JPPIPA 11(11) (2025)

Jurnal Penelitian Pendidikan IPA

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Acceptance of Coffee Ground Compost Fertilizer Produced by Students of the Agricultural Engineering Study Program at Serambi Mekkah University for Farmers in Aceh Besar Regency

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Received: September 12, 2025
Revised: October 14, 2025
Accepted: November 25, 2025
Published: November 30, 2025

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DOI: 10.29303/jppipa.v11i11.12837

Abstract: This study aims to analyze the acceptance of coffee-ground compost fertilizer developed by students of the Agricultural Industrial Engineering Program, Universitas Serambi Mekkah, among farmers in Aceh Besar Regency. The analysis was conducted using two theoretical frameworks: the Technology Acceptance Model (TAM) and the Diffusion of Innovation (DOI). Data were collected through questionnaires from farmers, focusing on indicators such as fertilizer quality, ease of application, affordability, accessibility, and soil impact. The TAM analysis revealed that farmers hold a positive perception of the fertilizer's usefulness and ease of use, influencing their attitudes and behavioral intentions toward adoption. Meanwhile, the DOI analysis highlighted the role of innovation characteristics, communication channels, time, and social systems in the diffusion process. This research provides an initial overview of the potential adoption of coffee-ground-based organic fertilizer as an environmentally friendly alternative to support sustainable agriculture in Aceh Besar.

Keywords: Coffee ground compost fertilizer; Diffusion of innovation; Farmer acceptance; Sustainable agriculture; Technology acceptance model (TAM)

Introduction

Agriculture in Indonesia faces significant challenges related to soil fertility degradation caused by the continuous use of chemical fertilizers (Cajucom, 2017). In this context, organic fertilizers made from local resources are increasingly viewed as a sustainable solution to improve soil health and reduce environmental impacts (Sunartaty et al., 2024). Coffee grounds, a byproduct of the agro-industry, contain a high level of organic matter and represent a valuable resource for compost production (Siahaan et al., 2025). Converting this waste into organic fertilizer not only addresses waste management issues but also adds economic value to local communities (Jumar et al., 2023).

Students from the Agricultural Industrial Engineering Program at Universitas Serambi Mekkah have developed an innovative organic fertilizer made from coffee-ground compost. However, the success of such an innovation does not solely depend on its technical quality; it also requires acceptance and adoption by the end-users, namely farmers (Mesmar et al., 2024). Therefore, it is essential to employ theoretical frameworks that assess both acceptance and innovation diffusion (Aliasuddin et al., 2020).

The Technology Acceptance Model (TAM) serves as a useful framework to evaluate how farmers perceive the fertilizer in terms of usefulness (perceived usefulness) and ease of application (perceived ease of use) (Zarei et al., 2022), which in turn shape their

How to Cite:
AR, C., Akmal, N., & Ambartiasari, G. Acceptance of Coffee Ground Compost Fertilizer Produced by Students of the Agricultural Engineering Study Program at Serambi Mekkah University for Farmers in Aceh Besar Regency. *Jurnal Penelitian Pendidikan IPA*, *11*(11). https://doi.org/10.29303/jppipa.v11i11.12837

attitudes and behavioral intentions to adopt the innovation (McCormack et al., 2021). On the other hand, the Diffusion of Innovation (DOI) theory offers insights into how innovations spread within communities, emphasizing factors such as relative advantage, compatibility, complexity, trialability, and observability, (Haji et al., 2020). By integrating these two frameworks, this research provides a comprehensive understanding of both individual acceptance and collective adoption potential of coffee-ground compost fertilizer among farmers in Aceh Besar Regency (Jumar et al., 2023).

Method

This study employed a descriptive qualitative approach supported by basic quantitative data. Farmers in Aceh Besar Regency were selected purposively as respondents. At the preliminary stage, one farmer was engaged as a trial respondent to test the research instrument.

Research Instrument

The instrument consisted of a questionnaire using a 5-point Likert scale. Indicators included fertilizer quality, ease of application, affordability, accessibility, and soil improvement effects. The questionnaire was designed based on TAM and DOI constructs.

TAM Analysis

The data were analyzed by examining farmers' perceptions of usefulness and ease of use. These perceptions were then linked to attitude toward use, behavioral intention, and actual acceptance of the fertilizer.

DOI Analysis

The diffusion analysis focused on the five main dimensions of innovation: relative advantage, compatibility with farmers' needs, complexity, trialability, and observability. Additionally, communication channels, time, and social systems were assessed to understand the spread of adoption among farmers.

