



Farming Efficiency of Pest and Disease Control Techniques on The Efficiency of Shallot (*Allium ascalonicum* L.) Farming in Local Agricultura Areas in Timor-Leste

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ABSTRACT: Agriculture is one of Timor-Leste's most important economic sectors, providing a living for the vast majority of the population. The key issue for shallot producers in Timor-Leste's local agricultural areas is the high intensity of plant pest organism attacks, which has an impact on production costs and revenue. The purpose of this study is to determine how pest and disease control approaches affect the efficiency of shallot (*Allium ascalonicum* L.) cultivation in Timor-Leste's local agricultural areas. This study employs a quantitative approach, collecting primary data from farmers via surveys, structured interviews, and questionnaires administered to a sample of 10 shallot farmers and 40 respondents in the study area, and analyzing farming efficiency using the Linear Regression Analysis method implemented in SPSS version 22. This study found that, when compared to other ways, the use of integrated control in shallot cultivation is the most profitable and efficient. With a production of 3,700-4,320 kg and a consistent selling price of \$3.50, total production costs (TC) range from \$660 to \$785. The t-test results showed that the variables Chemical Use (X_1), Biological Use (X_2), and Integrated Control (X_4) all had a significant and positive effect on the dependent variables. The use of biological uses (X_4) was the most significant factor, with a tcal value of 6,715, demonstrating that chemical technology intervention is still the principal driver of agricultural efficiency at this research site. The model accounts for 69% of the variance in farming efficiency ($R^2 = 0.690$). As a result, expanding farmer training and extension programs on integrated pest management (IPM) is critical for improving sustainable pest control and increasing the efficiency of shallot farming in Timor-Leste. So extension and training initiatives on integrated pest management (IPM) techniques should be strengthened to help farmers manage pests more efficiently and sustainably.

KEYWORDS: Pest, Disease control, shallots cultivation, farming efficiency.

1. INTRODUCTION

Agriculture is one of Timor-Leste's key economic sectors, providing a living for a considerable proportion of the people, particularly those who live on farms in rural areas. The agricultural sector is critical to Timor-Leste's economic structure and food security, as more than 70% of the population lives in rural regions and relies on subsistence farming (FAO Timor-Leste, 2021). According to the most recent data given by Timor-Leste's Ministry of Agriculture and Fisheries (MAF), shallot production in the country has grown significantly in recent years. According to MAF's 2023 annual report, total national shallot output has reached around 7,500 tons per year, up around 15% from the preceding year. This growth is credited to MAF's technical support and farmer empowerment programs, which include the distribution of better seeds, training in modern farming, and access to excellent fertilizers and pesticides.

Attack pests such as *Thrips tabaci*, armyworms (*Spodoptera exigua*), and diseases such as fusarium wilt (*Fusarium oxysporum*) and anthracnose (*Colletotrichum gloeosporioides*) cause high yield losses and hinder productivity in shallot cultivation systems in local farming areas, particularly in developing countries such as Timor-Leste. Farmers often use a variety of control strategies to deal with plant pest species, including chemical, biological, mechanical/physical, and integrated control (IPM) approaches (Salamiah, S., 2022). In-depth evaluations are required to determine the relative contribution of each control strategy to increasing productivity, lowering production costs, and minimizing negative environmental and health impacts, particularly in small-scale



farms with limited technology and access to information, such as those in Timor-Leste (MAF Timor-Leste, 2021). Farm efficiency is an important metric for analyzing the effectiveness of agricultural production systems because it reflects how well farmers can process and allocate production inputs such as land, labor, seeds, and agroinputs to maximize output. In the context of shallot cultivation, efficiency is influenced not only by technical and agronomic aspects, but also by pest and disease control measures used (Aldo, D., 2020).

Appropriate control measures can reduce plant pest damage, reduce the need for expensive inputs like chemical pesticides, and eventually boost farmers' profit margins. As a result, this study is extremely important in answering fundamental questions about the extent to which the effectiveness of various pest and disease control methods affects the economic efficiency and sustainability of shallot farming, particularly at the local level. Puryantoro, P., & Wardiyanto, F. (2022).

Based on this description, it is critical to evaluate the efficacy of various pest and disease control approaches in enhancing the efficiency of shallot farming at the local farm level in Timor Leste. Efficiency in this situation encompasses not only technical aspects of production, but also economic efficiency, labor, and the impact on the agricultural system's sustainability. As a result, this study is required to evaluate the impact of implementing various pest and disease control techniques such as chemical control, biological control, physical/mechanical control, and integrated control (IPM) on the effectiveness of shallot farming (Aldo, D., 2020). The purpose of this study is to determine how pest and disease control approaches affect the efficiency of shallot (*Allium ascalonium* L.) cultivation in Timor-Leste's local agricultural areas.

