

MEASURING THE LABOUR PRODUCTIVITY OF SERICULTURAL FARMERS IN MAHASARAKHAM PROVINCE, THAILAND

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ABSTRACT

Sericultural farming is important to the local economy of Mahasarakham province of Thailand. This study measured the labour productivity of sericultural farmers by calculating the total labour value added per hour worked, given that the total labour value added refers to the difference between the total revenue and the total cost, not including the labour cost. This mixed-method research collected empirical data from 160 households in five districts of Mahasarakham during the 2020 production cycle using questionnaires and semi-structured interviews. Silk mulberry sales minus all costs (except labour) were used to represent the added value of labour. The overall total revenue data and total costs in each production cycle were used in this study. The study's results revealed that farmers' total labour productivity equated to 1.68 USD per hour per production cycle, 9.69 USD per day and 1,559.61 USD per year, calculated using the added value of labour divided by total hours worked. When comparing by district, Na Dun had the highest productivity of labour at 1.90 USD per hour, followed by Na Chueak (1.82 USD per hour), Wapi Pathum (1.70 USD per hour), Phayakkhaphum Phisai (1.50 USD per hour) and Yang Sisurat tires (1.46 USD per hour), respectively. The research results showed that the labour productivity of the studied sericultural farmers, 1.68 USD per hour, was higher than the minimum wage of Mahasarakham labours in 2022, which was 1.26 USD per hour. Despite the higher productivity cost, various challenges faced by the farmers were also identified, including a shortage of labour, lack of a market to support production, insufficient promotion and support from government agencies, a low price for silk products, damage to barns repair costs, lack of investment and production factors. The procedures and methods used to raise silkworms are complicated and time-consuming. Traditional farmers' barns are insufficient for raising silkworms and sick silk varieties; a suitable barn design and systematic production management are recommended, providing the research's empirical evidence confirmed to help enhance labour productivity. Based on the results and discussions, this paper recommends future studies to investigate practical guides to help increase labour productivity and tackle the challenges facing local sericultural farming to a wider extent.

Key words: Labour productivity, Measuring labour productivity, Sericultural farmers, Value-added labour



INTRODUCTION

Silkworm rearing is a popular rural occupation in Thailand, where most of the household labour force is employed. Every step of the production process, such as site preparation, preparing the soil for mulberry planting, silkworm rearing, weaving and sewing the finished products, is labour-intensive. Nowadays, Thai people pay more attention to local wisdom and prefer to consume products made from silk, such as ready-made silk, silk-cocoon products, hand-made products from silk, skin care silk (peptides), silk bedding goods, baskets and ladies' handbags, cushion covers and upholstery silk fabrics. Moreover, as of 2020, silk remained one of Thailand's most important export products. Silk threads, silks and silk products can all be exported. The local currency of Thailand is Baht. Since this study was conducted based on the production data in 2020, the presentation of this paper used the average exchange rate as of 2020, which was 31.2955 Baht/USD [1]. The sericultural industry of this country is worth up to 5,861,663.56 USD [2] and creates a significant number of jobs for rural workers. However, the traditional silk industry is beginning to fade away due to the lack of a new generation of intellectual successors or labour force. This is mainly due to the migration of workers from the agricultural sector to the industrial sector [3]. Silkworm rearing in Thailand can be carried out in all regions, but the main new mulberry cultivation area is in the Northeastern Region consisting of various ethnic groups, some of which are unique in producing silk patterns of different colours and quality. The presentation of this paper was based on an empirical study conducted in Mahasarakham, a province located in this region.

Mahasarakham is home to sericultural farmers of a total of 4,012 households with 161.12 hectares of mulberry plantations [4]. Most of these households are members of 299 registered sericultural cooperatives of the region. The province has 13 districts in total, of which six have high numbers of silkworm farmers, namely Phayakkhaphum Phisai (974 households), Wapi Pathum (780 households), Na Chueak (463 households), Yang Sisurat (436 households), Borabue (435 households) and Na Dun (433 households) [4]. This province operates silkworm rearing and mulberry cultivation from harvesting to the finished product. It also produces tie-dyed silk (woven in Northeastern Thailand) and the Sroi Dakh Mak pattern, a signature silk pattern representing the province's identity [5]. The silk production in this province uses different production techniques and is the only province in the region able to operate such techniques. A unique form of tapestry weaving in Thailand involves continuous supplementary weft and weft Ikat. Weaving such fabrics is complicated and creates extremely beautiful patterns and colours, giving the products a distinctive identity from the typical tie-dyed silk



sarongs produced in Northeastern Thailand. Therefore, silkworm rearing and silk production are labour-intensive and require skilled labour with extensive experience.

