AGRIBUSINESS STUDY OF ARTIFICIAL AND NATURAL VEGETATIVE PROPAGATION IN OPTIMIZING THE ECONOMIC VALUE OF NUTMEG PLANT PROPAGATION IN FAKFAK REGENCY

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Abstract

The purpose of this study was to conduct an agribusiness study on the effectiveness of artificial vegetative propagation techniques in nutmeg propagation and to compare the economic efficiency of nutmeg farming between natural and artificial vegetative nursery methods. Fakfak Regency is the largest producer of nutmeg, and this has long been recognized as reflected in its nickname as the "Nutmeg City." Proper cultivation practices are one of the keys to success in farming, where cultivation plays an important role in crop productivity, especially in providing superior seedlings. One propagation technique considered a solution is artificial vegetative propagation methods such as marcotting, budding, and top grafting. These methods are expected to produce plants identical to the parent plant in terms of superior genetic traits, early fruiting, and uniformity, with the potential for high productivity. Most nutmeg plantations in Fakfak Regency still apply natural (generative) propagation systems. This study used a quantitative method with a comparative approach to compare the effectiveness of natural and artificial nutmeg nursery methods in terms of growth, productivity, and economic efficiency. After identifying significant differences, the study continued with an agribusiness analysis of the upstream agribusiness subsystem and nutmeg farming using financial analysis methods: R/C Ratio and Net Income. The results showed that artificial vegetative methods had better success rates and growth than generative methods. Vegetative seedlings demonstrated faster and more uniform shoot growth, plant height, and leaf number. Economically, the generative method produced an R/C ratio of 1.42 with a net profit of IDR 14,750 per seedling, while the vegetative method produced an R/C ratio of 1.60 with a net profit of IDR 28,250 per seedling. This indicates that although the initial cost of vegetative propagation is higher, the resulting profit and added value are also greater. Overall, the study concluded that artificial vegetative propagation through top grafting is more effective and efficient for development in the nutmeg agribusiness system in Fakfak Regency. This method is recommended as a strategy to improve seedling quality, plant productivity, and farmers' income, while supporting sustainable nutmeg nursery development.

Keywords: vegetatif; agribusiness; nutmeg;cultivation.

INTRODUCTION

The economic development paradigm of developed countries with high per capita income generally provides protection for their farmers, as farmers constitute the majority and are major contributors to the political, economic, and democratic systems of the country. Farmers will achieve prosperity when the income obtained is sufficient to meet their family needs. Farmers' welfare is one of the important factors in a country's economic growth that emphasizes agricultural development. Cultivation aspects greatly influence the success of agribusiness, where cultivation plays an important role in plant productivity, particularly in the provision of superior seedlings. Farmers in Fakfak Regency still use natural vegetative methods, predominantly relying on seedlings that grow naturally from fruits falling from trees, while some farmers use older seedlings as planting material. This significantly affects the quality and quantity of plants in achieving production outcomes, resulting in yields that do not meet farmers' expectations. Fakfak Regency itself is the largest producer of nutmeg, and this has long been recognized, as reflected in the region's iconic nickname, "Nutmeg City." One plant propagation technique considered a solution is artificial vegetative propagation methods such as marcotting, budding, and top grafting. These propagation methods are expected to produce plants identical to the parent plant in terms of superior genetic characteristics, early fruiting, and uniformity, with a high probability of achieving greater productivity. Plant propagation using vegetative (clonal) methods allows additive and non-additive genetic variance to be inherited, so that the offspring inherit the full genetic potential of the parent tree (Duaja & Kartika, 2020). This issue is certainly important to examine, particularly in farming practices carried out by communities that still rely on natural propagation methods and farmers who expect seedlings to grow naturally. The impact on the economic value of nutmeg plants in Fakfak Regency, as well as its contribution to increasing farmers' income, needs to be further reviewed from an economic perspective, specifically whether artificial vegetative propagation methods can generate added value from various parts of the plant and contribute significantly to the agribusiness system as a whole.

