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ARTICLE

Effects of Aging Society on Labor Productivity: A Case Study of Thailand's Longan Production

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ABSTRACT

The objectives of this research were to examine the effects of an aging society on labor productivity within the Thai longan production sector, as well as to assess the technical efficiency associated with this demographic shift. Data were collected from a sample of 400 longan farmers, employing the Ordinary Least Squares (OLS) regression to investigate the relationship between the aging population and labor productivity in longan cultivation. Additionally, the Stochastic Frontier Model (SFM) was utilized to evaluate technical efficiency and its correlation with productivity in the context of an aging society. The findings suggest that the predominant segment of longan production in Thailand is supported by a workforce characterized by an average age of approximately 57 years. By the year 2025, the impact of Thailand's aging population may result in a significant number of longan farmers ceasing production due to health-related issues and diminished selling prices. Thus, projections indicate a potential decline in both the yield and the area cultivated for longan. Moreover, the transition into an aging society is likely to adversely affect labor productivity in agricultural production. Despite the current high level of technical efficiency in longan production, the aging of farmers is expected to lead to a reduction in overall productivity.

Keywords: Aging Society; Longan Production; Technical Efficiency; Labor Productivity

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1. Introduction

Population aging represents a significant global phenomenon that engenders multifaceted challenges across economic, political, and social spheres worldwide [1]. This demographic shift is increasingly evident in both developed and developing nations [2]. Notably, the incidence of population aging tends to be more pronounced in rural areas compared to urban centers [3]. Aging is increasingly evident in developed countries and is also becoming more prevalent in developing countries [4]. This disparity can be attributed to the age-selective nature of rural-to-urban migration, which predominantly involves younger adults relocating to urban environments in pursuit of enhanced employment opportunities [5]. Consequently, rural areas are left with a higher proportion of elderly individuals. As younger populations exit the agricultural sector, the significance of an aging farming demographic becomes increasingly prominent. This trend leads to a greater reliance on elderly individuals for labor within the agricultural industry. In many developing countries characterized by low capital-intensive agricultural systems, the aging of producers may correlate with a decline in labor productivity. The irreversible trend of an aging agricultural workforce represents a critical issue in the context of China's economic transformation, profoundly affecting the availability of agricultural labor, the allocation of production inputs, agricultural production efficiency, and the evolution of modern agricultural practices. Considering these developments, it is imperative to investigate the mechanisms through which an aging rural labor force impacts agricultural production. Such analysis is essential for formulating policy recommendations aimed at alleviating the challenges posed by population aging in the agricultural sector.

Longan represents one of Thailand's most significant economic fruits. The exportation of this fruit contributes to domestic income exceeding one billion baht annually, with both export value and quantity growing steadily each year. The primary importer of Thai longan is Mainland China, reflecting a persistent demand in this market. Cultural beliefs among Chinese consumers regard longan, commonly referred to as "dragon eye fruit," as a symbol of good fortune, as well as possessing medicinal properties. Despite the high demand, the production capacity within Mainland China is insufficient, with domestic output estimated to average 1.25 million tons per year, significantly below the consumption requirement of approximately 2 million tons. Thai longan distinguishes itself through its superior quality, sweetness, size, texture, and fine grain, setting it apart from the smaller, less sweet "Ping pong" longan varieties found in Vietnam. Facilitated by improved transportation infrastructure, including the routes of R12 and R3A that link Thailand, Laos, Vietnam, and Mainland China, the exportation of Thai longan has become increasingly efficient. Furthermore, the repeal of Thailand's tariffs on fruit imports under the ASEAN–China FTA has enhanced the convenience of longan exports to the Chinese market. The aging of the agricultural labor force has significant ramifications, particularly regarding its physical contributions to production in the apple sector. This demographic shift results in a dual decrease in labor supply: both in quantitative and qualitative dimensions. As individuals age, there is an inevitable decline in physical capacity, which can lead to a reduction in working hours, diminished productivity, or an overall withdrawal from the labor force. Consequently, farms engaged in apple production may experience a notable decrease in the total labor input provided by family members and other workers. Moreover, the adverse effects of aging extend beyond mere availability of labor; they also compromise the quality and efficiency of agricultural practices. Aging laborers may face limitations in their physical strength and endurance, rendering them less capable of executing labor-intensive management tasks within the orchard environment, such as shaking fruit from trees.

