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Research Paper

Youth, Agriculture, and Food Security: Understanding the Farmer Regeneration Challenge in Sumatra

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Abstract

Agriculture plays a major role in Sumatra's economy, however, younger generations lack interest in the agriculture sector. This will affect farmer regeneration, thus threatening food security. Currently, comprehensive analyses that reveal the level of farmer regeneration remain scarce. This study seeks to examine the level of farmer regeneration by understanding the determinants of an individual to be a farmer. In addition, we aim to assess the impact of young farmers on food security by utilizing the National Labor Force Survey (*Sakernas*) from 2018 to 2022. Logistic regression is used to examine how individual characteristics influence the likelihood of being employed as a farmer. The result of the study shows that only a very limited proportion of farmers' descendants in Sumatra choose to carry on their family farming business. Typically, younger individuals, women, individuals with at least a high school degree, and those who attended training, have migrated and adopted digital technology, tend to be more reluctant to become farmers. The analysis also highlights that promoting opportunities for young farmers and lowering the prevalence of undernourishment has a favourable effect on food security. To address the low percentage of younger individuals choosing farming, policies should focus on attracting educated youth through targeted training and incentives. Enhancing digital access and modernizing agriculture can also improve productivity and food security by reducing undernourishment.

Keywords: Agriculture; Farmer Regeneration; Young Farmer; Food Security.

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1. Introduction

Sumatra plays a crucial role in Indonesia's agricultural development. This region contributes 22.04 percent to the national economy, ranking second after Java, which accounts for 56.48 percent. While agriculture, forestry, and fishing make up 21.74 percent of this region's output, the share in Java is significantly lower at 7.27 percent, nearly three times less (BPS, 2023). Data from the 2018 Inter-Censal Agricultural Survey (ICAS) indicate that at least 8.6 million people (around 14.9 percent) in Sumatra work as farmers. However, the majority of these farmers are over 45 years old, with only 3.4 percent under 25 years old (BPS, 2019). The lack of enthusiasm among the younger generation to become farmers in Sumatra poses a significant challenge to farmer regeneration. This issue, if left unaddressed, could lead to severe consequences for food security and national agricultural transformation. Several studies have pointed out that even farmers' descendants are reluctant to take up farming as a profession (Prawesti et al., 2010; Yodfiatfinda, 2020). Factors contributing to this reluctance include low income, poor working conditions, limited land access, administrative burdens, and the impact of climate change on agriculture (Borda et al., 2023).

The involvement of the younger generation is vital to the success of Indonesia's agricultural development and food security. Young people are more likely to adopt digital technology, which can modernize agricultural practices, increase productivity, and improve supply chain efficiency. Their participation can also attract investment and support innovation in food systems, contributing not only to higher production but also to better food accessibility and stability. While young people are generally more inclined to adopt digital technology, their ability to do so in rural agricultural settings is influenced by several contextual factors. Access to reliable infrastructure, digital literacy, and financial capacity play significant roles in determining whether digital tools are utilized effectively in farming. For instance, limited internet connectivity and the high cost of technology can hinder adoption among rural youth (Deichmann et al., 2016). Furthermore, strengthening domestic production is a key government strategy for improving food security. Downstream industries can contribute indirectly to farmer regeneration by creating stable and profitable market opportunities that incentivize youth to pursue farming as a viable livelihood option. Therefore, it is essential to understand the factors influencing individuals' decisions to pursue farming and assess the impact of Sumatra's younger generation on food security.

Prior research has consistently highlighted a decline in agricultural employment and a lack of interest among young people in pursuing farming as a career. A comprehensive literature review by Borda et al. (2023) confirmed a widespread decline in farmer numbers and an aging farming population. Studies have found that even children from farming backgrounds often do not express interest in agriculture, exacerbating agricultural development challenges alongside the conversion of agricultural land (Yodfiatfinda, 2020). Ningsih & Syaf (2015) suggest that social interactions and peer influences also play a role in young people's career choices, with many rural youths viewing non-agricultural professions as more viable.

Research by Geza et al. (2021) found that young people remain skeptical about agriculture's potential to improve their quality of life. Many lack an understanding of agriculture's role in economic growth, and their disinterest in farming could have serious implications for food security. Studies such as Kondo (2021) emphasize that low farmer welfare is a primary deterrent, as farming offers lower incomes and poorer working conditions compared to other sectors. Lorenzen & Lorenzen (2011) also highlight that young people often view agricultural work as physically demanding and undesirable. Additionally, increased mobility and higher education opportunities have further reduced the likelihood of young people returning to farming after completing their education (Farrell et al., 2021).

The decision to pursue farming is influenced by both external and internal factors. Borda et al. (2023) identify key characteristics such as age, gender, education level, training experience, digital technology adoption, and migration background. Several studies establish a strong relationship between education and interest in agriculture, showing that individuals with higher education tend to leave farming in search of better-paying jobs in urban areas. They perceive agriculture as labor-intensive and physically demanding, preferring work environments with better financial prospects (Borda et al., 2023).

Studies on food security have employed various methodologies. Diaz-Bonilla et al. (2000) and Díaz-Bonilla & Thomas (2015) use food availability and access indicators, such as per capita food production,

food export ratios, and calorie and protein intake per capita. Harris-Fry et al. (2015) employ a family-based approach, while Pieters et al. (2014) explore food insecurity frequency as a determinant of food security. Pawlak & Kołodziejczak (2020) further examine regional food security clustering. Research on farmer regeneration, such as Nyathi et al. (2022), emphasizes family and financial factors in youth participation in agriculture. Dimelu et al. (2020) and Daudu et al. (2023) identify household size, social group participation, land ownership, credit access, and education level as significant factors influencing young people's involvement in farming.

Despite growing interest in farmer regeneration and youth engagement in agriculture, studies that comprehensively examine the extent of farmer regeneration, the individual determinants influencing agricultural career choices, and the contribution of the younger generation to food security, particularly in Sumatra, remain scarce. Existing research, such as Haryati et al. (2024), which investigated youth disengagement from farming in Sragen, and Setiawan et al. (2019), who examined young farmers' decisions to stay in or leave the agricultural sector in West Java, provide valuable insights but are limited in scope due to their localized focus and small sample sizes. Similarly, Nugroho et al. (2024) highlight the role of access to information in shaping youth perceptions of agriculture, yet their findings are based on case studies with constrained geographic coverage. To address these limitations, this study pioneers the use of the large-scale National Labor Force Survey (*Sakernas*) conducted by BPS-Statistics Indonesia, enabling a more robust and representative analysis. By integrating an assessment of regeneration levels, determinants of farming career decisions, and young farmers' contributions to food security, this study offers a novel and holistic contribution to the discourse on agricultural sustainability and youth participation in Indonesia.

