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THE EFFECT OF PRODUCTION INPUTS ON PRODUCTIVITY AND PRODUCTION RISK OF CLOVES IN EAST JAVA PROVINCE

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Abstract

Background: The demand for cloves, both domestically and internationally, continues to rise. However, clove productivity in East Java Province has shown fluctuations and a declining trend during the 2015 - 2022 period. This decline is influenced by various factors, including suboptimal farming input allocation, pest attacks, unpredictable weather conditions, and the cyclical nature of clove production.
Purpose: This paper examines the influence of production inputs on clove productivity and production risks in East Java Province.
Design/methodology/approach: This paper utilized secondary data from the 2014 Household Agricultural Survey, incorporating a sample of 937 clove farming households in East Java Province. The Just and Pope Model was utilized to evaluate the influence of production inputs on clove productivity and production risks.
Findings/Results: The analysis demonstrates that clove production risks in East Java are high, as indicated by a coefficient of variation (CV) greater than 0.5. Production inputs that increase clove productivity include family labor, external labor, organic fertilizers, pesticides, and plant population. However, the application of TSP fertilizers decreases clove productivity. Furthermore, the application of ZA fertilizers increases production risks, while family labor decreases production risks.
Conclusion: The findings emphasize the critical importance of managing production inputs to improve clove productivity and reduce associated risks. Key recommendations include implementing training programs to enhance farmers' knowledge, providing subsidies to encourage efficient input use, and adopting effective pest control strategies. These interventions are essential for promoting the sustainability and resilience of clove farming in East Java. This study offers actionable insights for policymakers and stakeholders, supporting efforts to stabilize productivity and mitigate production risks.
Originality/value: This paper adds to the understanding of production inputs influencing clove farming, particularly the input-related risks and productivity in East Java Province, providing insights for better farm management practices.

Keywords: cloves, productivity, production risk, production input, East Java

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INTRODUCTION

The plantation sector remains a key contributor to Indonesia's agricultural GDP, accounting for 29.64% of the sector's total output (Ditjenbun, 2021). Among primary plantation crops, cloves have emerged as a prominent product in both domestic and international markets. Indonesia leads the global clove trade, with a 48.75% market share, outperforming other major producers such as Madagascar, Tanzania, Comoros, and Sri Lanka (Rabbi, 2021). Domestically, nearly 90% of clove production is allocated to the clove cigarette industry, leaving only 10% for other uses, including the spice trade, aroma, and flavor industries. Cigarettes, a distinctive Indonesian cigarette product, have grown rapidly since 1927, particularly in East Java, where large cigarette companies such as PT Sampoerna, PT Djarum, PT Gudang Garam, and PT Bentoel are located (Wahyudi, 2017). However, as health awareness increases, demand for cigarettes has gradually declined, signaling a potential decrease in demand for cloves within this sector.

In contrast, clove exports have experienced significant growth, with export volumes rising from 13,000 tons in 2015 to 48,000 tons in 2020 (Ditjenbun, 2021). This trend aligns with the government's goal to increase spice exports, setting an ambitious target of $2 billion in spice revenue by 2024. Cloves are expected to play a substantial role in achieving this goal, with export growth reaching 52.84% over the past five years (Rabbi, 2021). Although East Java ranks fifth in clove production, with an average annual output of 10.7 thousand tons over the past 17 years, the province contributes significantly to Indonesia's clove exports, particularly to destinations like India, Vietnam, and Singapore (Jody, 2020). Furthermore, East Java is a production center for the cigarette industry, generating demand that underscores the importance of clove production in the region. Thus, maintaining a stable supply of cloves to meet both domestic and international demand is essential. However, clove production in East Java faces considerable volatility due to a unique three-tiered harvesting cycle, which alternates every four years between high, medium, and low yields. This natural cycle contributes to fluctuations in East Java's production output, which overall has shown a declining trend over the past 17 years. Although the cultivated area for cloves has gradually expanded over this period, production levels have not reflected this growth, indicating possible inefficiencies in yield per hectare (BPS, 2022). This discrepancy between cultivated area and yield growth suggests underlying production challenges, with productivity issues becoming more prominent each year. This volatility poses risks to farmers' income stability and raises concerns regarding the ability to meet growing export demands (Ekaputri, 2008).