Thus, the implications of an aging agricultural workforce underscore the necessity for strategic adaptations within farming practices, potentially incorporating technological advancements or modified labor strategies to mitigate the challenges posed by this demographic transition. The aging of the agricultural labor force has significant effects, particularly regarding its physical contributions to production in the longan sector. This demographic shift results in a dual decrease in labor supply: both in quantitative and qualitative dimensions. As individuals age, there is an inevitable decline in physical capacity, which can lead to a reduction in working hours, diminished productivity, or an overall withdrawal from the labor force. Consequently, farms engaged in longan production may experience a notable decrease in the total labor input provided by family members and other workers. Moreover, the adverse effects of aging extend beyond mere availability of labor; they also compromise the quality and efficiency of agricultural practices. Aging laborers may face limitations in their physical strength and endurance, rendering them less capable of executing labor-intensive management tasks within the orchard environment, such as shaking fruit from trees. Thus, the implications of an aging agricultural workforce underscore the necessity for strategic adaptations within farming practices, potentially incorporating technological advancements or modified labor strategies to mitigate the challenges posed by this demographic transition.

An analysis of the longan cultivation landscape in Thailand reveals that as of 2023, the total perennial area dedicated to longan farming measured 1,695,554 rai, representing a modest decrease of 2.47 percent from the previous year. This stagnation has corresponded with a 9.03 percent decline in net production, indicating a decrease in yield per rai in the country's longan output. Data shows that there are approximately 197,346 households engaged in longan cultivation nationwide, with over 82.53 percent of these households located in northern Thailand. The highest concentration of longan farming households belongs to Chiang Mai, Lamphun, and Chiang Rai, which collectively account for 162,874 households, or 65 percent of all longan farming households in Thailand, as presented in **Table 1**.

Table 1. The number of perennial areas and longan farmers' households in 2022–2023.

Province	Perennial Areas (Rai) in 2022	Perennial Areas (Rai) in 2023	Households in 2022	Households in 2023
Chiang Mai	456,444	453,443	72,540	72,396
Lamphun	367,943	363,626	51,206	50,805
Chiang Rai	245,311	238,128	40,458	39,673
Payao	96,504	94,311	19,840	19,601
Lampang	24,047	24,047	6,933	6,933
Tak	30,410	30,212	4,534	4,527
Kamphaeng Phet	12,084	11,680	1,588	1,585
Phrae	3,732	3,614	1,334	1,285
Sukhothai	1,510	1,416	544	541
Others	500,521	475,077	54,170	53,526
Total in Northern	1,738,506	1,695,554	253,147	250,872

Source: Office of Agriculture Economics [6].

Current remarks indicate that perennial areas and the number of longan farming households in Thailand are inclined to decrease since agricultural workers continuously move to the industrial sector, and the remaining agricultural workers are increasingly entering an aging society. Moreover, hard work, unstable income, and the lack of welfare and labor protection cause the new generation to lack motivation to enter the agricultural sector, leading to a shortage of labor in the agricultural sector. In addition, entering an aging society is a significant structural change in the Thai economy as stated by UN World Population Prospects, that many countries, including Thailand, are completely entering an aging society [7]. The elderly population in Thailand has increased dramatically, while the working-age population declines sharply compared to other countries in ASEAN. Regarding research from the Bank of Thailand, it implied that entering an aging society could affect economic growth by decreasing the quality and quantity of labor. The slowdown in future household consumption can also cause deterioration in the financial stability of Thai households.

