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Patchouli as an Emerging Agribusiness Opportunity in Southeast Sulawesi: An Analysis of Farmers' Adoption Decisions

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***Abstract*: This study analyzes the socioeconomic factors influencing farmers' decisions to cultivate patchouli (Pogostemon cablin) in a rural Indonesian context. Many maize farmers in Lameao Village in Muna District have recently switched to patchouli cultivation to capitalize on its substantially higher income returns. Using a survey of 67 farmers (49 patchouli adopters and 18 non-adopters) and a binary logistic regression model, we examine five hypothesized factors: formal education level, farming experience, landholding size, number of family dependents, and farm income. The results show that three factors have a significant impact on the decision to adopt patchouli farming, namely education level, farming experience, and household farm income. In contrast, landholding size and family dependent count show no significant effects on adoption. We discuss how the findings reflect farmers' socio-economic motivations and constraints, and we situate the results in the broader literature on agricultural innovation adoption. The paper concludes with implications for agribusiness development and rural policy, such as improving farmer education and extension, tailoring outreach to experienced growers, and facilitating market and processing support for patchouli, all while ensuring sustainable practices.**

***Keywords*: adoption, diversification, logistic regression, maize, patchouli.**

1. Introduction

Indonesia is the world's leading producer of patchouli oil, an essential oil derived from the leaves of the patchouli plant (*Pogostemon cablin*) [1]. Patchouli oil's musky, earthy fragrance is highly valued in international perfume, cosmetics, and aromatherapy markets [2], [3]. Social media-driven demand in recent years has further surged the global market for patchouli oil, prompting a rapid expansion of patchouli cultivation in Indonesia [1]. Indonesia's tropical climate is ideal for patchouli and, as a result, over 80% of global patchouli oil supply comes from Indonesia [1], [2], [4]. Farmers can earn up to IDR 2.4 million (USD 147) per kilogram of patchouli oil [1], making patchouli a highly profitable cash crop relative to traditional staple crops.

Sulawesi Island, particularly, has seen patchouli emerge as a key commodity since the early 2000s [1], [2]. Within Sulawesi, Southeast Sulawesi Province has promoted patchouli farming as an agribusiness opportunity for rural communities [5], [6]. Muna District, located in this province, is one such area where patchouli cultivation has recently gained popularity. Local authorities have encouraged communities to engage in the patchouli business to improve household incomes [1]. Although patchouli is not yet the leading commodity in the province in terms of cultivated area or number of farmers [7], it is becoming increasingly important in the regional agribusiness landscape. This growing significance is attributed to several advantages of patchouli cultivation, such as its high profitability, relatively low input requirements, and ease of cultivation. At the same time, many conventional estate crops in the region, including cocoa, clove, and cashew, are facing agronomic, market, or productivity challenges that have reduced their profitability [8]-[12]. In this context, patchouli is emerging as a strategic alternative for smallholders seeking more viable and sustainable income sources.

In Lamaeo Village of Muna District, a notable agrarian shift has occurred. Many farmers who traditionally grew maize have switched to patchouli cultivation. Maize farming in this village historically provided subsistence-level returns. Farmers reported that maize yields were barely sufficient to meet basic household needs. In contrast, patchouli offers a much higher economic return. A comparative analysis in the study area found that patchouli farmers earned on average around IDR 4.7 million per month, whereas maize farmers earned only about IDR 877 thousand per month. This five-fold income difference exemplifies the relative advantage of patchouli farming over maize. According to diffusion of innovations theory, *relative advantage*, or the perceived superiority of a new idea or practice over the existing one, is a primary driver of adoption decisions [13]. Indeed, as demonstrated in many studies [14], [15], patchouli's substantially higher profitability has been a strong pull factor for farmers. Many have been quick to adopt patchouli farming in hopes of increasing their income and well-being.

However, not all farmers have transitioned to patchouli. Despite the lucrative returns, a subset of farmers in Lamaeo continue to cultivate maize. As of the study period (2022), roughly 74% of the village's farming households had adopted patchouli (147 patchouli farmers out of 200 total farming

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households), while the remainder (53 farmers) still relied on maize as their primary crop. This scenario raises an important question: What factors determine a farmer's decision to switch from a traditional staple crop (maize) to a high-value crop (patchouli)? Understanding these factors is crucial for agribusiness development and rural policy, as it can inform strategies to encourage beneficial innovation adoption and identify barriers that need to be addressed.

Farmer decision-making in adopting new crops or agricultural technologies has been widely studied in both international and Indonesian contexts. Past research suggests that a variety of socioeconomic factors and farm characteristics can influence innovation adoption. Key factors frequently examined include the farmer's education level [16]-[18], farming experience (or age) [16], [19], [20], farm size (landholding) [21], household size or dependents [17], [22], income level or wealth [23], and other factors such as access to information and markets. These characteristics can affect a farmer's ability to perceive the innovation's advantages, acquire knowledge about it, finance initial investments, and bear risks associated with change.

Against this background, this study focuses on analyzing the factors that influence farmers' decisions to cultivate patchouli in Lamaeo Village. The research addresses a gap in detailed empirical documentation of patchouli agribusiness adoption in Southeast Sulawesi, and situates it within the broader discourse on agrarian change, innovation adoption, and rural development.

2. Materials and Methods

A. Study Area and Population

The research was conducted in Lamaeo, a village in Kabawo Subdistrict, Muna District, Southeast Sulawesi, Indonesia. This village was selected because of the presence of patchouli farming alongside traditional maize farming, making it a suitable case to study farmers' crop-decision factors. Lamaeo is one of villages where patchouli cultivation had recently been introduced and promoted. Patchouli farming became attractive in Lamaeo around 2020-2021, when farmers observed early adopters achieving higher incomes from patchouli oil sales. By 2022, a majority of farming households in the village had at least partly shifted to patchouli cultivation. Maize, however, remained an important crop, especially for food and local market sales, so some farmers continued to specialize in maize or maintained maize alongside patchouli.

