Jurnal Penyuluhan Pertanian

Journal homepage: https://jurnal.polbangtan-bogor.ac.id/index.php/jpp

The Effectiveness of Liquid Organic Fish Fertilizer Extension on the Behavioral Transformation of Green Mustard Farmers

Vandalisna[1], Nurul Insani Darwis[1] , Arman[1] , Sugeng Mulyono[2] , Budi Putra[3]

[1]Gowa Agricultural Development Polytechnic, Gowa, Sulawesi Selatan, Indonesia, 92152
[2]Jambi Agricultural Training Center, Muaro Jambi, Jambi, Indonesia, 36361
[3] Batangkaluku Agricultural Training Center, Kabupaten Gowa, Indonesia, 92152
Email correspondence: vandachaniago9@gmail.com

Article Information

Received November 11, 2025
Revised December 15, 2025
Accepted December 22, 2025
Published online December 30, 2025

Keywords

Effectiveness of extension,
liquid organic fertilizer,
fish waste,
farmer behavior,
sustainable agriculture

Abstract

This study aims to analyze the effectiveness of extension activities on the use of liquid organic fertilizer (LOF) derived from fish waste in improving farmers' knowledge, attitudes, and skills in green mustard cultivation (Brassica juncea L.) as part of behavioral transformation toward sustainable agriculture. The background of this study is the farmers' high dependence on inorganic fertilizers, which negatively affect soil fertility, production costs, and the environment. Utilizing fish waste as raw material for LOF offers an innovative, economical, and environmentally friendly alternative consistent with sustainable agriculture principles. The research was conducted at the Pattunuang Farmer Group in Tetebatu Village, Pallangga District, Gowa Regency, South Sulawesi, involving 25 farmer respondents. A quasi-experimental method with a one-group pretest–posttest design was applied. Data were collected through questionnaires administered before and after the extension activities and analyzed descriptively and quantitatively using the extension effectiveness formula (ETP). The results indicated a substantial improvement in all behavioral aspects. Farmers' knowledge increased from 46.4% to 95%, attitudes from 48.4% to 97.4%, and skills from 37.2% to 99.2%. The extension effectiveness value (ETP) reached 95%, classified as "highly effective." This achievement was supported by participatory extension methods that integrated lectures, group discussions, leaflets, and hands-on demonstrations. Overall, the extension activities on fish-based LOF effectively enhanced farmers' competencies and awareness regarding the use of liquid organic fertilizer as a substitute for chemical fertilizers. These findings confirm that participatory, locally based extension approaches are effective in accelerating farmers' behavioral transformation toward environmentally friendly, independent, and sustainable agricultural systems.

E-ISSN: 1907-5893
P-ISSN: 2599-0403
DOI: 10.51852/j2e7kg54

1. Introduction

The application of conventional agricultural systems with the use of synthetic chemical fertilizers is still the primary choice in agricultural cultivation systems in Indonesia due to its rapid visible effects on plant growth (Jensen, 2020; Das et al., 2021; Reumaux et al ., 2023). However, the long-term use of inorganic fertilizers has caused various serious problems, such as a decline in soil fertility degradation of the physical structure of the land (Ekawandani and Halimah, 2021; Penuel et al., 2023), and an increase in farmers dependence on expensive external inputs (Abror and Harjo, 2018; Kalkhoran, 2019). These conditions highlight the need for more environmentally friendly and sustainable alternatives to maintain the balance of the agricultural ecosystem while reducing production costs (Schrama et al., 2018). One innovation that is beginning to be widely developed is the use of fish waste as a raw material for Liquid Organic Fertilizer (LOF). Fish waste, which has been a source of environmental pollution, actually contains high levels of protein, nitrogen, phosphorus, and potassium, which are important nutrients for plant growth (Putra and Ratnawati, 2019; Silawati et al., 2024). The use of fish waste as Liquid Organic Fertilizer not only has the potential to increase crop productivity, but also helps reduce organic waste from the fisheries sector, thereby supporting the concept of a circular economy in agriculture. Several studies have shown that the application of LOF made from fish waste can significantly increase crop growth and yield, for example in chili peppers, tomatoes, and green mustard, compared to the use of chemical fertilizers (Setiawan et al., 2002; Abror and Harjo 2018; Harahap et al., 2020). Despite its great potential, the adoption of fish waste LOF technology by farmers is still relatively low. Most farmers do not yet have adequate knowledge and skills in the process of producing and applying liquid organic fertilizer. The perception that organic fertilizer is less effective than chemical fertilizer is also still quite strong among farmers. These obstacles show that the successful application of technological innovations depends not only on the availability of the technology itself, but also on an extension process that is capable of changing farmers' mindsets and behaviors in a participatory and sustainable manner (Brzyska, 2023).

Agricultural extension plays an important role as a means of knowledge transfer and social learning for farmers. An effective extension program must be able to improve three main aspects of behavior, namely knowledge, attitude, and skills (Gulo et al., 2024). Thus, educational activities on fish waste LOF are expected to strengthen farmers' understanding of the benefits of organic fertilizers, foster a positive attitude towards innovation, and equip them with the technical skills to produce it independently. In Gowa Regency, the local government and agricultural extension workers have begun to promote the use of locally sourced organic fertilizers as part of a sustainable agriculture policy. However, empirical studies on the extent to which these extension activities are effective in changing farmers' behavior are still limited. The extension process also aims to increase the role of farmers in rural development (Apriyani and Marina, 2024) .