Regarding the reasons mentioned above, the trend of aging, especially in the agricultural workforce represents a critical issue in the context of Thailand's economy. This means that the study of the impact of the agricultural workforce in an aging society leads to the policy development and proper strategy. Studies on the aging society and longan productivity have never been conducted before, so the researcher wanted to study this issue for the reasons stated above.

Hence, the research team is interested in studying how an aging society impacts longan's labor productivity in Thailand which is confronting with the labor reduction issue including the change in the population structure that is in the opposite direction of longan's demand in foreign countries. Moreover, the technical efficiency in longan production has also been studied under the changing demographics of Thailand. The results of the study can be presented.

2. Literature Reviews

The research team aims to investigate the effects of an aging society on the labor productivity of longan cultivation in Thailand. This study examined previous work [8] utilizing the Ordinary Least Squares (OLS) and applies the Stochastic Production Frontier model (SFM) [9] to analyze technical efficiency. The detailed methodology and findings are as follows:

2.1. Labor Productivity

Labor productivity is the ability to do work that can be developed or enhanced in many ways, such as modifying work patterns by allowing workers to work more with machines, training workers before or during the job to have the right understanding and skills, encouraging workers to have higher education, and improving methods of business and industry management to be effective, etc. After having gone through the process of developing labor productivity, workers are able to produce more products and services, meaning that production is produced at lower costs. When there are a large number of goods and services, the supply of goods and services is higher and results in lower prices according to the market mechanisms. Citizens, including workers as consumers, can choose to buy goods at lower prices with goods and services being spent in greater numbers, enabling entrepreneurs or industries to maintain their competitiveness. This leads private investment to grow and results in increased employment and labor wages. Therefore, the mechanism increases labor productivity, in addition to making workers receive higher wages because it reduces production costs, reduces prices of goods and services, and increases the ability of businesses to reduce inflation; in the long term, it affects the maintenance of the living cost index and increases the living standard, which has a productive effect on the social and economic condition as well.

Labor productivity serves as a critical economic indicator, closely associated with economic growth, competitive advantages, and standards of living. It is defined as the total volume of output, quantified in terms of Gross Domestic Product (GDP), produced per unit of labor, which is typically measured by the number of employed individuals over a specified period. This indicator enables analysts to evaluate the relationship between GDP and labor input levels, as well as their growth rates over time. Consequently, it provides valuable insights into the efficiency and quality of human capital within the production process, contextualized within specific economic and social settings.

Labor productivity is measured by the amount of productivity per unit of labor, which is a simple measurement of productivity called "partial productivity", because it compares output to a single input of production by assuming that the rest of the production factors remain unchanged. Bode, Dohse and Stolzenburg [10] indicate that workforce aging is more significantly negatively correlated with productivity growth. However, the downside is that this measure of productivity still does not reflect productivity in line with the real world since, in actual production, all inputs must be changeable, including various qualitative factors such as technology and skills of labor in production that have a great influence on productivity.

There is also another important measure of productivity known as Total Factor Productivity (TFP). Aging society is projected to negatively impact the growth of total factor productivity (TFP) in Hong Kong. The findings indicate that the primary mechanism by which aging will influence the economic growth of Hong Kong is through a diminishing labor supply [11]. Aiyar and Ebeke [12] indicate that workforce aging adversely affects labor productivity growth, primarily through its detrimental impact on total factor productivity (TFP) growth. According to economic production theory, we can create a production function that describes the relationship between productivity and the production factors, for instance, land, labor, capital, and TFP of output arising from the non-increasing part of the factors of production (labor, land, capital), which herein refers to other factors such as advancement of technology and effective management.