The population of interest in this study was defined as all farmers in Desa Lamaeo who were either cultivating patchouli or cultivating maize as their main crop. There were approximately 200 farmers in these categories, consisting of 147 patchouli farmers (those who had adopted patchouli farming, often transitioning from maize) and 53 maize farmers (those still solely engaged in maize farming). These numbers indicate a high adoption rate (74%) of patchouli in the village within a short span, confirming the relevance of examining what differentiates adopters from non-adopters.

B. Sampling and Data Collection

Given the population size (200), a sample was drawn to participate in a structured survey. We employed simple random sampling stratified by farming category to ensure representation of both patchouli adopters and non-adopters. Using the Slovin formula with a 10% margin of error for manageability (α = 0.10), a total sample of 67 farmers was determined. This sample was allocated proportionally between the two strata: 49 patchouli-cultivating farmers and 18 maize-cultivating farmers.

Each selected respondent was interviewed in person during mid-2022. A survey questionnaire was used to gather data on the farmer's socioeconomic characteristics, farm profile, and the farmer's decision regarding patchouli cultivation. The questionnaire included both closed-ended and a few open-ended questions. Respondents provided informed consent, and anonymity was assured to encourage honest responses. The survey captured the dependent and independent variables.

Dependent variable is the farmers' decision to cultivate patchouli, operationalized as a binary variable: Y = 1 if the farmer was cultivating patchouli (at the time of survey, having switched from maize to patchouli farming), and Y = 0 if the farmer was not cultivating patchouli (i.e., still only farming maize). Notably, some "adopters" continued growing small plots of maize for household consumption, but if patchouli had been taken up as a farm enterprise, we classified them as Y=1. Thus Y=0 represents farmers who remained exclusively maize growers.

Independent variables consist of five variables, namely (1) Education level (X1: Education), measured as the number of years of formal schooling completed by the farmer, (2) farming experience (X2: Experience), measured as the length of time (years) the farmer has been engaged in farming as a primary occupation, (3) landholding size (X3: Land size), measured as the total area of agricultural land (in hectares) owned or managed by the farmer, (4) number of family dependents (X4: Dependents), measured as the number of individuals in the farmer's household who are financially dependent on the farmer, and (5) household farm income (X5: Income), measured as the average monthly farm income in Indonesian Rupiah (IDR). This includes net earnings from farming (gross revenue minus production costs) for the farmer's main crop.

C. Data Analysis Approach

The core analytical method used is binary logistic regression. This statistical technique is appropriate because our dependent variable is dichotomous (patchouli adopter vs. non-adopter), and we aim to estimate the probability of adoption as a function of multiple independent variables (X1 through X5). Logistic regression is well-suited to socio-economic data in adoption studies since it makes no strict assumptions of normality or linearity between independent and dependent variables. The logistic model estimates the log-odds of the outcome (Y=1) as a linear combination of the predictors:

$$Ln\left(\frac{P}{1-P}\right) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_k X_k$$

where P(Y=1) is the probability of a farmer adopting patchouli, β0 is the intercept (constant), β1 - βk are the coefficients for each independent variable defined above, and ε is the error term. The coefficients are estimated using the maximum likelihood method. Once estimated, they can be exponentiated to yield odds ratios (OR) for easier interpretation: an OR > 1 indicates the factor increases the odds of adoption, while OR < 1 indicates it decreases the odds (OR = 1 means no effect).

We entered all five predictors into the model simultaneously, as our interest was in the influence of each factor controlling for the others. Before running the logistic regression, we performed preliminary checks of multicollinearity, model specification, and goodness of fit.

For hypothesis testing, given the exploratory nature in a rural setting, we adopted a significance level of $\alpha = 0.10$ (90% confidence) as the threshold for identifying influential factors. This slightly relaxed criterion was chosen considering the relatively small sample size (67) and the expectation that some effects might be marginal yet meaningful in context. Thus, a p-value < 0.10 was considered evidence of a statistically significant effect, while $p < 0.05$ was noted as strongly significant. Each coefficient's Wald test was used to determine significance individually (partial effect), and a likelihood ratio (G) test assessed the significance of the model as a whole.

3. Results and Discussion

A. Profile of Respondent Farmers

Out of the 67 respondents, 49 had adopted patchouli farming (often referred to here as "patchouli farmers"), and 18 were still exclusively maize farmers. The majority of farmers in both groups were male household heads in their 30s to 50s. The average age for patchouli adopters was around 38 years, slightly younger than the average age of about 45 for maize-only farmers. This indicated that younger farmers were more represented among the innovators. This aligns with the idea that younger individuals may be more willing to embrace new opportunities, whereas older farmers may stick to tradition.

In terms of education, overall education levels were modest as about 60% of all respondents had completed only elementary school, 30% had junior high school, and only a small fraction had finished senior high school. None had university education. When broken down by group, patchouli adopters actually had a *lower* average formal education (roughly 6-7 years of schooling, primary level) compared to maize farmers (around 8 years). This somewhat counterintuitive pattern hints at the possibility that less-educated farmers were more inclined to switch to patchouli, whereas farmers with slightly more schooling perhaps did not rush into the new crop. The reasons could be manifold, such as that less educated farmers might have fewer alternative income prospects and thus readily pursue patchouli's profit, or they might be more influenced by peers and immediate economic needs. More educated farmers, in contrast, could be more cautious or have better understanding of the risks (or they might have off-farm income sources). This descriptive difference foreshadows the regression finding that education negatively correlates with adoption.

