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Evaluation of Farmers' Attitude Changes Toward the Utilization of Neem Leaf (Azadirachta indica) Botanical Pesticide for Fall Armyworm (Spodoptera Frugiperda) Control in Maize Cultivation in Parbuluan District

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Abstract: The infestation of fall armyworm (*Spodoptera frugiperda*) is one of the major constraints in maize cultivation, causing significant reductions in crop productivity. The use of neem leaf (*Azadirachta indica*) botanical pesticide has emerged as an environmentally friendly alternative for pest control; however, its adoption among farmers remains relatively low. Therefore, extension activities are needed to improve farmers' attitudes toward the utilization of this botanical pesticide. This study aimed to determine the percentage of change in farmers' attitudes before and after extension activities regarding the use of neem leaf botanical pesticide for controlling fall armyworm in maize cultivation in Parbuluan District. The study was conducted from February to May 2026 using a quantitative descriptive method. The respondents consisted of 33 farmers who were members of the Unggul Farmer Group and the Dalihan Natolu Farmer Group. Extension activities were carried out through method demonstrations and farm visits, supported by folder media and real objects. Data were collected using a Likert-scale questionnaire to measure farmers' attitudes before and after the extension program. The extension materials were developed based on research findings indicating that a botanical pesticide formulation consisting of 40% neem leaf extract combined with 20% soursop leaf extract was the recommended treatment for controlling fall armyworm. The results showed that the percentage of farmers' attitudes increased from 28.03% before the extension activities to 86.00% after the extension activities. This improvement indicates that the extension program was effective in fostering positive farmer attitudes toward the utilization of botanical pesticides as an environmentally friendly and sustainable alternative for pest management in maize cultivation.

Keywords: botanical pesticide, extension evaluation, fall armyworm, farmers' attitudes, maize, neem leaf.

INTRODUCTION

Maize (Zea mays L.) is one of the strategic food commodities that plays an important role in supporting national food security and serves as a primary raw material for the livestock feed industry. Although maize production has continued to increase, crop productivity still faces various constraints, one of which is the attack of plant pests. Among the various pest species, the fall armyworm (Spodoptera frugiperda) has become one of the major pests attacking maize from the vegetative to the reproductive growth stages, resulting in significant yield losses. According to FAO (2020), the fall armyworm is an invasive pest that threatens maize production in many countries due to its high reproductive capacity and rapid dispersal ability. The presence of this pest has become a serious threat to the sustainability of maize production and global food security (FAO, 2020).

In Indonesia, the occurrence of S. frugiperda was first reported in maize-growing areas across several provinces in 2019, and since then its distribution has expanded to many maize production centers throughout the country (Sartiami et al., 2020). Parbuluan District, Dairi Regency, one of the maize production centers in North Sumatra Province, is also facing problems associated with fall armyworm infestations. Attacks by this pest can cause severe leaf damage, inhibit plant growth, and reduce crop productivity if not managed properly.

Farmers' efforts to control fall armyworm are still predominantly dependent on synthetic pesticides. Excessive and improper use of pesticides may lead to various negative impacts, including pest resistance, pest resurgence, environmental pollution, and adverse effects on non-target organisms. Therefore, safer and more sustainable pest management alternatives are needed. One potential alternative is the use of botanical pesticides derived from neem (Azadirachta indica) leaves. Neem contains azadirachtin, a bioactive compound that acts as an antifeedant, growth regulator, and reproductive inhibitor of insects, making it a promising environmentally friendly pest control agent.

Despite the various advantages of botanical pesticides, their utilization among farmers remains relatively low. This condition is caused by limited knowledge, lack of practical experience, and low farmer confidence in the effectiveness of botanical pesticides compared to synthetic pesticides. The low acceptance of this innovation indicates that the successful introduction of a technology depends not only on the availability of the technology itself but also on the readiness and attitudes of farmers as technology users. Attitude is one of the key factors influencing farmers' decisions to accept and adopt agricultural innovations (Rizzo et al., 2024).

The low adoption rate of botanical pesticides further suggests that successful technology transfer is determined not only by the availability of innovations but also by behavioral changes among farmers as end users. In the context of agricultural extension, attitude is an important component influencing farmers' decisions to accept and implement an innovation. Farmers who possess positive attitudes toward a technology are more likely to be willing to try and adopt it in their farming activities (Rizzo et al., 2024).