The application of a participatory extension approach based on local resources can increase the efficiency of organic fertilizer use by up to 35% and strengthen farmers' awareness of green agriculture principles in Indonesia (Chau and Ahamed, 2022; Zhang et al., 2018). Similar findings were also reported by Mikasari (2022) and Purbiati et al. (2024), who found that intensive training and field demonstrations contributed significantly to accelerating the adoption of organic technology among horticultural farmer communities in East Java. These research results are in line with the direction of national policy in Regulation of the Minister of Agriculture of the Republic of Indonesia Number 01 of 2020 concerning Organic Farming Systems, which emphasizes the importance of developing innovations based on local potential, input efficiency, and strengthening farmer capacity through education and extension. Thus, research on the effectiveness of extension on the use of fish waste liquid organic fertilizer (LOF) is relevant not only to address local needs but also to support the implementation of national policies towards an independent, environmentally friendly, and sustainable agricultural system. This study aims to assess the effectiveness of extension activities on the use of Liquid Organic Fertilizer (LOF) made from fish waste on changes in the behavior of green mustard farmers, which includes increasing farmers' knowledge, attitudes, and skills in the production and application of organic fertilizers.

2. Research methodology

2.1. Research time and location

This research was conducted from May to July 2024 in the Pattunuang Farmer Group, Tetebatu Village, Pallangga District, Gowa Regency, South Sulawesi Province. This area was selected purposively because it is one of the centers for green mustard cultivation and has been the location of the Field Agricultural Extension (FAE) program, which is active in sustainable agricultural innovation activities. The agroclimatic conditions at the research site are classified as lowland with an annual rainfall of around 2000-2200 mm, an average temperature of 26-32°C, and red latosol soil types commonly used for horticultural cultivation. The socio-economic characteristics of farmers in this region are generally small-scale, with an average land area of 0.3-0.5 hectares per household, and they are still very dependent on the use of chemical fertilizers.

2.2. Research design

The study used a quasi-experimental research method with a one–group pretest–posttest design (Choenarom and Samputtanon, 2025).This design was chosen to measure changes in farmers' behavior after participating in extension activities on the use of fish waste-based LOF. In this design, respondents were given a pretest before the extension activity and a posttest after the extension activity was conducted to measure the level of improvement in knowledge, attitudes, and skills.

2.2.1. Determination of respondents

There were 25 respondents, who were members of the Pattunuang Farmer Group, selected using purposive sampling, with the criteria of having been active in vegetable farming for at least two years and willing to participate in the entire series of extension activities. The extension activity was carried out using a participatory approach, combining interactive lectures, group discussions, leaflet distribution, anddemonstrations of howto make and apply fish waste LOF. This model refers to the Participatory Extension Model , which emphasizes the active involvement of farmers in the learning process.

2.2.2. Data collection techniques

Data was collected using three main techniques, namely:

1. Direct observation of extension activities and the practice of making fish waste LOF. Observations were made to see the level of participation, involvement, and technical ability of farmers in applying the results of the extension.
2. Structured interviews (Armuand *et al.,* 2024) using questionnaires before and after extension (*pretest–posttest*) using pre- and post-extension questionnaires (pretest–posttest) covering indicators of farmers' knowledge, attitudes, and skills.
3. Documentation in the form of photographs of activities, field notes, and secondary data related to the socio-economic conditions of farmers from the Pallangga Subdistrict Agricultural Extension Center (BPP).

2.2.3. Data sources and types

This study used two main types of data, namely primary data and secondary data.

1. Primary data was obtained directly from field observations, interviews, and questionnaires filled out by farmer respondents. This data includes variables of knowledge, attitudes, and skills before and after extension.
2. Secondary data was obtained from the annual report of the Pallangga Subdistrict BPP, extension documents, Gowa Regency agricultural statistics publications, as well as references from scientific journals and government regulations related to organic farming.

The use of these two types of data aims to increase the validity of the research results through source triangulation (Ebert and Steinert, 2025; Gillings and Jaworska, 2025), so that the conclusions produced are more comprehensive and reliable.

2.2.4. Extension evaluation

Extension evaluation is an activity that plays an important role in efforts to improve agricultural extension programs more effectively and efficiently and to achieve predetermined objectives (Amalyadi *et al*., 2022). The answers obtained from the extension targets after answering all questions in the extension evaluation are given a score based on the answers selected, then processed and tabulated and depicted in the form of a continuum line. The initial evaluation (pre-test) is conducted to measure the initial level of knowledge, skills, and attitudes of the respondents and is carried out during the data collection of the respondents. The final evaluation (post-test) is conducted to measure the level of knowledge, attitudes, and skills of the respondents after the final extension. This evaluation was carried out by asking questions (questionnaires) to farmers to see the effectiveness of extension activities, which can be tested using the following formula:

$$\text{KSA level} = \frac{\text{Score obtained}}{\text{Maximum score obtained}} \times 100\%$$

The evaluation scoring is:
Very high : 4
High : 3
Fair : 2
Low : 1

The quality of knowledge, attitudes, and skills is further described in the form of a continuum (Mujahidah *et al*., 2023). The percentage effectiveness criteria for determining the effectiveness of extension services use the following formula:

$$EP = \frac{Ps-Pr}{(N.4.Q)- Pr} \times 100\%$$

Explanation:
EP = Effectiveness of counseling
Ps = Final test (Pro-test)
Pr = Initial test (Pre-test)
N = Number of respondents

4 = Highest score
Q = Number of questions
100% = PSK to be achieved
Where:
Ps-Pr = PSK improvement
N.4.Q = Gap score

The criteria for the percentage of counseling effectiveness are interpreted as follows:
0-25% = ineffective
26-50% = less effective
51-75% = fairly effective
76-100% = very effective (Padmowihardjo, 2002)

2.2.5. Extension Effectiveness

Data analysis was conducted using a quantitative descriptive approach, using the Extension Effectiveness (EE) formula to measure the success rate of extension in changing farmer behavior. The formula used refers to (Putra *et al.,* 2020)

$$EE = \frac{(N2 - N1)}{(100 - N1)} \times 100\%$$

where:
EE = Extension effectiveness (%);
N1 = Pre-test average score;
N2 = post-test average score.