Due to its importance to the Thai economy, this study examines the labour productivity of sericultural farmers raising silkworms in Mahasarakham Province. The results of this study can subsequently be used as a guideline in policy formulation to increase the capacity of the labour force in this agricultural sector.

LITERATURE REVIEW

Measuring labour productivity

Productivity is used to measure the capacity and efficiency of the inputs used to produce goods and services, such as labour and capital [6]. Depending on the nature of the data used, productivity can be measured in more than one way, such as at the micro, macro, or national level and in community enterprises and farmer groups. In this study, labour productivity is defined as a measure of the efficiency of sericultural farmers, which is considered an important labour factor in production at the micro level.

Labour productivity can be measured in a variety of ways, including comparing inputs with outputs [7], and these are classified by the Organisation for Economic Co-operation and Development [8] into two categories: 1) Partial productivity, representing the comparison of a specific input of production with the output produced, for example, by comparing the output per unit of labour. This is the simplest method and is generally measured in terms of the output ratio to labour input or capital input. 2) Total factor productivity, which is a comparative measure of the output produced with all the inputs used in production. Any production process involves not only the use of labour or capital but also other factors. In conjunction with this approach, the partial productivity limitation is reduced, resulting in a comparative measure of certain production factors only.

The measurement of labour productivity by data type can be categorized into two methods [9] as follows:

- 1) Productivity measurement by discrete data involving comparison of productivity with labour or capital factors used in production. This measurement technique can be classified into two types. See the examples below.



Firstly, by comparing the proportion of total output produced on average with all inputs, also known as the average product of labour (APL). For example, the average productivity per total labour factors used can be represented as shown in the following equation:

$$APL = TP/L \quad (1)$$

Where APL is the average product of labour, TP is the total product and L is the total labour factor used in production.

Secondly, comparing the proportion of the average change in total output and the change in the use of inputs is also known as the marginal product of labour (MPL). For example, the average change in total productivity per increase in the use of labour factors can be represented by the following equation:

$$MPL = \Delta TP / \Delta L \quad (2)$$

Where MPL is the marginal product of labour, ΔTP is the change in total output, and ΔL is the change in the use of labour factors.

- 2) Productivity, measured by continuous data using the production function to analyze the relationship between productivity and the factors used in production for multiple inputs such as labour and capital [9, 10], can be represented by the following equation:

$$Y = A K^\alpha L^\beta \quad (3)$$

Where Y is the total output, A is the parameter, K is the capital stock, and L is the number of workers involved in production. $\alpha + \beta = 1$ indicates constant returns to scale, $\alpha + \beta > 1$ indicates increasing returns to scale, and $\alpha + \beta < 1$ indicates decreasing returns to scale. The marginal product can be written as follows: From Equation (3), the production function is adjusted into a natural double logarithmic model.

$$\ln Y = \ln A + \alpha \ln K + \beta \ln L \quad (4)$$

Equation 4 finds the differentiation with respect to labour (L)

$$\begin{aligned} \frac{1}{Y} \frac{dY}{dL} &= \beta \frac{1}{L} \frac{dL}{dL} \\ \frac{L}{Y} \frac{dY}{dL} &= \beta \\ MPL &= \beta \frac{Y}{L} \end{aligned}$$

Where $\frac{Y}{L}$ is the APL and $\frac{dY}{dL}$ is the MPL

Labour productivity can be classified into two levels: macro and micro. The macro measure is used at the national, regional, or industrial level [11, 12]. It is commonly measured in terms of the ratio of productivity to labour factors or capital used in production. Hara and Ichiue [13] proposed the following measures for labour productivity:

$$\text{Labour Productivity} = \frac{\text{Real GDP}}{\text{Labour input}} = \frac{\text{Nominal GDP/GDP Deflator}}{\text{Employment} \times \text{Hours worked}} \quad (5)$$

Labour productivity can also be measured at the macro level in terms of the labour productivity index [14, 15, 16] as follows:

1) Average labour productivity per person Labour productivity index

$$= \frac{Q_t/Q_0}{L_t/L_0} \quad (6)$$

Where Q_t/Q_0 is the index of output in the current year, and L_t/L_0 is the index of labour input in the current year

2) Average labour productivity per hours worked Labour productivity index

$$= \frac{Q_t/Q_0}{H_t/H_0} \quad (7)$$

Where Q_t/Q_0 is the index of output in the current year, and H_t/H_0 is the index of hours worked in the current year.

