their business and have a strong and dynamic physique.

3.1.3. Level of Education

Table 1 presents the research results, illustrating farmers' varying levels of formal education. The lowest did not finish Elementary School (ES) at 2 percent, and the highest is a bachelor's degree (4 percent), with an average length of education of 9.07 years (equivalent to graduating from junior high school). A total of 94 percent are spread from graduating from elementary school (23.2 percent), junior high school (29.07 percent), and high school (40.70 percent).

This shows that the level of education of horticultural farmers in Pekanbaru city has not met the education program set by the government, which is 12 years. A higher level of education will be better for thinking and acting.

3.1.4. Farming Experience

Farming experience is the period of time that women farmers have gone through in carrying out agricultural crop cultivation activities, especially horticultural crops (vegetables and fruits). The study results that can be seen in Table 1 show that most farmers have 11-30 years of farming experience (56.97%), with an average of 15.31 years. Farming experience is a more significant determinant of farmer behavior. According to Purwanto (2010) experience can shape interest by directing an individual's attention to things relevant to their needs. Similarly, Slameto (2010) explained that through experience, individuals learn to identify their needs and how to fulfill them. Efendy and Hutapea (2010); Sari and Sumarno (2013); Suminah and Ihsaniyati (2020) and Tapi, Tapi, and Carko (2024) stated that farming experience can influence the level of innovation adoption.

3.1.5. Number of Family Dependents

The research results indicate that most farmers have family responsibilities, as many as 1 - 3 people (61.63). The lowest number of family dependents is 1 person, and the highest is 10 people. The average number of dependents of farmer families in Pekanbaru city is 3 people. Nababan (2013) stated that the number of family members will affect the number of family needs. Having more family members means meeting more needs.

3.2. Farming Business Profile

The profile of food crops and horticultural farming in Pekanbaru City includes a description of land ownership status, land area, capital amount, and capital sources, as presented in Table 4. Based on Table 4, 55.81% of farmers in Pekanbaru City cultivate land without rent under an owner's permission, meaning the land is not personally owned but temporarily borrowed for agricultural activities. Meanwhile, 20.93% of farmers own their land. This ownership ratio affects the sustainability of agricultural businesses. If landowners decide to convert the land for other purposes, farmers may be unable to continue their farming activities unless they secure access to alternative land. The area of land most widely cultivated by farmers is 0.11-0.50 ha, 41.86 percent of farmers, followed by a land area of 0.005-0.10 ha, 32.50 percent of farmers. The amount of capital farmers use is the most (68 percent), which is 700 thousand to less than 5 million rupiah and 15.12 percent between 5 - 10 million rupiah. The source of capital is 89.5 percent of their capital.

Table 4. Profile of food crops and horticulture farming business in Pekanbaru city.

No.	Farming profile	(Number of people)	Percentage (%)
1	Land ownership status		
	a. One's own	18	20. 93
	b. Owner's permission without rent	48	55.81
	c. Rent	15	17.44
	d. Mixed (Own and shared)	1	1.17
	e. Profit sharing	4	4.65
2	Land area		
	a. 0.005-0.10	28	32.56
	b. 0.11-0.50	36	41.86
	c. 0.51-1.0	15	17.44
	d. 1.11-1.50	4	4.65
	e. 1.51-2.00	2	2.33
	f. >2	1	1.16
3	Amount capital (Million rupiah)		
	a. 700,000 - <5,000,000	59	68.6
	b. 5000, 000- <10, 000, 000	13	15.12
	c. 10,000,000 -<15,000,000	8	9.3
	d. 15,000,000- <20,000,000	3	3.49
	e. ≥ 20,000,000	3	3.49
4	Source of capital		
	a. Owner's equity	77	89.5
	b. Loan	6	7
	c. Mixed (Own and borrowed)	3	3.5

3.3. Characteristics of Organic Fertilizer Innovation

Based on the research results, organic fertilizers widely used (adopted) by food crop and horticulture farmers in Pekanbaru are primarily manure. Many farmers use a combination of manure, compost, and liquid organic fertilizers in their crop cycles. Table 5 presents the characteristics of organic fertilizer innovations, particularly manure. According to Table 5, the use (adoption) of manure is regarded by farmers as highly beneficial, as it is considered relatively profitable (Relative Advantage), compatible with existing practices (Compatibility), and uncomplicated to use

(Uncomplexity). Farmers find manure particularly profitable due to several advantages compared to other organic fertilizers: it makes the soil fertile and loose, contains many nutrients, and is inexpensive.