Clove productivity remains below the optimal level of 500–600 kg/ha, with East Java averaging around 251 kg/ha from 2005 to 2021, indicating that current production practices fall short of their potential (Ditjenbun, 2021). Key factors driving this low productivity include market price fluctuations, which leave farmers with price uncertainty, thus reducing their incentives to invest in routine crop maintenance (Assouto et al. 2020). As a result, some farmers opt to switch to crops they perceive as more profitable, further decreasing clove production levels (Pamusu et al. 2019). Additional external challenges, such as pest attacks particularly from wood-boring beetles and vascular wilt bacteria worsen these problems, causing declines in clove quality and quantity (Kemala, 2020). These risks go up during the rainy season as increased moisture facilitates pest proliferation. The fluctuating nature of clove productivity may be influenced by production input management. Variations in the application of fertilizers, seeds, labor, and pesticides result in yield discrepancies among farmers. Inadequate input use and insufficient pest control measures constitute internal factors driving productivity instability. While labor is critical at every stage planting, fertilization, and harvesting variations in labor allocation between small and large-scale farms create differences in yield outcomes. Small-scale farmers typically rely on family labor to reduce wage costs, whereas larger operations often employ skilled external labor that can provide more consistent crop management (Warni et al. 2017; Damayanti, 2013). These differences emphasize the need for effective input management tailored to each farmer's scale and resources. Addressing these diverse challenges requires solutions such as intensification, which involves increasing crop care through optimized input allocation, and rehabilitation, which focuses on replacing damaged trees with quality seedlings to enhance productivity (Santoso, 2018). Contractual agreements also offer a viable strategy for mitigating production risks by sharing the risks between farmers and partner companies, potentially increasing farmers' income (Wahyudi, 2017). However, contractual agreements are also risky in terms of power imbalances, dissatisfaction with agreements, and inadequate knowledge transfer from companies to farmers which can lead to partnership failures. These agreements sometimes might worsen production risks rather than alleviate them (Sayid et al. 2022; Rustiana et al. 1997).

Productivity and risk factors in agricultural production have been extensively investigated across a range of crops, regions, and input types. Numerous studies identify major drivers of productivity, including plant age, seed quality, family and non-family labor, organic and inorganic fertilizers, pesticide application, plant population density, and external factors such as pest attacks and contract farming. For instance, research by Ariyanto et al. (2017) and Habun et al. (2016) indicates that plant age significantly influences productivity, with older plants requiring replanting to maintain optimal yields; Heriyanto and Darus (2017) further suggest that older plants encounter yield limitations without replanting. Labor quality, particularly family labor, has been widely recognized for its positive effects on production efficiency (Leovita and Martadona, 2021; Saptana et al. 2016), while non-family labor yields mixed results due to variability in skill and the potential for moral hazard. Fertilization is a crucial input; studies by Saputra (2019) and Suharyanto et al. (2015) highlight the nutrient-restorative benefits of organic fertilizers, although findings by Febriawan et al. (2018) indicate that excessive application may decrease productivity. The effects of pesticides are similarly dualistic. Studies by Heriyanto and Darus (2017) and Fanani et al. (2015) emphasize their role in mitigating pest-related risks, but Habun et al. (2016) caution against overuse, which may unintentionally elevate production risks. Contract farming, a focus of recent research, serves as a mechanism for risk-sharing and knowledge transfer, frequently contributing to productivity improvements (Saputra, 2019; Sayid et al. 2022). However, as Ragasa et al. (2018) indicate, contract farming does not uniformly enhance productivity, with potential shortfalls arising from breaches in agreements or inadequate support from contracting firms. While prior research has explored the general relationship between production inputs and agricultural productivity, few studies have specifically examined their impact on clove farming in East Java, a region characterized by high production risks and fluctuating productivity. This paper fills this gap by employing the Just and Pope Model to simultaneously analyze the effects of production inputs on both clove productivity and production risks. The dual focus on productivity and risk is unique, particularly in identifying how inputs such as ZA and TSP fertilizers, as well as family and external labor, influence these outcomes. These findings offer novel insights into risk mitigation and productivity enhancement, tailored to the specific conditions of clove farming in East Java.

This paper addresses the productivity challenges in East Java's clove sector by examining the impact of various production inputs on both yield and production risk. The approach includes assessing specific inputs such as fertilizers, labor, pest control, and planting practices proven to significantly affect agricultural outcomes. This paper uniquely employs the Just and Pope Model, which offers the advantage of simultaneously analyzing both the productivity and risk functions. In contrast to previous methods that focus solely on productivity or risk independently, this approach provides a comprehensive evaluation of how production inputs influence both outcomes. By integrating these dual perspectives, the study identifies which inputs enhance productivity and mitigate risks, offering strategic insights for optimizing clove farming practices. Studies by Pamusu et al. (2019) and Saputra (2019) highlight the benefits of targeted input management for improving productivity while reducing risks. This method not only deepens understanding of clove production dynamics but also supports the development of effective sectoral interventions.

The purpose of this paper is to analyze the influence of specific production inputs on clove productivity and production risks in East Java. By identifying inputs that enhance productivity and mitigate risks, the study aims to provide practical recommendations for optimizing clove farming practices. The findings are expected to support farmers and stakeholders in developing resilient agricultural strategies that meet both domestic and export market demands.