The effectiveness criteria are interpreted as follows:
0–25% = ineffective
26–50% = less effective
51–75% = moderately effective
76–100% = very effective (Padmowihardjo, 2002)

In addition, the quantitative results are supported by descriptive qualitative analysis based on observations and in-depth interviews to provide a more contextual interpretation of changes in farmers' behavior after the extension activities. This analysis reinforces the understanding of social dynamics and factors that influence the level of effectiveness of extension in the field.

3. Results and Discussion

3.1. Evaluation of extension on farmers' knowledge

The results of the extension activities show that farmers who are members of the Pattunuang Farmers Group experienced a significant increase in knowledge regarding the use of liquid organic fertilizer from fish waste, thus indicating the effectiveness of the extension materials and methods provided.

3.1.1. Initial Evaluation

Based on the results of the initial evaluation of knowledge conducted before the extension activity, a total score of 232 out of a maximum score of 500 was obtained. The percentage of respondents' knowledge achievement was:

DOI: 10.51852/j2e7kg54

$$\text{Percentage} = \frac{\text{Total Score}}{\text{Highest score}} \times 100\% = \frac{232}{500} \times 100\% = 46.4\%$$

Explanation:
NK : Not Knowledgeable
SK : Slightly Knowledgeable
K : Knowledgeable
HK : Highly Knowledgeable

If described using a continuum, it would be as follows:

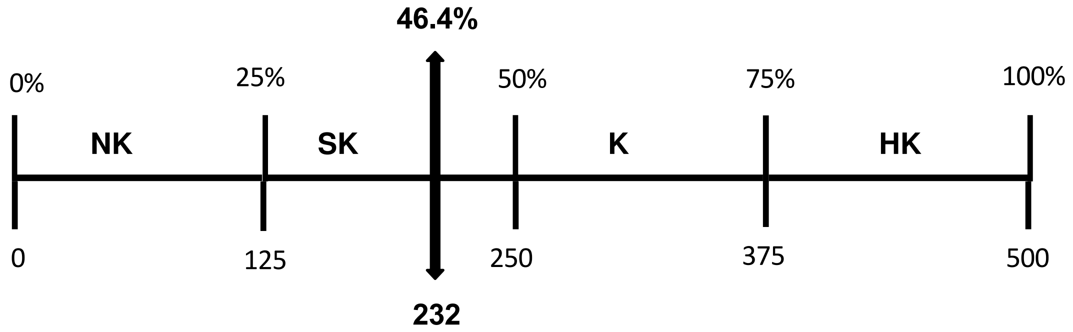

Figure 1. Continuum Line of Knowledge Aspects in the Initial Evaluation

The continuum line in Figure 1 shows that the farmers' level of knowledge before receiving extension services was 232 or 46.4%, which falls into the category of Slightly Knowledgeable (SK). This indicates that before receiving extension services, the farmers' level of knowledge about the benefits, methods of production, and application of fish LOF was still relatively low. This low level of knowledge may be due to limited access to information, lack of direct experience in using fish LOF, and farmers' habit of still relying on inorganic fertilizers.

3.1.2. Final Evaluation

After the extension activities were conducted, the final evaluation results showed a significant increase. The total knowledge score of the respondents increased to 475 out of a maximum score of 500. The percentage of knowledge achievement of the respondents was:

$$\text{Percentage} = \frac{\text{Total Score}}{\text{Highest score}} \times 100\% = \frac{475}{500} \times 100\% = 95\%$$

If described using a continuum, it would be as follows:

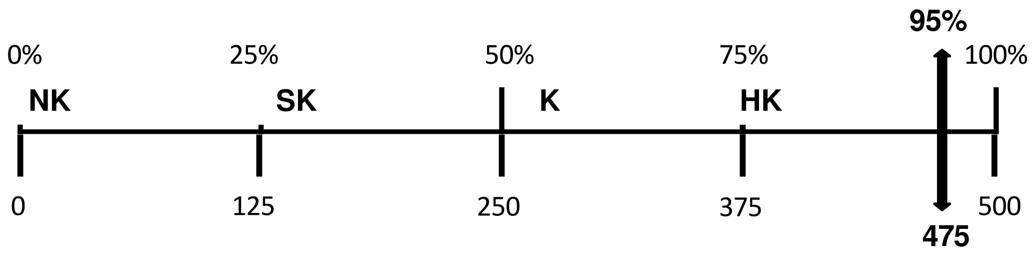

Figure 2. Continuum Line of Knowledge Aspects in the Final Evaluation

This score is in the Highly Knowledgeable (HK) category on the continuum line. This means that after being given material and demonstrations on the production and application of Fish LOF, respondents have a good understanding of the concept, benefits, and how to apply it in green mustard cultivation. The increase from 46.4% to 95% shows a 48.6% increase in knowledge after the extension activities were carried out. This change indicates that the extension activity was very effective in increasing farmers' understanding of Fish LOF.