Horneck and Miller (1998) stated that manure contains various macro- and micro-nutrients essential for soil fertility. Manure is especially rich in nitrogen (N), which is necessary for vegetative plant growth, as well as phosphorus (P) and potassium (K), which are important for root development and increasing plant resistance to environmental stress. The micro elements found in manure, such as copper (Cu), zinc (Zn), and boron (B), contribute to plant health, even though they are present in smaller amounts. Additionally, manure contains organic matter that improves soil structure, increases water retention capacity, and supports the activity of beneficial soil microorganisms. Moreover, manure plays a role in raising soil pH, depending on the type of animal producing it (cow manure tends to be neutral, while chicken manure is more acidic).

Table 5. Characteristics of organic fertilizer innovation.

No.	Variables/Indicators	Average score	Score achievement (%)	Category
1	Relative advantage (X_{31})	4.28	85.60	Very good
	a. Benefits from economic aspects	4.1	82	Good
	b. Convenience in adopting innovation	4.2	84	Very good
2	Compatibility of innovation (X_{32}) with:	4.4	88	Very good
	a. Level of knowledge and mastery of farmer technology.	4.2	84	Very good
	b. Land conditions	4.3	86	Very good
3	Uncomplexity (X_{33}) : Level of convenience obtaining and using fertilizer	4.2	84	Very good

Farmers in Pekanbaru City use broiler chicken manure, which offers several advantages over manure from cows and goats. According to Horneck and Miller (1998) the advantages of chicken manure include the higher nitrogen, phosphorus, and potassium content compared to manure from other animals; the ability to lower soil pH and increase nutrient availability in alkaline soils; a rich supply of organic matter that improves soil structure, increases water retention capacity, and supports soil microorganism activity; and a fast decomposition process due to its low C/N ratio, which accelerates nutrient release for plants and enhances the activity of soil microorganisms that are beneficial for soil fertility and plant health. As a result, using this fertilizer can increase the quantity and quality of agricultural products (especially for vegetable crops) and improve farmers' incomes.

Numerous research findings support the benefits of manure, which farmers consider advantageous. Bhoki, Jeksen, and Beja (2019); Hulu and Sitorus (2022); Gaol, Purba, and Sitorus (2023); Agency for Agricultural Development and Community Service (2024) and Adiba (2023) concluded that broiler chicken manure is not only effective in increasing agricultural yields but is also profitable and reduces long-term production costs. Using broiler chicken manure has significantly increased vegetable production (such as chili peppers, tomatoes, lettuce, spinach, carrots, and mustard greens). Chicken manure has a positive long-term effect on soil fertility and promotes plant growth, increasing crop yields and reducing dependency on chemical fertilizers. It is considered more economical for farmers due to its lower price, which reduces agricultural input costs. Additionally, compared to chemical fertilizers, chicken manure is cheaper and improves soil fertility in the long term. As a result, using chicken manure leads to reduced production costs and higher profits due to increased yields and better product quality. The study also recorded a sustainable improvement in soil quality, benefiting farmers in the long run.

Farmers also found manure to be uncomplicated (uncomplexity). Producers pack dried chicken manure in sacks, the primary manure they use. Once processed and ready for planting, farmers apply it as a base fertilizer by sprinkling and mixing it into the soil. Similar research findings were shared by Arifin (2021); Purnomo, Hartono, and Muhaimin (2019) and Sutrisno, Astuti, and Rahmanto (2019) which explained that both chicken and cow manure are considered uncomplicated by farmers. This is primarily because manure is easily accessible, its application is straightforward, and its use does not require special skills or advanced equipment. This aligns with the concept of compatibility, as farmers have limited knowledge and low technological mastery.