METHODS

East Java Province was purposefully selected for this research, as it is one of the largest clove-producing regions in Indonesia (BPS, 2022). Additionally, East Java holds a strategic role in clove exportation, with primary destinations such as India, Vietnam, and Singapore, and serves as the hub for Indonesia's cigarette industry. The presence of major companies like PT Sampoerna, PT Djarum, PT Gudang Garam, and PT Bentoel further underscores the province's economic significance for cloves, making it a critical region to study both clove productivity and production risks (Wahyudi, 2017; Jody, 2020).

This paper utilized secondary data sourced from the 2013 Agricultural Census and the 2014 Plantation Household Survey on clove plantations conducted by Statistics Indonesia (BPS) in East Java Province. Additional supporting references were obtained from Statistics Indonesia (BPS), the Directorate General of Plantations, the Ministry of Agriculture, and other relevant literature from books, journals, and online resources related to the research topic.

The initial sample of clove farms from the 2014 Plantation Household Survey on clove plantations conducted by Statistics Indonesia (BPS) in East Java Province included 3,299 farms. Filtering was applied to select only farms with systematically planted clove crops, allowing for productivity measurement per land unit, resulting in 1,113 farms. Outliers were subsequently removed by evaluating the average value of each production input, producing a final sample of 937 farms. Outlier removal involved excluding extreme input values significantly deviating from the mean and aligning input use with recommended dosage ranges, such as for fertilizer and pesticides, as outlined by the Dinas Perkebunan Jawa Timur in 2013.

This paper examined clove production risk by calculating the coefficient of variation. To examine the effect of inputs on productivity and production risk, the Just and Pope method was applied, as it accommodates both productivity and variance functions. In analyzing the variance function, the model utilized the error term from the productivity function analysis as the dependent variable in the variance model. This approach resulted in a regression analysis that revealed the impact of agricultural inputs, pest and disease incidence, and contract farming on production risk.

The analysis used to estimate the risk level of clove production uses the calculation of the coefficient of variation which includes:

Variance

The variance value is a statistical measure that is able to describe how far the data is spread, in this case, clove productivity. The variance value according to Elton and Grubber (1995) can be written with the following formula:

$$\sigma_i^2 = \sum p_{ij}(R_{ij} - \bar{R}_i)^2 \; ..... (1)$$

Description: σ^2 (Variance of clove productivity); p_{ij} (Probability of an event 1,2,3,...(j=number of respondents)); R_{ij} (Clove productivity (kg/ha)); $\bar{R}_i$ (Clove productivity expectations (kg/ha))

Standard deviation

Standard deviation is the square root of variance. Standard deviation measures the difference in the productivity of each farmer by calculating how far the data is spread from its mean value. Mathematically, according to Elton and Grubber (1995), standard deviation can be written as follows:

$$\sigma_i = \sqrt{\sigma^2} \; ..... (2)$$

Description: σ^2 (Variance of clove productivity); σ_i (Standard deviation of clove productivity)

Coefficient of variation (CV)

The coefficient of variation is the ratio of the standard deviation to the mean value expressed as a percentage. The coefficient of variation is used to compare the risk faced to the productivity obtained. Mathematically, according to Elton and Grubber (1995), the coefficient of variation can be written as follows:

$$CV = \sigma_i / \bar{R} \; ..... (3)$$

Description: CV (Coefficient of variation); σ_i(Standard deviation); $\bar{R}$ (Clove productivity expectations (kg/ha))

According to Hernanto (1993), the size of the level of risk faced by farmers can be known from the magnitude of the CV value with the following criteria:

- If the CV value is > 0.5, it can be concluded that clove farming in East Java faces high risk.
- If the CV value is <0.5, it can be concluded that clove farming in East Java faces low risk.

The second analysis is used to estimate the input factors that affect the productivity and risk of clove production using the Just and Pope model, namely the Cobb-Douglas production function.

The productivity function and risk function of clove productivity are as follows :

Productivity Function:

$LnY_i = \beta_0 + \beta_1 LnX_{1i} + \beta_2 LnX_{2i} + \beta_3 LnX_{3i} + \beta_4 LnX_{4i} + \beta_5 LnX_{5i} + \beta_6 LnX_{6i} + \beta_7 LnX_{7i} + \beta_8 LnX_{8i} + \beta_9 LnX_{9i} + \beta_{10} D_{1i} + \beta_{11} D_{2i} + \beta_{12} D_{3i} + \varepsilon_i$ ….. (4)

Production Variance: $\varepsilon_i^2 = (Y_i - \hat{Y}_i)^2$

Productivity Variance (Risk) Function:

$Ln\varepsilon_i^2 = \Theta_0 + \Theta_1 LnX_{1i} + \Theta_2 LnX_{2i} + \Theta_3 LnX_{3i} + \Theta_4 LnX_{4i} + \Theta_5 LnX_{5i} + \Theta_6 LnX_{6i} + \Theta_7 LnX_{7i} + \Theta_8 LnX_{8i} + \Theta_9 LnX_{9i} + \Theta_{10} D_{1i} + \Theta_{11} D_{2i} + \Theta_{12} D_{3i} + \sigma_i$ ….. (5)

Description: Y (Actual clove productivity (kg/ha)); $\hat{Y}$ (Presumptive or average clove productivity (kg/ha)); X_1 (Plant age (year)); X_2 (Total external labor used per year (HOK/ha)); X_3 (Total family labor used per year (HOK/ha)); X_4 (Amount of NPK fertilizer used per year (kg/ha)); X_5 (Amount of ZA fertilizer used per year (kg/ha)); X_6 (Amount of TSP fertilizer used per year (kg/ha)); X_7 (Amount of organic fertilizer used per year (kg/ha)); X_8 (Amount of pesticide used per year (liters/ha)); X_9 (Total plant population produced (tree/ ha)); D_1 (Dummy Certified seedlings (D_1= 1 if using certified seedlings and D_1 = 0 if not using certified seedlings)); D_2 (Dummy pest attack (D_1= 1 if the farmer faces a pest attack and D_1 = 0 if the farmer does not face pest attack)); D3 (Dummy Contract Farming (D_1= 1 if the farmer follows contract farming and D_1= 0 if the farmer does not follow contract farming)); ε_i^2 (Variance of clove productivity); i (Farmer respondents); β_0,Θ_0 (Constant); β_1,.., β_{12}(Estimated parameter coefficients of clove production inputs X_1, X_2, …,X_9, D_1, D_2, D_3); Θ_1,..,Θ_{12} (Estimated parameter coefficients of clove production inputs X_1, X_2, …,X_9, D_1, D_2, D_3); ε,σ (Error).

The utilization of production inputs in agricultural practices plays a crucial role in influencing crop productivity, particularly for cloves. Significant factors impacting productivity include plant age, labor type, fertilizer application, pesticide usage, plant population, seed quality, pest attacks, and the collaborative nature of contract farming (Ariyanto et al. 2017; Astuti et al. 2019; Mustari et al. 2020; Saputra, 2019; Sayid et al. 2022). Research indicates that younger plants generally exhibit higher productivity levels (Habun et al. 2016), while skilled labor contributes positively to production efficiency (Leovita and Martadona, 2021). Appropriate application of fertilizers and pesticides is essential for maximizing yield; however, excessive use may lead to adverse effects on production (Febriawan et al. 2018; Habun et al. 2016). Additionally, maintaining an optimal plant population is vital, as overcrowding can result in competition for resources (Heriyanto and Darus, 2017). Furthermore, contract farming arrangements can enhance productivity through effective knowledge transfer; however, there exists a risk of reduced yields if contractual obligations are not fulfilled by partnering companies. Consequently, further investigation is warranted to comprehensively assess the impacts and interactions of these factors on agricultural productivity. Therefore, the first hypothesis in this paper is as follows:
H1: Production inputs positively affect the clove productivity in East Java Province.

Various factors, such as plant age, seed quality, labor, and the use of fertilizers and pesticides, can influence this risk. Older plants require more intensive care, increasing the risk of pest infestations (Kemala, 2020). Proper allocation of labor is also a key factor; research indicates that efficient labor usage can reduce production risk (Saptana et al. 2016). Appropriate fertilization, whether organic or inorganic, is essential for mitigating risk (Mutisari & Meitasari, 2019; Astuti et al. 2019). However, excessive fertilizer application can lead to increased risk (Febriawan et al. 2018). Pesticides serve to protect plants from pests and diseases; proper use can decrease risk, but over-application can elevate production risk (Fanani et al. 2015; Mutisari and Meitasari, 2019). Plant population density also affects risk; high density can limit nutrient absorption, thereby increasing risk. The quality of seeds influences risk as well, where the use of certified seeds can reduce risk. Contract farming can distribute risk between farmers and companies; however, risks may increase if companies fail to meet their commitments (Sayid et al. 2022; Eaton and Shepherd, 2001). Therefore, the second hypothesis of this paper is as follows:
H2: There is a difference in the impact of various production inputs on clove production in East Java Province, with some inputs reducing production risks while others increasing them.

The research framework presented in Figure 1 outlines the analysis of fluctuating clove productivity in East Java by integrating internal and external factors influencing production. Internal factors include crop age, the use of family and external labor, the application of various fertilizers (NPK, ZA, TSP, and organic fertilizers), pesticide usage, plant population, and the adoption of certified seedlings. External factors encompass pest attacks and participation in contract farming arrangements. These variables collectively contribute to production risks, which are examined using the Just and Pope Model production function. The framework categorizes these factors into risk-inducing and risk-reducing components, providing insights into their respective impacts. The outcomes of this analysis serve as the basis for formulating recommendations and strategies for effective risk management, ultimately aimed at stabilizing and enhancing clove productivity in the region.