LITERATURE REVIEW

1. Farming

Farming is the cultivation of crops to produce sustainable outputs in economic, social, and environmental aspects. To achieve optimum production, continuous maintenance is required. Proper allocation of resources will generate optimal profits when the utilization of resources produces outputs greater than the inputs used. Resource allocation is one of the important aspects in farming activities, particularly in nutmeg farming. Efficient resource allocation will maximize output and provide benefits to farmers as the main actors in farming activities. In general, farmers' income in Indonesia is still relatively low due to limited land ownership, small capital capacity, and insufficient knowledge and understanding of crop cultivation techniques. Farmers' ability to manage agricultural products, especially nutmeg, is closely related to their managerial skills and expertise. Farmer characteristics are generally shaped by biological factors, including genetics, as well as socio-psychological factors in the form of conative and affective components related to habits and behavior. (Manyamsari, 2014).

2. Artificial Vegetative

Plant propagation is the process of reproducing new plants from various parts of the parent plant with the aim of increasing plant numbers, preserving the important characteristics of the parent plant, and maintaining the existence of the species (Luta & Group, n.d.). Propagation techniques commonly practiced by farmers include natural and artificial methods. Farmers often modify cultivation treatments in the hope of increasing crop production, which is directly proportional to the probability of obtaining higher income. One of the most commonly applied techniques is artificial vegetative propagation, which is used to produce seedlings with qualities identical to those of the parent plant (Latifah et al., 2023).

There are several artificial vegetative propagation techniques commonly practiced by farmers, either on a large scale or in limited quantities (Agroteknologi et al., 2017): (1) Cuttings – The process of cutting or separating plant parts such as roots, stems, or leaves from the parent plant and planting them in a growing medium to develop roots and shoots. (2) Air Layering – The process of peeling the stem and wrapping it with moist soil or growing media until roots develop. After the roots have formed, the plant is transferred to planting media for further maintenance.. (3) Grafting – The process of attaching a bud from a superior plant onto the stem of another plant used as the rootstock for propagating superior plants.

3. Research Review

(Marlinda et al., 2023) Conducted an agribusiness study of leading food crop commodities in Lima Puluh Kota Regency by considering the agribusiness system from upstream to downstream in order to analyze leading food crop commodities and examine the agribusiness system of these commodities in Lima Puluh Kota Regency. The results of the analysis showed that, in general, the agribusiness system for leading food crop commodities in Lima Puluh Kota Regency has not been operating effectively, integratively, and synergistically, particularly in the downstream agribusiness subsystem.

(Rosmalah, 2p023) Conducted a study on the upstream agribusiness system and vegetable marketing in Konda District, South Konawe Regency using descriptive and qualitative data analysis methods with a Likert scale. The study involved 58 respondents selected using the Slovin formula to represent the actual population conditions. The results showed that the upstream agribusiness system and marketing subsystem implemented in Konda District have been functioning; however, several indicators still require attention because they have not yet operated optimally.

METHOD

1. Research Approach

   This study employed a quantitative method using a comparative approach to compare the effectiveness and efficiency of natural and artificial nutmeg nursery methods, with the aim of identifying differences in growth, productivity, and economic efficiency. Comparative research is a type of study conducted to identify or compare two or more variables or phenomena. (Data & Interpretasi, n.d.).
2. Data Analysis Techniques
   1. Descriptive Analysis focuses on presenting the characteristic data of the objects being studied, namely the characteristics of respondents and the condition of nutmeg farming in Fakfak Regency.
   2. Cost Analysis
      This analysis is used to calculate the total costs incurred in farming activities carried out by farmers. The calculation of total cost is expressed in the following formula: $TC = TFC + TVC$
   3. Depreciation Cost
      Depreciation cost is the monetary value obtained by subtracting the purchase cost from the estimated resale value and dividing it by the useful life of the asset. The calculation of depreciation cost is formulated as follows: $Depeciation = \frac{Purchase - Residual\ Value}{Age\ of\ Use}$
   4. Analisis R/C Ratio
      Revenue Cost (R/C) analysis is the comparison between the revenue earned and the costs incurred in a business activity. The calculation of the R/C ratio can be expressed in the following formula: $RC = \frac{R}{C}$
   5. Nett Income
      Net income is the net profit obtained from farming activities after the total farming revenue has been calculated and reduced by all costs incurred in the farming operation. The calculation of net income is expressed in the following formula: Nett Income $= TR - TC$

RESULTS AND DISCUSSION

This study compared the effectiveness of generative and artificial vegetative nutmeg propagation methods and their impact on the economic efficiency of nutmeg farming. Observation parameters in the study were recorded weekly starting from the seedling stage. Plant height growth and leaf number were among the growth characteristics observed to evaluate effectiveness.