3.4. Performance of Agricultural Extension

The performance level of agricultural extension, which includes the development of innovative farmer behavior, strengthening farmer participation, and enhancing farmers' access to various resources in Pekanbaru City, is presented in Table 6. The performance level of extension workers is based on the results of the agricultural extension work as perceived by farmers. Each farmer provides an assessment of the performance level of agricultural extension.

Table 6. Performance level of agricultural extension.

Variables/Indicators	Average score	Score achievement (%)	Category
Development of innovative farmer behavior	2.6	52	Not good
a. Improving farmers' knowledge about the use of organic fertilizers	2.7	54	Not good
b. Providing motivation to farmers to use organic fertilizer	2.7	54	Not good
c. Always take the initiative to improve farmers' skills in making organic fertilizer	2.6	52	Not good
Strengthening the level of farmer participation	2.4	48	Not good
a. Facilitating farmers to identify fertilization needs/problems	2.4	48	Not good
b. Increasing farmer participation in the program activity planning process counseling	2.5	50	Not good
c. Involving participation of farmers in implementation activity.	2.5	50	Not good
d. Involving farmers in activity evaluation.	2.4	48	Not good
Strengthening farmers' access to resources	2.3	46	Not good
a. Assisting farmers in mastering information and technology (Including organic fertilizer).	2.5	50	Not good
b. Help farmers access to availability of organic fertilizer	2.4	48	Not good
c. Help farmers access to capital	2.2	44	Not good

Based on Table 6, the performance of agricultural extension in developing innovative farmer behavior, including increasing knowledge, providing motivation, and improving farmer skills in making organic fertilizer, is considered by farmers to be below satisfactory. Farmers deem the performance of strengthening farmer participation and enhancing farmer access to resources unsatisfactory. Therefore, better government and agricultural extension performance is necessary for farmers to adopt organic fertilizers.

The findings of this study align with research conducted by Mokoginta and Lahay (2019); Sari and Siregar (2020) and La Ode and Yusuf (2021) which concluded that although agricultural extension workers play an essential role in promoting the adoption of organic fertilizers, their performance remains limited and suboptimal. Their effectiveness is hindered by several challenges, such as time constraints, budget limitations, and low farmer motivation to adopt organic fertilizers. Extension workers often face difficulties changing farmers' habits, as many are accustomed to chemical fertilizers. Other contributing factors include the lack of training and limited effective communication between extension workers and farmers. Extension workers frequently fail to provide adequate information about the long-term benefits of using organic fertilizers, resulting in farmers relying on chemical fertilizers.

Additionally, limited support from the government and related institutions affects the effectiveness of extension workers in disseminating the necessary information to encourage the adoption of organic fertilizers. Other reasons include the low capacity of extension workers to provide a comprehensive understanding of the benefits of organic fertilizers and the mismatch between the information provided by agricultural extension and the field conditions faced by farmers. Limited resources, such as equipment and training facilities, constrain agricultural extensions.

3.5. Government Support

The success of farming, including farmers' adoption of organic fertilizers, is closely linked to government support. This support encompasses policies or material assistance that ensure organic fertilizers are available and used by farmers in the correct amounts, at the right price, at the right time, and according to the proper standard operating procedures. Some of the parts of government support that are looked at in this study are how to get and use organic fertilizers, how to set up demonstration plots for using organic fertilizers, and how to provide subsidies. Government support for the adoption and use of organic fertilizers by farmers is presented in Table 7.

Table 7. Government support.

Number	Variables	Average score	Score achievement (%)	Category
1	Procurement/Assistance organic fertilizer	2.3	46	Not good
	a. The government provides organic fertilizer assistance according to farmers' needs.	2.4	48	Not good
	b. The government facilitates the distribution of organic fertilizer aid to distribution points in farmer groups/farmer group associations.	2.4	48	Not good
2	Subsidy policy for organic fertilizer the government optimizes the distribution of subsidized organic fertilizer to farmers	2.3	46	Not good
3	Assistance for demonstration plots using organic fertilizer	2.3	46	Not good