Data Processing

Data from the questionnaire were organized into separate TAM and DOI analysis tables. The results were compared and interpreted through descriptive and narrative analysis, supported by schematic representations (matrices).

Result and Discussion

TAM (Total Acceptance Measurement) Analysis – Farmers' Acceptance of Coffee-Ground Compost Fertilizer

The Total Acceptance Measurement (TAM) framework is widely used to understand the degree of acceptance of new technologies or agricultural inputs by users. In this study, TAM is applied to assess how farmers perceive and accept coffee-ground compost fertilizer developed by students of the Agricultural Industrial Engineering Program at Universitas Serambi Mekkah. Although only one respondent was involved, the qualitative-descriptive analysis provides valuable insights into individual perceptions of fertilizer quality, ease of application, affordability, accessibility, and soil impact. According to Ambong et al. (2020) (Author, Year), TAM offers a systematic way to evaluate acceptance by linking perceived usefulness and ease of use with behavioral intentions and actual adoption. The indicators of the TAM framework are presented in Table 1 and illustrated in Figure 1.

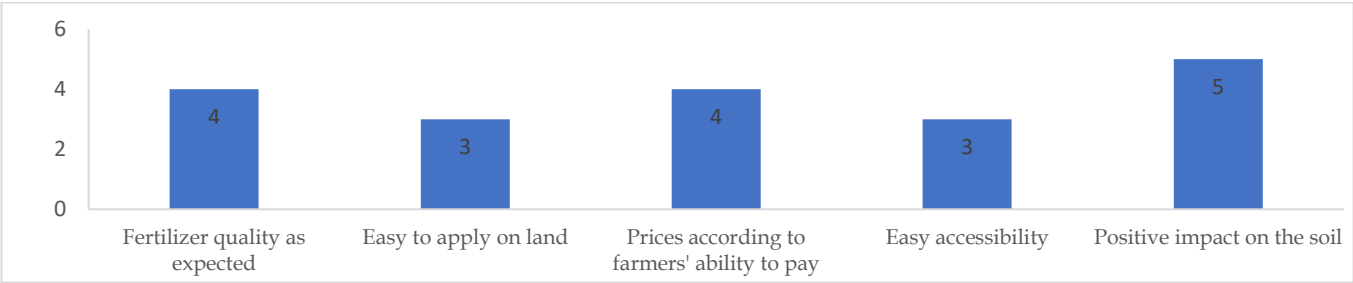

Figure 1. Indicators of the TAM framework

Table 1. The Indicators of the TAM Framework

Indicator of TAM	Score TAM	Qualitative Analysis
Fertilizer quality as expected	4	Farmers consider the quality of the fertilizer to be quite good.
Easy to apply on land	3	Fertilizer application is fairly easy, but requires adaptation.
Prices according to farmers' ability to pay	4	The price is acceptable, according to the farmers' ability.
Easy accessibility	3	Limited availability affects continuity.
Positive impact on the soil	5	The positive impact is very evident in soil fertility.

Fertilizer Quality

The indicator "Fertilizer quality meets expectations" scored 4 out of 5, showing that the farmer perceived the compost as satisfactory in supporting crop growth, supplying essential nutrients, and maintaining acceptable physical properties such as texture and odor. Fertilizer quality is a decisive factor in technology acceptance, as farmers often evaluate products based on visible improvements in crop performance. Previous studies (Zarei et al., 2022) emphasize that product quality is one of the strongest determinants of agricultural innovation acceptance, particularly when the innovation directly affects yield and soil fertility (Hasler et al., 2017).

Ease of Application

The indicator "Ease of application in the field" received a score of 3, indicating relative ease but requiring additional steps compared to conventional fertilizers. Farmers generally prefer simple and time-efficient methods, and additional labor requirements may reduce acceptance. Literature shows that ease of use strongly influences farmers' decisions to adopt new agricultural inputs, as innovations perceived as complex or labor-intensive tend to face adoption barriers (Arif et al., 2020). In the TAM framework, this corresponds to the construct of perceived ease of use, which has a direct effect on behavioral intention (Folorunso et al., 2008).

Affordability

The indicator "Price suitability with farmers' capacity" scored 4, showing that the farmer considered the product economically feasible. Cost-effectiveness plays a critical role in farmers' adoption decisions. Studies Haji et al. (2020) suggest that affordability is one of the main drivers of organic fertilizer adoption, as smallholder farmers often operate under tight financial constraints. According to TAM, when users perceive that the benefits of a product outweigh its costs, the likelihood of adoption increases significantly (Alsyouf et al., 2023).