Efektivitas Bibit Pala Generatif

1. Soil pH

Soil pH measurement was conducted to assess the level of soil acidity and its negative impact on plant productivity, nutrient absorption, and microorganism activity.

Tabel 1. Soil pH Recapitulation

SAMPEL	Soil pH				
	I	II	III	IV	V
GN-01	5,9	6	6,1	6,2	6,1
GN-02	6	6,1	6,2	6,3	6,2
GN-03	6,1	6,2	6,3	6,4	6,3
GN-04	5,8	6	6,1	6,2	6,1
GN-05	6	6,1	6,2	6,3	6,2
GN-06	6,1	6,2	6,3	6,4	6,3
GN-07	6	6,1	6,2	6,3	6,2
GN-08	5,9	6	6,1	6,2	6,1
GN-09	6	6,1	6,2	6,3	6,2
GN-10	6,1	6,2	6,3	6,4	6,3
GN-11	5,8	6	6,1	6,2	6,1
GN-12	6	6,1	6,2	6,3	6,2
GN-13	6,1	6,2	6,3	6,4	6,3
GN-14	5,9	6	6,1	6,3	6,1
GN-15	6	6,1	6,2	6,3	6,2

The measurement results showed that the soil pH was slightly acidic, with a value of 5.5, which is still suitable for nutmeg plants. However, the relatively low pH value caused the availability of macronutrients such as nitrogen (N), phosphorus (P), and potassium (K) to become less optimal for plant absorption. In the initial measurement, the soil pH values were relatively lower than in subsequent observations, ranging from 5.8 to 6.1. This condition indicated that the planting media was still in the early stage of environmental adaptation, where soil microorganism activity and the mineralization process of organic matter had not yet occurred optimally. Over time, the soil pH values increased from observations II to IV, indicating an improvement in the soil's chemical condition.

2. Cotyledons

Cotyledons function in carrying out photosynthesis during epigeal germination and in the transformation, absorption, and transport of nutrients from the endosperm to the growing seedling. This physiological process is indicated by morphological and anatomical changes in the cotyledons before the first leaves emerge..

Tabel 2. Cotyledon Growth at Average Temperature 40ºC

SAMPEL	Cotyledon (cm)		
	I	II	III
GN-01	0	0	0
GN-02	0	0	0
GN-03	0	0	0
GN-04	0	0	0
GN-05	0	0	0
GN-06	0	0	0
GN-07	0	0	0

Based on the observation results, nutmeg seedlings propagated using the generative method under the observed environmental temperature conditions had not shown optimal growth during the observation period. Plant height growth, new leaf formation, and stem development had not shown significant changes. This condition was influenced by environmental growing factors. The study was continued to measure the length of time required for the seeds to begin germination, marked by the emergence of the first leaves (cotyledons).

Tabel 3. Cotyledon growth 31ºC

SAMPEL	Cotyledon (cm)		
	I	II	III
GN-08	1,2	2,4	3,8
GN-09	1,5	2,8	4,2
GN-10	1,8	3,1	4,5
GN-11	0	0	0
GN-12	1,6	2,9	4,3
GN-13	1,9	3,2	4,7
GN-14	0	0	0
GN-15	1	2,2	4,1

Based on the observations of cotyledon growth in generative nutmeg seedlings under two different temperature conditions, significant differences were found in plant growth responses. In sample groups GN-01 to GN-07, which were exposed to a temperature of 40°C under direct sunlight, all samples showed no cotyledon growth during the three observation periods, with cotyledon height remaining at 0 cm in each observation. This condition indicates that unsuitable environmental temperatures inhibited the germination process and early growth of nutmeg seedlings, preventing the cotyledons from developing normally.