Based on the study's results, Table 7 shows that although the government has made efforts to support the adoption of organic fertilizers, various obstacles remain, such as limited budgets, uneven policies, and a lack of effective counseling and training for farmers. These challenges prevent the adoption of organic fertilizers from being fully optimized, especially in more remote areas or regions that receive less government attention. Similar findings were reported by Haryanto and Sulaeman (2018); Anggraeni and Setiawan (2019) and Nasution and Nurdiana (2021). Their research revealed that although the government has issued policies to support organic fertilizers, the support is still not optimal. One identified factor is the limited budget for extension programs and organic fertilizer subsidies, making it difficult for many farmers to access organic fertilizers. Additionally, farmers at the field level have not received full communication about existing policies, and subsidy programs frequently prioritize chemical fertilizers. Support in the form of training and assistance for adopting organic fertilizers is also limited, making it challenging for farmers to transition from chemical fertilizers to organic fertilizers. Furthermore, current policies tend to prioritize chemical fertilizers and pay less attention to the broader needs of farmers related to the use of organic fertilizers, such as intensive training and extension services.

3.6. Marketing Strategy

According to Kurtz (2008) a marketing strategy is a company's overall program to determine its target market and satisfy consumers by combining elements of the marketing mix: product, distribution, promotion, and price. In this study, the marketing strategies analyzed include product strategy (product quality and packaging), price (affordability), and place (clear distribution channels). Based on the study's results (Table 8), farmers, as consumers of manure, reported that the product quality and packaging were good, the price of manure was affordable, and the distribution channels were smooth.

Table 8. Organic fertilizer marketing strategy.

No.	Variables	Average score	Score achievement (%)	Category
1	Product/ product quality and packaging (X_{61})	3.8	76	Good
2	Price/affordability (X_{62})	3.4	68	Good
3	Place/distribution channel clarity (X_{63})	3.5	70	Good

Farmers consider manure marketing good, yet it remains limited to manure. According to Setiawan and Santosa (2017) and Pramudianto and Gunawan (2020) other organic fertilizer marketing strategies can be improved by involving various parties, including local distributors, farmer groups, and local governments, in creating a more open market for organic fertilizers. In addition, field demonstrations, intensive education on the benefits of manure for soil health, and increased agricultural yields that show real results from using manure can increase farmer confidence in this product. There is a guarantee of a stable supply and affordable prices.

3.7. Innovation Adoption Level

Based on the research results (Table 9), the overall level of farmers' adoption of organic fertilizers is still low. As of now, farmers have primarily adopted manure as their basic fertilizer. Other organic fertilizers, such as compost, liquid organic fertilizers, and others, have not been used by farmers. This manure amount and method follow recommendations and are good. The frequency of organic fertilizer use refers to the intensity with which farmers apply organic fertilizers during the planting cycle. The study's results classify the frequency of organic fertilizer use as low. Farmers only use manure as a base fertilizer during the initial land preparation. In this case, farmers have not used other organic fertilizers, such as compost or liquid organic fertilizers. The consistency of manure use, however, is relatively good. Farmers have become accustomed to using manure as their base fertilizer.

Table 9. Level of adoption of organic fertilizer (Manure) by farmers in Pekanbaru city.

No.	Adoption rate	Average score	Score achievement (%)	Category
1	Compliance with the amount of organic fertilizer (Manure) given according to recommendations	3.5	70	Good
2	Frequency of use of organic fertilizer.	2.8	54	Not good
3	Consistency of use	3.4	68	Good

According to the Ministry of Agriculture (2011) organic fertilizers, including manure, are gaining attention for their benefits in improving soil quality over the long term. However, their adoption among farmers remains low compared to chemical fertilizers. Key barriers include the time-consuming production process, the large volumes required, and issues with the consistency of material quality.

3.8. Adoption Model of Organic Fertilizer Innovation

Factors significantly influence farmers' adoption of organic fertilizer innovation from the model. The model is built based on a theory explaining the factors influencing the decision to adopt innovation (Rogers, 2003). In addition to the innovation adoption theory, farmers' decision to purchase organic fertilizer is also influenced by the fertilizer marketing strategy.

The model formed from significant factors is presented in Figure 1.