2.2. Productivity and Aging Society

Researches in many countries, such as Lee's [13], indicate that aging may be an implication for productivity and farming; contrarily, empirical evidence presents deterioration in productivity among high-aging agricultural workers. The age of farmers may have an effect on the decision-making and learning in the farming process which may be directed towards productivity, where many research such as references [14–17], showed that aging workers tend to have a lower rate of acceptance, learning, and using technology than others while young farmers have better adaptability to improve their productivity. Li et al. [18] observed that the aging population diminishes the physical capability of the labor force, resulting in a decline in production output. This reduction contributes to the exacerbation of cultivated land abandonment in mountainous regions. Maestas, Mullen and Powell [19] demonstrate that aging is associated with a decline in labor productivity across all age cohorts. However, aging workers may also have more experience and assets, which they can turn to be managers and employ extensive farming. Entering an aging society may not always cause a decrease in productivity. Saiyut [20] and Suphannachart [21] found that the presence of aging farmers tends to increase technical inefficiency within the agricultural sector. However, when older farmers are combined with capital investments, this inefficiency is mitigated. Hence, the previous empirical evidence represented in many countries suggests that the hint of aging on agricultural development might diverge across contexts [22]. Some researchers have determined that the adverse effects of aging on food crop production are relatively minor. They argue that factor substitution and collective decision-making can effectively mitigate the labor supply constraints associated with the limited physical and human capital of elderly farmers [23, 24]. Calvo-Sotomayor, Laka and Aguado [25] show that a 1% increase in the workforce aged between 55 and 64 is associated with a reduction in the annual productivity growth rate ranging from 0.106% to 0.479%. The aging of the agricultural labor force manifests a significant "human capital effect," primarily influencing the quality of labor supply. This phenomenon is particularly pronounced in the context of longan cultivation, which necessitates a higher degree of specialized knowledge and management skills compared to the cultivation of conventional food crops.

2.3. Ordinary Least Squares Regression (OLS)

One of the most widely used techniques to estimate several coefficients of linear regression equations is Ordinary Least Squares (OLS) regression, a statistical technique employed to elucidate the relationship between one or more independent quantitative variables and a dependent variable, commonly referred to as "simple" or "multiple linear regression". The OLS method seeks to minimize the sum of squared errors (SSE) to achieve the best-fitting line. In addition to OLS, alternative estimation methods such as Maximum Likelihood Estimation (MLE) and Generalized Method of Moments (GMM) can also be utilized. When analyzing a model with (p) explanatory variables, the following OLS regression model is employed:

$$Y = \beta_0 + \sum\nolimits_{j=1\ldots p} \beta_j X_j + \varepsilon \tag{1}$$

where Y is the dependent variable, β_0 is the intercept of the model, X_j corresponds to the jth explanatory variable of the model (j = 1 to p), and e is the random error with expectation 0 and variance σ^2.

2.4. Stochastic Frontier Model (SFM)

The Stochastic Frontier Model (SFM) serves as a statistical tool utilized for measuring economic efficiency. This model specifically assesses the productive efficiency of a firm by examining the combination of resources employed to produce output at the lowest possible average total cost. Conversely, productive inefficiency is defined as the condition in which a firm fails to achieve the lowest unit cost for its output. In general, there exist two primary strategies for enhancing productivity: technological advancement and procedural improvements. For instance, providing education and training to employees can equip them to utilize optimal technological practices effectively. When firms perform efficiently, they are able to operate closer to the existing efficiency frontier, which implies that increases in productivity can lead to improvements in overall efficiency. The initial empirical formulation of the SFM was established by Aigner, Lovell and Schmidt[26] and Meeusen and van Den Broeck[27], which can be expressed as follows:

$$\log Y = x'\beta - U + V, \tag{2}$$

where $Y = y \in ⊠_+$ represents the amount of output, x is a vector $k \times 1$ of inputs, and β denotes a vector of unknown parameters. The error component $V = v \in ⊠$ is characterized as a zero-mean symmetric error, with $G(v) = Pr(V \leq v)$ assumed to be continuous and independent of the variable x. Nevertheless, this error component is contingent upon unknown parameters encapsulated within the vector δ_v. The second error component, $U = u \in ⊠_+$ where $⊠_+ = ⊠_+ \cup \{0\}$ represents a non-negative random variable with a cumulative distribution function (CDF) characterized by its non-negativity, $F(u) = \Pr(U \leq u)$. In the context of the SFM, U indicates the presence of unobserved inefficiency. If production operates at full efficiency, the frontier of maximum output can be illustrated for a given set of inputs x. Conversely, if inefficiencies exist, U will diminish the output, resulting in a deviation from the frontier.