At the micro level, labour productivity can be measured using the Individual Industrial Establishment or the individual level, using the following formula [7, 17]:

$$\text{Labour productivity} = \text{Total labour value added/Hours worked} \quad (8)$$

$$\text{Total labour value added} = \text{Total revenue} - \text{Total cost (Except labour cost)} \quad (9)$$

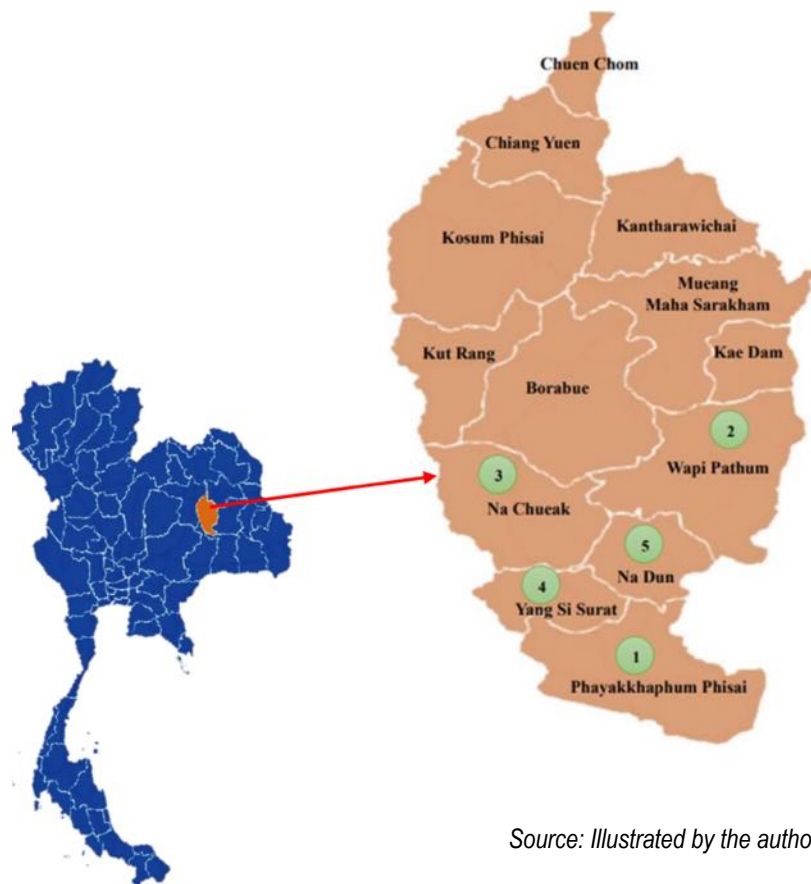
Working hours are considered using an average of eight hours per day, the average working hours per worker or household for a period of one day, one week, one month, or one year.



In summary, labour productivity can be measured in several ways and conclusively classified into three groups: 1) comparing inputs with outputs, 2) type of data and 3) level of study. This study measures labour productivity at the micro level using the value added by sericultural farmers in Mahasarakham Province, Thailand.

MATERIALS AND METHODS

This study employed an explanatory mixed-method research approach, also known as quantitative dominant or quantitative driven mixed-method, to allow the researchers to use quantitative instruments and then employed qualitative analysis to explain the detailing and subjective experiences concerning the research inquiry [18]. Figure 1 shows the study sites comprising five districts in Mahasarakham Province with the highest populations of sericultural farmers, namely Phayakkhaphum Phisai (974 households), Wapi Pathum (780 households), Na Chueak (463 households), Yang Sisurat (436 households), and Na Dun (433 households), a total of 3,521 households. This study adopted the formula used by Santipolvut [19] at a 95% confidence level and was applied using a 5% randomization error and a total sample of 359 households.



Source: Illustrated by the authors

Figure 1: The research sites in Mahasarakham Province in Thailand

The decimal latitude and longitude coordinates for Mahasarakham Province are 16.18483, 103.30067. The study sites comprised five districts in Mahasarakham province with the highest populations of sericultural farmers chosen for this study, namely (1) Phayakkhaphum Phisai (974 households), (2) Wapi Pathum (780 households), (3) Na Chueak (463 households), (4) Yang Sisurat (436 households), and (5) Na Dun (433 households), respectively (a total of 3,521 households).

Using the mixed-method approach, the researchers used primary data from responses to a survey questionnaire collected using nonprobability sampling and accidental sampling for farmers willing to provide information. The unit of analysis was sericultural farming households. The data collection fieldwork was carried out from June–July 2021. The researchers and two research assistants distributed the questionnaires in person on-site to collect the 2020 annual production data. The collected data was then processed using Statistical Package for the Social Sciences (SPSS) as the statistical software package for processing the calculations of the labour productivity of sericultural farmers, which was measured at the micro level using the added value of labour.