Looking at farming experience, patchouli adopters had on average about 10-12 years of farming experience, whereas maize farmers averaged closer to 18-20 years. Many patchouli adopters were relatively new farmers or the younger generation in farming families. In fact, several patchouli farmers were second-generation farmers who took over or co-managed farms with their aging parents and decided to introduce patchouli. By contrast, many of the maize-focused farmers were veteran cultivators who had been growing maize or other traditional crops for decades. This indicates a potential pattern of generational shift in which newer farmers drive the adoption of the new crop, while long-established farmers retain the old crop. This aligns with general observations in innovation diffusion that early adopters often include those who have less entrenched experience with the old ways, whereas those with very long experience may be set in their ways or skeptical of unproven methods [16].

For landholding size, there was no stark difference between the two groups. Most farmers in Lamaeo have small landholdings. The average land area was about 0.8 hectares for patchouli adopters and 0.9 hectares for maize farmers, which is essentially the same given the variability. Farm sizes clustered in the range of 0.5 to 1.5 ha for the majority of respondents, reflecting the generally small-scale nature of agriculture in the village. Notably, some patchouli farmers were actually tenant farmers or sharecroppers on others' land (though they were the decision-makers in farming that land). The lack of a clear land size disparity between adopters and non-adopters suggests that farm size was not a decisive factor in who adopted patchouli. Even those with very small plots ventured into patchouli if they saw an advantage, and conversely, having more land did not necessarily push a farmer to try patchouli as they could simply plant more maize. This supports the notion that patchouli cultivation is scale-neutral to some extent, and that even smallholders can profit from it.

Examining household dependents, patchouli-adopting households tended to be slightly larger on average. The median number of dependents among patchouli farmers was 4 (typically a spouse and 2-3 children), whereas for maize farmers it was 3. In fact, a descriptive cross-tabulation revealed that 71% of patchouli farmers had medium-sized families (3–5 members), compared to only 11% of maize farmers, while 89% of maize farmers had small families (<3 members). This is an intriguing pattern: it suggests that farmers with more mouths to feed were more often found among the patchouli adopters. They may have been driven by the need for higher income to support their families. One farmer with five children explained that the schooling and future of his kids pushed him to try patchouli, because *"with maize alone, I could never save enough or cover education costs, but patchouli offers hope for more income"*. Larger families also mean more labor availability. Indeed, some patchouli farmers utilized family labor for tasks like harvesting leaves and processing, which might have made adoption easier.

Finally, regarding farm income levels, the difference was already highlighted. Patchouli farmers' current farm incomes were dramatically higher, owing to the profitability of

patchouli. But it is important to contextualize this: many patchouli farmers *before* adopting were maize farmers with incomes similar to those of the current maize farmers. The leap in income came *after* adoption, as a consequence of patchouli's high returns. Our survey did not directly capture the income of adopters *prior* to switching (which would ideally be used to predict adoption), but we use current income as a proxy, recognizing that it blurs cause and effect. Nonetheless, it stands to reason that those who switched did so expecting a higher income and indeed realized it. Non-adopters (maize farmers) at the time of survey continued to have quite low monthly farm incomes (often less than IDR 1 million). The perception of higher earnings from patchouli was nearly universal; even maize farmers acknowledged that "patchouli yields more money." Some maize farmers indicated they refrained from switching not because they doubted the profit, but due to other concerns (lack of knowledge on patchouli cultivation, fear of market uncertainty for patchouli oil, or the need to ensure a steady supply of maize for food/livestock).

B. Logistic Regression Results

The binary logistic regression model was estimated using the five independent variables (Education, Experience, Land size, Dependents, Income) to predict the probability of a farmer being a patchouli cultivator (Y=1). The overall model fit the data well, with a likelihood ratio chi-square (G-test) of 66.486 ($df = 5$, $p < 0.001$), indicating that the predictors as a set significantly improve the prediction of adoption likelihood. The Hosmer-Lemeshow goodness-of-fit test yielded a p-value of 0.48 (which is > 0.05, indicating no evidence of poor fit), suggesting the model's estimates are consistent with the observed outcomes. The Nagelkerke R^2 was approximately 0.91, implying that about 91% of the variation in the adoption decision could be "explained" by these five factors. Focusing on the individual predictors' effects, the logistic regression coefficient estimates (B), their standard errors, Wald statistics, p-values, and odds ratios (OR) are summarized in Table 1.

Table 1 indicates that three out of the five hypothesized factors show a statistically significant influence on the adoption decision (at least at the 10% level), while the remaining two do not. The significant factors are Education, Farming Experience, and Income.

1) Education Level

Education turned out to have a negative coefficient ($B = -0.644$) with $p = 0.083$, which meets our 10% significance criterion. The odds ratio is 0.525, meaning that for every additional year of formal education, the odds of the farmer being a patchouli adopter decrease to about 52.5% of what they were before (almost halved). In other words, farmers with higher education were less likely to adopt patchouli, while those with less schooling were more likely to adopt. This finding quantitatively confirms the descriptive observation that patchouli adopters tended to have lower average schooling.

This result may initially seem surprising, as one might expect that more educated farmers would be quicker to recognize and act on a profit-making opportunity [24]. However, several possible explanations align with this finding. First, in the context of Lamaeo Village's agrarian community, formal education levels are generally low for all, so the variation is not huge. Education here might proxy other factors: farmers with slightly higher education might pursue or prefer stable income sources or employment. For example, some higher-educated individuals might have part-time jobs or positions in the village administration, making them less dependent on high-risk crops. Meanwhile, those with minimal education rely entirely on farming and hence were eager to boost income through any available avenue, patchouli included.

Another aspect is openness vs. skepticism. Some local informants noted that a few of the more educated farmers were initially skeptical about patchouli. They questioned whether they could sell the oil easily, worried about price fluctuations, and were aware of potential market risks [5]. Less educated farmers, conversely, often followed the example of pioneer adopters without overanalyzing market logistics. In essence, they were more influenced by peer success and the immediate economic narrative. In other words, lower-educated farmers can be more easily influenced by others' opinions or short-term incentives, whereas higher-educated farmers tend to deliberate more rationally and cautiously before switching crops. In our case, the caution of the relatively educated may have translated to inaction (sticking with maize) until patchouli's viability was absolutely proven.