To improve farmers' understanding and acceptance of neem leaf botanical pesticides, agricultural extension activities were conducted through method demonstrations and farm visits. However, the effectiveness of these extension activities needs to be evaluated to determine the extent to which the delivered materials influence farmers' attitudes toward the introduced innovation. Such evaluation is important because attitude change is an initial indicator that determines the sustainability of technology adoption at the farmer level (Harahap and Effendy, 2017). Therefore, this study aimed to determine the percentage change in farmers' attitudes before and after participating in extension activities regarding the utilization of neem leaf (Azadirachta indica) botanical pesticides for controlling fall armyworm (Spodoptera frugiperda) in maize cultivation in Parbuluan District.

RESEARCH MATERIALS AND METHODS

This study was conducted from February to May 2026 in Parbuluan District, Dairi Regency, North Sumatra Province, Indonesia. The research location was selected purposively because the area is one of the maize production centers experiencing fall armyworm (Spodoptera frugiperda) infestations and still exhibits a low level of adoption of pest management technologies among farmers.

Research Method

This study employed a quantitative descriptive method using a survey approach. The respondents consisted of 33 farmers who were members of the Unggul Farmer Group and the Dalihan Natolu Farmer Group. The respondents were selected based on their suitability with the objectives of the extension program, namely maize farmers actively engaged in cultivation during the vegetative growth stage of the crop.

The extension materials were developed based on research findings indicating that a botanical pesticide formulated from neem leaves (*Azadirachta indica*) at a concentration of 40%, combined with soursop leaves at a concentration of 20%, was the recommended treatment for controlling fall armyworm in maize cultivation. The extension materials were delivered based on a synopsis and extension preparation sheet that had been prepared beforehand. The extension activities were conducted using method demonstrations and farm visits. Method demonstrations were used to directly demonstrate the preparation and application of botanical pesticides, while farm visits were carried out to strengthen farmers' understanding through field observation and direct assistance on their farms. The extension media used included folders as printed educational materials and real objects consisting of the materials and equipment required for the preparation of botanical pesticides.

Data Collection Method

Data were collected using a Likert-scale questionnaire administered before and after the extension activities. Prior to its use as a research instrument, the questionnaire was tested for validity and reliability using the Statistical Package for the Social Sciences (SPSS) software. The validity test was conducted on 15 respondents using the Pearson Product-Moment correlation at a significance level of 5% (r-table = 0.514). The results indicated that 10 statement items had calculated correlation coefficients (r-count) greater than the r-table value and were therefore considered valid and suitable for use in the study. Subsequently, reliability testing was performed using Cronbach's Alpha method. The results showed that the Cronbach's Alpha coefficient exceeded 0.60, indicating that the instrument was reliable and appropriate for data collection.

Farmers' attitudes were measured using a five-point Likert scale consisting of Highly Effective (5), Effective (4), Moderately Effective (3), Ineffective (2), and Highly Ineffective (1). The collected data were analyzed descriptively using percentages to determine changes in farmers' attitudes toward the utilization of neem leaf botanical pesticides for controlling fall armyworm in maize cultivation. Attitude scores were calculated using the following formula:

Attitude Score (%) = (Maximum Score/Obtained Score) × 100

The resulting attitude scores were then interpreted using a continuum line to determine the effectiveness level of the extension program. The criteria used were as follows: 0–20% (strongly disagree), >20–40% (disagree), >40–60% (moderately agree), >60–80% (agree), and >80–100% (strongly agree). The comparison between pre-extension and post-extension attitude scores was used to determine changes in farmers' attitudes as an indicator of farmers' acceptance of the innovation introduced through the extension program.

RESULTS AND DISCUSSION

Geographical Location

Parbuluan Sub-district is one of the administrative sub-districts in Dairi Regency. It is located at an elevation of 900 to 1,400 meters above sea level. Geographically, Parbuluan Sub-district lies between 98° East Longitude and 2.15°–3.00° North Latitude. Parbuluan Sub-district has a strategic position as it is bordered by two regencies, namely Toba Regency and Pakpak Bharat Regency. This strategic geographical location makes Parbuluan Sub-district a region with significant potential to support inter-regional connectivity, both between sub-districts and neighboring regencies.