RESULTS

The socioeconomic characteristics of clove farmers in East Java provide valuable context for understanding the variations in farm input allocation observed in this study. The majority of farmers are within the productive age group of 41-60 years, suggesting sufficient physical capability and experience in managing clove cultivation (Perkiö-Mäkelä and Hirvonen, 2019). However, the relatively low education levels where 59% of farmers only completed primary school may limit their ability to adopt advanced farming techniques and optimize input usage (Guest et al. 2023). Most farmers operate on small-scale farms, with 96% managing less than 0.5 hectares of land, which restricts their capacity to achieve economies of scale (Dhillon and Moncur, 2023). Land ownership also plays a role in farming decisions, as 80% of respondents cultivate their own land, while 20% work on leased plots. These socioeconomic factors influence the diverse patterns of input allocation, such as labor, fertilizers, and pesticides, which are crucial for clove productivity and risk management (Mdoda and Gidi, 2023).

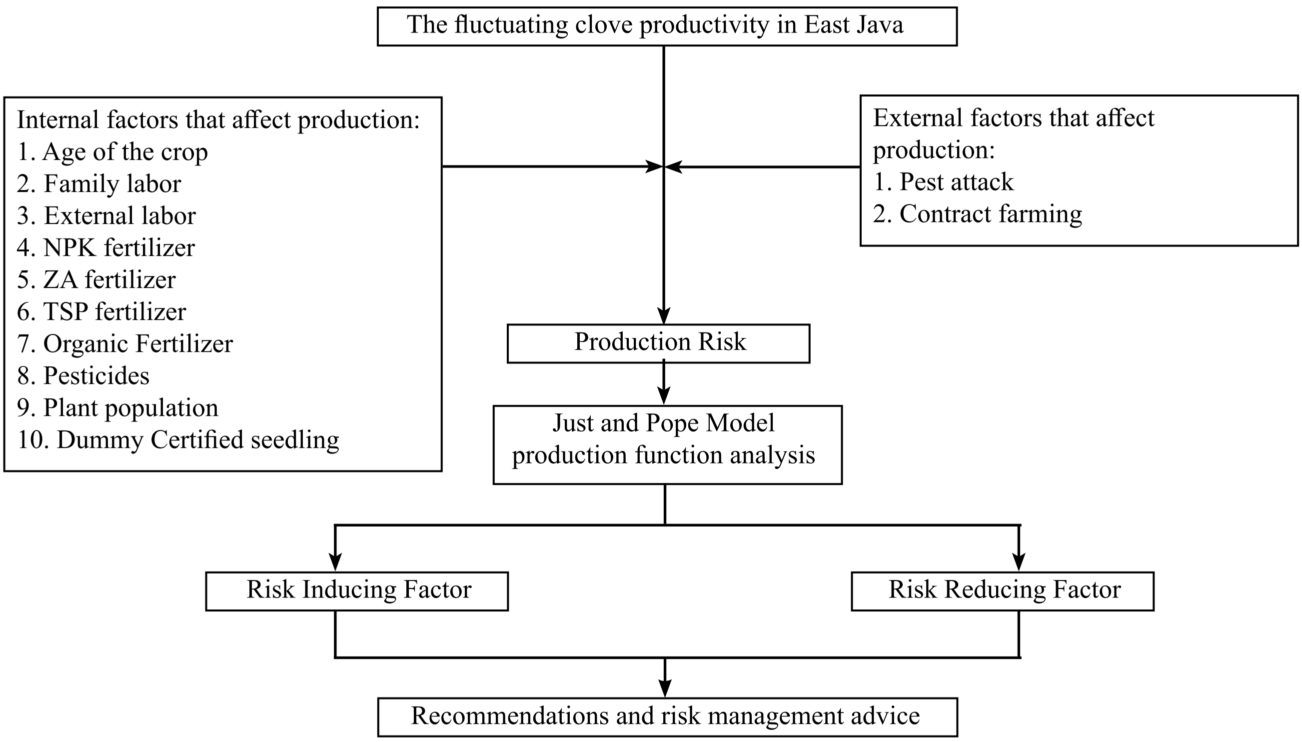

Figure 1. Research Framework

Farm inputs represent the production means utilized during farming operations. The clove farming inputs examined in this study include plant age, family labor, external labor, NPK fertilizer, ZA fertilizer, TSP fertilizer, organic fertilizer, pesticides, and plant population. The allocation of these inputs varies across farmers. In East Java, the average productivity of cloves is 2,600 kg/ha, with a maximum productivity of 16,000 kg/ha/year. The standard deviation for clove productivity is relatively high, at 2,578.75, suggesting a significant variation in productivity levels among farmers. This disparity may be attributed to the differences in the age of the clove trees in the production group. Data from the production group indicate that the age of clove trees ranges from 8 to 55 years. This variation in tree age may lead to differences in the amount of production per hectare. Closer proximity to the optimal productive age of around 30 years correlates with higher productivity. A significant proportion of the trees are still relatively young, which could explain the high standard deviation in productivity, as these plants have not yet reached their peak productivity. The average tree age cultivated by farmers is 18 years, indicating that most plants are still within their productive phase (Nurheru, 1984). Regarding labor usage, most clove farmers rely on family labor, likely due to the small-scale nature of their farms. Plant care involves applying fertilizers and pesticides. The average plant population is 272 trees/ha, with a minimum of 100 trees/ha and a maximum of 625 trees/ha.

Clove Farming Risk Analysis

The risk level in clove farming in East Java was analyzed to assess the likelihood of production loss faced by farmers. One method for evaluating production risk is the coefficient of variation (CV), which compares the standard deviation to the expected value. A higher coefficient of variation indicates a greater production risk for farmers. The average productivity of cloves in East Java Province is 2,600 kg/ha/year. Variance, which measures the dispersion of clove productivity data, was calculated using equation (1) and found to be 6,649,928. Subsequently, the standard deviation, derived from the variance as outlined in equation (2), was 2,579. To