Existing Condition of Commercial Sericulture Production in Northeastern Thailand

Krittayaporn Sumranpath[1,*], Am-on Aungsuratana[1], Tipvadee Auttathom[1] and Nongnooch Poramacom[2]

ABSTRACT

The objectives of the investigation were: 1) to determine the existing technology and local wisdom applications in commercial sericulture production in the study area; 2) to investigate appropriate technology in commercial sericulture production; and 3) to identify constraints and recommendations on commercial sericulture. The target group was sericulture farmers in Huafai village, Pordang subdistrict, Chonnabot district, Khon Kaen province. The sample size was determined according to Arkin. Forty-eight sericulture farmers were selected through a multistage sampling technique. Key stakeholders in commercial sericulture—namely, three government officials and two intermediaries, were purposively selected. Data collection was performed by interviewing the sericulture farmers, as well as by conducting in-depth interviews with key stakeholders. Descriptive statistics were used along with content analysis.

The findings revealed that the farmers applied integrated methods consisting of local wisdom and technology to reduce costs and improve the quality of production, divided into three aspects: 1) in terms of silkworm rearing, farmers should scatter calcium carbonate or talcum powder on silkworms after the molting stage; 2) in the silk yarn reeling process, farmers used the developed reeling apparatus and soaked silk yarns in water after reeling; and 3) in the silk fabric weaving process, farmers mixed olive oil or vinegar with dyes in the dying process; they used rice-wash water in silk yarn combing, and made their own weaving supplies. The main production constraints were: silkworm disease, the high cost of production, mulberry disease, and limited capital. A strategic policy for commercial sericulture production support should focus on: 1) research and development sericulture disease protection and warp yarn production; 2) group empowerment for bargaining; 3) providing soft loans; 4) supporting more marketing channels; and 5) establishing a marketing information center.

Keywords: sericulture production, commercial sericulture production, appropriate technology in sericulture

[1] Faculty of Agriculture at Khampaeng Saen, Kasetsart University, Khampaeng Saen Campus, Nakhon Pathom 73140, Thailand.

[2] Faculty of Economics, Kasetsart University, Bangkok 10900, Thailand.

* Corresponding author, e-mail: ksumranpath@gmail.com

บทคัดย่อ

วัตถุประสงค์ของการวิจัยเพื่อศึกษา 1) สภาพการใช้เทคโนโลยีและภูมิปัญญาในการผลิตไหมเชิงการค้า 2) เทคโนโลยีที่เหมาะสมในการผลิตไหมเชิงการค้า 3) ปัญหาและข้อเสนอแนะในการผลิตไหมเชิงการค้า กลุ่มตัวอย่างที่ใช้ในการศึกษา คือ เกษตรกรผู้ปลูกหม่อนเลี้ยงไหม บ้านหัวฝาย ต.ปอแดง อ. ชนบท จ.ขอนแก่น จำนวน 48 ราย โดยการสุ่มแบบหลายขั้นตอน และ ผู้มีส่วนได้เสียในห่วงโซ่อุปทานการผลิตไหม ประกอบด้วย เจ้าหน้าที่จากหน่วยงานที่เกี่ยวข้อง จำนวน 3 ราย และ พ่อค้าคนกลางจำนวน 2 ราย โดยการคัดเลือกแบบเจาะจง เก็บรวบรวมข้อมูลโดยการใช้แบบสัมภาษณ์ สำหรับเกษตรกรผู้เลี้ยงไหมและการสัมภาษณ์เชิงลึกผู้มีส่วนได้ส่วนเสีย วิเคราะห์ข้อมูลด้วยสถิติเชิงพรรณนาและการวิเคราะห์เนื้อหา