The boundaries of Parbuluan Sub-district are as follows:

North: Sumbul Sub-district

East: Toba Regency

South: Pakpak Bharat Regency

West: Sidikalang Sub-district

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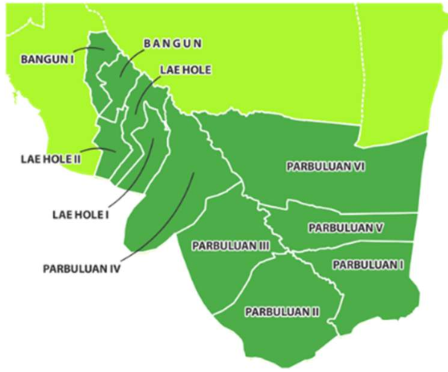

Figure 1. Map of Parbuluan Sub-district

Source: Statistics Indonesia (BPS), Parbuluan Sub-district, 2022

Climate and Weather Conditions

Based on data obtained from the Parbuluan Statistics Office (BPS) in 2022, Parbuluan District has a tropical climate characterized by two seasons: the rainy season and the dry season. These seasons are generally distinguished by the number of rainy days occurring each month. The area has an average temperature of approximately 16°C and annual rainfall ranging from 2,000 to 3,500 mm. According to the Oldeman climate classification system, Parbuluan District falls under the C1 climate type, with soil pH ranging from 5 to 6. The wet months typically occur from October to December, while the dry months extend from February to June.

In general, tropical regions such as Parbuluan District experience relatively stable temperatures throughout the year and maintain high humidity levels. High rainfall during the rainy season supports the growth of various agricultural and horticultural crops. However, it may also contribute to the increased development of weeds, pests, and plant diseases.

Demographic Conditions

Based on data obtained from the Civil Registration and Population Office, Parbuluan District had a total population of 28,381 people in 2024, consisting of 14,200 males and 14,181 females. Overall, the male and female populations are relatively balanced, with a sex ratio of 100.13, indicating that there are approximately 100 males for every 100 females. The population of Parbuluan District is composed of several ethnic groups, including Pakpak, Toba, Karo, and Simalungun. The major religions practiced in the district are Islam, Protestantism, and Catholicism. These diverse communities generally coexist harmoniously and peacefully.

Respondent Characteristics

The respondent characteristics in this study included several socio-economic aspects, namely age, gender, educational level, farm size, and land ownership status. These characteristics are important for describing the profile of the extension program participants and for explaining factors that may influence the acceptance and adoption of agricultural innovations among farmers. Understanding respondent characteristics provides valuable insights into the capacity of farmers to receive, evaluate, and implement new technologies introduced through agricultural extension activities. Furthermore, these characteristics can affect farmers' access to information, decision-making processes, and willingness to adopt environmentally friendly pest management practices, including the utilization of neem leaf (*Azadirachta indica*) botanical pesticides for fall armyworm control in maize cultivation.

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Table 1. Respondent Characteristics

No	Characteristics	Category	Number of Respondents (Persons)	Percentage (%)
1	Age (Years)	29 – 36	6	18
		37– 44	4	12
		45 – 52	7	21
		53 – 60	9	27
		61 – 68	3	9
		69 – 76	4	12
2	Gender	Male	12	37
		Female	21	63
3	Education Level	Elementary School	5	15
		Junior High School	6	18
		Senior High School	21	64
		Diploma (D3)	1	3
4	Land Area (Ha)	0,5	17	52
		1	12	36
		1,5	2	6
		2	2	6
5	Land Ownership	Self-owned	33	100
		Rented	0	0
		Amount	33	100

Source: Primary Data (2026)

Respondents' ages ranged from 29 to 76 years, with the largest age group falling within the 53–60 years category (27%). This indicates that most farmers are within the productive to late productive age range and remain actively involved in farming activities. According to Dayat and Anwarudin (2020), farmers' age is one of the factors influencing participation in agricultural extension activities. Nevertheless, elderly farmers can still actively participate if the extension materials and implementation are adapted to their needs and conditions.

The majority of respondents were female, accounting for 21 individuals (63%), while males accounted for 12 individuals (37%). This dominance of women indicates their high involvement in farming activities, both in production and farm management stages. This role positions women as a potential group in the adoption and dissemination of agricultural innovations. This finding is consistent with Manto, Indriani, and Saleh (2023), who stated that women play an important role in agricultural activities as part of efforts to increase household income.

Most respondents had completed senior high school education (SMA), totaling 21 individuals (64%), followed by junior high school (SMP) with 6 individuals (18%), elementary school (SD) with 5 individuals (15%), and diploma level (D3) with 1 individual (3%). This relatively good educational background indicates that most farmers have sufficient capacity to receive and

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understand information delivered through extension activities. According to Singh, Dorward, and Osbahr (2016), education is one of the key factors influencing farmers' ability to understand information, make decisions, and adopt innovations in farming systems.

