

A Preliminary Study of the Changes in Textile Production under the Influence of Eurasian Exchanges during the Song-Yuan Period

MAU Chuan-hui 毛傳慧*

Imported into ancient China as luxury products, cotton goods came through both the famous overland Silk Road and maritime routes via Southeast Asia.¹ Archaeological evidence clearly testifies that cotton culture had existed in the Turfan and Dunhuang regions since the sixth century AD, but the quality of those products was inferior to that of imported fine cotton cloth. Several names were assigned to this exotic luxury textile;² therefore it was difficult for Chinese people to identify the plants from which the cloth was

* The present paper is a corrected and modified version of the draft presented at the workshop on Eurasian Influences on Yuan China held in Binghamton University (November 2009). The author is thankful to the anonymous referee and to the editor for helpful suggestions. The achievement of the present paper has benefitted from financial aid from the National Tsing Hua University (100N2525E1)

- 1 For more details on the history of the cotton industry in China, see Amano Moto-suke 1962, 482-498; Chen Zhongyi and Zhao Gang 1977, 1-43, as well as the article of Eric Trombert 1996, 205-227. Dieter Kuhn (1988) gave a detailed description of the procedure. In this work, he also collected rich materials for Chinese textile technology study. Nevertheless, the reader should be aware that the techniques mentioned underwent a very long period of evolution. Also the techniques varied greatly from one period to another and even between one region and another.
- 2 In Chinese historical sources the descriptions of the cotton cloth and cotton plantations may date back to the first millennium BC. Zhao Gang found that the terms for the cotton cloth and the cotton imported from the Western region (*xiyu* 西域) were less diversified than those that came from Southern China. Also, a certain number of these terms – such as *baidie* 白疊, 白疊, 白氎, *bodie* 帛疊 and *buida* 白荅 – were phonetic transcriptions of one and the same Sanskrit term, *patta*. Meanwhile, the descriptions of the cotton imported from the Southern regions of China were more diversified, the terms were more numerous and quite different from each other. Zhao Gang suggested that the cotton seeds might have been imported into Southern China before the appearance of cotton cloth. Types of cotton wool were named after the plants used to produce them, for example: *tonghua* 桐華, 槿華, *duluo mian* 妬羅綿, *douluo mian* 兜羅綿. For more details, see Chen Zhongyi and Zhao Gang 1977, 4-17.

made. However, the first Chinese character for naming cotton, *mian* 棉, finally emerged in the eleventh century.³

This appearance coincided with the beginning of the expansion of cotton cultivation in China. Simultaneously, one can notice that the price of silk clothes decreased (in fact, the same phenomenon also happened to all kinds of textiles),⁴ paradoxically following a reduction of the mulberry plantations surface areas.⁵ It is also during this period that the most ancient existing Chinese treatise on sericulture showed up, namely, the *Canshu* 蠶書 (*Description of silkworm breeding*), written in 1082–1084 by Qin Guan 秦觀 (1049–1100).⁶ Moreover, in Southern

3 The most ancient extant text where the term *mian* 棉 is written with the radical *mu* 木 (tree) is the *Guangyun* 廣韻 (*Extensive Rimes*), at least starting from the Song edition, which has an excerpt from a lost book by Zhang Bo 張勃 entitled *Wulu* 吳錄 (*Notes on [Eastern] Wu*) describing the cotton tree; see *Guangyun* (“Xia pingsheng” 下平聲), 2.5a (139). Before that there existed the character *mian* 綿 (also written 緜) with the radical *mi* 糸 (fibre or silk) for referring to silk floss or to fibres.