During the data collection fieldwork for the survey questionnaire, qualitative data were also collected using open-ended questions for semi-structured interviews, which allowed the respondents to freely share their views nested in the scope of the investigation [18]. The interviews were conducted by the researchers and two trained research assistants who collected the survey data on-site. This qualitative data analysis and interpretation helped enhance the statistical interpretation while providing additional explanations of subjective perspectives embedded in the studied farmers' experiences.

RESULTS AND DISCUSSION

Data were collected from a sample of 160 sericultural farmers, classified into the five districts: Phayakkhaphum Phisai (37 households), Wapi Pathum (33 households), Na Chueak (32 households), Yang Si Surat (32 households), and Na Dun (26 households), accounting for 44.56% of the total sample size of 359 households.

The results show that 100% of farmers used household labour, with the average workers per household being 1.78 at an average age of 57.55 years, 91.25% of whom were female and 8.75% male. These results are consistent with studies previously conducted in other regions of Thailand, the Northeast and the Central regions [20, 21] that the most sericultural labourers are elderly. It helps confirm the



recent challenge for labour productivity in Thailand. The sustainable development of this traditional agricultural production urgently requires public policies to help encourage the knowledge transfer from the senior family labourers to the younger generations, especially those under 45 [21].

Silkworm rearing is the type of work that can be done at home, and in the past, silkworm rearing and weaving were important tasks for women who would weave their cloth and produce and sell it locally. The results of this study indicate that overall, the average household income of sericultural farmers, including that earned from silkworm rearing, amounted to 5,970.91 USD per year. The average income from silkworm rearing was only 1,658.96 USD per year or 27.78% of the average household income. Regarding education, most sericultural farmers (76.14%) completed elementary school. This result is relevant to the average age of the respondents of 57.55 years, considered as elderly having a lower educational level than the current compulsory educational level for younger generations in Thailand. Only 17.54% of the respondents had completed secondary school, the national compulsory educational level and only 6.32% with a high vocational certificate.

As discovered in the interviews, the low education level was a negative factor for labour productivity; it caused the labourers to resist new production technology and innovation introduced to help enhance productivity. Therefore, this paper agrees with previous empirical studies identifying public support for offering learning programmes for sericultural family labourers to impact labour productivity positively [20, 21]. However, according to the recent public report of a sericultural authority, namely the Queen Sirikit Department of Sericulture's Annual Report of Fiscal Year 2021 [22], most public educational and promotional schemes mainly target younger generations. Results of this paper suggest otherwise; such public promotional programs should be provided for both senior and younger family labourers to lay a consistent understanding linking traditional and innovative production knowledge to benefit the family business.

The labour productivity of sericultural farmers is measured at the micro level using the added value of labour divided by the number of hours worked. The added value of labour is calculated as total revenue minus total costs (except labour). The findings agree with a previous study that the total revenue is a vital part of calculating labour productivity using the added value of labour calculating technique [7]. The total revenue of sericultural farmers is generated from the sale of mulberry leaves, mulberry fruit, mulberry products, mulberry seedlings, silk threads, silkworm pupa, silk manure and woven fabrics. However, the sericultural



farmers interviewed did not have a detailed record of their total revenue, and therefore, only the overall revenue data in each production cycle was used in this study.

The results showed that the studied farmers had an average total revenue of 1,658.96 USD per year. When considering the figures by district, Na Dun had the highest average total revenue of 1,823.23 USD per year, followed by Yang Si Surat (1,712.86 USD), Wapi Pathum (1,703.04 USD), Na Chueak (1,601.97 USD), and Phayakkhaphum Phisai (1,453.72 USD). However, when considering the average total revenue per production cycle, Na Dun was found to have the highest average total revenue of 294.38 USD per production cycle, followed by Na Chuea (269.77 USD), Wapi Pathum (256.79 USD), Yang Si Surat (253.12 USD), and Phayakkhaphum Phisai (228.50 USD). Since the market price of the silk product in Mahasarakham was no different due to the farmers using similar production techniques, the difference in total revenues across the five research sites was caused by the production size. According to the interview data collected on the questionnaire survey site, the farmers explained that the more inputs used per production cycle, the more silk produced, resulting in more revenue for the farmers. As one explained:

“In the cycle that inputs were plenty, such as when we had abundant mulberry leaves, family labourers were available to work with many hours, and all the weaving equipment was well functioning, we produced more silk. Then, we earned more income.”