This finding echoes some local studies. For example, Karyani et al. [25] reported that education level was not a significant factor in farmers' financing decisions and that practical experience often mattered more. While that study was in a different domain (potato farmers and credit sources), the underlying implication is similar, that rural farmers sometimes rely more on experiential knowledge and advice rather than formal education when making decisions. In Lamaeo, patchouli farming knowledge was spread farmer-to-farmer; even those with low education level could learn by doing or from neighbors.

It is important to state that this result does not imply that education is a disadvantage. Rather, it suggests that in this particular adoption scenario, farmers with lower schooling were actually at the forefront of trying patchouli. They might have been more motivated by the need to improve livelihoods

Table 1
Binary logistic regression estimates of factors influencing farmers' decision to adopt patchouli farming

Predictor	Coefficient (B)	Std. Error	Wald (χ^2)	p-value	Odds Ratio
Constant (Intercept)	+8.116	4.715	2.962	0.085	–
Education (years)	–0.644	0.371	3.013	0.083 *	0.525
Experience (years)	–0.607	0.288	4.434	0.035 **	0.545
Land size (hectares)	+0.001	0.024	0.003	0.957	1.001
Dependents (count)	+0.931	1.447	0.413	0.520	2.536
Income (IDR/month)	+0.000*	0.000	4.047	0.044 **	1.000

*Notes: *Significance levels: p<0.10 marked with *, p<0.05 marked with ***

quickly (since they had fewer alternatives). Over time, as patchouli farming becomes well-established and information permeates, we might see more educated farmers also joining in once risk perceptions diminish. Indeed, adoption literature notes that early adopters are not always the most educated; sometimes they are those under greater economic pressure or those with social connections that promote the innovation, whereas late adopters may include highly educated individuals who waited for certainty.

2) Farming Experience

Farming experience shows a negative and significant effect on patchouli adoption. The coefficient B = -0.607 (p = 0.035) indicates that each additional year of farming experience *reduces* the odds of switching to patchouli by a factor of 0.545 (OR = 0.545). In practical terms, a farmer with, say, 10 more years of experience than another is significantly less likely to have adopted patchouli. This result suggests that the longer a farmer has been farming (primarily maize, historically), the less inclined they were to change to the new crop. Conversely, relatively inexperienced farmers (younger farmers or those newer to farming as an occupation) were more likely to embrace patchouli.

This aligns strongly with the narrative that younger generation farmers are the innovators in the village, while the older generation holds onto the traditional crop. Experience can correlate with age, and it is well-documented in adoption studies that older age often hinders adoption of innovations due to factors like risk aversion, satisfaction with existing practices, or shorter planning horizons before retirement. Our finding is consistent with this general trend that, effectively, each additional year of age/experience significantly lowered adoption probability. Tasnim et al. [16], studying modern farming practices in Bangladesh, similarly found that older farmers were less likely to adopt new practices. They also found farming experience to be positively correlated with adoption in their case, which at first glance contradicts our result. However, the context differs. In their case, farming experience may have come with younger farmers as well (since they looked at tribal farmers with maybe different patterns). In the patchouli case, the key difference might be that older, experienced maize farmers were deeply invested in and knowledgeable about maize farming, possibly making them less confident in switching to a crop they have never grown before.

Local context offers insight as well. Farmers with 20-30 years of maize farming have a wealth of indigenous knowledge about maize cultivation and a reliable routine. Asking them to uproot that routine for patchouli (which requires learning about plant cuttings, distillation processes, etc.) is asking them to leave their comfort zone. Many such experienced farmers expressed hesitation to “start from zero” with a new crop.

This finding corroborates Andriani et al. [19] who noted that generally, experience helps in decision-making because experienced farmers can be decisive. However, the decision could be to continue a practice they trust. In our case, the experienced farmers decisively continued maize, while the less experienced decisively took up patchouli. A study by Anggriani et al. [20] on palm oil policy adoption found no effect of experience, but they provided an interesting explanation. In their scenario, all farmers had relatively low experience with the new crop (palm) since they previously grew rubber. Thus, experience in the old crop did not translate to the new context. For patchouli, a similar logic might apply: experience in maize does not directly help in patchouli cultivation. In fact, it may impede as one’s farming habits are tied to maize.

One beneficial side of involving experienced farmers is their resource endowment and status in the community. Many experienced farmers in Lamaeo have larger farms or more capital. If they could be convinced or aided to try patchouli on a portion of their land, their example could further legitimize the new crop among any remaining skeptics. For now, it appears patchouli diffusion in Lamaeo has been a bottom-up youth-led process. Over time, as patchouli proves itself, some experienced farmers might gradually adopt.

3) Landholding Size

The regression results show no significant effect of land size on patchouli adoption (B = +0.001, p = 0.957). The odds ratio is essentially 1.0, implying that a difference of one hectare of land makes virtually no difference in adoption probability. In other words, farmers with both small and large landholdings were equally likely (or unlikely) to adopt patchouli. This confirms our earlier observation and is an important finding that patchouli cultivation is scale-neutral in this context, meaning that even farmers with very limited land can engage in it and benefit. However, this result is in contrast with the finding of some studies that large farms are more likely to adopt improved crop varieties [26].

This result aligns with the nature of patchouli farming. Patchouli is a relatively high-value crop per unit area, and it does not require extensive land to be economically viable. In fact, many patchouli farmers in Lamaeo started by planting just a portion of their land (say 0.2–0.3 ha) with patchouli to test it, while keeping the rest for maize or other uses. Even that small area could yield a meaningful amount of oil for sale, given patchouli’s value. So, land was not a limiting factor. Contrast this with some agricultural innovations (like mechanization or certain precision technologies) where large scale is needed to justify investment. Patchouli is not like that; it is more about labor and processing availability than sheer land area.