The majority of respondents owned 0.5 hectares of land (17 individuals or 52%), followed by 1 hectare (12 individuals or 36%), while 1.5 hectares and 2 hectares were each owned by 2 individuals (6%). This indicates that maize farming in the study area is dominated by smallholder farmers. Land size is one of the factors that can influence production capacity and farmers' opportunities to adopt agricultural technologies. Singh *et al.* (2016) further emphasized that farmers' resources, including land size, play a significant role in decision-making and innovation adoption in agriculture.

All respondents were farmers who owned their farmland. Land ownership provides farmers with greater flexibility in determining the technologies applied in their farming activities, as they have full control over land management. Landowners tend to be more open to adopting innovations compared to tenants or sharecroppers. This is supported by Shibata, Cardey, and Dorward (2020), who explained that ownership of productive assets, including land, influences decision-making and innovation adoption in the agricultural sector.

Extension Implementation

The extension activity was conducted in Bangun Village, Parbuluan District, Dairi Regency. The implementation of the extension program consisted of several stages: (1) participants gathered at the designated location at the scheduled time; (2) attendance was recorded; (3) the researcher delivered material on fall armyworm pests and the use of neem (*Azadirachta indica*) botanical pesticide using folders and live demonstration media; (4) after the presentation, a practical demonstration on the preparation and application of neem-based botanical pesticide was conducted to provide farmers with direct learning experience; and (5) the extension followed a pre-prepared implementation plan (LPM) to ensure a structured flow of discussion. The material was delivered based on the prepared synopsis, while maintaining flexibility during the session.

Figure 2. Implementation of Extension Activities

Source: Personal Documentation

Extension Evaluation

Extension evaluation is a systematic process used to assess the level of success of a program in achieving its predetermined objectives, particularly in terms of changes in knowledge, attitudes, and skills of the target group. Extension evaluation is defined as a structured process conducted to measure the extent to which an extension activity achieves its planned objectives, including improvements in knowledge, attitudes, and skills among participants (Harahap and Effendy, 2017).

Attitude Evaluation

To measure changes in attitudes, a Likert scale questionnaire was used, administered before and after the extension program (Harahap and Effendy, 2017). Farmers' attitudes were assessed using a Likert scale consisting of 10 positive statements. The scoring range was from 1 to 5, where higher scores for each positive statement indicate a better attitude or stronger agreement with the given statement. The results of this measurement can be interpreted using interval and percentage analysis to determine the level of assessment based on the interval calculation method. The evaluation aimed to measure farmers' attitudes before and after participating in the extension program. The following presents the attitude questionnaire results of farmers prior to participating in the extension activity:

No	Number of Statements	Obtained Score	Maximum Score	Percentage	Criteria
1	Statement 1	50	165	30,30	Highly Ineffective
2	Statement 2	49	165	29,70	Highly Ineffective
3	Statement 3	45	165	27,27	Highly Ineffective
4	Statement 4	49	165	29,70	Highly Ineffective
5	Statement 5	45	165	27,27	Highly Ineffective
6	Statement 6	48	165	29,09	Highly Ineffective
7	Statement 7	48	165	29,09	Highly Ineffective
8	Statement 8	41	165	24,85	Highly Ineffective
9	Statement 9	46	165	27,88	Highly Ineffective
10	Statement 10	46	165	27,88	Highly Ineffective
	TOTAL	**467**	**1650**	**28,30**	**Highly Ineffective**

Source: Primary Data (2026)

Attitude Score 1 = (467 / 1650) × 100%

= 28.30%

Based on the calculation, the pre-extension attitude score obtained was 28.30%. Referring to the score interpretation criteria used in this study (which generally follow a Likert scale or similar measurement scale), a score of 28.30% falls within the 20%–40% range.

The continuum line of the pre-extension attitude evaluation level is presented below:

Figure 2. Continuum Line of the Pre-Extension Attitude Evaluation Level

Source: Primary Data (2026)

Based on Figure 1, it can be seen that the attitude evaluation level prior to the extension activity on the management of fall armyworm infestation in maize was categorized as appropriate. This is because the analysis result of 28.30% falls within the "Disagree" category. These findings indicate that before the extension activity was conducted, most farmers had not yet developed a positive attitude toward the use of neem leaf botanical pesticide as an alternative method for pest control.