This research has several objectives. The primary goal is to assess the extent of farmer regeneration, particularly among individuals with a family farming background. The second objective is to analyze the characteristics influencing individuals' decisions to pursue farming as a profession. Lastly, the study examines the contribution of young farmers to food security in Sumatra. Unlike previous research, which has primarily focused on farmer regeneration and youth disinterest in agriculture, this study provides a holistic approach by integrating all these aspects into a single analysis.

3. Methods

The research utilizes data from the National Labor Force Survey (hereinafter referred to as *Sakernas*) from 2018 to 2022, as well as a compilation of data acquired from the BPS-Statistics Indonesia and the Ministry of Investment (MoI). The sample comprises individuals aged at least 15 years in Sumatra. There are 218,734 individuals distributed across 85,224 households under the 2022 *Sakernas*.

Several concepts and definitions, albeit limited in scope, need to be developed for the purpose of determining the extent of farmer regeneration in Sumatra. The population for this study will be categorized based on their parent or descendant status. Parents are defined as individuals whose relationship with the head of household is that of parents or parents-in-law, or the one who is the head of a household or their spouse, provided that they have at least one (biological/step/adopted) child. Conversely, an individual is considered a descendant if they are the (biological/step/adopted) child of the head of the household.

Furthermore, in the analysis, it is necessary to clarify the definition of a farmer, whether they are a parent or a descendant. For this study, farmers are defined as individuals who work in the agricultural sector with employment status including: own-account worker; employer with temporary worker/unpaid worker, and employer with permanent/paid worker.

This study employs a household-based approach to gauge farmer regeneration in Sumatra, which may lead to a potential underestimate. This is because it is difficult to determine the parent-descendant relationship when each individual has established their household, possibly as a result of marriage or divorce. This indicates that it is plausible for a child to inherit the occupation of farming from parents who also work in farming. Nevertheless, it may be challenging to identify the regeneration of farmers if both individuals have already formed their household, even if they keep living in the same house. The utilization of *Sakernas* data can serve as an effective approach to analyze the regeneration of farmers, notwithstanding the constraints that may be present.

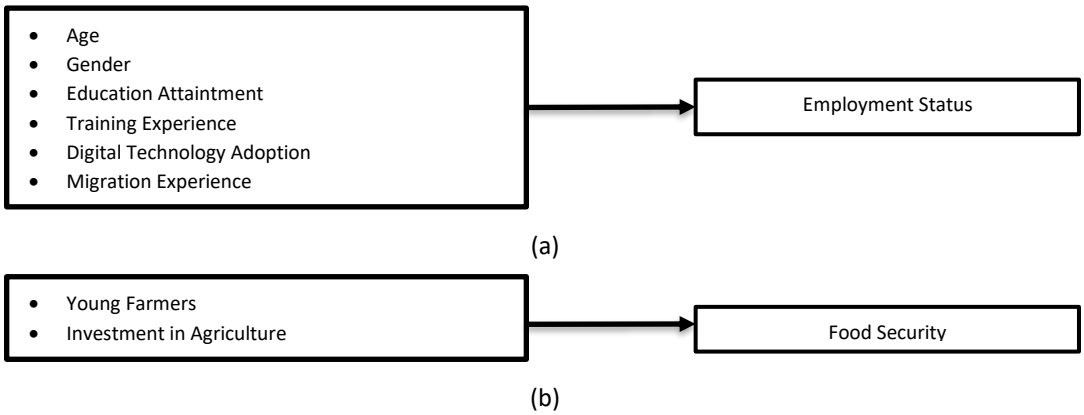

Figure 1. A conceptual framework for examining the impact of individual characteristics on the employment status (a) and the relationship between young farmers and investment in agriculture on food security (b)

Data Analysis Technique

Figure 1 illustrates the conceptual framework developed to address the study's objectives, highlighting (a) the influence of individual characteristics on employment status in agriculture, and (b) the relationship between young farmers, agricultural investment, and food security. This study employs two analytical methods. Firstly, a descriptive study will be conducted to address the first objective regarding the extent of farmer regeneration in Sumatra. In order to address other hypotheses, this research will utilize regression models, specifically binary logistic and panel regression.

Logistic regression is employed to analyze the relationship between a categorical/dichotomous dependent variable and independent variables. This regression model will be utilized to investigate the second hypothesis, which aims to comprehend the impact of individual characteristics on their employment status as farmers. The model is based on 2022 *Sakernas* data, incorporating the following specification:

$$\ln\left(\frac{\pi_{ij}}{1-\pi_{ij}}\right) = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_5 + \beta_6 x_6 \quad (1)$$

Where

π_{ij} : the probability that individual *i* in group *j* is a farmer

x_i : *i*-th variable (see Table 1)

β_0 : Intercept

β_i : parameter coefficient of the *i*-th variable

Panel regression, on the other hand, is employed to scrutinise the next hypotheses, which investigate the potential positive impacts of young farmers and investment on food security. This research employs young farmers as a proxy for potential and prospective workers in the agricultural sector in order to promote farmer regeneration.

The selection of variables in the model is based on both theoretical relevance and alignment with the research objectives. Prevalence of Undernourishment (PoU) is used as the dependent variable to proxy food security, in line with Sustainable Development Goal 2 (Zero Hunger). To capture the influence of capital in agriculture, investment is included as a key explanatory variable, comprising both foreign direct investment (FDI) and domestic investment (DI) in the agricultural sector, both commonly used in previous studies to represent capital flows and infrastructure support in agricultural productivity. These variables also serve as control variables to isolate the effects of agricultural labor composition, particularly the role of young farmers, which is central to the study's aim of examining the impact of farmer

regeneration on food security. Thus, the incorporation of these variables is grounded in empirical evidence and policy relevance.