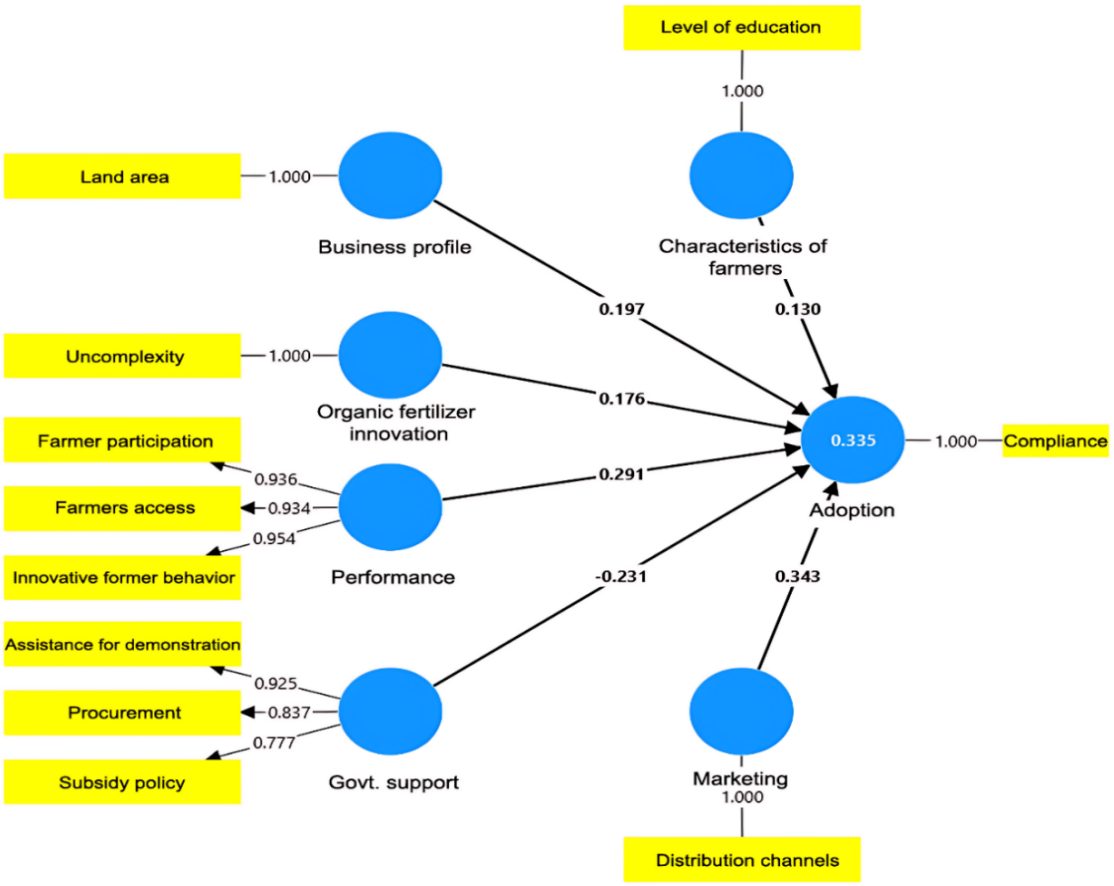

Figure 1. The adoption model of organic fertilizer by farmers in Pekanbaru city (PLS research model output with all valid loading factor indicators).

The results of the statistical test for the estimated parameters of the research model (PLS output) are presented in Table 10. Based on the test results, it is found that the indicators significantly influencing entrepreneurial behavior and business success are those with T statistics greater than 1.96. According to the research findings (Figure 1 and Table 10), several key elements influence farmers' decision-making in adopting organic fertilizer innovations. For farmer characteristics, education level plays a significant role. Regarding the farming business profile, land ownership area is a determining factor. Regarding the innovation's characteristics, the complexity level affects adoption decisions. The performance of agricultural extension workers is also crucial, with indicators such as developing innovative behavior, strengthening farmer participation, and enhancing farmers' control over resources being significant. Government support, including fertilizer assistance, subsidy policies for organic fertilizers, and support for demonstration plots, also has a considerable impact. Furthermore, the marketing strategy for fertilizers, particularly the efficiency of distribution channels, plays a role in adoption decisions. Finally, the level of decision to adopt the innovation is influenced by the degree to which the amount of organic fertilizer used aligns with recommendations.