Under the 31°C temperature treatment, nutmeg seedlings showed a better growth response. In the first observation, cotyledon height had begun to develop, ranging from 1.0–1.9 cm. In the second observation, cotyledon height increased to 2.2–3.2 cm, and in the third observation reached a range of 3.8–4.7 cm. The study results also showed that not all samples at 31°C experienced cotyledon growth. Samples GN-11 and GN-14 still recorded 0 cm throughout all observation periods. This indicates that other factors also influenced growth success, such as seed quality, seed viability level, planting media conditions, as well as soil moisture and aeration factors.

Effectiveness of Top-Grafted Nutmeg Seedlings

Tabel 4. Status of Scion Graft Union in Polybags

SAMPEL	WEAK			
	I	II	III	IV
VSP 01	TT	TT	TT	T
VSP 02	TT	TT	TT	TT
VSP 03	TT	T	T	T
VSP 04	TT	TT	TT	T
VSP 05	TT	T	T	T
VSP 06	TT	TT	TT	TT
VSP 07	TT	TT	TT	T
VSP 08	TT	T	T	T
VSP 09	TT	TT	TT	TT
VSP 10	TT	TT	T	T

During the first week of observation, all samples showed TT status, indicating that the graft unions were still in the initial wound adaptation phase and that complete tissue union had not yet occurred. This condition is normal because, in the early stage of top grafting, the plant is still undergoing tissue healing and callus formation processes. In the second week, several samples began to show T status, namely samples VSP 03, VSP 05, and VSP 08, indicating that cambium union between the rootstock and scion had begun to occur in some seedlings, allowing the graft union to start developing physiologically. However, most of the other samples still remained in TT status, indicating that the grafting process had not yet succeeded or required a longer adaptation period.

These observation results indicate that the success rate of nutmeg top grafting increased over time. The process of plant tissue union requires an adaptation period; therefore, grafting success can generally only be confirmed optimally in the third to fourth week after grafting. The results of this study indicate that the top grafting method is quite effective for nutmeg seedling propagation, with a relatively good success rate.

Tabel 5. Growth in Height of the Scion (E) and Rootstock (B)

SAMPEL	GROWTH (cm)			
	I	II	III	IV
VSP 01	E:8,0 B:17,0	E:9,1 B:17,3	E:10,1 B:18,0	E:12,0 B:19,0
VSP 02	E:8,5 B:17,0	E:8,5 B:17,0	-	-
VSP 03	E:10,0 B:19,0	E:10,2 B:19,3	E:11,2 B:20,0	E:12,0 B:20,0
VSP 04	E:9,0 B:18,0	E:9,1 B:18,2	E:10,0 B:18,8	E:12,0 B:20,0
VSP 05	E:9,5 B:17,5	E:9,7 B:17,8	E:10,6 B:18,4	E:12,5 B:19,5
VSP 06	E:8,5 B:17,0	E:8,5 B:17,0	-	-
VSP 07	E:9,5 B:18,5	E:9,8 B:18,9	E:10,9 B:19,6	E:12,8 B:20,8
VSP 08	E:10,0 B:19,0	E:10,3 B:19,4	E:11,4 B:20,1	E:13,2 B:21,0
VSP 09	E:9,0 B:18,0	E : 9 / B : 18	-	-
VSP 10	E:9,5 B:17,5	E:9,7 B:17,8	E:10,8 B:18,5	E:12,7 B:19,7

Seedlings that were successfully grafted showed a consistent increase in height from the first to the fourth observation. In the first observation, scion height ranged from 8.0–10.0 cm, while rootstock height ranged from 17.0–19.0 cm. This condition indicates that the initial size of the planting materials was relatively uniform and within the ideal range for the top grafting process. Overall, the results of the study showed that the top grafting method in nutmeg plants was able to enhance seedling height growth in successfully grafted samples. The stable growth observed from week to week indicates that the top grafting technique is effective as an alternative vegetative propagation method for producing superior, uniform seedlings with good early growth performance.