Table 1. Description of Binary Logistic Regression Model Variables

Variable	Category	Notation
Dependent Variable		
Employment Status of Farmer	1: Farmer 0 : Not Farmer	y
Independent Variable		
Age	1 : 15 – 30 Years Old 0 : Over 30 Years Old	x_1
Sex	1 : Male 0 : Female	x_2
Education	1 : Senior high school and above 0 : Below senior high school	x_3
Training Experience	1: Have Attended Training 0 : Never Attended Training	x_4
Digital Technology Usage	1 : User 0 : Non-User	x_5
Migrant Status	1 : Migrant 0 : Non Migrant	x_6

Table 2. Description of Panel Regression Model Variable

Variable	Proxy	Unit Measurement	Notation
Dependent Variable			
Food Security	Prevalence of Undernourishment (PoU)	Point	PoU
Independent Variable			
Young Farmer	Percentage of Farmers Aged 15-30 years	Percentage	YF
Investment	Foreign Investment in the Agriculture Sector	Thousand USD	FI
	Domestic Investment in the Agriculture Sector	Million Rupiah	DI

The regression model encompasses all provinces in Sumatra from 2018 to 2022. First, the modelling process involved the selection of the Common Effect Model (CEM), Fixed Effect Model (FEM), and Random Effect Model (REM). The statistical testing method utilized to compare CEM and FEM is known as the Chow Test. The Hausman test is a statistical technique utilized to differentiate between FEM and REM. This panel model assesses the robustness of the model by examining classical assumptions, including normality, homoscedasticity, and non-multicollinearity. The panel regression model equation specifications for this research are presented in the following equation;

$$PoU_{it} = \alpha + \beta_1 \quad YF_{it} + \beta_2 \ln FI_{it} + \beta_3 \ln DI_{it} + u_{it} \tag{2}$$

$$u_{it} = \mu_i + \varepsilon_{it} \tag{3}$$

Information:

PoU_{it} : Prevalence of Undernourishment in province *i* during period *t*

YF_{it} : Percentage of Farmers Aged 15-30 years in province *i* during period *t*

FI_{it} : Foreign Investment in the Agriculture Sector in province *i* during period *t*

DI_{it} : Domestic Investment in the Agriculture Sector in province *i* during period *t*

α : Intercept

β_k : Parameter Coefficient of *k*-th Variable

μ_i : Individual effect in province *i*

ε_{it} : *Error* terms (*idiosyncratic error*)

3. Results and Discussions

3.1 Farmer Regeneration Level in Sumatra

According to Table 3, a small percentage of farmer descendants (6.71 percent) work as farmers in Sumatra. Most descendants of farmers take non-agricultural sectors as their profession choices. Consistent with the research conducted by Yodfiatfinda (2020) and Prawesti et al (2010), it has been observed that the percentage of descendants of farmers who choose to pursue farming as a profession is exceedingly low. The reluctance among farmer descendants to engage in farming can be attributed to several factors, including low income, poor working conditions, limited land access, administrative burdens, and the adverse effects of climate change on agriculture (Borda et al., 2023). These challenges contribute to the perception of farming as an unattractive and less viable career option, leading many to seek opportunities in other sectors. This suggests that only a minority of farmers' descendants possess a willingness to work in the agricultural sector. Figure 2 illustrates the distribution of descendants of farmers in Sumatra who opt to pursue a profession in agriculture. The highest proportion of farmer descendants working in agriculture is observed in South Sumatra, which falls within the darkest green category (8.4–11.2 percent). This suggests that South Sumatra maintains a relatively strong continuity of agricultural work among farming families. Moderate levels of participation (5.9–8.4 percent) are identified in provinces such as Jambi, Riau, and Lampung. In contrast, the provinces in the northern and western parts of Sumatra, such as Aceh and West Sumatra, show the lowest proportions of farmer descendants engaged in agriculture (1.1–4.1percent).

Table 3. Distribution of descendants and their parents by sector in Sumatra

		Parents		Total
		Agriculture	Non-Agriculture	
Descendants	Agriculture	6.71	1.73	3.70
	Non-Agriculture	93.29	98.27	96.30
Total		100	100	100

Source: *Sakernas* 2022, processed.

Table 4. Distribution of descendants and their parents by sector in Indonesia

		Parents		Total
		Agriculture	Non-Agriculture	
Descendants	Agriculture	5.48	1.11	2.45
	Non-Agriculture	94.52	98.89	97.55
Total		100	100	100

Source: *Sakernas* 2022, processed.

The rate of farmer regeneration in Sumatra remains better than the national level. Table 4 shows that the percentage of descendants of farmers who choose to pursue working in the agriculture sector as a profession at the national level is only 5.48 percent. Meanwhile, there are 1.73 percent in Sumatra and 1.11 percent nationwide of children without a family-farming background who become farmers. Looking more broadly, Sumatra has a somewhat greater percentage of descendants who work in the agriculture sector (3.70 percent) than the national level (2.45 percent). This suggests that the sustainability of the agricultural sector in Sumatra, a region that continues to significantly depend on agriculture, remains better than that of the national level.

Education is one indicator determining the quality of descendants who choose to become farmers. It is intuitively possible to determine whether descendants who become farmers do so voluntarily or if they have no other option in choosing their job due to extreme poverty conditions, for example. According to data from the BPS-Statistics Indonesia in 2019, there are 49.89 percent of poor households work in the agriculture sector (BPS, 2019).

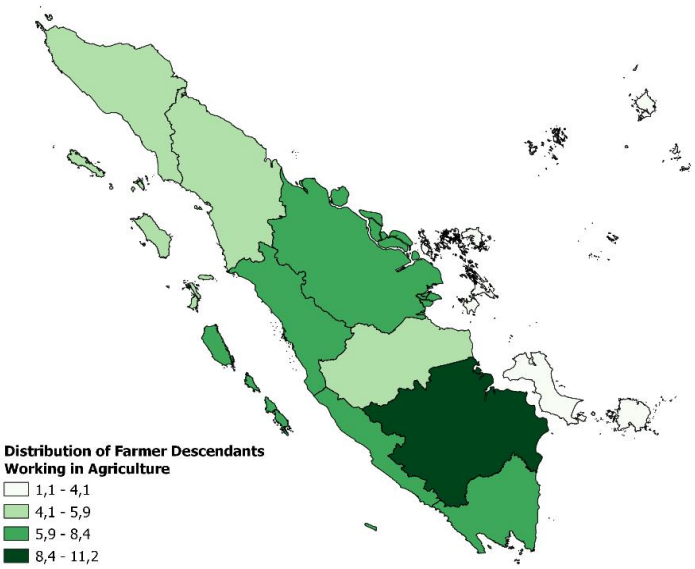

Figure 2. Distribution of Farmer Descendants Working in Agriculture in Sumatra, 2022

Source: *Sakernas* 2022, processed.