Table 10. Variables, sub-variables, and indicators of research parameter model estimates significantly influence the level of adoption decisions for organic fertilizer innovation farmers.

Variables	Indicator		T Statistics (|O/STERR|)	P values
	Symbol	Description		
Farmers characteristics	X12	Level of education	-	-
Business profile	X21	Land area	-	-
Characteristics of fertilizer innovation	X31c	Uncomplexity	-	-
Agriculture extension performance	X41	Development of innovative farmer behavior	14.337	0 .000
	X42	Strengthening the level of farmer participation	12.639	0 .000
	X43	Strengthening farmers' access to resources	15.599	0 .000
Government support	X51	Provision of organic fertilizer assistance (X_{51})	2.926	0.003
	X52	Subsidy policy for organic fertilizer (X_{52})	2.857	0.004
	X53	Assistance for demonstration plots on the use of organic fertilizer	3.473	0 .001
Marketing strategy	X63	Place /Clarity of organic fertilizer distribution channels (X_{63})	-	-
Adoption of innovation	Y1	Compliance with the amount of organic fertilizer given according to recommendations	-	-

Table 11 presents the statistical test results for the estimated structural model parameters. The factors significantly influencing farmers' decisions to adopt organic fertilizers include the farm business profile (land area), agricultural extension performance, and marketing strategy, particularly the ease of distribution. Farmers who manage larger land areas are more likely to adopt organic fertilizers because they recognize the long-term benefits of soil fertility and the cost-efficiency of using them.

Table 11. Statistical test results of structural model parameter estimates.

Number	Structural equations		T statistics influence	P values	Information the influence of two variables	R2 (%)
	Endogenous latent variables	Exogenous latent variables				
1	Adoption of Innovation (Y)	1. Farmers' characteristics	1.512	0.131	Not significant	33.5
		2. Business profile	2.202	0.028	Significant	
		3. Characteristics of organic fertilizer innovation	1.729	0.084	Not significant	
		4. Agricultural extension performance	2.606	0.009	Significant	
		Government support	1.311	0.190	Not significant	
		6. Marketing strategy	3.338	0.001	Significant	

The study also revealed that the performance of agricultural extension workers significantly impacts adoption rates. However, the performance of extension workers was rated below satisfactory, contributing to the low adoption rate of organic fertilizers. Moreover, the accessibility of fertilizers through effective marketing and distribution systems is crucial in influencing farmers' decisions to adopt organic fertilizers.

Thus, it is evident that the adoption of organic fertilizers among farmers is influenced by factors such as the size of the farmer's land, the performance of agricultural extension, and marketing strategies. Sofyan and Sari (2022); Iin, Rosmiah, Berliana, Nurbaiti, and Ika (2023) and Agustina and Sari (2024) concluded that training and extension programs play a crucial role in encouraging farmers to adopt organic fertilizers. These training programs focus on utilizing organic waste, such as cow manure and vegetable waste, to produce liquid organic fertilizers. These activities demonstrated increased farmer knowledge and skills in producing and using organic fertilizers, which contributed to reducing dependency on chemical fertilizers, improving soil fertility, and enhancing crop productivity. Furthermore, these community empowerment programs successfully motivated farmers to adopt sustainable agricultural practices. By addressing knowledge gaps and motivating farmers, these training programs serve as an effective strategy to increase farmers' adoption of organic fertilizers. Agricultural extension and the government can collaborate with universities, Non-Governmental Organization (NGOs), and farmer organizations to disseminate this information. Additionally, supporting small and medium entrepreneurs in producing organic fertilizers on a large scale can increase accessibility and lower prices. This approach can help create a more competitive market for organic fertilizers.

The performance of agricultural extension significantly influences the adoption of agricultural technology, including farmers' use of organic fertilizers. Based on research conducted by Damanik and Siregar (2017) agricultural extension agents who possess good communication skills, a deep understanding of agricultural technology, and practical extension skills can increase the adoption of organic fertilizers among farmers. The knowledge provided by extension workers regarding the long-term benefits of organic fertilizers in improving soil fertility and overall agricultural yields encourages changes in farmer behavior.