Several factors influenced the increase in knowledge, including:

1. Interactive extension methods, such as discussions and live demonstrations of Fish LOF production, helped farmers understand the concept in practical terms.
2. Attractive extension media, such as pictures, sample materials, and field practices, facilitated the reception of information.
3. The relevance of the material to farmers' needs, as fish-based liquid organic fertilizer provides a solution to the high cost of chemical fertilizers and maintains soil fertility.

The results of the study show that extension activities have a positive and significant impact on increasing farmers' knowledge of fish-based liquid organic fertilizers, as indicated by an increase in the percentage of knowledge from 46.4% in the initial evaluation to 95% in the final evaluation, or an increase of 48.6%. This increase in knowledge is an important asset in encouraging changes in farmers' attitudes and behaviors towards the application of environmentally friendly agricultural technologies, particularly in areas where knowledge was initially low and where the extension process showed the most significant improvement in understanding.

3.2. Evaluation of extension services on farmers' attitudes

3.2.1. Initial Evaluation

Based on the results of the initial evaluation of farmers' attitudes before the extension program on the use of Liquid Organic Fertilizer (LOF) Fish for the growth of green mustard plants, a total score of 242 out of a maximum score of 500 was obtained. The percentage of respondents' attitudes can be calculated as follows:

$$\text{Percentage} = \frac{\text{Total Score}}{\text{Highest score}} \times 100\% = \frac{242}{500} \times 100\% = 48.4\%$$

Explanation:

D : Disagree
SD : Slightly Disagree
A : Agree
SA : Strongly Agree

If depicted on a continuum line, this value is in the Slightly Disagree (SD) category.

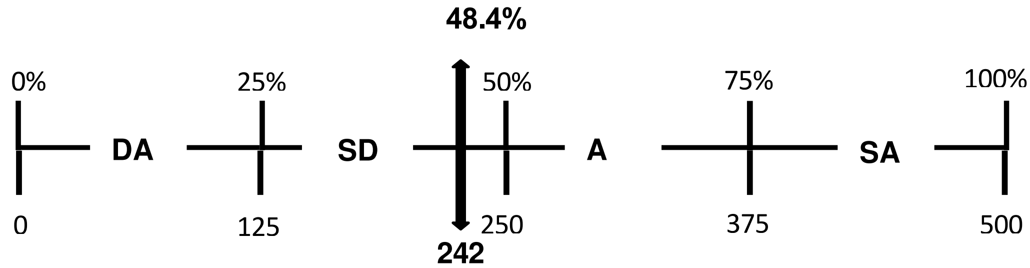

Figure 3. Continuum of Attitudes in the Initial Evaluation

Figure 3 shows that most respondents did not have a positive attitude toward the application of LOF Fish before the extension program. They tended to be hesitant or distrustful of the effectiveness of liquid organic fertilizer compared to the chemical fertilizers commonly used. Some respondents also showed a passive attitude towards agricultural innovation because they had never seen the results of using LOF Ikan firsthand, so their level of trust in this technology was still low. In addition, the habit of using chemical fertilizers, which are considered more practical and produce faster results, also contributed to the low level of acceptance of LOF ikan. The percentage of 48.4% classified as Disagree (SD) indicates that in the early stages, farmers' attitudes towards the use of LOF Fish were still negative or had not been optimally formed. Several factors that may have influenced this result include:

1. Lack of information and direct experience. Before the extension activities, most farmers had never made or used Fish LOF, which caused doubts about its effectiveness.
2. Habits and beliefs about chemical fertilizers. Farmers who have long used chemical fertilizers tend to perceive that organic fertilizers take a long time to show significant results.
3. Lack of real-life examples in the field. The absence of models or examples of LOF Fis application in their surroundings causes farmers to remain hesitant and reluctant to try it.

These results emphasize the importance of a participatory and practical extension approach, so that farmers can see firsthand the benefits of using Fish LOF. With extension activities and field demonstrations, it is hoped that farmers' views will change and they will develop a positive attitude towards environmentally friendly organic farming technology..

3.2.2. **Final Evaluation**

Based on the final evaluation of attitudes obtained from 25 respondents after extension on the use of Fish LOF on the growth of green mustard plants, a total score of 487 out of a maximum score of 500 was obtained. The percentage of respondents' attitudes can be calculated as follows:

$$\text{Percentage} = \frac{\text{Total Score}}{\text{Highest score}} \times 100\% = \frac{487}{500} \times 100\% = 97.4\%$$

This value indicates that the farmers' attitudes after the extension program were in the Strongly Agree (SA) category. In other words, the majority of respondents had a very positive attitude toward the use of fish LOF in green mustard cultivation. This means that the extension program had a very significant impact in shaping farmers' positive attitudes toward the application of organic farming technology, particularly the use of fish-based LOF.

When depicted on a continuum, the value falls into the Strongly Agree (SA) category..

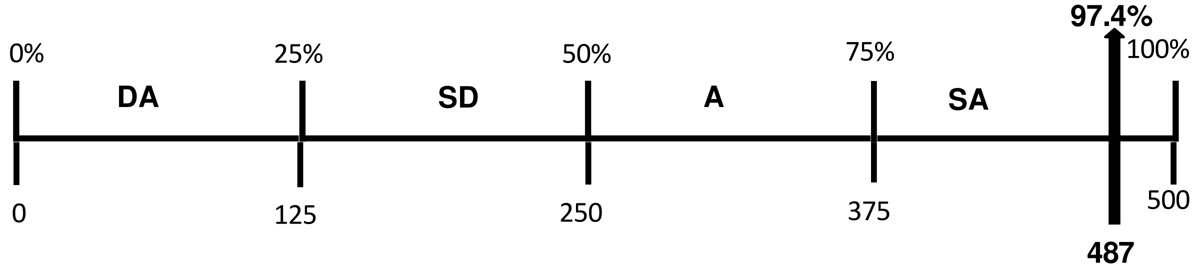

Figure 4. Continuum line of attitude aspects in the final evaluation

The increase in scores from 48.4% in the initial evaluation to 97.4% in the final evaluation shows a 49% increase in farmers' attitudes after the extension activities. This increase illustrates the farmers' positive change in perspective and acceptance of the innovation of using fish LOF.