2. LITERATURE REVIEW

2.1. Pest and Disease Control Techniques

Tahyudi *et al.* (2020) argue that successful pest and disease control techniques for shallot farming must take into account the spatial and temporal interactions between plant pest organisms and environmental factors. Suggested strategies are: (1) Integrated Monitoring: Pest populations and disease development are intensively monitored on a regular basis to inform decision-making. This data serves as a feedback loop in an economic system, requiring any fluctuations to be examined before changes are implemented. (2) Use of Resistant cultivars: The first step in a preventive strategy is to introduce onion cultivars resistant to key diseases such as *Fusarium oxysporum*, *Alternaria porri*, and *Pythium spp.* (3) Biological Control and Crop Rotation: The use of biological agents like *Trichoderma spp.*, *Pseudomonas fluorescens*, or local endophytic bacteria has been shown to reduce soil pathogen populations. Meanwhile, crop rotation with nonhost commodities hinders pathogen life cycles. (4) Environmental and Drainage Management: Cultural engineering, such as plant spacing, water and drainage management, and balanced fertilization, serves to produce a less hospitable habitat for infections. (5) careful use of vegetables and synthetics Pesticides: When necessary, pesticides are applied judiciously depending on economic criteria. Vegetable insecticides derived from local plants such as neem, soursop, or tobacco can be applied in an environmentally acceptable manner. (6) Farmer engagement and Local Adaptation: This technique promotes farmer engagement in decision-making while also valuing traditional traditions and local understanding. This is consistent with the Marshallian paradigm, which views the agent as the primary driver in the innovation and adaptation process.

2.2. Chemical control

According to Abdullah, M., and Sualiaman, R. (2020), the following pesticide classes are relevant for managing pests and illnesses in shallots: (1) Fungicides: A pesticide used to control fungal or fungal illnesses. Systemic fungicides with active components such as propineb, mankozeb, difenoconazole, or triazole are often used to limit mycelial growth and pathogen sporulation in diseases such as purple spot and *fusarium wilt*. To avoid resistance, active ingredient rotation should be considered when selecting fungicides. (2) Insecticides: used to kill disease vector insects and direct pests like *Thrips tabaci*, which, in addition to causing leaf damage, has the potential to transmit plant viruses. The usage of insecticides containing active chemicals such as abamectin, spinosad, or emamectin benzoate should be based on an economic threshold. (3) Bacteria and Nematicides: Although bacteria and nematode infestations in shallot crops in the tropics are relatively rare, the use of bactericides such as oxytetracycline or nematicides such as fenamifos can be part of integrated control, particularly in fields with a history of recurrent infestation. (4) Acaricides and Molluscicides: Acaricides are used when there is a population of mites or ticks that damage the leaf structure, whilst molluscicides are used to combat snails and snails that attack the bottom portion of the plant, particularly in marshes and rainy seasons. (5) Herbicides: Herbicides are useful in managing weeds, which not only compete for nutrients and water but can also act



as alternate hosts for infections. Selective herbicides with active chemicals such as paraquat, glyphosate, or pre-emergents like alachlor are used to increase labor efficiency and yield.

2.3. Biological Control

Febrianti and Pujiati (2020) categorize natural enemies into three kinds, including: (1) Predators: Predators are species that prey on multiple pests over their lifecycle, such as ladybugs (*Coccinellidae*), spiders, praying mantises (*Mantidae*), and dragonflies. (2) parasitoids: parasitoids, such as *Aphidius colemani*, are insects that lay eggs on or inside the body of the host (pest), and the larvae feed on the host, causing the host to die. (3) Entomopathogenic Pathogens: Fungi like *Metarhizium anisopliae* attack insects by entering the cuticle, growing inside the body, and killing the victim by systemic infection.