Figure 3 depicts that the percentage of descendants who never attended school and have completed their elementary school level is higher among descendants with a family-farming background (27.09 percent) than among descendants without a family-farming background (28.91 percent). Conversely, descendants who decided not to follow in their parents' footsteps as farmers acquired considerably better education, with approximately 17 percent of them successfully finishing elementary school, while 10.13 percent proceeded to obtain a college degree. Both descendants with and without family farming background exhibit similar characteristics, however, the percentage of descendants without family farming background who have only completed elementary school is greater than that of descendants from farmer parents. It indicates that the competency of a descendant who decides to pursue a profession in farming is not better than those who take employment in other sectors.

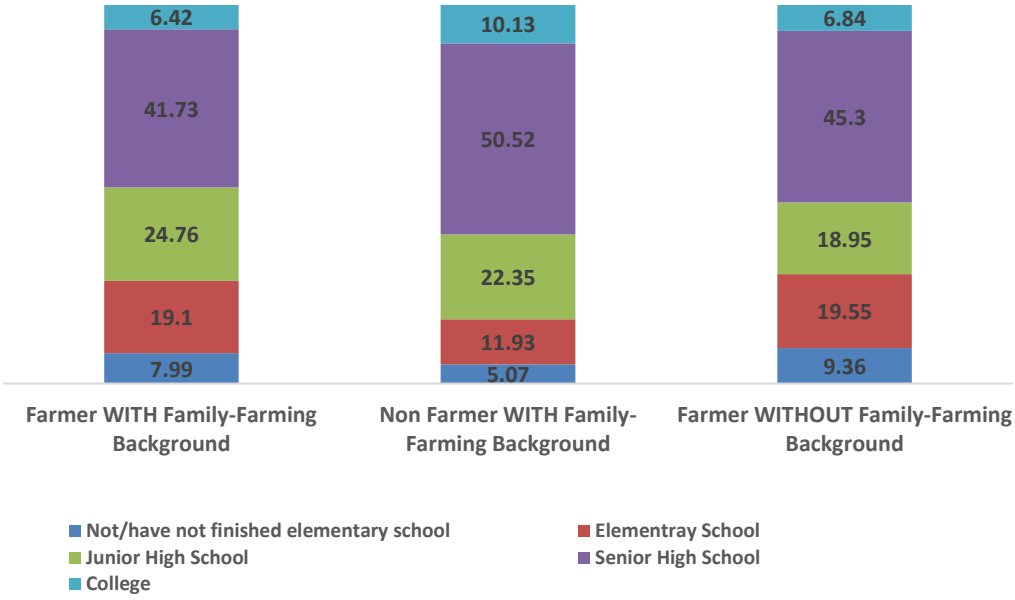

Figure 3. Comparison of a descendant's decision to become a farmer based on the educational background and profession of their parents
Source: *Sakernas* 2022, processed.

Table 5. Employment Conditions of Descendants with and without Family-Farming Background

Conditions	Descendants with a family-farming background working as farmers	Descendants with a family-farming background NOT working as farmers	Descendants without a family-farming background working as farmers
Internet and digital technology adoption (percent)	16.65	76.06	69.92
Income (Rupiah)	1,557,356	1,677,521	1,663,030
Having more than one job (percent)	17.83	12.13	25.84
Average of working hours per week	32.61	40.33	31.13

Source: *Sakernas* 2022, processed.

Table 5 provides further information on the comparison between the three groups. The level of digital technology adoption differs significantly among each group. Descendants with and without a family-farming background who are engaged in agricultural sectors exhibit a comparatively lower rate of embracing digital technology, in contrast to descendants who participate not in agricultural sectors despite having a family-farming background. The high degree of digital technology adoption is directly proportional to each group's income level. Greater levels of digital technology usage are associated with significantly greater incomes for groups. When considering individuals who have more than one job, it is observed that descendants who work in agriculture with farmer parents have a comparatively lower percentage, with their working hours typically being the longest. This suggests that the likelihood or tendency to seek alternative employment is lower in comparison to a descendant who chooses to pursue farming, regardless of whether their parents are farmers or not.

3.2 Effect of Individual Characteristics on the Motivation to Work as Farmers in Sumatra

The motivation of someone to become a farmer is influenced by various individual characteristics. Using binary logistic regression, the relationship between individual characteristics and the decision to become a farmer was examined, based on the framework in Figure 1a. Table 6 presents the estimation result summary of the relationship between employment status and individual characteristics (Appendix 2 provides the complete estimation result). The model employed has a strong correlation with a significance level of one percent. Furthermore, all variables have a significant impact with various directions of correlation.

Table 6. Binary Logistic Regression Model Parameter Estimation

Variable	Coefficient	Odds Ratio	P-value
Intercept	-1.3491	0.26	0.0000
Age (x_1)	-1.5765	0.21	0.0000
Sex (x_2)	1.4959	4.46	0.0000
Education (x_3)	-0.5940	0.55	0.0000
Training Experience (x_4)	-2.2521	0.11	0.0000
Digital Technology Usage (x_5)	-1.5290	0.22	0.0000
Migrant Status (x_6)	-4.1604	0.02	0.0000

Age is one of the significant determinants in determining an individual's choice to participate in agriculture. Younger people have a propensity to pursue a profession in farming at a rate of 0.26, or stated, the likelihood of younger people not pursuing a profession in agriculture is 3.85 times greater than that of older people. It may be related to the percentage of agricultural workers in Sumatra amounts to a

mere 19.53 percent (as indicated in Appendix 1). Sumberg et al (2017) argued that youth's disinterest in pursuing a profession in agriculture is directly related to the low rate of farmer regeneration. The perception that work in the agriculture sector is less prestigious is the cause of the lack of interest (Özçatalbaş & Imran, 2020). According to Geza et al. (2021), there exists a negative perception among young people concerning the potential of agriculture to enhance their overall welfare. Another obstacle that develops is the reluctance of parents to encourage their children to pursue opportunities in agriculture; instead, they prefer their children to have white-collar occupations that are perceived to offer greater revenue with lower risks (Chinsinga & Chasukwa, 2018; Yeboah & Jayne, 2018).