The finding is consistent with some previous studies in Indonesia. For example, Zulkarnain et al. [27] found that farm size did not significantly affect farmers’ decisions in a study on crop choice, reasoning that if the cultivation methods are similar and the crop can be grown on small plots, land size does not matter. In Lamaeo, the process of land preparation for maize and patchouli is quite alike and neither crop requires specialized large fields, thus farmers “do not consider the breadth of land in deciding to farm patchouli”. Our result also resonates with global literature that in cases of high-value or niche crops, smallholders can adopt and sometimes even have an advantage in intensive management of small plots [28].

It is worth noting that while landholding size per se is not affecting whether they adopt, once adopted, some farmers expressed a desire to expand patchouli planting to more of their land because of the high profits. There might be indirect effects:

a farmer with more land has the flexibility to diversify. They could try patchouli on a part of their land without giving up maize entirely, whereas a land-poor farmer with only 0.2 ha might face an all-or-nothing choice. However, given patchouli's profitability, even small landholders went "all in" because even a tiny patchouli farm could out-earn a larger maize field. In our sample, some of the smallest landowners were indeed among the first to switch; likely because they were desperate to improve their income from their meager land asset and patchouli offered a way.

For policy, the lack of a land size effect is encouraging: it means programs to promote patchouli (or similar high-value crops) can be inclusive of small-scale farmers, who form the majority of rural poor. There is no need for land consolidation or large estates; interventions can focus on providing planting material, technical guidance, and market linkages to farmers regardless of farm size. It also suggests that risks of unequal benefits accruing only to big farmers may be lower in this scenario; small farmers appear equally able to benefit from patchouli cultivation. This is a positive for equity in rural development.

4) Number of Dependents

The variable for household dependents (family size) did not show a statistically significant effect on adoption (B = +0.931, p = 0.520). This means that having a large family does not significantly guarantee that a farmer will switch to patchouli, once other factors are accounted for.

The lack of significance implies that the effect of family size might be indirect or confounded with other factors. For instance, family size could be linked with the farmer's age (older farmers may have more children, but older farmers were less likely to adopt). Such opposing influences can cancel out a clear effect of dependents in the multivariate model. It could also be that family needs manifest through the income variable: larger families have more need for income, which might push the farmer to either have a higher income (through diversifying or working harder) or to try new things. In our model, income is already capturing a big part of economic motivation.

The qualitative insight from the village was that farmers with many dependents felt pressure to earn more, which aligns with general theories (Harris as quoted in Harudu and Rahmaniya [29]). Many patchouli adopters cited family welfare such as *"school fees, daily expenses for my big family,"* as a key reason to seek higher profits. In that sense, having more dependents was a motivational factor. However, the fact that some farmers with equally large families stayed with maize indicates other considerations (e.g., one maize farmer with five children said he was worried about food security; he preferred the guarantee of maize for feeding his family over the cash from patchouli, which could fluctuate in price). This highlights the duality of family size influence: it can push toward higher income (favoring adoption) but also heighten risk aversion (discouraging adoption if the new crop is perceived risky). These opposing forces might be why, statistically, the net effect is null.

Another point is labor. Larger families potentially offer more family labor. Patchouli cultivation and oil processing are labor-intensive (harvesting leaves, tending plants, and especially the distillation process which can require several people to operate in shifts for many hours). Some patchouli farmers leveraged family labor for these tasks. If a farmer had few family members, they might worry about the labor requirement of patchouli (though they could hire labor, but that cuts profit). In Lamaeo, labor was generally available through extended family or neighbors, so this was not a deciding factor for most, but it could play a role in some cases.

The result of no significant effect of dependents is in line with some prior findings where family size did not directly predict adoption. For instance, a study on Bantaeng rice farmers' adoption of new seed by Panca [30] found that family size was not a determinant, suggesting that it is the quality of labor or specific needs rather than just the count of people that matters. On the other hand, some studies on sustainable agriculture practices have found a positive correlation between family size and adoption, reasoning that more labor allows uptake of labor-intensive innovations [31]. Our case might differ because patchouli's labor demand, while significant, can be managed if farmers cooperate or hire help during distillation.

Thus, the household dependent factor seems to neither strongly encourage nor discourage patchouli adoption in a standalone sense. Economic need due to a large family might drive a farmer towards wanting the high income of patchouli, but that same large family might also rely on the stability of maize as food, resulting in a balanced outcome on a community level.

Policy-wise, this suggests that while extension messages can appeal to farmers' desire to improve family welfare, one should also address the food security concern [32], [33], [34]. For large households especially, ensuring that adopting a cash crop will not jeopardize their food supply is crucial. Measures such as encouraging a mix of food and cash crops, or facilitating access to affordable staple food in markets, could alleviate the concerns of those who fear that switching to patchouli might leave them without enough maize to eat or sell locally. Essentially, addressing the risk side will allow the economic need motivation to come to the forefront.

5) Farm Income

Household farm income emerges as a positive and significant predictor of patchouli adoption (B = +0.00044, p = 0.044). This means that higher-income farmers were more likely to have adopted patchouli. This result might seem contradictory since one might expect poorer farmers to be the ones eager to escape poverty via a high-profit crop. However, the interpretation here is that *those* who did adopt ended up with much higher incomes. Farmers who were in a better economic position (or who saw a clear path to profit) took up patchouli, and indeed have realized higher incomes as a result. It could be capturing two related phenomena: (1) somewhat better-off or more commercially oriented farmers decided to adopt, and (2) adopting patchouli then significantly raised their incomes above those who did not adopt. Our data cannot fully disentangle these, but either way it underscores that income considerations were central to the decision.