Several factors contributed to this improvement in attitude, including:

1. Better understanding after the extension activities. The extension activities provided clear explanations about the benefits of Fish LOF, how to make it, and its impact on soil fertility and crop yields. This understanding made farmers more open and receptive to the real benefits of this technology (Faisal, 2020) .
2. Applicable field demonstrations. Through hands-on activities, farmers were able to see the process of making and using Fish LOF in real life. This fostered a sense of trust and confidence that Fish LOF could produce optimal results for green mustard crops.
3. Social support and shared experiences. Group discussions and sharing experiences during extension activities helped strengthen positive attitudes among farmers. When some participants showed interest and good results, it motivated others to follow suit.

Thus, extension activities have proven effective in changing farmers' attitudes from Disagree to Strongly Agree towards the use of fish-based liquid organic fertilizer. This positive attitude is an important asset in encouraging the continued application of Fish LOF in the field, as well as a first step towards a more environmentally friendly and sustainable agricultural system (Rahayu *et al.,* 2022).

3.3. Skill Aspects

3.3.1. Initial Evaluation

The results of the initial evaluation of the skill aspects obtained from 25 respondents showed a total score of 186 out of a maximum score of 500 and a minimum score of 125. The percentage of achievement is calculated as follows:

$$\text{Percentage} = \frac{\text{Total Score}}{\text{Highest score}} \times 100\% = \frac{186}{500} \times 100\% = 37.2\%$$

Explanation:
NS : Not Skilled
LS : Less Skilled
S : Skilled
HS : Highly Skilled

The skill level of respondents was categorized as Less Skilled (LS), as they only achieved 37.2% of the maximum possible score. These results indicate that, in general, the skill level of respondents is still at an early or basic stage. A score of 37.2% indicates that most respondents have not yet mastered the skills being measured optimally.
Several possible factors that influence this result include:

1. Lack of practical experience: respondents may not have had many opportunities to apply the skills being evaluated in a real-world context.
2. Ineffective learning methods: if learning focuses more on theory than practice, skill mastery will be lower.
3. Variable learning motivation: some respondents may have lower motivation and interest in the skills being evaluated.
4. Availability of facilities and supporting resources: limitations in tools, materials, or practice media can affect skill evaluation results.

When depicted on a continuum, this score falls into the Less Skilled (LS) category.

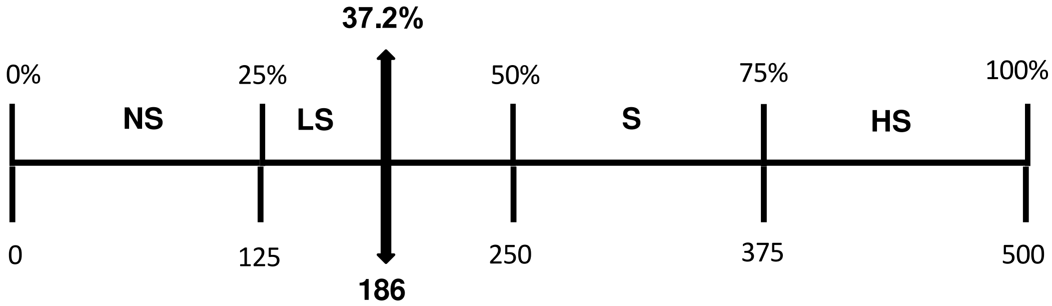

Figure 5 . *The* continuum line of *a* skill spectrum at the initial valuation

The results are depicted in the form of a skill continuum line with a range from 125 (low) to 500 (high), so that a score of 186 is close to the lower limit. This reinforces the finding that the respondents' skills are still in the unskilled category or need further training.

3.3.2. Final evaluation

Of the 25 respondents, the total skill aspect score in the final evaluation was 496 out of a maximum score of 500. If converted back to a percentage:

$$\text{Percentage} = \frac{\text{Total Score}}{\text{Highest score}} \times 100\% = \frac{496}{500} \times 100\% = 99.2\%$$

The respondents' mastery of skills in the final evaluation can be categorized as very high (close to 100%). This shows that almost all respondents have achieved (or come very close to) the maximum criteria of the measurement instrument used. When depicted on a skill continuum from a minimum score (125) to a maximum score (500), a score of 496 is very close to the top of the continuum. This means that the collective skill achievement is at its peak, almost at the maximum.