2.4. Mechanical Control and Technical Culture

Technical culture control, also known as agronomic culture, is an ecological technique that uses agroecological principles to generate environmental circumstances that are advantageous for the growth of cultivated plants while being unfavorable for pests (Hakim, L., 2021). This technique comprises: (a) crop rotation, particularly with non-host crops or crops that are antagonistic to specific diseases, which can diminish the population of specific pathogens in soil. For example, rotating onions with legumes or refugia crops can help prevent *Fusarium oxysporum* growth. (b) tight planting and spacing, which allows the plant canopy to cover the soil surface more quickly, reduces sunlight penetration into the soil, and inhibits weed growth. (c) fallowing, both wet and dry, is efficient at reducing populations of diseases and weeds that require specific soil conditions to grow. (d) Water and drainage management, such as adjusting water levels or establishing drainage channels, can generate unfavorable soil conditions for waterborne pathogens including *Pythium spp.* promote the health of the onion roots. (e) the use of mulches and organic debris, which not only physically hinder weed development but also improve soil fertility and natural hostile microbial activity.

2.5. Integrated Control (IMP)

According to Hakim, L. (2021), the theory of the fundamental principles of integrated pest management (IPM) in shallot cultivation: (1) Healthy Plant Cultivation: Healthy plant cultivation is the primary component of the Integrated Pest Management (IPM) strategy. Onion plants that grow well with proper feeding and cultivation treatments are more resistant to Plant Disturbing Organism attacks. (2) Preservation and Use of Natural Enemies: Natural enemies, including as predators, parasitoids, and entomopathogenic diseases, play a vital role in naturally lowering pest populations. (3) Periodic Observation (Monitoring): Monitoring is a strategic stage that involves determining the dynamics of pest populations and their natural enemies on a regular basis. Weekly intensive observations can be conducted to count the number of pests at each stage of plant growth. (4) Farmers as Integrated Pest Management (IPM) Experts: Empowering farmers to be the primary actors in the Integrated Pest Management (IPM) system is a critical component of successful long-term pest and disease control. Field-based training, such as the Field School for Integrated Pest Management (IPM), is critical to improving farmers' understanding of agricultural ecology and agroecosystem management.

2.6. Farming efficiency

According to Farrel (1957), as mentioned in Suwarnata et al. (2020), there are three types of efficiency in shallot farming: technical efficiency, allocative efficiency, and economic efficiency. (1) Technical efficiency: This dimension assesses a producer's capacity to maximize output from a given set of inputs. Technically efficient producers operate at the production frontier, which is the highest level of productivity possible with current technology. Inefficiency happens when production occurs below this frontier as a result of poor management, obsolete processes, or resource misallocation. (2) allocative efficiency: allocative efficiency is the best mix of inputs to reduce production costs given input prices and technology constraints. This type of efficiency guarantees that resources are employed in the most economically effective manner, thereby matching production costs with market circumstances. (3) Economic efficiency: By integrating technical and allocative efficiency, Farrell created the concept of overall economic efficiency. It represents a producer's ability to reduce costs while increasing output, and serves as a baseline for comparing performance across enterprises or industries.

2.7. Researcher Model

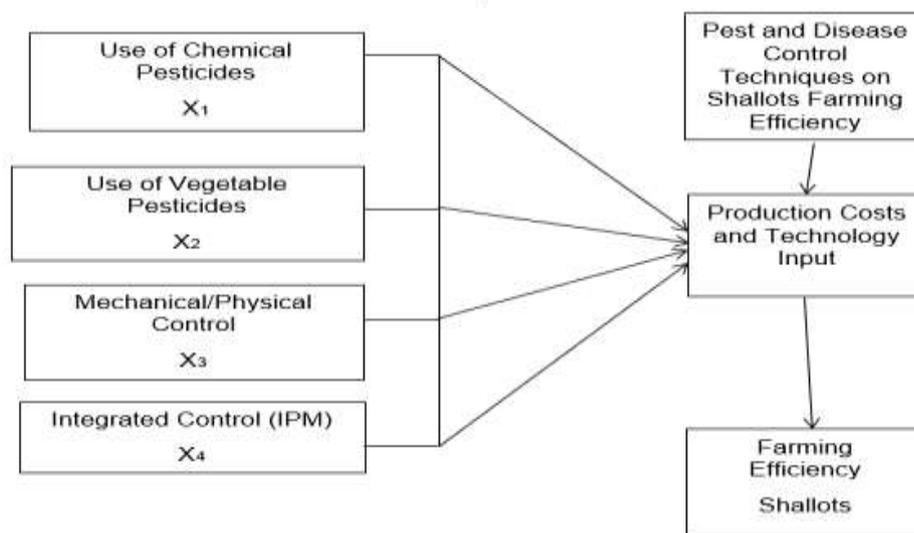


Figure 1. Research Model

3. METHODOLOGY

3.1. Time and Place

The study was carried out from August 1st to November 28th, 2025, at the onion cultivation farm site in Usitaqueno Village, Oe-silo Sub-District, Oe-cusse District, which is one of Timor-Leste's native onion producing farms.