Farmers with more resources could better afford the initial

costs of patchouli cultivation. Although patchouli is not extremely capital intensive, it does involve some investment, such as obtaining patchouli cuttings or seedlings, possible costs of building or accessing a distillation unit, and the opportunity cost of not planting maize on that land. A maize farmer making barely enough to survive might actually lack the spare funds or credit to make the switch. Conversely, a farmer who had some savings or side income could invest in patchouli and wait a few months for the first harvest and oil distillation to pay off. Thus, pre-adoption income or wealth can influence ability to adopt. This is consistent with many studies that find wealthier farmers adopt innovations earlier because they can handle the risk and costs [17].

On the other hand, the strong effect of income in the model also reflects the post-adoption outcome, implying that patchouli farmers' incomes soared relative to maize farmers. In fact, patchouli farmers earn several million rupiah a month, whereas maize farmers are earning under one million. This disparity drives the statistical significance. It validates the fundamental premise that income gain is the driving incentive for patchouli adoption. Farmers themselves recognized that *"patchouli yields much higher economic value or income compared to other farming"*. Many studies have similarly found that income potential was a significant factor in farmers' commodity selection decisions, as farmers naturally gravitate to the option that promises greater economic returns [14], [15], [23], [35], [36]. Our finding is in line with that: patchouli was chosen because it promised and delivered superior income, whereas maize was relatively unprofitable. All patchouli adopters reported earning more money than they did with maize.

From a policy and agribusiness perspective, this underscores that economic incentives work. If farmers see a viable opportunity to significantly increase their income, many will take it, provided they have the means to do so. Thus, one way to promote rural development is to introduce and facilitate access to higher-value agricultural opportunities (whether new crops, improved varieties, or value-add processing) for small farmers. In doing so, attention must be paid to ensure that poorer farmers are not excluded due to lack of initial capital. Microcredit or subsidy programs can help low-income farmers overcome adoption barriers so they too can benefit from profitable innovations. In Lamaeo, while income is shown as a positive factor, we should be cautious: it might imply that the poorest maize farmers (with the lowest income) did not adopt, possibly because they could not afford the transition risk. If true, they risk being left further behind as others prosper. Policymakers should identify such farmers and support them, so the innovation does not widen inequality.

Another aspect is ensuring that the high income from patchouli is sustainable. Patchouli prices can fluctuate with global markets [37]. At the time of study, patchouli oil prices were attractive [1]. Demand was high, partly driven by trends in aromatherapy and cosmetics. However, if many farmers rush into patchouli, oversupply could occur, or market bottlenecks (e.g., limited distillation capacity or middlemen driving prices down). Additionally, patchouli cultivation has agronomic challenges and continuous planting can lead to declining yields and requires crop rotation after a couple of years [1]. There are also environmental issues if expansion is not managed. Thus, while current income gains are great, extension services and agribusiness actors should work to stabilize the patchouli value chain: e.g., forming cooperatives [38] to get better oil prices, ensuring sustainable cultivation practices (to maintain oil quality and yield) [39], [40], and possibly facilitating direct links to exporters or processors to reduce dependency on middlemen [41].

Thus, the factors influencing patchouli adoption in this village underscore a broader phenomenon in agrarian change: when a new opportunity arises, those who take it are often not the "usual suspects" of innovation theory (the well-educated, big farmers), but rather those under economic pressure or with fewer attachments to old ways. They become the pioneers if the opportunity is compelling enough. The more entrenched farmers may lag, but they should not be forgotten because with the right support, they too can benefit [42]. For policymakers and development practitioners, the lesson is to identify and lower the barriers that hold back those laggards (be it risk, lack of knowledge, or capital constraints) while harnessing the enthusiasm of the early adopters. By doing so, the community as a whole can transition more smoothly and equitably to a more prosperous farming system.

4. Conclusion

This study examined the socioeconomic factors affecting farmers' decisions to cultivate patchouli in a rural Indonesian village. Using a binary logistic regression approach, we identified that education level, farming experience, and farm income are the significant determinants of patchouli adoption. Specifically, lower formal education and fewer years of farming experience increase the likelihood of switching from maize to patchouli, while higher household farm income also correlates with adoption. In contrast, landholding size and number of family dependents were not statistically significant factors in the decision.

In practical terms, the patchouli adopters tend to be younger farmers with modest education who are seeking higher earnings, whereas those who continued with maize are often older, more educated or experienced farmers who may be more cautious or had lower initial capacity to change. The overriding incentive for adoption is the substantial income gain from patchouli farming, which is a clear demonstration of economic motivation driving innovation uptake in agriculture. Patchouli farming was shown to yield far greater profits than the traditional maize farming, and farmers responded to this economic "pull" factor. However, our findings also reveal a potential divide: farmers with more experience (often older) and higher education did not adopt as readily, indicating the need for inclusive strategies to bring all farmers on board with beneficial innovations.

From an agribusiness and rural development perspective, the findings of this study carry several important implications. First, promotion of profitable crop diversification should be prioritized in policy and development interventions. Second, targeted farmer support is necessary to address the varying

capacities and preferences of different farmer segments. Third, agricultural education and extension services should be strengthened to ensure that all farmers, regardless of formal education level, have access to practical knowledge and training on best practices in patchouli cultivation, processing, and marketing. Fourth, financial and infrastructural support, including access to affordable credit, planting materials, and communal distillation units, can lower entry barriers for low-income farmers and enhance value chain participation. Lastly, a focus on sustainable and balanced development is essential to prevent unintended consequences such as food crop displacement or land degradation.

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References

[1] E. Tarigan, D. Alangkara, and F. Syam, "Growing demand for patchouli oil is driving the industry in Indonesia, but at what cost?," CityNews. Accessed: May 01, 2025. [Online]. Available: halifax.citynews.ca

[2] A. Wahyudi, E. Ermiati, S. Sujianto, and N. Maslahah, "Developing sustainable production of patchouli oil in Kolaka, South East Sulawesi, Indonesia: a problem-solving approach," *IOP Conf. Ser. Earth Environ. Sci.*, vol. 974, no. 1, p. 012109, Jan. 2022.