evaluate production risk, the coefficient of variation (CV) was employed. CV compares the standard deviation to the mean productivity value, as stated in equation (3). The coefficient of variation in this study was calculated to be 0.99. According to Hernanto (1993), the magnitude of this coefficient of variation has exceeded 0.5 so it can be concluded that clove farmers in East Java Province face a high level of risk. The estimation results of the clove productivity function model, as specified in equation (4), are presented in Table 1 showing that not all variables included in the model have a significant effect on clove productivity. The variables that have a positive and significant effect on clove productivity are plant age, external labor, and plant population at the one percent real level and organic fertilizer and pesticides at the five percent real level. Meanwhile, TSP fertilizer has a negative and significant effect on productivity at the one percent real level. Plant age has a positive effect on plant productivity. Each annual plant has a different age of productivity, as long as the plant is still at a productive age and has not reached its maximum age limit, the tree can still produce high clove production (Ariyanto et al. 2017). In clove farming in East Java, the average age of cultivated plants is 18 years. According to Kemala (2020), cloves have a productive age ranging from 10-30 years old, therefore increasing the age of the plant is still able to increase productivity. Family labor has no significant effect on clove productivity because it has a p-value of more than the real level of five percent. One of the shortcomings of family labor is the low skill and knowledge in running a farm. This may stem from limited access to formal agricultural training, as well as the absence of specialized knowledge on optimizing farming practices, pest control, and soil management. According to Suratiyah (2015), family labor often lacks exposure to modern farming techniques, which can hinder productivity. Furthermore, family labor may not be as efficient as external labor due to the varying levels of experience and motivation among family members. These factors could contribute to the diminished impact of family labor on clove productivity, as their involvement may not bring the same level of expertise and efficiency as trained external workers who can implement best practices in clove farming.

Table 1. Estimation results of the productivity function and production risk function for clove farming in East Java

Variable	Regression Coefficient	P-Value
Productivity Function		
Intercept	0.08	0.85
Ln Plant age	0.34**	0.00
Ln External labor	0.03	0.08
Ln Family labor	0.07**	0.00
Ln NPK fertilizer	0.00	0.74
Ln ZA fertilizer	-0.00	0.36
Ln TSP fertilizer	-0.03**	0.00
Ln Organic fertilizer	0.01*	0.01
Ln Pesticide	0.03*	0.03
Ln Plant population	1.09**	0.00
Dummy Certified seedlings	0.05	0.71
Dummy Pest attack	-0.03	0.57
Dummy Contract Farming	0.08	0.52
R-Squared		0.33
Prob (F-statistic)		0.00
Risk Production Function		
Intercept	-3.56	0.00
Ln Plant age	0.29	0.08
Ln External labor	-0.20**	0.00
Ln Family labor	0.05	0.05
Ln NPK fertilizer	0.00	0.70
Ln ZA fertilizer	0.05*	0.01
Ln TSP fertilizer	-0.01	0.40
Ln Organic fertilizer	0.02	0.20
Ln Pesticide	0.00	0.80
Ln Plant population	0.27	0.16
Dummy Certified seedlings	-0.43	0.31
Dummy Pest attack	0.01	0.93
Dummy Contract Farming	-0.34	0.38
R-Squared		0.04
Prob (F-statistic)		0.00