Accessibility

The indicator "Ease of access to the product" received a score of 3, highlighting limitations in distribution and market availability. Accessibility is a crucial external variable in TAM because even high-quality and affordable fertilizers cannot be adopted consistently if they are not readily available. Research supports the notion that limited market access and weak distribution networks hinder innovation diffusion in rural farming communities. Ensuring availability through local cooperatives or extension programs can therefore strengthen adoption.

Soil Impact

The indicator "Positive impact on soil" scored 5, the highest, indicating strong farmer appreciation of the compost's ability to improve soil fertility, enhance soil structure, and retain moisture. These outcomes align with literature showing that organic fertilizers improve soil health and long-term productivity compared to chemical fertilizers. In TAM, perceived usefulness is strongly reflected when farmers observe clear environmental and agronomic benefits, leading to more positive attitudes toward adoption (Alsyouf et al., 2023).

The TAM analysis, even with one respondent, shows that coffee-ground compost fertilizer has strong potential for acceptance, driven by quality, affordability, and soil impact. However, ease of application and accessibility need improvement to ensure wider adoption. Literature consistently emphasizes that acceptance of agricultural innovations depends not only on product characteristics but also on socio-economic and infrastructural factors (Arif et al., 2020). This preliminary result may serve as a foundation for refining product development, strengthening distribution strategies, and scaling adoption in broader farmer communities.

DOI (Degree of Importance) Analysis – Acceptance of Coffee Waste Compost Fertilizer

The Degree of Importance (DOI) analysis is used to evaluate how important each indicator is for farmers in determining their decision to adopt coffee waste compost fertilizer. DOI emphasizes the perceived importance of factors influencing fertilizer adoption. Even with a single respondent, this analysis provides a clear picture of the farmer's priorities regarding product characteristics.

Based on the observation, the indicator "Important for increasing crop yield" received a score of 5, indicating that the farmer considers this factor highly significant. Crop yield is the primary goal of fertilizer application; thus, the quality and effectiveness of the compost become the main benchmarks for adoption. This maximum score highlights that fertilizer acceptance is not only influenced by its availability but also by tangible benefits in improving productivity. This finding Aizstrauta et al. (2015), diffusion of Innovations theory, which states that relative advantage (Hasler et al., 2017) is one of the strongest drivers of adoption.

The indicator "Important for farmer work efficiency" obtained a score of 4, suggesting that ease of use and efficiency in application are moderately important. Work efficiency covers time, energy, and labor required for fertilizer use. Fertilizers that are easy to apply tend to encourage adoption, whereas those that require excessive effort may discourage use. This is supported by Al-Razgan et al. (2021) who emphasized

that labor efficiency is a key determinant in the adoption of agricultural technologies, particularly in resource-limited farming systems (Al-Razgan et al., 2021).

The indicator "Important for operational farming costs" received a score of 5, underscoring the importance of affordability. Even if effective, compost must remain cost-efficient to be included in farmers' production budgets. The maximum score reflects that adoption sustainability is strongly tied to cost factors, making price and cost-effectiveness critical strategic considerations. This corresponds with the findings of Shang et al. (2021) who highlighted that economic viability is a decisive factor for smallholder farmers in adopting new inputs.

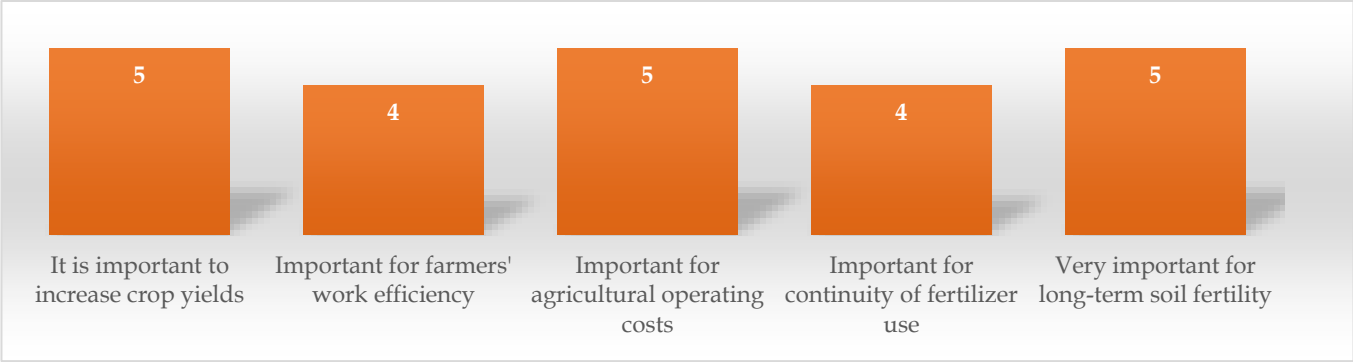

Figure 2. DOI (Degree of Importance) analysis – acceptance of coffee waste compost fertilizer