3.2. Tools and Materials

A variety of equipment and resources were required to assist the data gathering process, field observations, and application of the pest and disease control approaches to be examined. The instruments and materials employed in this investigation are: (1) Stationery and extra materials (field notebooks, observation sheets, interview questionnaires, and survey sheets for technical and economic farm data recording). (2) A camera or camera phone for record-keeping (to document farm activity). (3) A camera or camera phone for record-keeping (to document crop conditions, pest infestations, and agricultural operations). (4) Personal protective equipment (masks, gloves, and other protective gear while accompanying or monitoring the use of chemical pesticides or biological materials in the field).

3.3. Sample

The research sample was chosen on purpose by selecting farmers who actively cultivate shallots and have used one or more pest and disease control approaches (chemical, biological, mechanical/physical, or integrated) in the previous planting cycle. This sampling technique was used to ensure that the data collected accurately reflects the reality of pest and disease control and its effectiveness in the local context Renggo, Y. R. (2022). The number of samples in this study was 10 farmers and 40 respondents in shallot cultivation, chosen using a purposive selection method with certain criteria. With this methodology, the research findings are expected to reflect the actual field conditions and give a solid foundation for drawing conclusions and making relevant recommendations for the development of more efficient shallot farming in Timor-Leste.

3.4. Data Type and Source

1. Primary Data: Primary data for this study was gathered through direct interviews, questionnaires, and field observations. Interviews were designed to acquire detailed information about pest and disease control measures used by farmers. Suhono, T., and Al Fatta, H. (2021) designed questionnaires to collect quantitative data on production costs, crop yields, pest attack frequency, and the type and intensity of management strategy use. In addition, direct on-farm observations were made to assure data accuracy and to document the actual conditions of control implementation in the field.



2. Secondary Data: This study collected data using three primary strategies (Equatora & Awi, 2021), namely: (1) structured interview: Interviews with shallot farmers were performed directly, using standardized questionnaire procedures. Questions were designed to elicit information about the types of pest and disease control measures utilized, the frequency of application, the expenditures incurred, production yields, and farm income. This interview contributes to the collection of detailed and accurate data based on field conditions. (2) field Observation: On-farm observations were made to document actual pest and disease control procedures, such as methods employed (chemical, biological, mechanical, or integrated), crop conditions, and yields. This observation attempts to confirm the accuracy of respondents' answers and collect objective data on farming activities. (3) documentation: information was gathered from official sources such as the Department of Agriculture, farmer cooperatives, and scientific publications. This secondary data set contains historical and statistical information on cropping area, production, insect infestations, and control measures typically employed in the research region. This documentation was used to supplement and compare original data using triangulation.

3.5. Research Variables

1. Independent Variables: the independent variable in this study is the pest and disease management measures used by shallot farmers. Chemical control (pesticide use), biological control (natural enemy usage), mechanical control (manual sweeping or weeding), and the use of integrated pest management control (IPM), which combines various strategies, are among the techniques Ulfa and Fikriyah (2022) employ. These approaches' variations are examined to determine their impact on shallot farming efficiency.
2. Dependen Variable: The dependent variable in this study is the efficiency of shallot farming, which is calculated as the ratio of output to production input. Ulfa and Fikriyah (2022) examine this efficiency using economic indicators such as the R/C ratio (Revenue to Cost ratio) and the B/C ratio (Benefit to Cost ratio). These ratios demonstrate the amount to which crop yields and farmer income can cover production expenses, hence demonstrating the level of success and efficiency of shallot farming in particular agricultural areas.

3.6. Measurement scale

In this study, the measuring scale is tailored to the type of data for each variable to ensure proper statistical processing and analysis. The measuring scales employed are: always, often, seldom, and never. Respondents select the choice that most accurately reflects their degree of agreement with each statement. This measurement approach enables researchers to acquire quantitative data from the responses obtained.