Description: ** significant at the real level α = 1%. *) significant at the real level α = 5%

The estimation results in Table 1, show that the family labor regression coefficient is positive and significant at the one percent real level. Clove farming in the process of planting, fertilizing, and harvesting requires a large amount of labor (Damayanti, 2013). In addition, the harvesting process still uses manual methods, namely picking by hand so it takes a lot of time, while harvesting cannot be done for a long time because the clove flowers that have bloomed will reduce the quality produced. Therefore, this process requires a lot of labor (Sutriyono, 2019). NPK fertilizer has no significant effect at the five percent real level. When viewed from the average use of NPK fertilizer by clove farmers in East Java, the amount is still below the recommended use limit of only 288 kg/ha, while the dose should be 549 kg/ha (Hartanti 2023). So this is thought to be the cause of the use of NPK fertilizer has no significant effect on clove productivity. ZA fertilizer had no significant effect at the five percent real level. The average use of ZA fertilizer by clove farmers in East Java is 182 kg/ha, while the recommended dosage is 250-400 kg/ha. Through a comparison of the recommended dose and the average use by farmers, it turns out that the use is still below the recommended limit. In addition, according to Suhaeni (2023), ZA fertilizer must be given at the right time, namely before the rainy season and after harvest. Fertilizer application that is not in accordance with the recommended time can potentially reduce the benefits of fertilizer to plants, so that it becomes less optimal in increasing clove productivity.

TSP fertilizer is negative and significant at a one percent real level. This result is in line with Fanani et al. (2015) and Kadarwati (2006) that the application of TSP fertilizer can reduce productivity if the application is not given at the recommended dose. The average use of TSP fertilizer is 118 kg/ha, while the recommended use of TSP fertilizer is 100 kg/ha (Disbun East Java 2013). If the application of TSP fertilizer is not adjusted to the needs of the plant, it can reduce the benefits of fertilizer. So it has the potential to reduce the productivity of clove plants. Organic fertilizer is positive and significant at the real level of five percent. These results are in line with Saputra (2019) and Suharyanto et al. (2015) that the use of organic fertilizer can increase plant productivity because of its role in meeting plant nutrient needs and replacing or complementing chemical fertilizers.

Pesticides were positive and significant at the five percent real level. This result is in line with Astuti et al. (2019); Fajriadi et al. (2019); and Mustari et al. (2020) that pesticides can prevent pests and diseases so as to increase productivity. The plant population is positive and significant at the real level of one percent. In line with Habun et al. (2016) and Heriyanto and Darus (2017), the plant population that is cultivated is identical to the amount of crop production that can be produced. The more the number of trees, the higher the production level. Certified seeds had no significant effect at the five percent real level. According to Heriyanto et al. (2019), only 23 percent of farmers received certified seedlings. The remaining 73 percent have to buy their own seeds from retailers. Farmers often face price uncertainty in the market, which leads to lower incomes. This makes it quite difficult for farmers to obtain quality certified seedlings from seed breeders because they usually have a higher price. Therefore, the uncertainty in the quality of certified seedlings purchased from retailers is suspected to make the effect of certified seedlings insignificant in increasing productivity (Edson and Akyoo, 2021). Pest attacks do not have a significant effect on clove productivity. In this paper, pest attacks are thought to have no significant effect because farmers have started using pesticides to eradicate pests and diseases that attack. This is also evidenced by the estimation results on the pesticide variable which can significantly increase the productivity of clove crops (Islam et al. 2023). Contract farming also has no significant effect at the five percent real level. This is thought to be due to the factor of farmers having a low level of education. Based on the analysis of existing data, the majority of farmers are elementary school graduates. According to Norfahmi et al. (2017), farmers who have a low level of formal education tend to find it more difficult to accept innovations and various new knowledge about their farms.

The estimation of the production risk function, as outlined in equation (5), indicates that only the family labor variable has a significant effect on reducing production risk. The results of this estimation are in line with Saptana et al. (2016) that the use of family labor allows farmers to manage their farms without having to rely on the availability of foreign/outside family labor. In addition, clove farming in several cultivation processes there are several processes that require a large amount of labor, one of which is the harvesting process. Through the additional use of family labor, it can help reduce the risk of losses during the harvest process and save more on labor costs (Leovita and Martadona, 2021). However, this increase in the use of family labor must be followed by the provision of training or counseling to improve the skills and skills of the workforce so that they can support the maintenance process of clove farming. Another variable that has a significant effect is the use of Za fertilizer, which can increase production risk. This result is in line with Mutisari and Meitasari (2019) that the additional use of ZA fertilizer can potentially increase production risk. The average use of ZA fertilizer on clove farms in East Java is still in the recommended dosage range but is suspected to be not given at the right time, which should only be before the rainy season. In addition, it is also suspected that there is an interaction between ZA fertilizer and other fertilizers that can affect the benefits of ZA fertilizer. Based on the data, the use of organic fertilizer by clove farmers in East Java is given in quite a large amount. According to Hanifah et al. (2017), the use of more than one type of fertilizer with unadjusted doses can potentially increase nitrogen elements in the soil that can interfere with plants in absorbing the nutrients needed.