Table 2. DOI Indicators and Qualitative Analysis of Farmers' Perceptions of Fertilize

DOI indicator	Score DOI	Qualitative Analysis
It is important to increase crop yields	5	It is very important for production success.
Important for farmers' work efficiency	4	It's important enough to lighten the workforce.
Important for agricultural operating costs	5	It is quite important to reduce the workload.
Important for continuity of fertilizer use	4	Important for long-term use.
Very important for long-term soil fertility	5	It is very important to maintain soil fertility.

The indicator "Important for continuity of fertilizer use" scored 4, showing that product availability and consistent supply are fairly important. Farmers prefer products that are easily accessible and usable in the long run. This factor is linked to long-term effectiveness for both soil and crops. While not the top priority, continuity still plays a vital role in adoption decisions. According to consistent access and supply chain reliability significantly influence farmers' willingness to maintain the use of agricultural innovations (Chen et al., 2022).

Finally, the indicator "Very important for long-term soil fertility" obtained a score of 5, confirming that the farmer strongly values the ecological and sustainability aspects of fertilizer use. Maintaining soil health ensures long-term productivity, which becomes a central consideration. This is consistent with the findings of (Hasler et al., 2017) who emphasized that sustainable agricultural practices that protect soil fertility are increasingly prioritized by farmers and researchers alike.

Overall, the DOI analysis shows that farmers place the highest importance on crop yield, operational costs, and long-term soil fertility. Factors such as work efficiency and continuity of use are also considered but are secondary compared to the first three. This analysis provides a strong foundation for planning fertilizer adoption strategies, product development priorities, and farmer education approaches. Although based on a single respondent, it reflects the main preferences that can serve as a reference for broader studies and practical decision-making in the field.

Chemical analysis of soil and fertilizer is an essential stage in evaluating the quality of fertilizer and its potential to support soil fertility. The analyzed parameters include pH, organic carbon (C-organic), moisture content, ash content, total nitrogen (N-total), C/N ratio, and phosphorus (P), both for regular soil and coffee waste compost fertilizer. Although the data presented are illustrative, this analysis provides an initial overview of the differences between the two samples and their agricultural implications.

The results show that the pH of regular soil is 5.8, indicating moderately acidic conditions. Acidic soils can reduce nutrient availability, particularly phosphorus, while increasing the mobility of toxic heavy metals. In contrast, the pH of coffee waste compost is 6.5, closer to neutral, indicating a more stable and favorable condition for mixing with soil. A near-neutral pH helps maintain soil stability, improves nutrient availability, and supports beneficial microbial activity essential for decomposition and nutrient absorption. According to

Domantay et al. (2023), soil pH is one of the most critical factors influencing nutrient solubility and microbial diversity, directly affecting crop productivity.

The organic carbon content in regular soil is 2.1%, whereas in coffee waste compost it is significantly higher at 28%. High organic carbon in compost indicates richness in organic matter, which improves soil structure, enhances water-holding capacity, and provides energy for soil microorganisms. Increasing soil organic matter through compost application significantly improves soil quality and long-term fertility. Amar et al. (2021) who emphasized that soil organic carbon is a key indicator of soil health and sustainable agricultural productivity.