ผลการวิจัยพบว่า เกษตรกรมีการใช้ภูมิปัญญาท้องถิ่นร่วมกับเทคโนโลยีการผลิตไหมเชิงการค้าเพื่อให้สามารถลดต้นทุนและพัฒนาคุณภาพการผลิต ประกอบด้วย 3 ประเด็นคือ 1) การเลี้ยงไหม เกษตรกรใช้ปูนขาวหรือแป้งเด็กโรยบนหนอนไหมหลังจากไหมลอกคราบ 2) การสาวไหม เกษตรกรใช้เครื่องสาวไหมแบบปรับปรุงในการสาวเส้นไหมและการนำเส้นไหมไปแช่น้ำหลังจากการสาวเส้นไหม และ 3) การทอผ้า เกษตรกรผสมน้ำมันมะกอกหรือน้ำส้มสายชูในการย้อมสีเส้นไหม ใช้น้ำซาวข้าวในการหวีหูก และทำอุปกรณ์ในการทอใช้เอง ปัญหาที่พบมากที่สุดคือ ปัญหาโรคไหม ต้นทุนการผลิตสูง โรคหม่อน และการขาดแคลนเงินทุน ข้อเสนอแนะในการพัฒนา 1) ควรมีการวิจัยและพัฒนาการป้องกันและกำจัดโรคหม่อน-ไหมและการวิจัยและพัฒนาการผลิตเส้นไหมพุ่ง 2) การเพิ่มอำนาจการต่อรองด้านการตลาดให้แก่กลุ่มผู้ปลูกหม่อนเลี้ยงไหม 3) สนับสนุนเงินทุนดอกเบี้ยต่ำ 4) เพิ่มช่องทางการตลาดไหมและ 5) จัดตั้งศูนย์ข้อมูลข่าวสารด้านการตลาด

คำสำคัญ: การผลิตไหม การผลิตไหมเชิงการค้า เทคโนโลยีที่เหมาะสมในการเลี้ยงไหม

INTRODUCTION

Silk is one of the most popular natural fibers in the world because of its special characteristics of luster and softness. It is regarded as the “Queen of textiles”. It is also an important commodity particularly in East Asia, South Asia and Southeast Asia.

In Thailand, sericulture has been developed as a major occupation for income generation since it can be done throughout the year. At present, both local wisdom and modern techniques have been employed in sericulture production to serve both domestic and international demands

The Queen Sirikit Department of Sericulture (2011) revealed that in Thailand there were around 94,633 sericulture households across the whole kingdom with the mulberry cultivation area approximately 106,106 rai (16,977 hectares). The Office of Agricultural Economics (2005) reported that the various silk varieties were either native, Thai hybrid, or foreign hybrid. Approximately 80 percent of silk production takes place in the northeastern, northern, central, eastern and southern regions, respectively. In 2005, the total annual production of silk yarn was 1,600 t, annual handicraft production was 1,150 t and annual industrial production was 430 t, while domestic demand was estimated to be at least 2,000 t (Boonchoo, 2006).

The study site at Huafai village was in Prodang subdistrict, Chonabot district, Khon Kaen province, northeastern Thailand. The village is well recognized for silk fabric weaving. Sericulture farmers in the village grow mulberry, rear silkworms, and weave silk fabric for household use and domestic market supply. These activities are the main income generator throughout the year. However, they have encountered many production problems including variable product quality, poor

product quality, and lack of silk production management to meet quality requirements and market standards (Industrial Promotion Center Region 5, 2009). The current study was necessary to investigate appropriate commercial sericulture production techniques to improve productivity and to achieve a better income for the target group.

Literature review

Technology applications in sericulture production

Previous studies conducted by Chooprayoon, Boonchoo,& Leepayakun (2002), Kaemkla (2005), Misatho (2005), and Chantarasena (2006) revealed that in sericulture, using a mowing machine to prune mulberry was the best application of technology for cost reduction. In addition, using 3 percent formalin to clean silkworm rearing rooms and tools, both before and after rearing, was effective in disease and infection prevention.

It was also found that farmers scattered calcium carbonate over silkworms to prevent diseases. They used a drill to peel floss from mounting. A modern silk yarn reeling apparatus was employed to get better silk yarn quality. Farmers applied technology by using chemical dyes to dye silk yarns before weaving. Moreover, they also used industrial silk yarns to make products.