External labor has no significant effect on production risk, presumably because it has a relatively small role in crop management and maintenance. Similarly, the use of NPK, TSP, and organic fertilizers because their use tends to be in small amounts, not in accordance with the recommended allocation of proper fertilizer application. While in the use of pesticides, farmers tend to control pests and diseases using non-chemical methods such as agronomic, mechanical with existing tools, and biological through appropriate natural predators. The use of certified seeds is also thought to have no significant effect on reducing the risk of clove production, this is because the quality of seeds used is poor, as many as 73 percent of farmers buy seeds from retailers whose quality cannot be trusted (Heriyanto et al. 2019). Meanwhile, in contract farming cooperation, one of the reasons that causes contract farming to have less significant influence is the low extension level from companies to contract farmers. Based on data from the 2013 agricultural census, of the farmers who participated in contract farming, only 43 percent received regular counseling. This is suspected to be the reason why contract farming has a less significant effect in reducing production risk (Abdulai and Al-hassan, 2016).

Managerial Implications

The findings of this paper highlight the significance of understanding the diverse inputs utilized in clove farming in East Java and their effects on productivity. With an average productivity of 2,600 kg/ha and notable variability, farmers and policymakers need to address the age of clove trees and the application of fertilizers. The data suggest that increasing the average age of clove trees and optimizing fertilizer usage, particularly NPK and TSP, can enhance productivity. Additionally, given that family labor has been shown to lack a significant impact on productivity due to skill limitations, there is an urgent need for training programs aimed at improving labor efficiency. Furthermore, the high coefficient of variation (0.99) indicates the considerable production risks faced by clove farmers, primarily stemming from improper input application and limited access to quality seeds. It is crucial to prioritize educating farmers on the appropriate timing and dosage of fertilizers while also improving the quality of seeds used in farming. Although contract farming has not demonstrated a significant effect, it presents an opportunity for enhancing farmer resilience and productivity. By increasing support and training from contracting companies, the potential for contract farming to positively influence clove production can be realized. Overall, these insights can inform interventions designed to optimize clove farming practices and mitigate risks associated with production variability. The government has a key role in these efforts by supporting the development of policies that provide access to quality fertilizers, seeds, and technical training. Strengthening agricultural extension services and offering incentives for the adoption of sustainable farming practices can improve productivity and reduce risks. Additionally, fostering collaboration between farmers and contracting companies could further promote knowledge exchange and improve overall farming practices. These insights can guide interventions aimed at optimizing clove farming practices and addressing production variability.

CONCLUSIONS AND RECOMMENDATION

Conclusions

Production inputs that can increase clove productivity are family labor, non-family labor, organic fertilizer, pesticides, and plant population. Meanwhile, TSP fertilizer reduces clove productivity. In factors affecting production risk, production inputs that increase the risk of clove production (risk-inducing factor) are Family Labor. While the input that reduces production risk (risk-reducing factor) is the use of ZA fertilizer. These findings are consistent with several studies that emphasize the importance of labor and organic fertilizers in boosting agricultural productivity. However, the observed role of family labor in increasing both productivity and risk is a notable distinction from other studies, where labor inputs were generally not seen as risk-inducing factors. This could be due to specific socio-economic conditions in East Java, or differences in data and methodology used in other studies.

Recommendations

This paper recommends that clove farmers in East Java consider increasing the use of family labor to enhance clove productivity and mitigate production risks. Additionally, it is advised that farmers receive mentoring to improve their skills and knowledge in farm management. To further improve productivity and reduce risks associated with pests and diseases, farmers are encouraged to increase plant populations and apply pesticides and fertilizers appropriately. Future research should focus on analyzing technical efficiency to assess how effectively farmers utilize inputs to produce clove output. Moreover, investigating the factors influencing farmers' decisions to adopt certified seeds or participate in contract farming and the subsequent impact on clove farming performance specifically regarding profits and costs would provide valuable insights. This would be particularly useful in light of the observed lack of significant effects of these variables on clove productivity, thereby helping to guide farmers' decisions on whether to continue adopting certified seeds and participating in contract farming. The paper acknowledges certain limitations, including its regional focus on East Java, which may not be generalizable to other areas, and the use of cross-sectional data, which restricts long-term analysis. Future studies could address these limitations by expanding the scope to include other regions, incorporating external factors such as climate and market access, and further exploring technical efficiency and the adoption of certified seeds or contract farming.

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