As guided by a study from Thailand [24, 25], the costs of production of sericultural farming consist of water, electricity, fertilizer, silk varieties, mulberry varieties, prophylactic chemical consumables for rearing silkworms, calcium hydroxide, threshing basket, silkworms shelf, traditional silk thread production machine, weighing machine, charcoal stove and miscellaneous expenses. However, the farmers did not have a detailed record of the production costs. Therefore, only the data on the overall cost of production in each production cycle was used in the analysis. The results of the study reveal that the farmers as a whole had average costs of 138.72 USD per year, and when considering the figures by district, Yang Si Surat was found to have average costs per year of 291.68 USD, followed by Na Dun (128.60 USD), Phayakkhaphum Phisai (95.48 USD), Na Chuek (92.86 USD), and Wapi Pathum (85.00 USD), respectively. The results showed a noticeable cost difference between the first and second and the remaining districts. An explanation was given according to the data that some farmers interviewed in the first and second districts recently invested in new weaving equipment and barn facilities at



the time of the survey fieldwork. Most of the studied farmers did not account for the sunk cost of equipment used for more than two decades in some sericultural households.

The survey indicated an average of 6.44 production cycles per year. The average cost per production cycle was 21.59 USD. When classifying the cost per production cycle, Yang Si Surat District was found to have the highest costs of 42.73 USD, followed by Na Dun (21.21 USD), Phakkhaphum Phisai (15.71 USD), Na Chuek (15.43 USD), and Wapi Pathum (12.84 USD). The results showed that production cost was not the same for each area, caused by the difference in farmers' ability to keep silkworms free from disease, which helps to reduce loss. Grasserie is the most common disease in silkworms, caused by the nuclear polyhedrosis virus (NPV), resulting in decreased productivity [26]. Consequently, farmers have to bear the additional costs involved in managing the disease. However, outbreaks of Grasserie disease occur all year round, being most prevalent during the summer and rainy seasons [27]. According to the total revenue and total costs data presented in Table 1, the added value of labour can be identified from the total revenue minus total costs [7].

The findings of this study revealed that overall, the average added value of workers per year equates to 1,520.24 USD, with Na Dun exhibiting the highest of 1,694.63 USD, followed by Wapi Pathum (1,618.04 USD), Na Chueak (1,509.11 USD), Yang Si Surat (1,421.19 USD), and Phayakkhaphum Phisai (1,358.24 USD), respectively. In addition, when considering the added value of labour per production cycle, farmers were found to have 117.14 USD, classified by district. Yang Si Surat had the highest added value of labour per production cycle of 248.95 USD, followed by Na Dun (107.38 USD), Phayakkhaphum Phisai (79.77 USD), Na Chuek (77.43 USD), and Wapi Pathum (72.16 USD), respectively.

A supporting reason for Yang Si Surat farming showing the highest added value of labour was explored in the interview data supplemented by pictures of barns taken from the research sites. Most studied sericultural barns in this district showed relatively better facilitation and management. While farmers in the other sites operated their production traditionally, often running the business in the family's houses, many barns in the Yang Si Surat district were stand-alone buildings based on the design guided by regional sericultural promotional authorities, see examples in Figure 2. This finding is consistent with the previous discussion showing the highest production costs of the Yang Si Surat district. Farmers in this district recently invested in weaving and barn facilities. Therefore, this result of Yang Si Surat farming having the highest added value of labour per production cycle



compared to other districts helped confirm the positive impact of a higher capital-labour ratio on labour productivity.



Source: the authors

Figure 2: Two pictures of an example of a barn with a suitable design and systematic management of sericultural production from the Yang Si Surat district

Farmers rearing silkworms need to have areas for planting mulberry trees as a source of food for the silkworms throughout the year. The farmers have an average area available for mulberry planting of 0.31 hectares per household, enabling them to rotate silkworm production throughout the year. However, if they have insufficient mulberries for rearing silkworms, farmers can buy mulberry leaves from other farmers in the area at a price of 0.16-0.32 USD per kilogram. Similar to other farming sectors in Thailand, such as rice production [23], this result confirms the importance of personal networks of local farmers in fostering local agricultural development. The mulberry varieties grown in Mahasarakham Province were developed in Thailand, namely Buriram 60 (80%) and Sakon Nakhon 85 (20%). The mulberry cultivar Buriram 60 (Bor. 9) has a good rooting rate and produces a high yield per farm. The soft leaves are very suitable for raising silkworms. Most of the silkworms raised (75%) are mixed species, followed by local Thai varieties (25%). However, as previously mentioned, the average cultivation area of mulberry farmers is less than 0.32 hectares per household. Due to the limited cultivation area and labour force available in the households, silkworms can only be reared 6.44 times per year on average.