Local wisdom application in sericulture production

Chantarasena (2006), Tiensawang (2006), and Kaewpichit (2008) pointed out that farmers applied local wisdom in their production. They used a sickle for mulberry leaf harvesting to save time. They also observed silkworm behavior during rearing, and enlarged rearing areas accordingly.

Additionally, they used a net cleaning method on the silkworm beds and a hand tool to pull out cocoons from mounting. Holding the mounting over fire for cleaning was also practiced. Farmers used natural materials to dye silk yarns and reeled yarns onto spools. Silk yarns were prepared based on the fabric type they intended to weave. Farmers used local wisdom to create weaving patterns and they used local materials to make weaving tools.

Research objectives

1. To determine existing technology and local wisdom applications in commercial sericulture production in the study area.
2. To investigate appropriate technology in commercial sericulture production
3. To determine constraints and recommendations for commercial sericulture production towards policy and implementation orientation.

Definitions

Commercial sericulture production refers to best practices in sericulture production towards standardization gathered from a literature review, relevant agencies, sericulture experts, and progressive and best practice farmers in sericulture production in the study area. It comprises 3 major categories and 21 sub-categories. These three major categories are silkworm rearing, silk yarn reeling, and silk fabric weaving.

Silkworm rearing refers to the practices of farmers at the research site toward commercial sericulture production. It comprises 10 operations—variety selection, rearing room and equipment preparation, disinfection, feeding, rearing area enlargement, bed cleaning, handling of instars, collecting mature worms for mounting, cocoon harvesting, and pest prevention.

Silk reeling refers to the practices of farmers at the research site toward commercial sericulture production. It comprises seven operations—silk reeling place preparation, equipment preparation, cocoon culling, cocoon degumming, reeling techniques, re-reeling techniques, and storage and packaging.

Silk fabric refers to the practices of farmers at the research site toward commercial sericulture production. It comprises three operations—dyeing, yarn preparation, and weaving.

METHODOLOGY

Scope of the study

This study focused on the technology and local wisdom applications in commercial sericulture production consisting of silkworm rearing, silk yarn production, and silk fabric weaving.

The respondents were 48 sericulture farmers who engaged in sericulture production in Huafai village, Pordang subdistrict, Chonnabot district, Khon Kaen province in 2010. The data were collected between May and September 2011.

Population and sampling technique

The target group of this study was the key stakeholders in commercial sericulture supply chain, consisting of:

Sericulture farmers

The population consisted of 145 sericulture farmers in Huafai village, Pordang subdistrict, Chonnabot district, Khon Kaen province. The sample size was determined by Arkin (1974). A multistage sampling technique was used to select samples, resulting in 48 sericulture farmers being surveyed.

Government agencies

A purposive selection was made consisting of three officials from three government agencies responsible for both policy and implementation of sericulture promotion strategies in Khon Kaen province who were chosen to support the data from the respondents. The officials were from The Queen Sirikit Department of Sericulture, the Department of Industrial Promotion, and the Department of Agricultural Extension.

Market intermediaries

Two intermediaries in the sericulture supply chain in Khon Kaen province were selected through purposive sampling to support the data from the respondents.

Data collection and analysis

The data were collected from interviews with 48 sericulture farmers. The questions defined the personal background of respondents and their applications of technology in and local wisdom of commercial sericulture production. In-depth interviews were conducted with stakeholders in the sericulture supply chain. The data were used for supporting policy implementation and marketing aspects.

The data were analyzed using descriptive statistics (percentage, arithmetic mean, and standard deviation). Content analysis was used to analyze the in-depth interview data.