The assumption regarding the two error terms represents another critical aspect of the SFM that has garnered significant attention from researchers. Typically, these scholars assume that the one-sided and two-sided error terms are independent, as this assumption facilitates the computation of the joint distribution of the errors. However, this perspective may be unrealistic in certain empirical contexts.

3. Methodology

The data obtained from the questionnaire will be subjected to analysis, which will include the following:

3.1. Longan Production Situation in Thailand

This section will include descriptive statistics encompassing demographic details. The data will be described using frequency distribution and percentage calculations, which will subsequently be presented in tabular format.

3.2. The Impact of Aging Society on Labor Productivity in Longan Production

This analysis will focus on the influence of an aging society on labor productivity within longan production. Data will be gathered regarding longan output and the inputs utilized in production to calculate labor productivity. The data will be categorized into historical data and current data, enabling forecasts for future labor productivity to be generated. A comparative analysis will then be performed to summarize the effects of an aging society on labor productivity in longan production, employing the Ordinary Least Squares (OLS) regression.

3.3. Technical Efficiency in Longan Production in the Context of an Aging Society

This segment of the study will utilize the Stochastic Production Frontier model to assess technical efficiency amid the challenges posed by an aging society. The Cobb-Douglas production function will be implemented, represented by the following equation of dependent and independent variables:

$$\log Y_i = x_i^{'}\beta_i - U_i + V_i \tag{3}$$

where Y_i denotes the quantity of longan yield, x_i shows the inputs utilized in longan production, β_i represents the parameter to be estimated, V_i signifies the two-sided error term, and U_i is the one-sided error term.

4. Data

This gathered data from the population of longan farming households located in the three primary provinces of Chiang Mai, Lamphun, and Chiang Rai. The sampling process involved categorizing the population based on geographic areas and calculating the sample size in accordance with Yamane's formula, utilizing a 5 percent margin of error, as illustrated in **Table 2**. Moreover, the variable descriptions are presented in **Table 3**.

Table 2. The sample size and population.

Important Longan Cultivation in Thailand	The Number of Households Engaged in Longan Cultivation in 2023	Proportion	Samples
Chiang Mai Province	72,396	44	176
Lamphun Province	50,805	31	124
Chiang Rai Province	39,673	24	96
Total	162,874		400

Table 3. Variable descriptions.

Model	Variable	Description
Ordinary Least Square (OLS)	Dependent variable $y = \frac{Y}{L}$ is the labor productivity of longan production	Y is the quantity of longan production (tons), L is the number of laborers in longan production (number)
	Independent variable x_1 is the gender of the longan farmer	Categorical variable with 1 = Male 2 = Female
	x_2 is the age of the longan farmers	Number of years of age of the longan farmers
	x_3 is the marital status of longan farmers	Categorical variable with 1 = Single 2 = Married 3 = Divorced/Separated/Widowed
	x_4 is the household status of longan farmers	Dummy variable with 1 = Head of household 0 = Others (Spouse of the head of household or Son/Daughter/Resident)
	x_5 is the education level of longan farmers	Dummy variable with 1 = Educated 0 = Uneducated
	x_6 is the longan production experience of longan farmers.	Number of years of longan production
Stochastic Production Frontier	Dependent variable Y is the longan production	Number of longan production (Kilograms) expressed in a natural logarithm
	Independent Variables Cultivated area	Number of cultivated area (Rai) expressed in a natural logarithm
	Chemical fertilizer	Kilograms per rai expressed in a natural logarithm
	Hormone dosage	Kilograms per rai expressed in a natural logarithm
	Hormone dosage	Kilograms per rai expressed in a natural logarithm
	Pesticide	Kilograms per rai expressed in a natural logarithm
	Potassium	Kilograms per rai expressed in a natural logarithm
	Labor	Number of laborers in longan production expressed in a natural logarithm
	Farmers' aging	Year of age expressed in a natural logarithm