Men exhibit a significantly higher tendency towards performing agricultural activities, with a ratio of 4.46 times more likely than women. One of the factors that drives women not to work as farmers is the inequality in compensation obtained by men and women (Unay-Gailhard et al., 2019). As stated by Fanelli (2022), particularly in high-income and middle-income countries, the share of women in the agricultural sector remains comparatively limited. Moreover, women exhibit a higher propensity to undertake domestic chores than men (Huyer et al., 2015). Land ownership remains predominantly male-dominated, which consequently restricts women's access to the capital necessary to become farmers. The findings of the 2021 SITASI survey indicate that a disparity persists between males and females in terms of secure agricultural land tenure (BPS, 2022).

One of the factors contributing to increased productivity, particularly in the agricultural sector, is a higher level of education, which enables one to cultivate agricultural land more effectively (Ninh, 2021). Educated farmers possess not only the ability to effectively employ existing information but also enhanced accessibility to that which they require. Consequently, farmers who have received greater education can select a combination of agricultural resources that is more effective compared to farmers with lesser levels of knowledge (Reimers & Klasen, 2013).

Individuals who have completed senior high school or vocational school have a 0.55 times greater likelihood of becoming small farmers. In other words, individuals with at least a senior high school or vocational school education have a 1.82 times greater likelihood of taking part in farming. This model indicates that individuals with advanced degrees are hesitant to pursue farming as a profession. One of the reasons is the belief that experience is more important than a college degree in becoming a farmer. This presumption, nevertheless, is invalid in the context of high-productivity and production-driven agriculture, which needs the use of advanced seeds, genetic engineering, digital technology, and contemporary agricultural methods. In addition to this, farming continues to be regarded as an unpromising occupation that fails to offer adequate financial support and well-being (Ningsih & Syaf, 2015).

Engaging in training, similar to pursuing education, seeks to enhance professional competencies and proficiencies in order to boost productivity and consequently raise living standards. Participating in training activities increases the likelihood of becoming a farmer by 0.11. In other words, the likelihood of an individual not becoming a farmer is 9.09 times greater than the likelihood of them becoming a farmer after receiving training.

The use of digital technology has a role to play in enhancing production and economic productivity, particularly in agriculture. Digitalization offers the agriculture sector the chance to enhance the quality of its workers and their output (Pauschinger & Klauser, 2022; Skvortsov, 2020). Individuals who utilize digital technology and the internet have a 0.22 percent reduced probability of becoming farmers. This indicates that internet and digital technology users have a 4.54-fold lower probability of being employed as farmers. According to the data presented in Table 5, only a small percentage of farmers from agricultural households make use of digital technology in their jobs.

Furthermore, when farmers are learning agricultural techniques, they will rely on the experience of traditional farmers rather than the information and digital technology offered by experts and the government (Rust et al., 2022). The idea of digital technology being costly creates a disparity in its adoption among farmers and workers in the agricultural sectors (Bontsa et al., 2023). This should be a priority, since the use of digital technology among farmers can enhance their knowledge of agricultural technology, marketing, and agriculture methods, leading to higher income and productivity (Mdoda & Mdiya, 2022).

Considering the migration experience of the population, individuals who are migrants have a relatively low tendency to pursue farming, with a likelihood of 0.02 times. Conversely, their likelihood of not becoming farmers is 50 times higher. The limited involvement of migrants in farming can be attributed to their restricted land ownership, as evidenced by Gunawan et al. (2016) and Wijaya & Syairozi (2020). Individuals with restricted land resources in both their destination and origin regions, particularly households with limited agricultural land, have a tendency to migrate even in the short term (Chandrasekhar & Sahoo, 2019). Although not engaged in agriculture, the movement pattern, particularly from Java to Sumatra and Kalimantan, predominantly consists of individuals seeking employment as plantation workers.

3.3 Relationships among Young Farmers in Sumatra and Food Security

The Sustainable Development Goals (SDGs) have established a second objective to eradicate hunger, achieve food security and enhance nutrition, and promote sustainable agriculture. The prevalence of undernourishment is one of the indicator variables in SDG 2.1.1. This indicator quantifies the percentage of the population whose typical food intake does not provide enough energy to meet their energy needs. As the value of this indicator increases, the level of food security in the area decreases, or the level of food insecurity increases, and vice versa. Figure 4 depicts the prevalence of undernourishment in Sumatra by province over two time periods, 2018 and 2022. In 2022, the majority of provinces, including Aceh, Riau, Jambi, Bengkulu, Lampung, Bangka Belitung, and the Riau Islands, are expected to witness a substantial rise in their numbers, ranging from 10.8 to 15.2 percent. In contrast, North Sumatra and West Sumatra exhibit comparatively higher levels of food security, ranging from 5.8 to 8.7 percent. The only province in which the prevalence of undernourishment has decreased is South Sumatra.

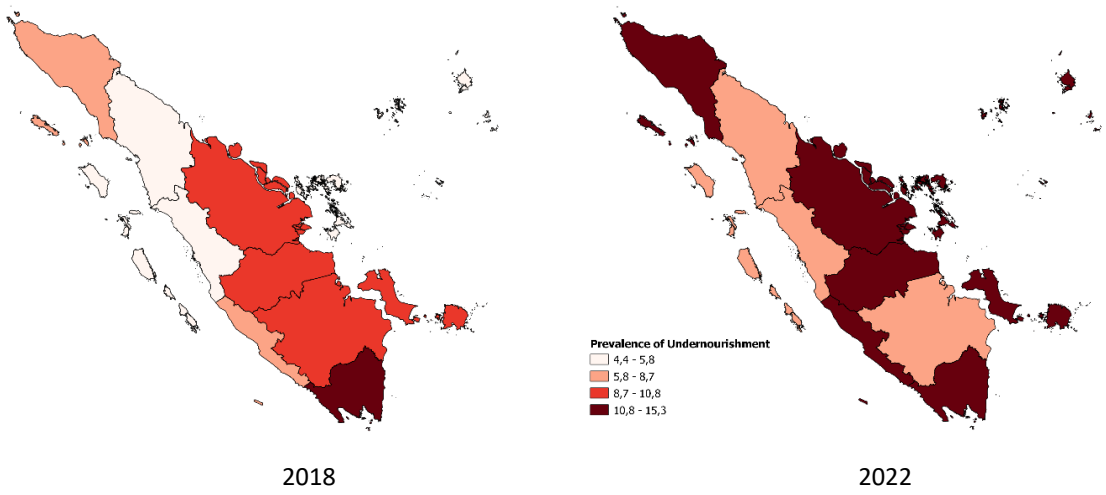

Figure 4. Prevalence of Undernourishment in Sumatra by Province, 2018, and 2022
Sources: *Susenas* 2018 and *Sakernas* 2022, processed.