RESULTS AND DISCUSSION

Technology applications in commercial sericulture production

The data obtained from 48 sericulture farmers in Huafai village, Pordang subdistrict, Chonnabot district, Khon Kaen province, northeastern Thailand is shown in Table 1. It was found that there were 11 technology applications in sericulture production. These were: silk yarns reeling, rearing of newly-hatched larvae, silk yarn dyeing, silkworm disease prevention, mulberry watering, silk yarn re-reeling, weed control, silk yarn preparation, mulberry cultivation, bed cleaning, and silk yarn drying.

The results showed that all of the respondents applied technology in silk yarn reeling according to the recommendations from the concerned agencies in order to reduce the production time. All farmers used the developed silk yarn reeling apparatus in the reeling step because it offered higher productivity and better quality of silk yarn than could be achieved using conventional equipment. This result was similar to that reported by Chooprayoon et al. (2002).

In practices that were performed by more than 50 percent of the farmers, rearing of newly-hatched larvae was undertaken by the majority of respondents (77.1%). Additionally, high percentages of farmers also employed technology in

Table 1 Technology applications in commercial sericulture production

Technology application	n	%
Silk yarn reeling	48	100.0
Rearing of newly hatched larvae	37	77.1
Silk yarn dyeing	33	66.8
Prevention of silkworm disease	25	52.1
Irrigation	21	43.7
Silk yarn re-reeling	13	27.1
Weed control	12	25.0
Silk yarn preparation	6	12.6
Mulberry planting	1	2.1
Bed cleaning	1	2.1
Silk yarn drying	1	2.1

silk yarn dyeing and in silkworm disease and pest prevention, which accounted for 66.8 percent and 52.1 percent, respectively.

Disease prevention was addressed by the farmers scattering calcium carbonate and "Pebsol" on newly-hatched larvae to reduce moisture. In addition, they used either olive oil or vinegar for wrap yarn dyeing. They also used drops of dish washing liquid mixed with dyes before dyeing because these methods could help the yarns to absorb colors more efficiently and prevent spotting.

As a technique for disease prevention in silkworms, most farmers scattered either calcium carbonate or "Pebsol" on silkworms after molting stage to reduce moisture and therefore prevent diseases. The results were similar to those reported by Kaemkla (2005) and Misatho (2005).

Practices that were used by less than 50 percent of the sample group were: 43.7 percent of the respondents had water irrigation in their plots and technology applied consisted of re-reeling silk yarn (27.1%), weed control (25.0%), silk yarn preparation (12.6%), mulberry cultivation (2.1%), bed cleaning (2.1%), and silk yarn drying (2.1%).

The findings indicated that a few farmers used sprinklers and furrows which were recommended by the Department of Agricultural Extension to irrigate their plots. In addition, they used the developed re-reeling apparatus in silk reeling because this apparatus could spread silk yarns during re-reeling which was one of the standards of silk skeins.

In weed control, some farmers used a steel plow to save time and labor. In addition, farmers also used an electric warping board to save time and labor in the silk yarn preparation process. Some farmers grafted mulberry and the grafted cut stems were covered with rice husks and kept under shade, watered for 5-7 days until the roots appeared and were ready for planting. This method increased the growth rate of mulberry. In bed cleaning, some farmers used a cleaning net technique to remove waste manure because it was convenient and shortened the rearing time.

For the final stage, in silk yarn drying, some farmers used an electric dryer to dry silk yarns after bleaching. This technique helped shorten the drying time and was convenient.

Local wisdom applications in commercial sericulture production

Local wisdom applications are shown in Table 2. There were seven techniques derived from local wisdom—silk fabric weaving, silkworm disease and pest prevention, silk yarn re-reeling, newly-hatched larvae rearing, silkworm selection,

mulberry disease prevention, and collecting mature worms for mounting.

The results indicated that there were two local wisdom applications that were applied by more than 50 percent of the respondents, being weaving and pest prevention which accounted for 72.9 percent and 52.1 percent, respectively. The findings revealed that the farmers applied local wisdom because they had learned these techniques from their ancestors.