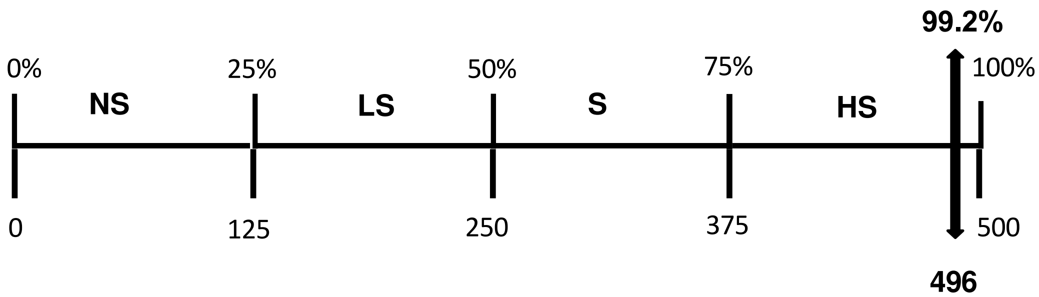

Figure 6. Continuum of Skill Aspects in the Final Evaluation

3.4. Effectiveness of Extension

Based on the results of extension activities on the production of LOF from fish and its application to green mustard plants carried out in the Pattunuang Farmer Group, Tetebatu Village, Pallangga District, Gowa Regency, data on changes in farmers' knowledge, attitudes, and skills were obtained as presented in Table 1.

Table 1. Average Knowledge, Attitude, and Skill Levels of Respondents in the Pattunuang Farmer Group, Tetebatu Village

Description	Max. Value	Mark Which is obtained				Change	
		Initial Test	Percentage (%)	Final Test	Percentage (%)	value	Percentage (%)
Knowledge	500	232	46.4	475	95	243	48.6
Attitude	500	242	48.4	487	97.4	245	49
Skills	500	186	37.2	496	99.2	310	62
Amount	1500	660		1,458		798	

Based on Table 1, there was a significant increase in all three aspects measured. Knowledge increased by 48.6%, attitude by 49%, and skills by 62%. The total increase in all three aspects was 798 points from the previous score. Next, the Effectiveness of Extension (EE) is calculated using the formula:

$$EE = \frac{P_s - P_r}{(N \times 4 \times Q) - P_r} \times 100\%$$

$$EE = \frac{1458 - 660}{(25 \times 4 \times 15) - 660} \times 100\%$$

$$EE = \frac{798}{840} \times 100\% = 95\%$$

Description:
Criteria for the effectiveness of extension services (Padmowihardjo, 2002):
0-25% = Ineffective
26-50% = Less effective
51-75% = Effective
76-100% = Very effective

3.4.1. Effectiveness of extension on farmers' knowledge

The extension activities carried out in the Pattunuang Farmer Group showed a significant increase in farmers' knowledge regarding the use of liquid organic fertilizer (LOF) made from fish waste. The measurement results showed a pretest average score of 46.4%, which increased to 95.0% in the posttest. Based on the extension effectiveness formula (EE), a value of 91.0% was obtained, which is categorized as highly effective according to the classification (Salam et al. 2024) .

This increase indicates that extension methods that combine interactive lectures, group discussions, and demonstrations are able to rapidly expand farmers' knowledge. Extension materials that use local examples (fish waste from markets and ponds around Gowa) also make the topic more relevant and easier to understand. These findings are in line with research by Sarina *et al*. (2024), which reports that extension based on local resources can increase farmers' understanding by up to 30% more than conventional one-way extension.

This increase in knowledge reflects the effectiveness of the social learning process that occurs during extension activities. According to Leeuwis and van den Ban (2004), two-way communication in agricultural extension is key to internalizing technological innovations. In this context, farmers not only receive information but also discuss and relate it to their own experiences in using chemical fertilizers, leading to meaningful and sustainable learning.

3.4.2. Changes in farmers' attitudes toward liquid organic fertilizer

Attitudes also showed a strong improvement after the extension program. The average pretest score of 48.4% increased to 97.4% after the program. The EE score obtained was 95.1%, which is categorized as highly effective. This indicates a significant change in farmers' perceptions of liquid organic fertilizer from fish waste, which was previously considered less practical than chemical fertilizers. Before the extension program, most farmers believed that the use of LOF did not produce results as quickly as urea or NPK fertilizers. However, after receiving scientific explanations about the organic nutrient content and its long-term benefits for soil fertility, farmers showed a more open attitude. Most expressed their willingness to try and even produce LOF independently.

These results confirm the diffusion of innovation theory (Rogers, 2003), which explains that attitude change is an important stage in the innovation adoption process. Positive attitudes emerge after individuals gain sufficient understanding and feel confident about the benefits of innovation. Social support from fellow farmers in the group also strengthens their confidence to switch to more environmentally friendly agricultural practices. This study supports the findings of Novita *et al.,* (2023), who reported that community-based participatory training can increase farmers' willingness to adopt organic fertilizers by up to 90% of the total participsants. In the context of Gowa Regency, this extension program not only functions as a medium for technology transfer but also as a means of collective empowerment where farmers jointly build a commitment to the sustainability of their own land.

3.4.3. Improvement in farmers' skills in making and applying LOF

The most noticeable change occurred in terms of skills. Before the training, only a small number of farmers had ever tried making LOF independently, with an average score of 37.2%. After the training, the score increased dramatically to 99.2%, resulting in an EE of 98.3%, which is classified as highly effective. Skills improved significantly after the demonstration plot (demplot) session and hands-on practice of making fish waste LOF. Farmers were taught how to chop fish waste, mix it with molasses and water, and ferment it for 10–14 days using simple closed containers. In the application stage, farmers were trained to spray LOF at a dose of 10 ml/liter of water on green mustard plants once every two weeks.

This learning-by-doing method proved effective because it allowed farmers to learn directly through experience. This principle is in line with the andragogy approach, which emphasizes adult learning through real experiences. After the activity, some farmers even modified additional ingredients such as coconut water and shrimp waste to improve the aroma and fermentation power, indicating that a process of local innovation had begun. This improvement in skills also strengthens empirical evidence that field demonstrations are the most effective method in agricultural learning (Suyanto *et al*., 2022). With improved skills, farmers are now able to produce LOF independently, reducing their dependence on inorganic fertilizers and reducing production costs by 20–25% per planting season.