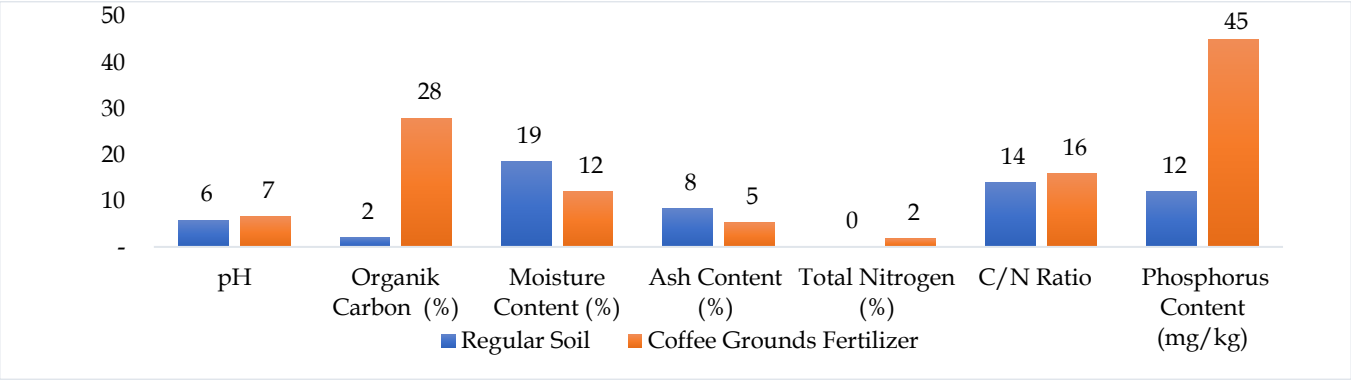

Figure 3. Chemical analysis of soil and coffee waste compost fertilizer

The moisture content of regular soil is 18.5%, while coffee waste compost shows a lower value of 12%. Lower moisture content in compost suggests greater stability for storage and application, reducing the risk of fermentation or spoilage before use. Adequate soil moisture, however, supports gas exchange and microbial activity, enhancing the interaction between compost and soil. Kasongo et al. (2011) highlights that optimal moisture balance plays a pivotal role in microbial-driven decomposition processes and nutrient cycling (Arif et al., 2020). Ash content in regular soil is 8.3%, while in compost it is 5.2%. Ash content reflects the mineral fraction remaining after combustion. These values suggest that coffee compost contains sufficient minerals to support plant growth, although its dominant composition is organic matter beneficial for microorganisms and soil structure.

The total nitrogen (N-total) in regular soil is only 0.15%, compared to 1.8% in coffee waste compost. Nitrogen is an essential nutrient for plant growth, particularly in leaf development and protein synthesis. An increase in nitrogen content through compost application supports optimal vegetative growth. The C/N ratio of regular soil is 14, while compost has 16, showing a relatively balanced supply of carbon and nitrogen. This balance ensures stable decomposition and nitrogen availability for plants. Hafeez et al. (2023) explained, the C/N ratio is a crucial indicator of the decomposition rate and nutrient release in organic amendments.

Phosphorus (P) content in regular soil is 12 mg/kg, whereas in coffee compost it reaches 45 mg/kg. Phosphorus plays a vital role in root development, flowering, and crop yield. A fertilizer rich in phosphorus increases soil availability of this nutrient, thereby supporting early plant growth and enhancing productivity. This observation is supported who noted that phosphorus is often a limiting nutrient in many soils, making phosphorus-rich composts especially valuable (Hu et al., 2025). Chemical analysis demonstrates that coffee waste compost possesses superior qualities compared to regular soil in terms of organic carbon, total nitrogen, and phosphorus, as well as having a more favorable pH. These characteristics highlight its potential to improve soil fertility, support plant growth, and enhance soil structure. With proper application, coffee waste compost can serve as an effective organic fertilizer alternative to promote sustainable agriculture in Aceh Besar Regency (Jumar et al., 2023).

Conclusion

The results of the TAM (Total Acceptance Measurement) analysis indicate that coffee waste compost fertilizer is well accepted by farmers, particularly due to its quality, affordable price, and positive impact on soil. However, ease of application and accessibility remain challenges that need to be addressed to enhance adoption. From the DOI (Degree of Importance) perspective, farmers consider increased crop yield, affordable operational costs, and long-term soil fertility as the most important indicators for fertilizer adoption. Work efficiency and continuity of use are also valued, though not as top priorities. The chemical analysis demonstrates that coffee waste

compost fertilizer contains significantly higher levels of organic carbon, total nitrogen, and phosphorus compared to regular soil, with a near-neutral pH that enhances nutrient availability, soil fertility, and microbial activity.

Acknowledgments
The authors gratefully acknowledge the Ministry of Research and Technology of the Republic of Indonesia (Kemenristek) for providing financial support through the research grant awarded in 2025.

Author Contributions
Conceptualization, CH.; Methodology, CH.; Validation, I.; writing—original draft preparation, CH, GT, NA.; Writing—Review and editing, R.S.

Funding
This research was funded by the Ministry of Education, Culture, Research, and Technology of the Republic of Indonesia through the 2025 Research Grant Program. The primary funding was provided under Master Contract Number 134/C3/DT.05.00/PL/2025, with subsequent derivative contracts issued on June 12, 2025, under Contract Numbers 40/LL13/AL.04/AKA.PL/2025 and 030/LPPM-USM/2025.

Conflicts of Interests
The authors declare no conflict of interest.

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