4 One can observe a drop in price since the mid-Tang period, but most of the data came from the imperial institutions or from the registry of tax collection. A piece of evidence comes from Lu Zhi 陸贄 (754–805) who criticized the “two taxes measures” and reported: 往者納絹一匹，當錢三千二百文；今者納絹一匹，當錢一千五六百文。 “Formerly, a piece of ordinary silk cloth paid as part of tax could be worth 2,200 to 2,300 coins. Nowadays, one piece is worth 1,500 to 1,600 coins.” Cf. *Tang Lu Xuan-gong ji* 唐陸宣公集 22.250 (“Zhongshu zouyi” 中書奏議, “Junjie fushui xu baixing 1” 均節賦稅恤百姓第一條). Some historians proposed to view the phenomenon in the context of the government’s decision to encourage sericulture activity by increasing the price of silk cloth. Shimai Kazuyasu 島居一康 provided detailed analyses of the influence of tax systems on the price of silk goods; see Shimai Kazuyasu 1993, 348–403. According to the study of Quan Hansheng 全漢昇, in the Ming period the price of silk fell even more considerably: in the Song dynasty, one piece of ordinary silk cloth cost on average 1.57 *liang* of silver and in the Ming, 0.6 *liang* (one *liang* was equal to 37.30 g in the Song and Ming dynasty); see Wu Chengluo 1937, 74. See Quan Hansheng 1991, 580f.

5 Several studies focused on the evaluation of the volume of silk production on the basis of tax records, for example, Chao Yea-shu 1974; Lu Huayu 1995, 1–82. These publications provide information about the provinces where sericulture was practiced and where farmers were able to pay the tax levied on silk products. However, they do not give us any information about the surface area of the mulberry tree plantations or the volume of silk production. It is highly probable that the area and/or volume increased in some provinces while in others the farmers abandoned silk production for other activities.

6 There are two suggestions concerning the authorship of the *Canshu*. Some scholars considered Qin Guan as the author of the treatise, while others attributed it to Qin

Song (1127–1279) times, the great development of the silk industry resulted both in technical progress and in the specialization of its production. One can observe the specialization of the silk industry through two phenomena: first the dividing of the working process among several persons and the concentration of the silk work in some regions famous for their delicacy. Secondly, at the beginning of the Qing period, sericulture was concentrated in some specialized centres (e. g. the deltas of the Lower Yangzi and Pearl River, and the Red Basin) where “the local conditions were not suitable for cotton plantation”, as Yan Kaishu 嚴開書 (c. 1612–1672) suggests.⁷ Several local civil officials and elite members, such as Tang Zhen 唐甄 (1630–1704) and Yang Shen 楊峴 (1699–1794), even had to call on their people to restart the sericulture abandoned by their ancestors.⁸

Zhan 秦湛, the son of Qin Guan. On the basis of an analysis of several relevant documents, I tend to follow the former hypothesis. For more details, see my article of 2005.

- 7 In the early Qing, a literatus of Huzhou origin, Yan Shukai, described the history of the development of cotton production and the diminution of sericulture from the Song–Yuan period to his lifetime as follows (*Yan Yishan xiansheng wenji* 嚴逸山先生文集 8.18a, 404): [木綿] 至宋元間而其種始至，關陝閩廣首得其利，迨洪永之際，遂遍播於天下，其利殆百倍於絲枲。自此而天下之務蠶桑者日漸以少，以故曩時無地不產絲綿，而今則否。獨惟予郡，以地土卑濕，不宜於木綿，又田瘠稅重，不得不資以營生，故仍其業不變耳。“During the transition of Song-Yuan period the species [of the cotton plant] arrived [in China]. The regions of Guanzhong, Shaanxi, Fujian and Guangdong were the first to benefit from the advantages of it. Up to the end of the Hongwu (1368–1398) and the beginning of the Yongle (1403–1424) era, the cotton plant extended throughout the Empire because the benefits obtained from it were a hundred times higher than those produced from silk or hemp. From then on farmers occupied with sericulture were fewer and fewer. That’s why formerly there is no place where the people did not produce both silk yarn and floss; but at the present time, that’s not the case any more. Only in my hometown the inhabitants can do nothing but continue sericulture practice because of its geographic situation the land is low and the soil is wet which is not suitable for cotton planting. Otherwise as the earth is barren but the taxes are heavy, the inhabitants are bound to practice sericulture.” Some historians argued on the basis of this quotation that the diminution of the surface of mulberry tree plantations was a result of the expansion of cotton culture; see, for example, Peng Zeyi 1984, 1.210.
- 8 Tang Zhen promoted sericulture in the regions under his jurisdiction and composed several texts for encouraging sericulture, which were collected in *Qianshu* 潛書 (“Xiapian xia”, *jiaocan* 教蠶). Yang Shen tried to bring back sericulture to his native region in Shaanxi. He had set up an experimental farm for developing agricultural and sericulture techniques and spreading knowledge. He compiled several treatises among which the most famous was the *Binfeng guangyi* 幽風廣義 from 1742.