Figure 5 demonstrates that, except for West Sumatra and Jambi, the percentage of young farmers has remained relatively constant over the past five years. The proportion of young farmers witnessed a rise in West Sumatra but a decline in Jambi. Several other provinces have tended to be in the same value group over the last five years.

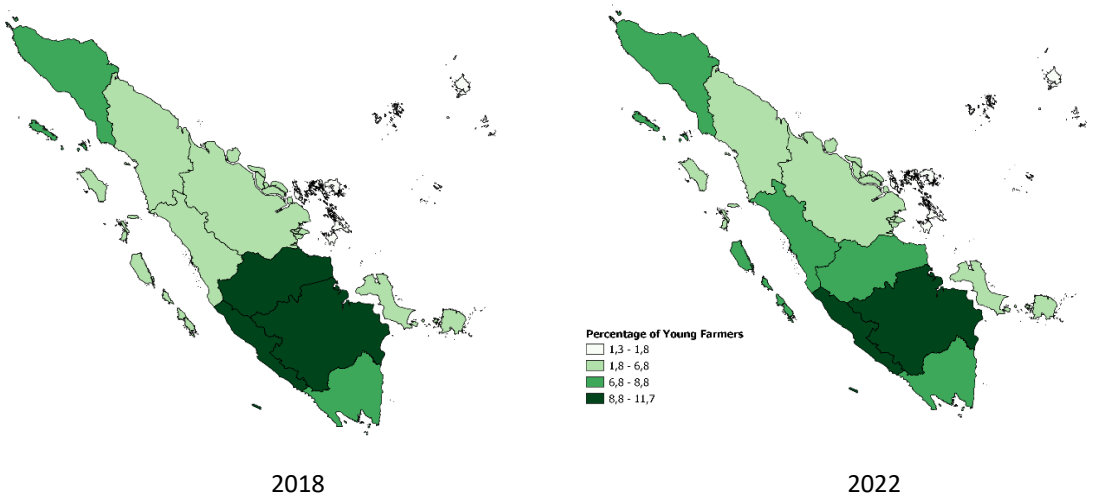

Figure 5. Percentage of Young Farmers in Sumatra by Province, 2018, and 2022
Sources: *Susenas* 2018 and *Sakernas* 2022, processed.

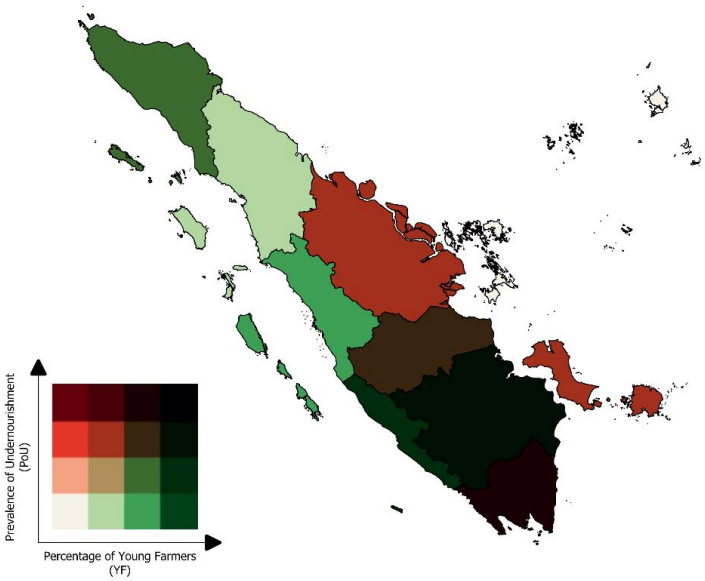

Figure 6. Relationship between the Prevalence of Undernourishment and the Percentage of Young Farmers in Sumatra by Province, 2022
Sources: *Susenas* 2018 and *Sakernas* 2022, processed.

A bivariate choropleth in Figure 6 illustrates the correlation between the proportion of young farmers and the prevalence of undernourishment in 2022. In contrast to other provinces, South Sumatra and Lampung have a higher proportion of young farmers, as evidenced by their darker hues; however, these regions also have a high prevalence of undernourishment. Conversely, Bengkulu exhibits a prominent dark green hue, indicating a higher proportion of young agricultural workers compared to other provinces in Sumatra. Additionally, it has a relatively low prevalence of undernourishment. West Sumatra exhibits a similar correlation, but with a little lower percentage of young farmers than Bengkulu. Particular consideration should be given to provinces, such as Riau and the Bangka Belitung Islands, which have a comparatively low proportion of young farmers but a high prevalence of undernourishment.

3.4 Relationship between Investment and Food Security in Sumatra

Investment is a crucial component of capital in the production process, which has the potential to enhance output. Increased investment in the agricultural sector is expected to enhance agricultural production, hence positively influencing food security. Investment is categorized into two types: domestic investment and foreign investment. Figure 7 illustrates the correlation between foreign investment and

the prevalence of undernourishment. Bengkulu and West Sumatra have higher levels of foreign investment (FI) in the agriculture sector and a lower prevalence of undernourishment. Despite receiving substantial FI in the agricultural sector, the prevalence of undernourishment remains high in the Bangka Belitung Islands, which deserves attention.

Figure 8 illustrates the relationship between domestic investment in the agricultural sector and the prevalence of undernourishment. The pattern seen in this figure is similar to that of FI in the agricultural sector. Bengkulu and West Sumatra continue to exhibit the same trend as before, characterized by significant domestic investment in the agricultural sector and a relatively low prevalence of undernourishment. Despite significant domestic investments in agriculture, the Bangka Belitung Islands and Jambi have a high prevalence of undernourishment.