3.4.4. Overall effectiveness of extension

Based on the overall average of the three aspects measured: knowledge, attitude, and skills, the Extension Effectiveness (EE) score was 95%, which is classified as highly effective. The simultaneous improvement in these three aspects demonstrates the success of the participatory extension model that was implemented. The results of this study prove that a two-way communication approach and direct experience have a much greater impact than conventional lecture-based extension. Theoretically, these results support the concept of participatory rural appraisal, which emphasizes the importance of farmer involvement in every stage of the activity. Active participation not only increases understanding but also fosters a sense of ownership of the innovations introduced. This is key to the sustainability of organic practices after the extension program ends.

From a policy perspective, these findings reinforce the direction of the implementation of Minister of Agriculture Regulation No. 01 of 2020 concerning the Organic Farming System, which places education and extension as the main instruments in the transformation towards sustainable agriculture. Activities such as this can serve as a model for replication in other regions, especially in areas with abundant fish waste potential. Thus, the results of this study not only contribute practically to strengthening farmer capacity, but also provide a scientific basis for local governments in formulating participatory extension strategies based on local resources to accelerate the adoption of organic technology in Indonesia.

4. Conclusion

The results show that the extension activities are very effective with an effectiveness score of 95%. Knowledge increased from 46.4% to 95%, attitudes from 48.4% to 97.4%, and skills from 37.2% to 99.2%. This improvement proves that extension methods using a group approach, lectures, leaflets, and demonstrations are capable of increasing farmers' abilities and awareness of the importance of applying liquid organic fertilizer. Thus, these extension activities have succeeded in encouraging farmers to transform their behavior towards environmentally friendly and sustainable agricultural practices.

5. References

Abror, M, and Rakhmad, Pavi Harjo. 2018. “Efektifitas Pupuk Organik Cair Limbah Ikan dan *Trichoderma* Sp.terhadap Pertumbuhan dan Hasil Tanaman Kailan (*Brassica oleraceae* Sp.).” *Jurnal Agrosains dan Teknologi* 3(1): 1–12. https://jurnal.umj.ac.id/index.php/ftan/article/view/2466.

Amalyadi, Rezki, Ismulhadi, and Wahyu Windari. 2022. “Evaluasi Hasil Penerapan Rancangan Penyuluhan Tentang Pengaplikasian Pakan Fermentasi Gedebog Pisang Untuk Sapi Potong Desa Tambaksari Kecamatan Purwodadi Kabupaten Pasuruan.” *Jurnal Sains Peternakan* 10(1): 21–25.

Apriyani, Nina, and Ida Marina. 2024. “The Role of Agricultural Extenders in Farmers’ Group Activities and Their Relationship with Rice Productivity.” *Journal of Sustainable Agribusiness* 03(01): 1.

Armuand, Gabriela, Maria Grandahl, Helena Volgsten, and Jenny Stern. 2024. “Characteristics of Good Contraceptive Counselling – An Interview Study.” *Sexual and Reproductive Healthcare* 39 (December 2023).

Asil, Ali Akbar, 2025. “Designing, Prototyping, and Evaluating an Assistive Device for Lower Limb Muscle Stretching: With the Participatory Approach.” *Human Factors in Healthcare* 8 (July): 100109. https://doi.org/10.1016/j.hfh.2025.100109.

Brzyska, Joanna. 2023. “Poland’s Innovation Performance: Drivers, Challenges, and Policy Implications.” *Procedia Computer Science* 225 (2023): 3352–61. https://doi.org/10.1016/j.procs.2023.10.329.

Cameira, Maria do Rosário et al. 2025. “Present and Future Challenges for Hydraulic Reliability and Energy Efficiency in Collective Irrigation Systems: A Participatory Modelling Approach.” *Agricultural Water Management* 309 (January).

Chau, Nguyen Thi, and Tofael Ahamed. 2022. “Analyzing Factors That Affect Rice Production Efficiency and Organic Fertilizer Choices in Vietnam”. *Sustainability (Switzerland)* 14(14): 1–11.

Choenarom, Chanokruthai, and Juraipon Samputtanon. 2025. “The Effectiveness of a Question-Embedded Movie Clips Learning Program in Nursing Students: A Quasi-Experimental Pretest-Posttest Study”. *JMIR Nursing* 8: 1–12.

Das, Suryatapa, Annalakshmi Chatterjee, and Tapan Kumar Pal. 2021. "Organic Farming in India: A Vision towards a Healthy Nation". *Food Quality and Safety* 4(2): 69–76.

Ebert, Cara, and Janina Isabel Steinert. 2025. "Violence against Women and the Substitution of Help Services in Times of Lockdown: Triangulation of Three Data Sources in Germany." *Journal of Economic Behavior and Organization* 232: 106879. https://doi.org/10.1016/j.jebo.2024.106879.

Ekawandani, Nunik, and Noer Halimah. 2021. "Pengaruh Penambahan Mikroorganisme Lokal (MOL) Dari Nasi Basi Terhadap Pupuk Organik Cair Cangkang Telur." *BIOSFER : Jurnal Biologi dan Pendidikan Biologi* 6 (Volume 6 No 2): 2–9.

Faisal, Herry Nur. 2020. "Peran Penyuluhan Pertanian Sebagai Upaya Peningkatan Peran Kelompok Tani (Studi Kasus Di Kecamatan Kauman Kabupaten Tulungagung)." *Agribis* 6 (1): 46–54.