Several questions arise in this context: Did the development of the cotton artisanal industry really threaten that of the silk production and force people to shut down the latter in limited regions specifically assigned for sericulture, as many modern historians suggest? The arguments of Yan Kaishu apparently convinced some historians, but, in my opinion, the question is still far from being solved.⁹ For instance, Yan noted that his own region continued the practice of sericulture both for ensuring the very heavy fiscal duties and also because the soil was barren and not suitable for cotton plantation, which sounds contradictory, especially given that some historians convincingly depicted an exceptional development of the silk industry in the Jiangnan region during the Southern Song.¹⁰ Another question to be discussed is whether it is reasonable to consider the increase of cotton cultivation a sole consequence of the remarkable technical progress made in sericulture. In other words, did the high productivity in sericulture make it possible to release manpower and land for cotton plantation? At the same time, the high technical requirements for silk production made this a very attractive but also a high-risk activity. Under these circumstances, would it be reasonable to conclude that only the people possessing advanced technological expertise continued the production?

The present paper aims to examine, through a technical approach, the relationship between specialization in the silk industry and the spread of the cotton industry during the Song-Yuan period. At the same

⁹ See note 7.

¹⁰ Shiba Yoshinobu stressed the specialization and commercialization of the silk industry during the Song dynasty in his book entitled *Sōdai shōgyōshi kenkyū* 宋代商業史研究. Cf. Shiba Yoshinobu 1968, 271-295. Mark Elvin focused on the remarkably high level of technical development in textile production during the Song and Yuan periods. See Elvin 1973, 194-199. In his work the author seems to have had difficulties in explaining certain technical details of textile production. For instance, the spinning machine for hemp thread described by Wang Zhen 王禎 in his *Nongsu* 農書 was not the same as the silk reeling device; moreover, these two devices were based on different principles, while Elvin suggested that one and the same machine was used for both operations (195). The large spinning machine was actually adopted by the silk industry and continued to be used in late Qing China for silk yarn threading; see Mau Chuan-hui 2004, 40f. Elvin and other historians of the silk industry suggested that there was a close relationship between the large spinning machine in China and the silk-spinning machinery in Western Europe; see Kuhn 1989, 404-433; Claudio Zanier 1994, 52-63. However, the question of how textile techniques were circulated during the thirteenth century needs further systematic analysis.

time, I will consider political and social changes interrelated with technical development, and the consumption of Chinese textiles during the Song-Yuan period. In this case, it will be inevitable to examine the production of hemp and ramie fibres. Also, it will be necessary to consider the relation between foreign trade and the development of the silk industry abroad.¹¹ The examination of the technical progress during the studied period lies essentially in the analysis of texts related to sericulture and cotton techniques of the Song-Yuan period.¹² Qin Guan's *Canshu*, Chen Fu's 陳夔 *Nongshu* 農書 (1149), *Nongsang jiyao* 農桑輯要 (preface 1273) and Wang Zhen's 王禎 *Nongshu* 農書 (1313) provide essential data for an analysis of techniques.¹³ However, the techniques described by those treatises may have been invented and used for a certain period of time before they were collected by the authors. Other works, such as the *Qimin yaoshu* 齊民要術 (c. 534) by Jia Sixie 賈思勰, as well as some others, which appeared later than the period under study, as for example, the *Nongzheng quanshu* 農政全書 (1639) by Xu Guangqi 徐光啟 (1562–1633), will also be referred to for further examination.