[3] P. H. Abram, W. Putri, S. Nuryanti, and S. M. Sabang, "Characterization of patchouli oil (Pogostemon cablin Benth) production of Tinombala Village, Ongka Malino District, Parigi Moutong Regency," *J. Phys. Conf. Ser.*, vol. 2126, no. 1, p. 012024, Nov. 2021.

[4] S. Sukardi, S. Soeparman, B. D. Argo, and Y. S. Irawan, "The effect of pulsed electric field (PEF) on glandular trichome and compounds of patchouli oil (Pogostemon cablin, Benth)," *J. Nat. Sci. Res.*, vol. 3, no. 15, pp. 48–57, 2013.

[5] A. Rahman, L. Rudi, L. Ode Arham, and M. E. Wati, "Analisis Kualitas Minyak Nilam Asal Kolaka Utara Sebagai Upaya Meningkatkan dan Mengembangkan Potensi Tanaman Nilam (Pogostemon sp.) di Sulawesi Tenggara," *Akta Kim. Indones.*, vol. 4, no. 2, pp. 133–144, Oct. 2019.

[6] S. Sarmia, H. Saediman, and W. G. Abdullah, "Analisis Faktor-Faktor Yang Mempengaruhi Keputusan Petani Untuk Mengusahakan Usahatani Nilam Di Desa Lamaeo Kecamatan Kabawo Kabupaten Muna," *Innov. J. Soc. Sci. Res.*, vol. 4, no. 3, pp. 5329–5341, 2024.

[7] H. Saediman, "Prioritizing Commodities in Southeast Sulawesi Province of Indonesia Using AHP based Borda Count Method," *Asian Soc. Sci.*, vol. 11, no. 15, pp. 171–179, 2015.

[8] L. Geo and H. Saediman, "Analysis of Factors Affecting Cocoa Development in Southeast Sulawesi," *Pakistan J. Nutr.*, vol. 18, no. 5, pp. 479–490, 2019.

[9] [9] H. Saediman, S. Kurniansi, W. O. Yusria, and L. Geo, "Economic Returns and Production Constraints In Palm Sugar Processing In Kolaka District Of Southeast Sulawesi," *Int. J. Sci. Technol. Res.*, vol. 8, no. 11, pp. 3967–3970, 2019.

[10] S. Surni and H. Saediman, "Gender participation in palm sugar processing in Kolaka district of Southeast Sulawesi," *WSEAS Trans. Environ. Dev.*, vol. 16, pp. 34–39, 2020.

[11] A. S. Amri, B. Bahari, A. Gafaruddin, and H. Saediman, "Production and Income of Clove Farming in Latuo Village, Southeast Sulawesi: A Comparative Analysis Between 2023 and 2024," *Int. J. Sustain. Res.*, vol. 3, no. 3, p. (forthcoming), 2025.

[12] J. Witjaksono, Rusdin, Bungati, Asmin, and H. Saediman, "Analysis of clove supply chain: The case of Kolaka district," 2023, p. 120013.

[13] E. M. Rogers, *Diffusion of innovations*, 5th Editio. New York: Free Press, 2003.

[14] L. Geo and H. Saediman, "Rice farming to brick production: What are major drivers of livelihood shift?," *Biosci. Res.*, vol. 16, no. 4, pp. 3640–3647, 2019.

[15] H. Saediman, Y. Indarsyih, S. Abdullah, S. A. Fyka, and I. S. Mboe, "Assessing major drivers of crop shifting from rice to horticultural production: a case of Landono sub-regency in Southeast Sulawesi," *IOP Conf. Ser. Earth Environ. Sci.*, vol. 724, p. 012006, 2021.

[16] A. Tasnim, J. U. Ahmed, M. J. A. Khan, M. A. Al-Noman, A. Jannat, and M. M. Islam, "The role of livelihood diversification in agricultural modernization among tribal farmers in Bangladesh: A binary logistic model approach," *PLoS One*, vol. 20, no. 2, p. e0318457, Feb. 2025.

[17] G. Feder, R. E. Just, and D. Zilberman, "Adoption of Agricultural Innovations in Developing Countries: A Survey," *Econ. Dev. Cult. Change*, vol. 33, no. 2, pp. 255–298.

[18] P. J. M. Diederen, H. van Meijl, A. Wolters, and K. Bijak, "Innovation adoption in Agriculture: Innovators, Early Adoptors and Laggards," *Cah. d'economie Sociol. Rural.*, vol. 67, pp. 30–50, 2003.

[19] R. Andriani, B. Kusumo, E. Rasmikayati, G. W. Mukti, and S. Fatimah, "Faktor-Faktor yang Mempengaruhi Keputusan Petani Mangga dalam Pemilihan Pasar di Kabupaten Indramayu," *J. Penyul.*, vol. 15, no. 2, pp. 286–298, 2019.

[20] N. M. Anggriani, M. Edy, and S. Sofyan, "Analisis Respon Petani terhadap Kebijakan Pabrik Kelapa Sawit (PKS) di Aceh Timur," *J. Ilm. Mhs. Pertan. Unsyiah*, vol. 3, no. 2, pp. 195–206, 2018.

[21] M. Pandit, A. K. Mishra, and E. Segarra, "Adoption and Nonadoption of Precision Farming Technologies by Cotton Farmers," in *Selected Paper prepared for presentation at the Agricultural & Applied Economics Association's 2012 AAEA Annual Meeting, Seattle, Washington,* August 12-14, 2012, 2012.

[22] P. P. Grabowski, J. M. Kerr, S. Haggblade, and S. Kabwe, "Determinants of adoption and disadoption of minimum tillage by cotton farmers in eastern Zambia," *Agric. Ecosyst. Environ.*, vol. 231, pp. 54–67, Sep. 2016.

[23] M. Hayati and S. Maisaroh, "Faktor-Faktor yang Mempengaruhi Keputusan Petani dalam Pemilihan Komoditas," *J. Pamator*, vol. 12, no. 2, pp. 84–92, 2019.