Table 1. Likert Scale Scoring

Description	Score	Assessment
Always	SL	4
Often	SR	3
Rarely	JR	2
Never	TP	1

3.7. Data Analysis Technique

This study's data analysis methodologies were carried out in multiple structured stages to assess and explain the influence of pest and disease control techniques on shallot farming efficiency (Dhewy, R. C., 2022). Techniques utilized include: (1) describes the characteristics of respondents (age, level of education, gender) as well as the control techniques utilized. (2) Farming Efficiency Analysis: An R/C ratio of > 1 suggests an efficient and profitable farm, while <1 implies a loss. (3) Linear regression analysis: utilized to assess the impact of each control approach on agricultural productivity. (4) Cronbach's Alpha was used to assess the reliability of the questionnaire instrument. A score of $\alpha > 0.6$ was considered reliable. (5) Data Analysis: All data was analyzed using statistical tools such as SPSS-Version 22 and Microsoft Excel to achieve reliable and methodical results.



4. RESULTS AND DISCUSSIONS

4.1. Frequency Application of Pest and Disease Control Methods

Table 2. Frequency Application of Pest and Disease Control Methods

Control Method	Application Frequency	Number of Farmers (n)	Percentage of Farmers (%)	Description of Field Practice
Chemical use (X ₁)	High (1-2× per week)	16	80 %	Insecticides, fungicides, herbicides, bactericides and nematicides
Biological use (X ₂)	Low-Medium (1-2× per season)	12	70 %	Trichoderma, Beauveria bassiana, Bacillus thuringiensis
Mechanical/Physical control (X ₃)	Medium	8	50 %	Crop rotation, dense planting and spacing, land clearing, water management, land sanitation
Integrated control (X ₄)	Low-Medium	4	40 %	Combining sanitation, selective pesticides, and routine monitoring
Total		40	100	

Source: Primary Data Processed (2026)

Table 2. shows that chemical pest control (X₁) is the most commonly used method in shallot farming, with 80% of farmers applying it frequently due to its effectiveness, speed, and ease of application in the field. While 70% of farmers have chosen biological use (X₂), execution remains inconsistent due to insufficient technical understanding and practices. Farmers use mechanical/physical control (X₃) 50% of the time, but it is not considered a systematic pest control method. Integrated control (X₄) has the lowest adoption rate (40%), highlighting the need for more counseling, mentoring, and institutional strengthening to ensure farmers can implement sustainable pest control approaches effectively.

4.2. Dosage Pest and Disease Control Applications

Table 3. Dosage Pest and Disease Control Applications

Control Method	Application Dosage	Application Frequency	Field Description
Chemical use (X ₁)	1-2 ml/L of water or 0.5-1 kg/ha	1-2× per week	Anorganic fertilisers, insecticides, fungicides, herbicides, bactericides and nematicides
Biological use (X ₂)	10-20 ml/L water	1× per 7-10 days	Organic fertilisers such as compost
Mechanical/Physical control (x ₃)	Not chemical dosage based	2-3× per growing season	Crop rotation, dense planting and spacing, land clearing, water management, land sanitation
Integrated control (X ₄)	Chemical: 0.5-1 ml/L water Bio: 10 ml/L water	By control threshold	Combining sanitation, selective pesticides, and routine monitoring

Source: Primary Data Processed, 2026



According to the study's findings, the recommended dose of chemical pesticide treatment in onion production is 1-2 ml/L of water, applied 1-2 times per week. In the biological control technique, farmers apply plant-based pesticides at a rate of 10-20 ml/L of water. Meanwhile, using integrated pest management control (IPM) reduces the dose of chemical pesticides to 0.5-1 ml/L of water, taking into account the pest control threshold shown in table 3. Shallot farmers in Timor-Leste use chemical control (X_1) with high doses and frequency (1-2 times per week) to control pests like thrips, caterpillars, and leaf spot diseases, as determined by farmer experience. Biological use (X_2) is being applied with lesser frequency and effectiveness, relying significantly on concentration precision and application time due to technical restrictions in the field. Mechanical/physical control (X_3) is a preventive measure that avoids the use of chemicals, particularly during land preparation and vegetative phases. Meanwhile, integrated control (X_4) is still limited in application, characterized by the use of pesticides as a last resort and lower doses, implying that the notion of control thresholds and integrated pest control (IPM) in Timor-Leste has not been fully adopted by onion producers.