The low level of agreement among farmers may be attributed to limited information, experience, and understanding regarding the benefits, preparation methods, and field application of botanical pesticides. Farmers' attitudes toward an innovation are strongly influenced by their perceptions of that innovation. Farmers tend to be reluctant to accept or adopt new technologies if

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they do not fully understand the benefits, ease of use, and effectiveness of the technology. Kusmiyati and Kusnadi (2012) explained that farmers' perceptions are significantly associated with the acceptance of agricultural innovations; the more positive the farmers' perceptions of an innovation, the greater the likelihood that the innovation will be accepted and adopted.

The following are the attitude questionnaire results of farmers after participating in the extension program:

No	Number of Statements	Obtained Score	Maximum Score	Percentage	Criteria
1	Statement 1	134	165	81,21	Highly effective
2	Statement 2	133	165	80,61	Highly effective
3	Statement 3	136	165	82,42	Highly effective
4	Statement 4	137	165	83,03	Highly effective
5	Statement 5	136	165	82,42	Highly effective
6	Statement 6	135	165	81,82	Highly effective
7	Statement 7	136	165	82,42	Highly effective
8	Statement 8	134	165	81,21	Highly effective
9	Statement 9	137	165	83,03	Highly effective
10	Statement 10	136	165	82,42	Highly effective
	TOTAL	1354	**1650**	82,06	**Highly effective**

Source: Primary Data (2026)

Attitude Score 1 = (1354 / 1650) × 100%

= 82.06%

Based on the calculation results, the attitude score obtained was 82.06%. Referring to the score interpretation criteria used in this study, a score of 82.06% falls within the range of 80%–100%, which is categorized as very positive. The attitude evaluation after the extension activity is presented below in the form of a continuum line.

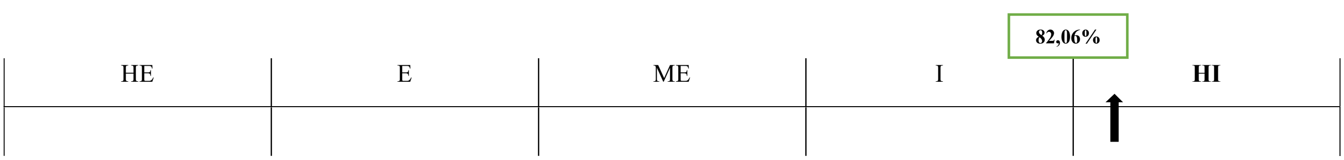

Figure 2. Continuum Line of the Post-Extension Attitude Evaluation Level

Source: Primary Data (2026

Based on the figure, it can be seen that the attitude evaluation level in the extension activity on controlling fall armyworm pests in maize cultivation was highly appropriate. This is indicated by the analysis result showing a score of 82.06%, which falls into the "strongly agree" category. The increase in questionnaire scores from before to after the extension activity demonstrates that the extension program had a positive effect on the attitudes of the participants. According to Fatchiya and Amanah (2020), the success of extension activities can be observed through changes in the knowledge, attitudes, and skills of participants after taking part in the program. The percentage increase in attitude score was 53.76%, comparing the results before and after the extension activity.

Furthermore, the use of method demonstrations and farm visits during the extension activities is believed to have contributed to the improvement of farmers' attitudes. Demonstration methods allow farmers to directly observe the process of producing and applying the introduced technology, thereby increasing their confidence in its effectiveness. These findings are consistent with the study of Rizzo *et al.* (2024), which stated that perceived benefits and confidence in the effectiveness of a technology are important factors influencing farmers' attitudes and decisions to adopt agricultural innovations. Therefore, the high level of farmer agreement after the extension activity indicates that the program successfully increased farmers' acceptance of neem leaf (*Azadirachta indica*) botanical pesticide as an environmentally friendly alternative for controlling fall armyworm pests.

CONCLUSION

The results of the attitude evaluation showed an increase from 28.30% before the extension activity to 82.06% after the activity, indicating that the extension program was successful in influencing farmers' willingness to accept and apply neem leaf botanical pesticide for fall armyworm control. This positive change in attitude was supported by the use of demonstration methods, which enabled farmers to directly observe the preparation and application of the botanical pesticide, thereby enhancing their confidence in the introduced innovation. In addition, the use of folder media and real objects helped clarify the information delivered, while the relevance of the extension materials to the actual problems faced by farmers increased the validity and usefulness of the information provided. Therefore, the combination of appropriate methods, media, and extension materials effectively encouraged positive changes in farmers'attitudes.

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