[24] T. W. Schultz, *Investing in people: The economics of population quality*. Berkeley CA: University of California Press Ltd, 1981.

[25] T. Karyani, A. M. Ulfah, and M. N. Risti, "Rantai Pasok Kentang (Solanum Tuberosum) dan Faktor-Faktor yang Mempengaruhi Petani dalam Memilih Sumber Pembiayaan (Suatu Kasus di Desa Margamekar, Pangalengan, Kabupaten Bandung)," *J. Agribisnis Terpadu*, vol. 9, no. 1, pp. 1–9, 2016.

[26] S. Ruzzante, R. Labarta, and A. Bilton, "Adoption of agricultural technology in the developing world: A meta-analysis of the empirical literature," *World Dev.*, vol. 146, p. 105599, Oct. 2021.

[27] Zulkarnain and M. Sukmayanto, "Keputusan Petani Beralih Usahatani dari Tanaman Kakao menjadi Lada Di Kabupaten Lampung Timur," *J. Pemikir. Masy. Ilm. Berwawasan Agribisnis*, vol. 5, no. 2, pp. 193–205, 2019.

[28] C. Ren *et al.*, "Trade-offs in agricultural outcomes across farm sizes," *Earth Crit. Zo.*, vol. 1, no. 1, p. 100007, Jun. 2024.

[29] L. Harudu and H. Rahmaniya, "Analisis Faktor-Faktor Penyebab Alih Guna Lahan Jagung Menjadi Lahan Nilam pada Masyarakat Petani di Desa Sawerigadi Kecamatan Barangka Kabupaten Muna Barat," *J. Penelit. Pendidik. Geogr.*, vol. 4, no. 3, pp. 133–140, 2019.

[30] S. Y. N. I. Panca, "Aplikasi Logit Model dalam Menganalisis Tingkat Adopsi Petani Padi Sawah Terhadap Benih Padi Varitas Unggul di Kabupaten Bantaeng," Universitas Hasanuddin, 2023.

[31] E. W. Kamau, R. Gitau, and H. K. Bett, "Effects of adoption of ecological farming practices on farm income in rural households: Evidence from Central Kenya," *Heliyon*, vol. 10, no. 14, p. e34610, Jul. 2024.

[32] H. Saediman, S. Aisa, M. Zani, M. A. Limi, and W. O. Yusria, "Food Security Status of Households in a Cassava-Growing Village in Southeast Sulawesi, Indonesia," *J. Agric. Ext.*, vol. 23, no. 1, pp. 199–209, Jan. 2019.

[33] H. Saediman, M. A. Limi, Rosmawaty, P. Arimbawa, and Y. Indarsyih, "Cassava consumption and food security status among cassava growing households in southeast sulawesi," *Pakistan J. Nutr.*, vol. 15, no. 12, pp. 1008–1016, 2016.

[34] N. Nurniati, H. Saediman, and F. N. Sadimantara, "Assessing Food Security Status Among Coastal Households in Sambuli Village in Southeast Sulawesi," *Int. J. Res. Eng. Sci. Manag.*, vol. 7, no. 4, pp. 101–104, 2024.

[35] H. Saediman, R. W. Astuti, L. O. Alwi, M. Zani, and I. S. Mboe, "Comparative profitability of small-scale rice and horticultural farming in

South Konawe District of Southeast Sulawesi Comparative profitability of small - scale rice and horticultural farming in South Konawe District of Southeast Sulawesi," *IOP Conf. Ser. Earth Environ. Sci.*, vol. 782, p. 022036, 2021.

[36] S. Surni, H. Saediman, F. Wulandari, M. Zani, L. Yunus, and S. A. A. Taridala, "Profitability and constraints of small-scale tomato production in Baubau municipality of Southeast Sulawesi," *WSEAS Trans. Environ. Dev.*, vol. 16, pp. 219–225, 2020.

[37] U. H. Nura, Fajri, and A. Nugroho, "Contribution of Financial Institutions Towards the Development of Patchouli Agroindustry in Aceh Jaya District of Indonesia," *Russ. J. Agric. Socio-Economic Sci.*, vol. 85, no. 1, pp. 189–194, Jan. 2019.

[38] N. A. P. Lestari, B. Bahari, W. G. Abdullah, and H. Saediman, "Institutions and Partnership in Clove Farming Development: A Case of Puulemo Village in Kolaka District of Southeast Sulawesi," *Int. J. Res. Eng. Sci. Manag.*, vol. 6, no. 12, pp. 168–172, 2023.

[39] N., E. M. Harahap, C. Hanum, and L. A. M. Siregar, "Enhancement of Drought Tolerance in Patchouli (Pogostemon cablin, Benth) by Modifying Micro Climate and Frequency of Fertilization," *Indian J. Agric. Res.*, vol. 54, no. 4, pp. 501–505, Apr. 2020.

[40] I. Zikri, Agussabti, Indra, S. Kamaruzzaman, E. Susanti, and Mujiburrahmad, "Study on sustainable agriculture and dimension of needs: a case study patchouli farming in Aceh Jaya," *IOP Conf. Ser. Earth Environ. Sci.*, vol. 667, no. 1, p. 012038, Feb. 2021.

[41] J. Juanda, L. Sutiarso, M. Maksum, and D. Ismoyowati, "Study of Modernization of Distillation Units and Applications of Nonlinear ROI Equity Model: A Case of Gayo Lues Patchouli Value Chain," *Aceh Int. J. Sci. Technol.*, vol. 8, no. 3, pp. 114–126, Jan. 2020.

[42] H. Saediman, I. S. Mboe, B. Budiyanto, S. Sarinah, and H. Hidrawati, "Smallholder adoption of horticultural crops: the case of dragon fruit in Southeast Sulawesi," *IOP Conf. Ser. Earth Environ. Sci.*, vol. 819, p. 012043, 2021.