4.3. Production Costs

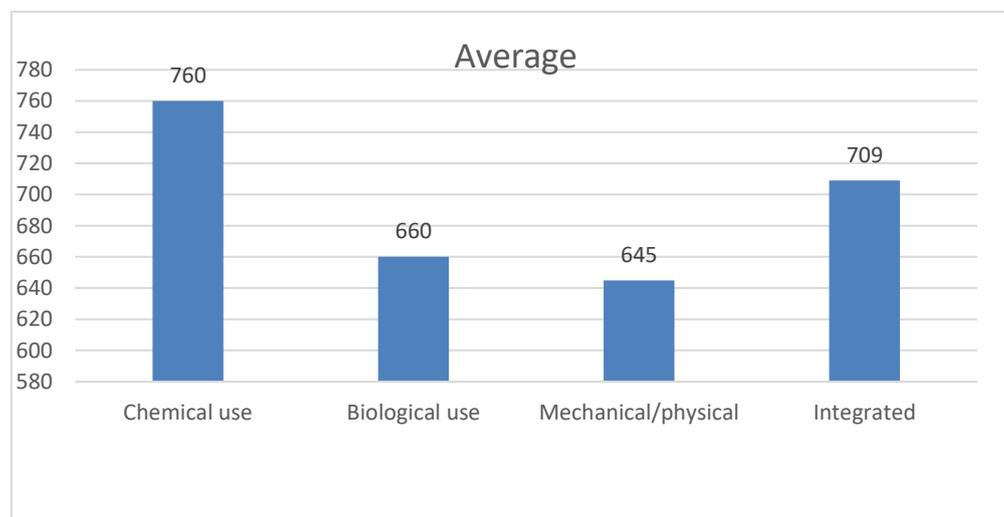


Figure 2. Graphic representing percentage distribution variable costs

Based on Figure 1. The use of chemicals (X_1) had a total production cost of USD 7,660 for 10 farmers, while the use of biological control (X_2) had a total value of USD 6,600 for 10 farmers, mechanical/physical control (X_3) had a value of 6,450, and integrated control (X_4) has a total value of USD 7,095 for 10 farmers, reflecting a combination of chemical and biological pesticide use with moderate labor costs. Overall, the cost difference between approaches is determined by the intensity of variable input consumption, particularly pesticides and labour, which are the most important elements influencing the economic efficiency of shallot production in Timor-Leste. The production cost structure of shallot cultivation in a sample of 10 farmers reveals that all control techniques incur expenses for land preparation and equipment depreciation, therefore the variation in percentage production costs is primarily impacted by variable cost components (Average). The use of chemicals (X_1) had a percentage production cost of USD 760 for 10 farmers, while the use of biological control (X_2) had a percentage value of USD 660 for 10 farmers, mechanical/physical control (X_3) had a value of 645, and integrated control (X_4) had a percentage value of USD 709 for 10 farmers, reflecting a combination of chemical and biological pesticide use with moderate labor costs. Overall, the cost difference between approaches is determined by the intensity of variable input consumption, particularly pesticides and labour, which are the most important elements influencing the economic efficiency of shallot production in Timor-Leste.



4.4. Revenues costs

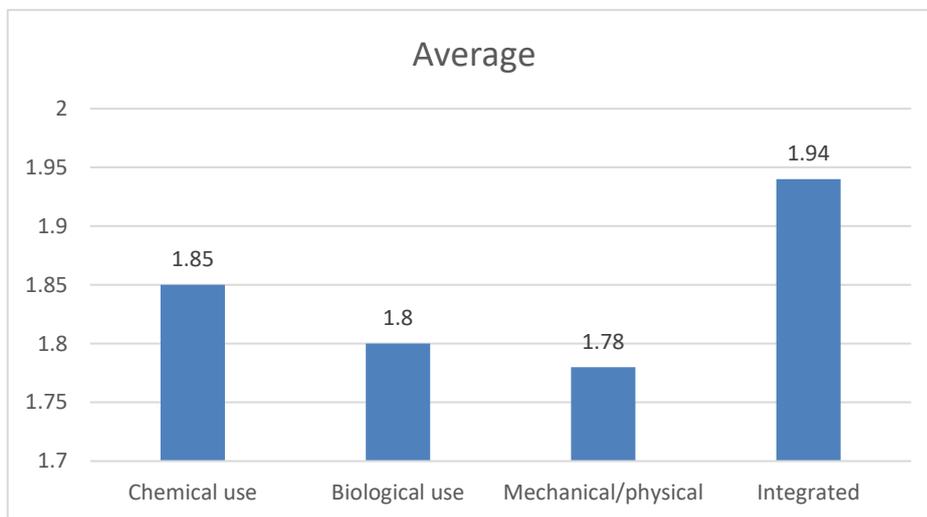


Figure 3. Graphic representing percentage distribution of R/C ration

According to Figure 2, based on the results of the costs and revenues of shallot cultivation in Timor-Leste in a sample of ten farmers, all control methods (chemical, biological, mechanical, and integrated) are economically viable efforts because the total revenues exceed the total production costs. Total production costs (TC) range between 660 and 785, with a production capacity of 3,700 to 4,320 kg and a constant selling price of 3.50. Total revenue (TR) fluctuates between 12,950 and 15,120. The R/C ratios for all sample farmers range from 1.85 to 1.94, and they are all more than one, meaning that each unit of cost incurred can generate revenue that is nearly doubled. This suggests that integrated control achieves a higher level of cost efficiency and production. Thus, economically, the integrated control system is the most viable and recommended since it may boost profits while maintaining a balance between production costs and yields.