When analysing the area factor, the research results showed the total labour value added (USD) per area (hectare), as presented in Table 2. The average total labour value added per hectare equated to 1,029.75 USD/hectare, with Wapi Pathum showing the highest of 1,223.65 USD/hectare and 242.58 USD/production cycle/hectare, followed by Na Chueak 1,105.62 USD/hectare and 244.99 USD/production cycle/hectare, Na Dun 1081.25 USD/hectare and 263.96 USD/production cycle/hectare, Phayakkhaphum Phisai 1,031.35 USD/hectare and 214.91 USD/production cycle/hectare, and Yang Si Surat 704.40 USD/hectare and 214.36 USD/production cycle/hectare.

In Thailand, the legal total labour work hours are eight normal working hours per day [28], and any overtime hours must be calculated inclusive as part of the total work hours or average working hours per worker in a one-day or one-year period. However, sericultural farming requires an unusual working activity of the labourers, especially those family labourers with no other employment apart from sericultural production. During a typical silkworm rearing cycle of 25 days on average, the labourers do not need to work in the rearing workspace all day; they can simultaneously involve in other activities while rearing the worms. For this reason, the labour work hours may result in overtime, finishing the daily work later than the normal eight hours per day. This study took into consideration this unusual labour work activity. Therefore, in the interview fieldwork, the respondents were asked to accumulate only the active time they spent in silkworm rearing work, regardless of the daily work hours that seemed longer than eight normal hours because they simultaneously did other jobs unrelated to sericulture in the farming area. As a result, the average working hours for all five districts under study were from the average working hours per day of 5.78.

Given that the standard legal work hour for business firms in Thailand is eight hours [28], the average working hours per day of 5.78 for sericultural farmers of this study was, therefore, equal to 0.72, or 72%, of the normal legal daily labour work hours in Thailand. It was used in the subsequent calculation for the labour productivity analysis; the number 0.72 was later multiplied by the working days per cycle (Table 3). As a result, the studied labourers rearing silkworms for 25 days resulted in 18.06 actual workdays per production cycle. The working hours per production cycle can also be calculated by multiplying 18.06 days of the actual production cycle by eight hours to get 144.48 hours per production cycle. However, when analysing the hours worked per day classified by district, the overall average working hours were no more than six hours per day, less than one workday.



Wapi Pathum District had the highest working hours per day and workdays, followed by Na Dun, Yang Sisurat, Na Chueak, and Phayakkhaphum Phisai, respectively. The results showed that the Wapi Pathum district has the highest working hours but the lowest cost of production and revenue. These results are consistent with the results presented earlier. Those other studied districts showing noticeably higher production costs than the others reported recently invested in new weaving equipment; most studied farmers, including those from the Wapi Pathum district, had used the old equipment for decades and did not consider the investment included in their recent years' cost of production. As a result, the lowest cost of production and revenue in this district was caused by the lower production size, which used fewer inputs. Then it delivered less output to generate revenue. Additionally, despite the results showing the highest working hours in the Wapi Pathum district, the less output used appeared to have more influence on the relatively lower revenue than the other studied districts.

The annual working hours of farmers can be calculated from the average production cycle per year multiplied by the average working hours per production cycle. Overall, the sericultural farmers worked 930.58 hours per year and an average of 116.32 days per year, classified by district, with Wapi Pathum having the most working hours of 982.16 hours per year (122.77 working days), followed by Yang Si Surat with 966.32 hours per year (120.79 working days), Na Dun with 943.46 hours per year (117.97 working days), Phayakkhaphum Phisai with 892.70 hours per year (111.59 working days), and Na Chuek with 871.64 hours per year (108.96 working days). However, sericultural farmers did not work all day, and these figures represent the average work carried out by the whole household. Based on the labour value added in Table 1 and the calculation of hours worked in Table 2, the sericultural farmers' labour productivity can be identified from the labour value added divided by the hours worked. The results of the study reveal that overall labour productivity averaged 1.68 USD per hour. In addition, the labour productivity per day can be calculated from the average working hours per day multiplied by labour productivity per hour. Labour productivity per year can be calculated from the hours worked per year multiplied by the labour productivity per hour (Table 4). Overall, the labour productivity per day equated to 9.69 USD per day and 1,559.61 USD per year.