This study focuses on analyzing the impact of an aging society on labor productivity and technical efficiency of aging society in Thai longan production, including longan farmers in Chiang Mai and Lamphun provinces who are over 50 years old, which accounted for 45.8 percent.

5. Empirical Results

5.1. Longan Production Situation in Thailand

The results from this study indicate that longan farmers in Thailand consist of 33.0% females and 67.0% males. The age of the farmers ranged from a minimum of 23 years to a maximum of 91 years, with an average age of 57.41 years. A significant majority of the longan farmers are married (93.5%), educated (80.5%), and serve as heads of households (68.3%). Furthermore, these farmers possess an average of 18 years of experience in longan cultivation. Most of the longan cultivation in Thailand required 1–5 workers in households, most of which used only 2 workers to take care of the longan plantation. According to the survey, it was found that by 2025, 87.3 percent of longan farmers would continue to cultivate longan. However, some 12.8 percent of farmers would no longer be farming due to health problems and low selling prices. As a result, the yield and acreage of longan in Thailand will be reduced by approximately 21 percent and the area of the longan plantation will be reduced by 12 percent as shown in **Table 4**.

Table 4. Information on the longan production situation in Thailand.

Gender of the Sample Group	Number	Percentage
Female	132	33.0
Male	268	67.0
Minimum Age	**Maximum Age**	**Average Age**
23	91	57.41
Marital Status	**Number**	**Percentage**
Single	20	5.0
Married	374	93.5
Divorced/Separated/Widowed	6	1.5
Household Status	**Number**	**Percentage**
Head of household	273	68.3
Others	127	31.8
Education Level	**Number**	**Percentage**
Educated	322	80.5
Uneducated	78	19.5
Lowest Longan Production Experience	**Highest Longan Production Experience**	**Average Longan Production Experience**
1 year	40 years	18 years
Number of Workers in Longan Production	**Number**	**Percentage**
1	165	41.3
2	193	48.3
3–5	42	10.6
Labor Decision to Produce Longan in 2025	**Number**	**Percentage**
Continue to cultivate longan	349	87.3
Stop cultivating longan	51	12.8
Situation of Longan Production	**In 2020**	**In 2025**
Number of longan products	3,475 tons	2,740 tons
Longan cultivation area	4,673 rai	4,123 rai

Source: Author's calculation.

5.2. Labor Productivity in Longan Production

Most of the longan production workers in Thailand were over 55 years of age (57 years on average), which is an age group that is entering an aging society. Thus, the study considers that by 2025, there will be a reduction in labor productivity in the longan production sector by more than 21 percent. **Table 5** shows that the labor productivity decreases from 54.4 to 82.3 in 2020 and 2025 respectively.

Table 5. The change in farmland, production, and labor productivity of longan influenced by aging in Thailand.

Year	Farmland (Rai)	Production (ton)	Partial Labor Productivity
2020	4,673	3,475	4.54

Source: Author's calculation.

In addition, this study examined factors affecting labor productivity in longan production in 2025 by using the multiple regression model by Ordinary Least Square. Several factors influencing longan productivity consisted of gender, age, status, household status, education level, and longan production experience. The relationship in Equation (4) can be calculated as follows:

$$y = \frac{Y}{L} = f(x_1, x_2, x_3, x_4, x_5, x_6) \tag{4}$$

where y is the labor productivity of longan production (Y is the quantity of longan production, L is the number of labors in longan production).

x_1 is the gender of the longan farmer.

x_2 is the age of the longan farmers.

x_3 is the status of longan farmers.

x_4 is the household status of longan farmers.

x_5 is the education level of longan farmers.
x_6 is the longan production experience of longan farmers.