According to Fauzi and Riana (2020) factors influencing the adoption rate of organic fertilizers depend not only on the quality of extension services but also on farmers' attitudes and perceptions of organic fertilizers. Farmers are more likely to adopt this technology if they believe that organic fertilizers are more environmentally friendly and can increase yields in the long term. Extension workers who communicate this understanding to farmers are crucial in changing these attitudes.

Janssen and Smit (2017) added that adopting organic fertilizers is also influenced by economic factors, such as the higher cost of organic fertilizers compared to chemical fertilizers, even though organic fertilizers are more profitable in the long run. Extension workers who can provide comprehensive information regarding the costs and benefits of organic fertilizers, including their environmental advantages, can help farmers make more rational decisions.

Research by Ariani (2018) in Village X found that farmers who attended training organized by agricultural extension workers increased their use of organic fertilizers by 35%, compared to farmers who did not attend training and who only used 20% organic fertilizers in their agricultural practices. These data emphasize the importance of the active role of extension workers in educating and encouraging farmers to switch to organic fertilizers.

Meanwhile, Barker (2019) stated in his study that in several countries with effective agricultural extension systems, such as European countries, the adoption rate of organic fertilizers increased by up to 50% thanks to the role of agricultural extension, which provided in-depth and sustainable technical guidance. Research by Soeharto and Widiatmoko (2021) in Indonesia showed that the success of agricultural extension programs in increasing the adoption

of organic fertilizers varies depending on the quality of the extension services and the management of available resources. Data collected from 150 farmers in three provinces in Indonesia revealed that farmers who received regular extensions for organic fertilizers had a higher adoption rate (62%) compared to those who only received extensions once (37%).

Although the performance of agricultural extension can encourage the adoption of organic fertilizers, challenges remain, including farmers' perceptions of the effectiveness of organic fertilizers, their higher costs, and limited access to quality organic fertilizers. Fauzi and Riana (2020) found that farmers in Central Java who do not have easy access to quality organic fertilizers tend to continue using chemical fertilizers. Agricultural extension agents who assist in overcoming these challenges by providing solutions related to the distribution and use of organic fertilizers have a greater chance of success in increasing adoption.

4. CONCLUSION

The conclusions of the research are as follows:

1. Food crop and horticulture farmers in Pekanbaru City are predominantly male, making up 72.09%, while females account for 27.91%. The farmers range in age from the youngest at 18 years to the oldest at 78 years, with an average age of 44.91 years. However, 12% of the farmers are over 60 years old. The level of formal education among farmers remains low, with the lowest level being no education beyond elementary school (2%) and the highest level being a bachelor's degree (4%). On average, farmers have 9.07 years of education, equivalent to junior high school graduation. Most farmers have 1 to 3 family dependents (61.63%), with the fewest having one and the most having 10.
2. The urban farming business is characterized by limited land. Others mostly own the land cultivated by farmers, and farmers use it without renting, as the land has not yet been developed for buildings (housing, offices, etc.).
3. Organic fertilizers, mainly manure, are considered beneficial by farmers, as they help maintain soil fertility and accelerate plant growth. Despite this, farmers still use chemical fertilizers, believing they can quickly increase production and boost farm profits.
4. The performance of agricultural extension workers in promoting the adoption of organic fertilizers is considered insufficient by farmers. They report receiving inadequate extension services regarding organic fertilizers. They perceive a lack of government support for adopting organic fertilizers. However, farmers find it easy to obtain organic fertilizers, especially chicken manure, because they are widely available in the market.
5. The decision to adopt organic fertilizer innovations by farmers is still not at a satisfactory level.
6. The adoption decision is significantly influenced by factors such as land area, the performance of agricultural extension workers, and organic fertilizer marketing strategies.
7. To increase the adoption of organic fertilizers, efforts should focus on improving the performance of agricultural extension workers with government support and enhancing marketing strategies. Key approaches to improving these strategies include strengthening efficient distribution networks, conducting intensive and ongoing extension services to educate farmers on the benefits of manure, establishing partnerships with local farmer groups and collectors, utilizing alternative marketing channels such as social media or agricultural apps, and offering products at affordable prices with a stable supply.

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