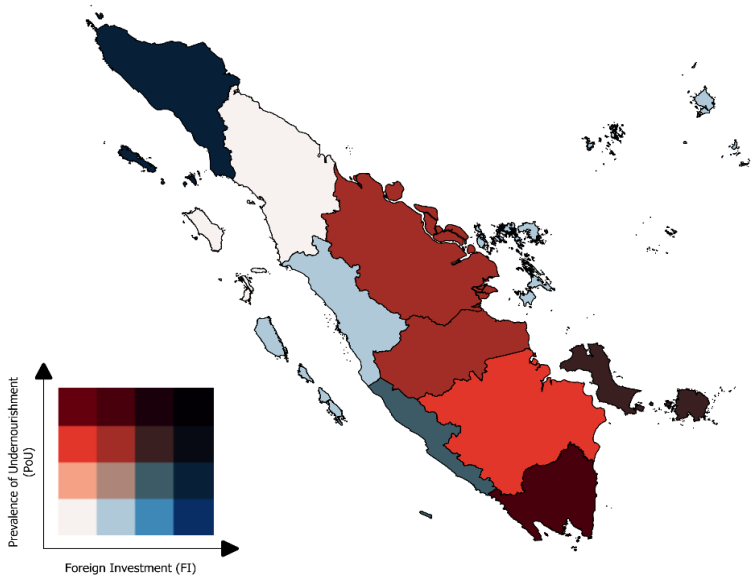

Figure 7. Relationship between the Prevalence of Undernourishment and Foreign Investment (FI), 2022
Sources: *Susenas* 2022 and BKPM 2022, processed.

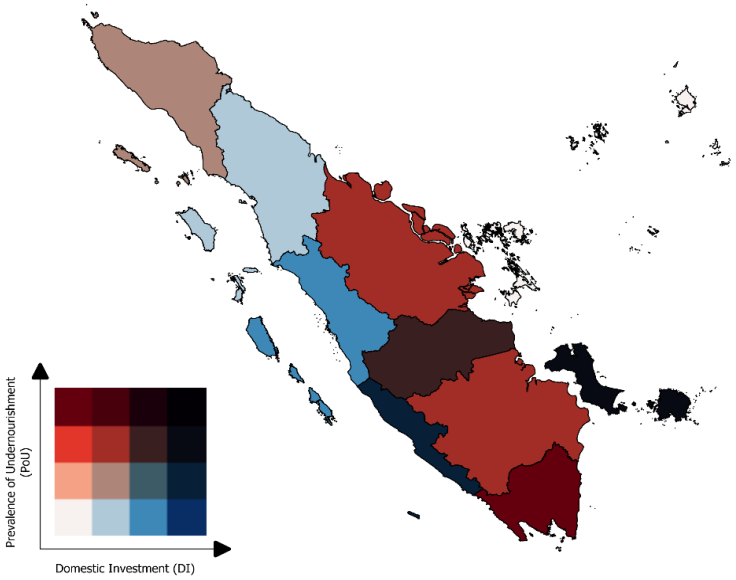

Figure 8. Relationship between the Prevalence of Undernourishment and Domestic Investment (DI), 2022
Sources: *Susenas* 2022 and BKPM 2022, processed.

3.5 Regression Model on the Impact of Young Farmers and Investment on Food Security in Sumatra

To address the final two hypotheses about the impact of young farmers and investment on food security in Sumatra, panel regression analysis was employed. First, the basic model of panel regression from equations (2-3) is chosen, which includes the Common Effect Model (CEM), Fixed Effect Model (FEM), and Random Effect Model (REM). Model selection is conducted using Chow and Hausman tests, as described in Appendix 4.

Following this, a variance-covariance structure test was conducted (see Appendix 5). The results indicated that both the LM and λ_{LM} tests were statistically significant, leading to the selection of the FEM cross section weight with robust coefficient covariance cross section SUR (PCSE) model. This approach handles non-identical residuals (heteroscedasticity) and cross-sectional correlation (Religi & Purwanti, 2017). Table 7 displays the chosen model, specifically the Fixed Effect Model (FEM). The chosen model satisfies the assumptions of normality and non-multicollinearity (see Appendix 6). Table 7 contains the estimated model parameter coefficients, which are represented by the following equation:

$$\ln \widehat{PoU}_{it} = (3{,}896 + \hat{\mu}_i) - 0{,}577 \ln YF^*_{it} + 0{,}018 \ln FDI_{it} - 0{,}066 \ln DI^*_{it} \quad (4)$$

Young individuals serve as pivotal agents of change across all facets of food systems, actively participating in the food and agriculture supply chains as both a profession and a means of livelihood (HLPE, 2021). The agricultural sector offers substantial entrepreneurial and employment opportunities, particularly for the youth demographic (Geza et al., 2021).

Table 7. Parameter Estimation of Panel Regression Model

Variable	Coefficient	t-Statistics	P-value
Intercept	3.896	5.52	0.000
Young Farmers (percent)	-0.577	-2.09	0.043
FI (Foreign Investment)	0.018	0.82	0.417
DI (Domestic Investment)	-0.066	-2.82	0.008

Young farmers have a crucial role in promoting and ensuring regional food security. According to the data in Table 7, there is a strong and statistically significant correlation between young farmers and a higher prevalence of undernourishment. An increase of one percent in the number of young farmers results in a decrease of 0.577 percent in the prevalence of undernourishment. The significance and impact of these two variables demonstrate the critical nature of the regeneration of farmers. The excess labor supply from the young generation can be maximally absorbed into the job market. Encouraging investment and implementing supportive policies in agriculture can create productive employment prospects for the younger generation (Proctor & Lucchesi, 2012). The low rate of farmer regeneration is a barrier to attracting young people to the agricultural sector.

In addition to the participation of young farmers, the capital in the form of domestic or foreign investment is expected to also serve as a crucial factor in agricultural development. The presence of domestic investment in the agricultural sector significantly and negatively impacts the prevalence of undernourishment. A one percent rise in domestic investment will result in a 0.066 percent decrease in the prevalence of undernourishment.