Most farmers used rice-wash water (which contains starch) for silk combing as it made weaving easier. Using this technique also made the silk fabric tighter during weaving, resulting in higher fabric quality. Moreover, they made their own weaving tools. For example, they made warp combs from coconut shells and used tree branches as wooden spools. These techniques had been learned from their ancestors. The use of local materials in weaving tools also helped to reduce production costs.

The farmers scattered talcum powder on silkworms after the molting stage to reduce moisture and prevent diseases. They also laid banana leaves on the bottom of the rearing bed to control moisture and protect the silkworms. Some farmers scattered rice on silkworms when feeding them with mulberry leaves so that the silkworms would not get stuck to each other. Pouring hot water around silkworm rearing rooms was used to prevent ants from entering.

Practices adopted by less than 50 percent of the respondents consisted of five techniques in silk yarn reeling, newly-hatched larvae rearing, silkworm selection, mulberry disease prevention, and collecting mature worms for mounting, which accounted for 27.1 percent, 10.4 percent, 4.2 percent, 2.1 percent and 2.1 percent, respectively. The farmers applied local wisdom in the re-reeling process by soaking silk yarns in water after reeling to prevent drying so that the yarns could be easily re-reeled. In addition, farmers used various techniques included using “tum jai” (paracetamol) which was mixed with chopped, young tamarind leaves before scattering over newly-hatched larvae. They also scattered talcum powder on newly-hatched larvae to reduce the moisture in the rearing beds which would make them healthier.

Some of the farmers used banana sheaths cut into a rectangular shape as a frame for newly-hatched larvae. The purpose of this technique was to keep the bed moist which in turn kept larvae healthy. The farmers selected silkworms by shaking cocoons. If a cocoon made a loud noise when it was shaken, it was good for breeding. They prevented diseases by pouring rice-wash water mixed with salt on the roots of mulberry bushes. They also applied fertilizers in the grooves to prevent termites.

When collecting mature worms for mounting, a few farmers placed a plastic sheet at the bottom of the baskets to prevent silkworm spillage. Then they collected mature worms for mounting.

Table 2 Local wisdom applications in commercial sericulture production

Local wisdom application	n	%
Weaving	35	72.9
Silkworm pest prevention	25	52.1
Silk yarn reeling	13	27.1
Rearing of newly-hatched larvae	5	10.4
Silkworm variety selecting	2	4.2
Mulberry disease prevention	1	2.1
Collecting mature worm for mounting	1	2.1

Appropriate technology in commercial sericulture production

The results showed that the farmers applied integrated methods consisting of local wisdom and technology to reduce the production cost and achieve better product quality. These applications were found in three operations in sericulture production:

1. Newly-hatched larvae rearing process: It was found that the farmers scattered calcium carbonate, Pebsol, or talcum powder on newly-hatched larvae and after the molting stage to reduce moisture. It was also found that the farmers used a net cleaning method for bed cleaning. Furthermore, instead of using newspaper, the farmers laid banana leaves at the bottom of the silkworm trays to keep the worms moist and therefore healthy.

2. Silk reeling process: The farmers used the developed reeling apparatus rather than hand reeling to increase productivity. The apparatus also offered better quality of silk yarns as the yarns were more consistent in diameter and unbroken. After reeling, the yarns were soaked in water to prevent drying out which made re-reeling easier. It was found that this procedure produced better yarn quality than the conventional method.

3. Silk weaving process: It was found that in the silk yarn dyeing stage, the farmers added olive oil or vinegar to dyes as they helped silk yarns to be more consistent in color intensity and to absorb dyes more efficiently. The farmers also mixed dish washing liquid with dyes as this gave a shiny effect to silk yarns and made the yarns stronger. Apart from these techniques, rice-wash water or hair conditioner was also used in silk combing to soften silk yarns and prevent breakage during weaving. The farmers tried to reduce production costs by making their own weaving essentials from natural materials, such as weaving combs from coconut shell, spools from tree branches, and strings made of banana trees. It was found that they also used an electric re-reeling machine and an electric warping machine to save time and to reduce labor costs.