Gillings, Mathew, and Sylvia Jaworska. 2025. "How Humans and Machines Identify Discourse Topics: A Methodological Triangulation". *Applied Corpus Linguistics* 5(1): 100121. https://doi.org/10.1016/j.acorp.2025.100121.

Gulo, Aguswita et al. 2024. "Inovasi Pupuk Organik Untuk Pertanian Ramah Lingkungan". *Jurnal Ilmu Pertanian dan Perikanan* 1(2): 68–73.

Harahap, FS, Susanti Rini, and Afriani Astri. 2020. "Crop Production Growth Response Green Mustard (Brassica Juncea L) Against Granting Urea Fertilizer and Manure Goat On Overseas Land Ultisol In District South." *International Journal of Science, Technology & Management* 1(3): 155–61.

Jensen, Erik Steen. 2020. "Intercropping of Grain Legumes and Cereals Improves the Use of Soil N Resources and Reduces the Requirement for Synthetic Fertilizer N : A Global-Scale Analysis."

Kalkhoran, Sanaz Shoghi. 2019. "Economic Management of Soil Acidity , Nitrogen Fertility and Agricultural Greenhouse Gas Emissions in Western Australia."

Mikasari, W. 2022. "Peningkatan Pengetahuan Petani Tentang Teknologi Pascapanen Tanaman Sayuran Di Kelurahan Bajak Kota Bengkulu." *Buletin Agritek* 3 (November). https://epublikasi.pertanian.go.id/berkala/bulagritek/article/view/3102%0Ahttps://epublikasi.pertanian.go.id/berkala/bulagritek/article/download/3102/3144.

Mujahidah, Aisyah et al. 2023. "Utilization Of Vegetable Pesticides (Umbi Gadung) as an Environmentally Friendly Solution For Sustainable Agriculture." : 24–35.

Novita Wulandari, Made et al. 2023. "Faktor-Faktor dan Perilaku Petani dalam Pengelolaan Usahatani Padi Organik di Kabupaten Lampung Tengah Farmers' Factors and Behavior in Organic Rice Farming Management in Central Lampung Regency." *Journal of Extension and Development* 05 (02): 2714–8351.

Penuelas, Josep, Fernando Coello, and Jordi Sardans. 2023. "A Better Use of Fertilizers Is Needed for Global Food Security and Environmental Sustainability." *Agriculture and Food Security* 12(1): 1–9. https://doi.org/10.1186/s40066-023-00409-5.

Purbiati, Titiek et al. 2024. "Performance and Community Acceptance of Paddy Management with Balanced Input Cultivation Technology in Kebonagung Village Madiun East Java Indonesia." *Heliyon* 10(9): e29834. https://doi.org/10.1016/j.heliyon.2024.e29834.

Putra, Andhika, Tri Mulyono, and Yusfita Chrisnawati. 2020. "Kajian Parameter Marshall dengan Menggunakan Limbah Serbuk Kerang Hijau Sebagai Filler Campuran Lapis Aspal Beton." *Menara: Jurnal Teknik Sipil* 15 (1): 1–8.

Putra, Bangun Wahyu Ramadhan Ika Hariyanto, and Rhenny Ratnawati. 2019. "Pembuatan Pupuk Organik Cair Dari Limbah Buah Dengan Penambahan Bioaktivator EM4 Bangun Wahyu R I H P dan Rhenny R." *Jurnal Sains dan Teknologi Lingkungan* 11(261): 44–56.

Rahayu, Nadya, Rr. Djawartiningsih, and Agus Sulistyono. 2022. "Pengaruh Jenis dan Tingkat Konsentrasi Pupuk Organik Cair terhadap Pertumbuhan dan Hasil Tanaman Cabai Rawit (*Capsicum frutescens*)." *Jurnal Agrium* 19(3): 197.

Reumaux, Rafaelle et al. 2023. "Land Parcel Identification System (LPIS) Data Allows Identification of Crop Sequence Patterns and Diversity in Organic and Conventional Farming Systems." *European Journal of Agronomy* 149 (July).

Salam, Muslim et al. 2024. "The Effectiveness of Agricultural Extension in Rice Farming in Bantaeng Regency, Indonesia: Employing Structural Equation Modeling in Search for the Effective Ways in Educating Farmers." *Journal of Agriculture and Food Research* 18 (October): 101487. https://doi.org/10.1016/j.jafr.2024.101487.

Schrama, M. et al. 2018. "Crop Yield Gap and Stability in Organic and Conventional Farming Systems." *Agriculture, Ecosystems and Environment* 256 (January): 123–30. https://doi.org/10.1016/j.agee.2017.12.023.

Setiawan, Agus Suyanto, and Taivan. 2002. "Pengaruh Pupuk Organik Cair Limbah Ikan terhadap Pertumbuhan dan Hasil Tanaman Cabai Rawit (*Capscum frutescens* L.) pada Tanah Aluvial di Polybag." *Jurnal Agroteknologi, Fakultas Pertanian, Universitas Panca Bhakti Pontianak* 15: 2022.

Silawati, Anis *et al*. 2024. "Pendampingan Pembuatan Pupuk Organik Cair dari Limbah Ikan Hasil Tangkapan Sampingan Udang di Desa Tanjung Pademawu." *Jurnal Ilmiah Pangabdhi* 10(2): 124–29.

Zhang, Min *et al*., 2018. "Increasing Yield and N Use Efficiency with Organic Fertilizer in Chinese Intensive Rice Cropping Systems." *Field Crops Research* 227 (April): 102–9. https://doi.org/10.1016/j.fcr.2018.08.010.