From Equation (4) it can be defined as Log-Linear or Logarithmic form and modified such equation to be used in research as Equation (5)

$$ln\,(y_i) = \beta_0 + \beta_1 lnx_{1i} + \beta_2 lnx_{2i} + \beta_3 lnx_{3i} + \beta_4 lnx_{4i} + \beta_5 lnx_{5i} + \beta_6 lnx_{6i} + \varepsilon_i \quad (5)$$

where $\beta_0, \beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6$ are the parameters, ε_i is the error term, and i = 1, 2, 3, ..., 400.

The results showed that the factors influencing the productivity of longan production consisted of agricultural age and longan production experience. As the farmers got older, it would reduce the productivity of longan production. If the age of the farmers increased by 1 year, labor productivity of longan production would decrease by 0.135 units, while the production experience would have a positive effect and go in the same direction as the labor productivity of longan production. When farmers had more experience in longan production, it resulted in an increase of 0.099 units of longan productivity with a statistical significance of 0.05 as shown in **Table 6.**

Table 6. Factors influencing longan productivity with the Ordinary Least Square (OLS) model.

Variables	Coefficient (Probability)	t – Ratio
Constant	7.243*** (0.000)	4.27
Gender	0.214 (0.342)	0.95
Age	−0.135** (0.056)	−0.312
Status (single/married)	−0.364 (0.158)	−1.899
Household status (head of household/resident)	−0.367 (0.113)	−1.589
The level of education	0.055 (0.736)	0.337
Experience in longan production	0.099*** (0.027)	0.982

Source: Author's estimations.
Note: *** Significant at 1 percent level, **Significant at 5 percent level, * Significant at 10 percent level.

5.3. Stochastic Production Frontier

Regarding the estimation of parameters in the Stochastic Production Frontier model (SFM), it was found that the cultivated area had a positive effect on longan yield, while chemical fertilizers and aging of longan farmers had a negative effect on longan yields as shown in **Table 7**. It implies that longan farmers entering the aging state will reduce their longan yields. The analysis of the technical efficiency level in Thai longan production found that longan farmers had an average technical efficiency of 0.9924 or 99.24 percent, meaning that they were able to increase their productivity by 8.76 percent by still using the same inputs. Most of the longan farmers had a very high level of technical efficiency that was in the range of 0.901–1.0000, accounting for 85 percent. Meanwhile, the other 15 percent had a high level of technical efficiency, respectively.

Table 7. Coefficient estimation result of stochastic production frontier.

Variables	Coefficient	t – Ratio	Probability
Constant	6.905	15.168	0.021**
Cultivated area	0.694	6.422	0.049**
Chemical fertilizer amount	−0.263	−0.766	0.092**
Hormone dosage	0.170	0.531	0.245
Pesticide	0.120	1.983	0.149

Table 7. *Cont.*

Variables	Coefficient	t – Ratio	Probability
Potassium	0.019	0.256	0.841
Labor	0.005	0.045	0.086**
Farmers' aging	–1.191	1.810	0.061**
σ^2	0.006	0.111	0.065**
γ	1.089	13.688	0.023**

Source: Author's estimations.

Note: 1. $\sigma^2 = \sigma_V^2 + \sigma_U^2$ and $\gamma = \frac{\sigma_U^2}{\sigma_V^2+\sigma_U^2}$,

2. *** Significant at 1 percent level, **Significant at 5 percent level, * Significant at 10 percent level.