In contrast, the relationship between FI and the agricultural sector is positive but not statistically significant. Consistent with the findings of Yao et al. (2020), it was observed that FI did not exert a substantial impact on the sufficiency of energy needed. Every developing country experiences a disparity between expected results and actual results regarding the flow of foreign investment (FI) to enhance food security (Jiang & Chen, 2020). Foreign investors produce food crops not always to meet the demands of the domestic market, but rather to supply the investor country or the world at large (Doğan, 2022). As a result, PMA does not consistently contribute to the improvement of food security.

These findings underscore the importance of prioritizing youth engagement and domestic investment in agriculture to strengthen food security in the region. Policies that support young farmers, such as access to land, training, and modern agricultural technology, can help reverse the declining interest in farming and enhance productivity. At the same time, fostering a conducive environment for

domestic investment is vital, as it directly contributes to reducing undernourishment. Conversely, the limited impact of foreign investment suggests the need for more strategic alignment of FI with national food security goals. Together, these insights call for targeted interventions that integrate youth empowerment and investment strategies into agricultural and food security policies.

Conclusion

Agriculture remains a vital sector in Sumatra, contributing significantly to the economy and employment. However, the declining interest of younger generations in farming presents a serious challenge, particularly for food security. This study highlighted the extent of farmer regeneration in Sumatra, identifying key individual characteristics influencing the decision to become farmers. The findings indicate that farmer regeneration in Sumatra remains alarmingly low. Only 6.71 percent of children from farming families continue working in agriculture, while the majority opt for non-agricultural careers. Among children without a family farming background, only 1.73 percent become farmers. South Sumatra Province has the highest percentage of children from farming families who pursue agriculture. While this problem is not exclusive to Sumatra, the region fares slightly better than the national average in terms of farmer regeneration. However, further analysis reveals that those who choose farming tend to have lower educational attainment compared to those pursuing careers outside agriculture. The study also highlights the economic disparities between young farmers and their peers in other sectors. Due to their widespread adoption of digital technology, non-farming youth earn higher incomes than those who remain in agriculture. Regression models indicate that young farmers positively impact food security by reducing the Prevalence of Undernourishment (PoU) in Sumatra. Additionally, increased domestic investment in agriculture correlates with lower PoU, while foreign investment has no significant effect.

The findings present several policy implications. The government must take proactive measures to ensure a sustainable future for farmers. Implementing farmer-friendly policies, such as subsidies for fertilizers, seeds, agricultural machinery, and training programs, can improve agricultural productivity and farmer welfare. Encouraging educated individuals from farming families to continue agricultural work could be beneficial. Higher education enables them to integrate digital technology into farming, fostering innovation and modernization. Moreover, creating a supportive investment environment, particularly for domestic investors, is crucial for the sustainable development of the agricultural sector in Sumatra. These policy directions align with Sustainable Development Goals, particularly SDG 2 (Zero Hunger), SDG 4 (Quality Education), and SDG 8 (Decent Work and Economic Growth), as well as the RPJMN 2020–2024 focus areas related to human capital development, economic transformation, and regional development. While broader, these recommendations are grounded in the study's empirical findings and offer a practical roadmap for ensuring the future of farming in Sumatra.

Limitations

Despite its contributions, this study has several limitations. First, it primarily focuses on individual characteristics influencing farmer regeneration, without an extensive examination of external factors such as land availability, policy support, and market access. Future research should incorporate these aspects for a more holistic understanding. Second, while the study establishes correlations between young farmers and food security, it does not establish direct causality. Further research employing longitudinal data and experimental approaches would strengthen these findings. Lastly, the study relies on regional-level data, which may not fully capture local variations within provinces. More granular data analysis could provide deeper insights into specific challenges and solutions for different areas within Sumatra.

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Appendices

Appendix 1. Descriptive Statistics of Individual Characteristics

Variable	Category	Percentage
	Dependent Variable	
Farmers Working Status	Farmer	19.53
	Non Farmer	80.47
	Independent Variable	
Age	15 – 30 years	27.78
	Greater than 30 years	72.22
Gender	Men	62.47
	Women	37.53
Education	Senior High / Vocational School and above	47.12
	Less than Senior High / Vocational School	52.88
Training	Have Attended Training	19.59
	Never Attended Training	80.41
Digital Technology Usage	User	34.37
	Non User	65.63
Migrant	Migrant	29.56
	Non Migrant	70.44

Appendix 2. *Goodness of Fit* of Binary Logistic Regression Model

Tests	*Chi-square*	Probability
Chi-Square Goodness Of Fit Tests	5.573	0.02
Omnimbus Test of Model Coefficient	28,622.89	0.00

Appendix 3. Descriptive Statistics of Panel Data

Variable	Obs.	Unit	Mean	Std. Dev	Min	Max
Prevalence of Undernourishment	50	Point	8.88	2.59	4.08	15.19
Young Farmer Percentage	50	Percent	6.73	2.52	1.30	11.66
Foreign Investment	50	000 USD	62,957.47	105.161.20	1,407.40	446,694.60
Domestic Investment	50	Billion Rupiah	1,959,790.91	2,751,881.84	30,243.80	12,176,006.20

Appendix 4. Panel Regression Model Selection

Tests	Statistics	Probability	Conclusion
Chow	7.01	0.000	*Fixed Effect Model*
Hausman	7.52	0.057	

Appendix 5. Variance-Covariance Structure Test

Assumptions	Test	Statistics	Probability	Conclusion
Homoscedasticity	LM	24.014	0.004	Not satisfied
Cross-Sectional Dependence	Lambda LM (λ_{LM})	191.277	0.000	Not satisfied

Appendix 6. Classical Assumption Test

Assumptions	Test	Statistics	Probability	Conclusion
Normality	Jarque-Bera	1.861	0.394	Satisfied
Non-multicollinearity	VIF	$\ln(YF) : 1.001$ $\ln(FDI) : 1.390$ $\ln(DI) : 1.389$	-	Satisfied

Appendix 7. Individual Effects

Provinces	Individual Effects
Aceh	0.132
Sumatra Utara	-0.435
Sumatra Barat	-0.274
Riau	0.106
Jambi	0.347
Sumatra Selatan	0.243
Bengkulu	0.336
Lampung	0.497
Kep Bangka Belitung	0.096
Kep Riau	-1.049