4.5. Linear regression analysis

Table 4. Linear Regression Calculation Results

Model	Unstandardized Coefficients		t	Sig.	Collinearity Statistics	
	B	Std. Error			Tolerance	VIF
(Constant)	-12.968	6.026	-2.152	.0038		
Chemical (X ₁)	.217	.071	3.046	.004	.967	1.034
Biological (X ₂)	.567	.084	6.715	.000	.992	1.008
Mechanical (X ₃)	.188	.076	2.486	.018	.984	1.016
Intengrated (X ₄)	.445	.010	4.039	.000	.982	1.019

Dependent Variable: Y

Source: Primary Data Processed, 2026

The results of linear regression analysis are as follows: the dependent variable (Y) can be seen from the constant value of -12.968, with the note that if the independent variable value of the chemical use variable (X₁) is 0,217, the value of the biological use variable (X₂) is 0,567, the value of the mechanical/physical control variable (X₃) is 0,188, and the value of the integrated control variable (X₄) is 0.445.



4.5.1. The effect of the chemical use variable (X₁) on farming efficiency (Y).

The chemical use variable has a tcal value of 3,046, which is more than the ttable value of 2,030. Similarly, the result value indicated a positive coefficient of 0,071 with a significance level of 0,004. This suggests that increasing the use of pesticides improves agricultural efficiency dramatically. This is the variable with the most significant influence. The impact of the chemical use variable (X₁) on farming productivity (Y).

4.5.2. Effect of biological use variables (X₂) on farming efficiency (Y)

The biological usage variable has a tcal value of 6,715, which means that the tcount is more than the ttable of 2.030. Similarly, the results revealed a positive coefficient of 0.084 with a significance level of 0.000. This demonstrates that biological interventions can significantly increase farmer production. The impact of the biological control variable (X₂) on farming productivity (Y).

4.5.3. Effect of mechanical/physical control variable (X₃) on farming efficiency (Y)

The biological usage variable has a tcal value of 2,486, which means that the tcount exceeds the ttable of 2.030. In contrast to the others, this variable has a negative coefficient of 0.076 and a significance level of 0.018. This idea proved to be correct, but in the opposite direction: the more the mechanical activity (without good management), the greater the risk of decreasing farming efficiency. The impact of mechanical/physical control variables (X₃) on agricultural productivity (Y).

4.5.4. The effect of the integrated control variable (X₄) on farming efficiency (Y).

The biological usage variable has a tcal value of 4,039, which means that the tcount exceeds the ttable of 2.030. Similarly, the results showed a positive coefficient of 0.010 with a significance level of 0.000. This demonstrates that combining control methods can considerably improve the efficiency of results. The impact of the biological control variable (X₄) on farming productivity (Y). As a result, the application of the Integrated Control (X₄) strategy is very relevant as agricultural research trends, because it is capable of balancing multiple control approaches to produce optimal output while not harming the plant ecology (Sarwono, J., 2022).

4.5.5. Reliability Test Results

Table 5. Reliability Test Results

Chemical Uses (X ₁)	0,883	0,6	Reliable
Biological -Uses (X ₂)	0,779	0,6	Reliable
Mechanical physical Control (X ₃)	0,899	0,6	Reliable
Integrated control (X ₄)	0,773	0,6	Reliable
Farming Efficiency (Y)	0,993	0,6	Reliable

Source: Secunda Data Processing, 2026

Based on the statistical data supplied, the instrument test revealed that all variables had a Cronbach Alpha value more than 0.6, indicating that the questionnaire was reliable for use in the study. In simultaneous model testing using the Anova table, an Fcal value of -12.968 with a significance level of 0.038 was found, indicating that this regression model is very practicable (goodness of fit) in explaining the influence of independent variables on dependent variables in aggregate. The Correlation Coefficient (R) of 0.831a and the Coefficient of Determination (R²) of 0.690 support the strength of this relationship, indicating that the variables X₁ to X₄ account for 69.0% of the variation in the dependent variable. The t-test results show that most variables have a significant effect (Sig. < 0.05), with biological uses (X₂) being the dominant factor with the highest tcal value (6.715). Chemical uses (X₁), mechanical/physical control (X₃), and integrated control (X₄) also showed a significant effect on agricultural yields.