Information was obtained from in-depth interviews with government officers working in agencies concerned with commercial sericulture production. They revealed that these agencies provided support and knowledge transfer on commercial sericulture. They gave support on production, provided know-how and technology, and created a network between sericulture production groups. The products supplied by the agencies included good silkworm eggs, mulberry varieties, materials for making rearing rooms, reeling machines, reeling essentials, and electric weaving machines. The agencies also organized on-site knowledge-and-technology-transfer workshops to target farmer groups. The workshops included sericulture, silk yarn reeling, silk yarn dyeing, silk fabric weaving, weaving patterns, and new product development. They also organized fieldtrips so that farmers could use and adapt the knowledge and know-how they saw to improve their own sericulture production as well as be able to achieve good product quality according to the Peacock standards (Queen Sirikit Department, 2008) and the Thai industrial standards for silk (Thai Industrial Standards, 1997)

Constraints in commercial sericulture production

Production and marketing constraints in commercial sericulture production are shown in Table 3. Four major constraints identified by more than 50 percent of the respondents were silkworm diseases (68.7%), high production costs (58.3%), mulberry diseases and pests (56.2%), and limited capital (52.1%)

The most serious constraints were silkworm diseases including *Grasserie spp.* and *Aspergillus spp.* infections, particularly during silkworm rearing. This response indicated that training courses on disease protection and eradication should be provided to reduce the infections.

The production cost was high for the weaving process because farmers bought industrial

warp yarns at high prices. Moreover, the labor cost was high in the dyeing and weaving stages. The government agencies relating to sericulture production should provide new technology to help farmers produce their own warp yarns to reduce production costs.

The most serious mulberry disease was root rot. Farmers in the Northeastern region always encountered this problem because of the sandy loam soil conditions. The agencies concerned should provide a new mulberry variety that is disease resistant and is high yielding.

The farmers had limited capital funds to invest in sericulture production. Soft loans should be provided by government agencies or sericulture co-operatives.

Marketing access was constrained by two factors that more than 50 percent of the respondents identified. A high percentage of the farmers indicated that they had limited access to market channels (58.3%) and marketing information (52.1%).

There were limited market channels, as most farmers only sold their silk products to their sericulture group or to middlemen who came to the village because the farmers were not familiar with other means of selling. To overcome this problem, network creation between the sericulture groups at the provincial and regional levels should be promoted. Furthermore, the government agencies concerned with the sericulture supply chain should provide access to various market channels.

The farmers also received insufficient marketing information, with most information related to production methods rather than to marketing. Therefore, the relevant government agencies should provide more marketing information and should establish a marketing information center for the farmers.

The survey results mentioned above were in agreement with the information obtained from the in-depth interviews with the three government officers and two intermediaries, which revealed that the farmers sold silk yarns to traders in the district business areas. The price of the yarns depended on their quality. In the case of silk fabric, it was found that traders would directly contact the weaving group to place orders with regard to quantity and the specifications. Once the weaving group had manufactured the products required, the middlemen would collect the goods from the group. The products were later traded in both domestic and international markets.

CONCLUSION AND RECOMMENDATIONS

This study investigated the techniques of

Table 3 Constraints in commercial sericulture production

(n = 48)

Constraint	Of concern		Not of concern	
	n	%	n	%
Production constraints				
Silkworm disease	33	68.7	15	31.3
High cost of production	28	58.3	20	41.7
Mulberry disease	27	56.2	21	43.8
Limited capital	25	52.1	23	47.9
Marketing constraints				
Limited market channels	28	58.3	20	41.7
Limited marketing information	25	52.1	23	47.9

commercial sericulture production. The results revealed that the majority of farmers applied technology and local wisdom to improve their productivity and produce outputs whose quality met the standard requirements.