When classifying by district, Na Dun was found to have the highest productivity of labour at 1.90 USD per hour and had a standard deviation (s.d.) of 0.98 (x-bar = 11.15 USD, s.d. = 5.45 per day and x-bar = 1,790.35 USD, s.d. = 774.32 per year), followed by Na Chuek at 1.82 USD per hour and had a standard deviation of 0.83 (x-bar = 10.29 USD, s.d. = 4.97 per day and x-bar = 1,585.05 USD, s.d. =



658.62 per year), Wapi Pathum at 1.70 USD per hour and had a standard deviation of 0.84 (\bar{x} = 10.03 USD, s.d. = 3.84 per day and \bar{x} = 1,672.42 USD, s.d. = 696.54 per year), Phayakkhaphum Phisai at 1.50 USD per hour and had a standard deviation of 0.61 (\bar{x} = 8.47 USD, s.d. = 3.68 per day and \bar{x} = 1,338.10 USD, s.d. = 687.87 per year), and Yang Si Surat at 1.46 USD per hour and had a standard deviation of 0.78 (\bar{x} = 8.53 USD, s.d. = 4.54 per day and \bar{x} = 1,413.56 USD, s.d. = 858.66 per year), respectively. However, silkworm rearing and mulberry cultivation are dependent on weather conditions and seasons, resulting in unstable production, which in turn affects labour productivity.

This paper showed that the labour productivity of silkworm farmers in this empirical study, which was carried out in Mahasarakham province, was higher than the minimum wage. However, as part of the analysis, the research data also showed that the average age of the sample farmers was 57.55 years old, meaning they were nearing retirement or were elderly. This paper considers this ageing labour force as a challenge to the sustainable development of the sericultural industry in Thailand. It discusses that the future of silkworm farm labour will continue to decline with no new generation of workers to replace them [29]. This paper supports previous studies [20, 21] suggesting public promotional schemes for knowledge transfer from the older to the younger generations of sericultural labours.

The paper also suggests an additional direction for farming educational schemes offered for sericultural labourers. Considering that the policymakers in Thailand recently focused on providing learning arrangements to promote farming education targeting the younger generations [22], this paper suggests extended target participants involve the older labourers with extensive experiences in the public knowledge promotional schemes. Linkages of the knowledge exchange could be created; the older labourers could learn more technical and innovative production techniques while the younger labourers could learn from the experienced labours valuable indigenous silk production techniques.

CONCLUSION, AND RECOMMENDATIONS FOR DEVELOPMENT

There are several ways to measure labour productivity. This study measures labour productivity at the micro level with the added value of labour divided by the number of hours worked. The added value of labour is calculated as total revenue minus total costs (except labour). The total revenue of sericultural farmers consists of mulberry leaves, mulberry fruit, mulberry products, mulberry seedlings, silk threads, silkworm pupa, silk manure, woven fabrics, and other products. The costs



of production consist of water, electricity, fertilizer, silk varieties, mulberry varieties, prophylactic chemical consumables for rearing silkworms, calcium hydroxide, threshing basket, silkworms shelf, traditional silk thread production machine, weighing machine, charcoal stove and miscellaneous expenses.

This study examined the labour productivity of sericultural farmers in five districts with the highest populations of sericultural farmers in Mahasarakham province, Thailand. It revealed that the total labour productivity of these farmers made higher than the province's minimum wage; the farmers made 9.69 USD per day for average working hours of 5.78 hours, or 1.68 USD per hour for the sericultural farming work.

The study also discovered that the sericultural farmers in Mahasarakham faced problems with silkworm rearing, thereby affecting total production, namely shortage of labour, lack of market to support production, insufficient promotion and support from government agencies, a low price for silk products, damage to barns repair costs, lack of investment and production factors. The procedures and methods used to raise silkworms are complicated and time-consuming. The farmers' barns are insufficient for raising silkworms and sick silk varieties. Given the results, this paper recommends future studies to focus on the factors affecting the labour productivity of farmers. It also suggests further examination and development of practical guides to help increase labour productivity based on the identified factors challenging the labour productivity of sericultural farmers.

The implementation of study results needs to consider three research limitations. First, the sericultural farmers of this study did not keep a detailed record of their total revenue and total costs. Therefore, only the overall total revenue data and total costs in each production cycle were used in this study. Second, the working days were calculated based on actual working hours, resulting in the average workday being less than eight hours. Finally, the empirical site of this study was a selected province from Thailand; future studies in other sites with different provincial or regional profiling may deliver different results. Nonetheless, providing its explicit analysis of the labour productivity based on the actual farming behaviour of the farmers, this paper could provide useful directions for future research. Furthermore, its discussions of results could be useful for promoting this important local agricultural industry. The policymakers can also use them to benchmark and evaluate their sericultural promotional policies to help increase the labour productivity of the farmers to a wider extent.