4.5.6. Test Results of Simultaneous Coefficients (F Test)

Table 6. Test Results of Simultaneous Coefficients (F Test)

Anova					
Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	57.635	4	14.409	19.498	.000 ^b
Residual	25.865	35	.739		
Total	83.500	39			

- a. Dependent Variable Y
- b. Predictor: (Constant), X₄, X₂, X₃, X₁

Source: Primary Data Processed (2026)

According to Table 6 above, the regression analysis yielded an F_{cal} value of 19.498. This value is then compared to F_{table} calculated at the number free degree (df counter) of magnitude 4 and the non-denominator degree (df of denominator) of 35 with a level of significance (0.05) of 2.64, implying that the F_{cal} of 19,498,18 is greater than the level of significance (0.05). As a result, chemical use (X₁), biological use (X₂), mechanical/physical control (X₃), and integrated control (X₄) all have a substantial effect on agricultural efficiency (Y), either individually or in combination. With a significance level of 0.000. The significance value of 0.000 is less than 0.05, hence H₀ is rejected and H₁ is accepted. Simultaneous testing (F test) revealed that chemical use (X₁), biological (X₂), mechanical/physical (X₃), and integrated control (X₄) all had a significant impact on shallot farming efficiency in Timor-Leste (F_{cal} 19,498 > F_{table} 2.64; p < 0.05).

4.5.7. Correlation coefficient (R) and Determination coefficient (R²)

Table 7. Correlation coefficient (R) and Determination coefficient (R²)

Model Summary^b

Models	R	R Square	Adjusted Square	R	Std. Error of the Estimate
1	.831 ^a	.690	.655		.85965

- a. Predictors: (Constant), X₄, X₁, X₃, X₂

Source: Primary Data Processed (2026)

Based on the statistical analysis results reported at a Correlation Coefficient (R) value of 0.831, it is clear that there is a very strong and positive linear link between all independent variables and production output. Furthermore, a Coefficient of Determination (R²) value of 0.690 indicates that 69.0% of the variation in the dependent variables can be explained by a combination of the variables Chemical Use (X₁), Biological Use (X₂), Mechanical/physical Control (X₃), and Integrated Control (X₄), with the remaining 0.9% influenced by factors outside the study model. The examination of this regression model revealed a very high level of prediction accuracy, as indicated by the Correlation Coefficient (R) of 0.831 and the Coefficient of Determination (R²) of 0.690. This means that the variables Chemical Use (X₁), Biological Use (X₂), Mechanical/physical Control (X₃), and Integrated Control (X₄) account for 69.0% of the variation in manufacturing yield (Y). The findings of the ANOVA test, which yielded a computed F value of 19.498 with a significance of 0.000, support the validity of this model, according to Ghazali (2020), indicating that the model is very practicable (goodness of fit) and has a strong collective influence. The strong R² value confirms that the combination of the four control techniques is the most important factor in influencing farmers' productivity at the research location.

5. CONCLUSION

The agricultural sector is crucial for Timor-Leste's economic structure and food security, as more than 70% of the population lives in rural areas and relies on subsistence farming. According to the study's findings, pest and disease control approaches have a substantial impact on the efficiency of shallot (*Allium ascalonicum* L.) production in Timorese agricultural areas. According to the findings, farmers mostly rely on chemical control methods, with 80% of farmers using pesticides on a regular basis due to their quick and practical effectiveness in controlling insect assaults. However, biological, mechanical, and integrated pest control (IPM)



techniques are still used at lower levels. The economic analysis shows that shallot farming in the research region is profitable and efficient, with R/C ratios ranging from 1.85 to 1.94. This indicates that each unit of production cost generates nearly double the revenue, proving that shallot growing is still financially viable for farmers. Integrated pest management outperforms other control options in balancing production costs and yields while maintaining sustainable farming practices. The regression model explains 69% of the variation in shallot farming efficiency ($R^2 = 0.690$), suggesting that pest and disease control measures significantly impact farm production and profitability. As a result, boosting farmer capacity through extension programs and integrated pest management (IPM) training is critical to improving sustainable pest control practices, reducing reliance on chemical pesticides, and increasing the long-term efficiency of shallot farming systems in Timor-Leste.

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