6. Discussion

This study illustrates the longan production situation in Thailand, highlighting that the majority of production relies on relatively older workers. The findings of this study indicate that the longan production landscape in Thailand heavily relies on an aging workforce, with the average age of workers being approximately 57 years. By the year 2025, the influence of Thailand's aging population is expected to result in a significant reduction in longan farmers, as many may cease production due to health issues and diminished selling prices. This demographic shift is likely to adversely impact both the yield and the cultivation area dedicated to longan farming, thereby compromising the overall productivity of labor in this sector.

The Ordinary Least Squares (OLS) model results indicate that a one-unit increase in farmer age is associated with a 0.136-unit decrease in longan production labor productivity. Given Thailand's aging population, longan production labor productivity is likely to decline due to these demographic shifts. This research suggests that the aging of longan farming households may hinder the development of the Thai agricultural sector, as a majority of these households are part of an aging workforce—a finding consistent with previous research indicating that aging leads to decreased productivity [10, 12, 19, 25, 28]. However, older farmers possess valuable experience that positively affects longan production labor productivity. Specifically, a one-unit increase in farmers' longan production experience is associated with a 0.099-unit increase in labor productivity. Therefore, encouraging older farmers to leverage their experience more effectively could mitigate the decline in longan production efficiency.

Furthermore, while the Stochastic Production Frontier (SFM) model indicates a high technical efficiency of longan production in Thailand (99.24% with available production factors), it also reveals that increasing farmer age negatively affects the technical efficiency of longan cultivation. However, because this model does not account for technological variables, the impact of technology adoption on longan production's technical efficiency warrants further investigation. Specifically, it is important to determine whether technology use has a positive or negative effect, as the aging of longan farmers may, in some cases, hinder the adoption of technology and innovation to enhance productivity in this sector [29]. Despite maintaining a high level of technical efficiency in longan production, the transition towards an aging workforce may lead to decreased yields among older farmers. This research highlights that the aging demographic within longan farming households could pose a significant barrier to the advancement of the Thai agricultural sector, as the majority of these households are composed of aging individuals. The evidence suggests a potentially negative correlation between the productivity of longan production and the aging of farmers, which may hinder the adoption of technology and innovation that are crucial for enhancing productivity in this field.

Given these insights, agricultural policy must strategically address the challenges of an aging society. This includes considering the use of age-appropriate technology in agriculture or implementing strategies to offset the decline in labor from aging workers to maintain productivity. Furthermore, encouraging greater participation of younger individuals in agriculture is crucial for the sustainable growth of longan production in Thailand.

7. Conclusions

This research investigates the impact of an aging society on longan production labor productivity in Thailand. Using the Ordinary Least Squares (OLS) model, this study analyzes the influence of aging on labor productivity within the longan sector. Furthermore, the Stochastic Production Frontier (SFM) model is employed to assess technical efficiency in the context of this demographic shift.

The study reveals that longan production in Thailand relies heavily on older workers (approximately 57 years of age), longan yield and acreage in Thailand are projected to decrease by approximately 21 percent, and the longan plantation area by 12 percent. Consequently, labor productivity is expected to decrease from 54.4 in 2020 to 82.3 in 2025.

By 2025, Thailand's aging population is projected to lead some longan farmers to cease production due to health issues and low market prices. Consequently, both longan yields and cultivated area in Thailand are expected to decline, impacting labor productivity. While the technical efficiency of longan production in Thailand remains high, the aging of the farming workforce may lead to yield reductions for some farmers.

To address these challenges, agricultural policy should prioritize the use of technology to supplement or replace aging workers, thereby maintaining productivity and encouraging greater participation of younger individuals in agriculture.

Author Contributions

Conceptualization, C.N. and K.S.; methodology, C.N.; software, C.N.; validation, C.N. and K.S.; formal analysis, C.N. and K.S.; investigation, C.N. and K.S.; resources, C.N.; data curation, C.N. and K.S.; writing—original draft preparation, K.S.; writing—review and editing, C.N. and K.S.; visualization, C.N. and K.S.; supervision, C.N. and K.S. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest

The authors declare no conflicts of interest.

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