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Table 1: Total revenue, cost and labour value added

District	Total revenue (USD per year)	Total revenue (USD per production cycle)	Total cost (USD per year)	Total cost (USD per production cycle)	Total labour value added (USD per year)	Total labour value added (USD per production cycle)
Phayakkhaphum Phisai	1,453.72	228.50	95.48	15.71	1,358.24	79.77
Wapi Pathum	1,703.04	256.79	85.00	12.84	1,618.04	72.16
Na Chueak	1,601.97	269.77	92.86	15.43	1,509.11	77.43
Yang Si Surat	1,712.86	253.12	291.68	42.73	1,421.19	248.95
Na Dun	1,823.23	294.38	128.60	21.21	1,694.63	107.38
Total average	1,658.96	260.51	138.72	21.59	1,520.24	117.14

Source: authors' own calculations

Note:

1. The calculation is based on the unit price of sericultural labour of 1.68 USD per hour for the sericultural farming work.
2. The sericultural farmers interviewed did not have a detailed record of their total revenue. Therefore, only the overall revenue data in each production cycle was used in this study.
3. The total revenue of sericultural farmers is generated from selling mulberry leaves, mulberry fruit, mulberry products, mulberry seedlings, silk threads, silkworm pupa, silk manure and woven fabrics.
4. The costs of production consist of water, electricity, fertilizer, silk varieties, mulberry varieties, prophylactic chemical consumables for rearing silkworms, calcium hydroxide, threshing basket, silkworms shelf, traditional silk thread production machine, weighing machine, charcoal stove and miscellaneous expenses.
5. Total labour value added = Total revenue – Total cost (Except labour cost)

Table 2: Total labour value added (USD) per area (hectare)

District	Area (Hectare)	Total labour value added (USD per year)	Total labour value added per hectare (USD per year/hectare)	Total labour value added (USD per production cycle)	Total labour value added per hectare (USD per production cycle/hectare)
Phayakkhaphum Phisai	0.26	1,358.24	1,031.35	79.77	214.91
Wapi Pathum	0.28	1,618.04	1,223.65	72.16	242.58
Na Chueak	0.27	1,509.11	1,105.62	77.43	244.99
Yang Si Surat	0.36	1,421.19	704.40	248.95	214.36
Na Dun	0.36	1,694.63	1081.25	107.38	263.96
Total average	0.30	1,520.24	10.29.75	117.14	236.06

Source: authors' own calculations

Table 3: Workday calculation and working hours

District	Working hours per day	Workdays	Workdays per actual production cycle	Working hours per production cycle	Average silkworm rearing cycle per year	Working hours per year	Workdays per year
Phayakkhaphum Phisai	5.65	0.71	17.66	141.25	6.32	892.70	111.59
Wapi Pathum	5.89	0.74	18.41	147.25	6.67	982.16	122.77
Na Chueak	5.66	0.71	17.69	141.50	6.16	871.64	108.96
Yang Si Surat	5.83	0.73	18.22	145.75	6.63	966.32	120.79
Na Dun	5.88	0.74	18.38	147.00	6.42	943.74	117.97
Total average	5.78	0.72	18.06	144.48	6.44	930.58	116.32

Source: authors' own calculations

Table 4: Labour productivity

District	Labour productivity (USD per hour)	S.D.	Labour productivity (USD per day)	S.D.	Labour productivity (USD per year)	S.D.
Phayakkhaphum Phisai	1.50	0.61	8.47	3.68	1,338.10	687.87
Wapi Pathum	1.70	0.84	10.03	3.84	1,672.42	696.54
Na Chueak	1.82	0.83	10.29	4.97	1,585.05	658.62
Yang Si Surat	1.46	0.78	8.53	4.54	1,413.56	858.66
Na Dun	1.90	0.98	11.15	5.45	1,790.35	774.32
Total average	1.68	0.82	9.69	4.57	1,559.61	745.64

Source: authors' own calculations

Note: labour productivity is among common partial productivity analysis techniques measuring the ratio of outputs to inputs. However, output of the sericultural production was reported in various forms, including mulberry leaves, mulberry fruit, mulberry products, mulberry seedlings, silk threads, silkworm pupa, silk manure and woven fabrics. These unique details of farming activities and associated outputs were the limitation for identifying the measuring unit for the sericultural farming output. This study used the selling values of the identified products as the unit of output for the calculation. It analysed labour productivity, referring to the USD value as the output produced per labour of the farm.

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