Tabel 6. Number of Leaves in Top-Grafting Growth

SAMPEL	NUMBER OF LEAVES			
	I	II	III	IV
VSP 01	1	2	5	7
VSP 02	0	0	0	0
VSP 03	2	4	6	7
VSP 04	1	3	4	6
VSP 05	2	4	7	8
VSP 06	0	0	0	0
VSP 07	1	2	4	7
VSP 08	2	3	7	8
VSP 09	0	0	0	0
VSP 10	2	4	5	7

In the first observation, most successfully grafted samples showed growth with the number of leaves ranging from 1–2 leaves. Samples such as VSP 02, VSP 06, and VSP 09 did not show any leaf growth, indicating that the grafting process in these samples was unsuccessful. In the second observation, the number of leaves began to increase in successfully growing samples, ranging from 2–4 leaves. This indicates that the graft union process had started to develop properly and the plants had begun active vegetative growth. Meanwhile, unsuccessful samples still showed no changes in leaf number. Overall, the results of the study demonstrated that the success of top grafting greatly influenced the increase in the number of leaves in nutmeg seedlings. Successfully grafted seedlings showed an increase in leaf number, while unsuccessful seedlings showed no vegetative development. This confirms that the top grafting technique plays an important role in enhancing the early growth of nutmeg seedlings.

Effectiveness of Method Comparison

The results of the study showed that nutmeg seedlings propagated through artificial vegetative methods had better growth effectiveness compared to generative nutmeg seedlings. Vegetative seedlings demonstrated faster and more uniform growth, as well as a higher survival rate during the observation period. Vegetative seedlings were able to show shoot and leaf formation more quickly than generative seedlings. This condition is attributed to the nature of vegetative propagation, which preserves the physiological characteristics of the parent plant, so that vegetatively propagated seedlings already possess more mature plant tissues and are ready for growth. This provides an advantage in accelerating the adaptation process of seedlings to the growing environment.

Plant height growth and canopy development in vegetative seedlings were relatively more stable and uniform among samples. This uniformity is an important indicator in nursery management and contributes to improving efficiency in field planting processes. Vegetative seedlings also showed better responses to environmental conditions, including temperature and soil pH within the optimal range. In terms of plant resistance, vegetative seedlings tended to have stronger root systems and greater adaptability to nursery environmental conditions. This had an impact on increasing seedling survival percentages and reducing plant mortality rates during the early growth phase. Overall, the results of this study indicate that artificial vegetative propagation of nutmeg is an effective method for producing superior seedlings with faster and more uniform growth, and with the potential to enhance sustainable nutmeg productivity. Artificial vegetative methods can therefore be recommended as a more efficient and sustainable nursery technology alternative for the development of nutmeg agribusiness in Fakfak Regency.

Econom Analysis

The comparison of these two methods was conducted to determine differences in early growth, seedling survival rates, and seedling production efficiency.

1. Generative Nursery Method

The data in this study were obtained through direct interviews and questionnaire distribution to nutmeg farmers, using a conversion of 20 seedlings, to collect information regarding the costs of seed procurement, planting media, polybags, labor, equipment, and operational expenses during the nursery process.

Number of Seedlings	TC	TR	RATIO	NETT INCOME
20	705.000	1.000.000	1,42	14.750

2. Metode Pembibitan Vegetatif

Number of Seedlings	TC	TR	RATIO	NETT INCOME
20	935.000	1.500.000	1,60	28.250

The analysis results showed that both the generative and vegetative top-grafting nursery methods were economically feasible to implement. The generative nursery method produced a total production cost of IDR 705,000 with revenue of IDR 1,000,000, an R/C ratio of 1.42, and a net profit of IDR 14,750 per seedling. Meanwhile, the vegetative top-grafting nursery method required a higher production cost of IDR 935,000, but generated greater revenue of IDR 1,500,000 with an R/C ratio of 1.60 and a net profit of IDR 28,250 per seedling.

Although the initial cost of the vegetative method was higher, the profit obtained was nearly twice that of the generative method. This indicates that the vegetative top-grafting method is more efficient and provides greater economic added value. From a sustainability perspective, the generative method functions as a source of rootstock, while the vegetative method serves as the primary strategy for producing superior, uniform, and productive seedlings. The combination of these two methods is recommended to support sustainable nutmeg nursery development and increase farmers' income.

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CONCLUSION

1. Artificial vegetative propagation techniques through top grafting have proven effective in improving the growth and success of nutmeg seedlings, as indicated by better and more uniform shoot growth, plant height, and number of leaves.
2. Artificial vegetative propagation provides higher economic added value compared to generative methods, increasing nursery business profits and strengthening the competitiveness of the nutmeg agribusiness through improved seedling quality and market value.

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