Farmers applied technology in order to improve their productivity in silk yarn reeling, newly-hatched larvae rearing, silkworm disease prevention, irrigation, and mulberry planting. In addition, they applied technology to improve the product quality in the silk yarn reeling, silk yarn re-reeling, and silk yarn dyeing stages. They also applied technology for weed control, silk yarn preparation, bed cleaning, and silk yarn drying in order to reduce production costs.

Farmers applied local wisdom in silkworm disease prevention, silk yarn reeling, newly-hatched larvae rearing, silkworm selection, mulberry disease prevention, and collecting mature worms for mounting. They also applied local wisdom in silk fabric weaving in order to improve silk product quality and to reduce production costs.

The findings indicated that the main production constraints in commercial sericulture production were silkworm diseases and pests, the high cost of production, mulberry diseases and pests, and limited capital funds, respectively. In addition, marketing was a serious constraint as the farmers had limited market channels and limited marketing information.

It was found that a strategic policy to promote sericulture commercial production should focus on research and development in mulberry and silkworm disease protection. Providing new technology in making warp yarns could help in reducing the production cost. The sericulture groups should be empowered for bargaining and the government agencies concerned should provide soft loans to farmers.

Farmers should be supported in finding new market channels as well as creating networks between the sericulture groups at the provincial and regional levels. In addition, a marketing information center should be established to provide useful information on sericulture marketing to farmers.

REFERENCES

Arkin, H. (1974). *Handbook of sampling for auditing and accounting* (2nd ed.). New York: McGraw-Hill Book.

Boonchoo, S. (2006). *Thai silk handicrafts cottage small and medium.* In Enterprises International Workshop on Silk Handcrafts Cottage Industries and Silk Enterprises Development in Africa, Europe, Central Asia and the Near East. Rome, Italy: Food and Agriculture Organization of the United Nations.

Chantarasena, W. (2006). *Studied on factor affecting silk production development expectation of Ban Toong Samae silk production group member, Nong Ya Sai district, Suphan Buri province* (Unpublished master's thesis). Kasetsart University, Bangkok. [in Thai]

Chooprayoon, S., Boonchoo, S., & Leepayakun, P. (2002). *Silk production technology*. Bangkok: Funny Publishing.[in Thai]

Industrial Promotion Center Region 5. (2009). *Sericulture group operation report in Khon Kaen province*. Khon Kaen:Industrial Promotion Center Region 5. (Mimeographed) [in Thai]

Kaemkla, W. (2005). *Condition on Thai hybrid silkworm rearing of sericulture farmer group in Nonsa-Nge village, Kra Tiam subdistrict, Sung Khla, district, Surin province.* Bangkok: Department of Agricultural Extension.[in Thai]

Kaewpichit, R. (2008). *Indigenous knowledge for Pak Thong Chai silk-cloth production for development to be standard of community products* (Unpublished master's thesis). Mahasarakham University, Mahasarakham. [in Thai]

Misatho, S. (2005). *Technology application in Thai hybrid silkworm rearing of sericulture farmer in Mahasarakham province*. Bangkok:

Department of Agricultural Extension. [in Thai]

Office of Agricultural Economics. (2005). *Agricultural statistics of Thailand 2011*. Bangkok: Office of Agricultural Economics. [in Thai]

Queen Sirikit Department of Sericulture. (2011). *The sericulture statistics of Thailand year 2010*. Retrieved from: http://www.qthaisilk.com/qthaisilk/upload_ page/datasilk_page_1.jpg

Queen Sirikit Department of Sericulture.(2008). *Royal peacock standard*. Bangkok: Queen Sirikit Department of Sericulture. (Mimeographed) [in Thai]

Thai Industrial Standard.(1997). *Silk fabric standard*. Bangkok: Thai Industrial Standard Institute. [in Thai]

Tiensawang, J. (2006). *Women farmer roles in community enterprises development: a case study of BanToong Samae weaving group, Nong Kham subdistrict, Nong Ya Sai district, Suphan Buri province* (Unpublished master's thesis). Kasetsart University, Bangkok. [in Thai]