-
- 11 Luce Boulnois and Liu Xinru studied the spread of the influence of wars, trade, emigration and pilgrimage on the silk industry; see Boulnois 2001 and Liu Xinru 1996. In his work, Walter Endrei examined the technical evolution of the textile industries in the Middle Ages by considering the raw material supply, manpower and productivity of different processes. He discussed the circulation of technology between the two extremities of the Eurasian continent and the mutual influences between the technologies of production of different textile fibers, such as wool, silk and cotton; see Endrei 1968, 11–136. In any case, the practice of sericulture in Southern France dates not later than the end of thirteenth century. Since the end of the fifteenth century, the seigneur d'Alan and French kings tried to improve their silk production by introducing white mulberry trees and advanced techniques; see Le Roy Ladurie 1966, 1.216f.
 - 12 Several modern historians contributed to the studies of the general development of textile techniques in Chinese history, for example: Chen Weiji 1992; Kuhn 1988; Zhu Xinyu 1985; Zhao Feng 2005. For a more detailed description of the evolution of technology in the silk industry during the Song and Yuan periods, see Mau Chuan-hui 2010a, 299–351; 2010b, 131.6.2, 193–217.
 - 13 The works of several modern historians containing annotated bibliographies of ancient Chinese agricultural treatises are useful to understand the background and the nature of those treatises. For a general survey on Chinese agricultural treatises, see Wang Yuhu 2006; Amano Motonosuke 1975. One can find detailed studies of some well-known Song Yuan treatises in the works of Amano Motonosuke 1967, 341–468, Shi Shenghan 1982 and Miao Qiyu 1988.

Social Evolution during the Song-Yuan Period

Since the mid-eighth century, the Yellow River Valley had frequently encountered military troubles, which heralded the second great immigration of northern population to southern China. Great riches, advanced know-how and abundant manpower were introduced into the regions of the Lower Yangzi Valley, the Red Basin in Sichuan province and the Pearl River Delta in Guangdong.¹⁴

Following the setting up of the Southern Song Court at Lin'an 臨安 (modern day Hangzhou), the Lower Yangzi Valley finally replaced the Yellow River Basin, becoming a new economic centre of China.¹⁵ The delta of the Lower Yangzi must have appeared to be an appropriate location for the new capital of the central government of the Southern Song because its economy and agriculture had been developed progressively since the early eighth century. The events that took place in the first millennium AD in this area can be summarized as follows:

In his work entitled *Tangdai Jiangnan nongye de fazhan* 唐代江南農業的發展, Li Bozhong 李伯重 argued that before the mid-eighth century the inhabitants of the Jiangnan region bore a heavier tax burden than those in northern China, even though the total fiscal income was less than that collected from the northern regions, and therefore the produc-

14 The silk industry in Guangdong has been studied by a number of modern historians. Most of them focused their research on the mechanization of silk reeling techniques during the Late Qing period. When comparing the techniques, one can observe that several operations were similar to those described by Chen Fu; cf. Mau Chuan-hui 2006, 4-15. The concept of Chen Fu as well as agricultural techniques developed by him in the Jiangnan region, may have been introduced from there to the Pearl River delta owing to emigrations or to the civil offices. They had developed during the sixteenth century while maritime trade flourished and led to a special landscape of Guangdong with the spread of the system of *sangji yutang* 桑基魚塘 (Mulberry-based fish pond).

15 Since Zhang Jiaju 張家駒 (1914-1974) published his work *Liang Song jingji zhongxin de nanyi* 兩宋經濟重心的南移 in 1957, the question of how the economic centre moved from the Yellow River to the Jiangnan region has been discussed by numerous modern historians. While the silk industry played an important role in Chinese economy, the shift of centre of the silk industry was directly implicated in this movement. Almost all modern historians agree with the conclusion that in the Southern Song, the Jiangnan silk industry replaced that of the Yellow River delta to be the new centre. See, for example, Huang Shirui 1985-1987. Only very few historians argued that during the Song dynasty the silk industry in Northern China excelled the Jiangnan production in quantity as well as in quality. Cf. Li Qing 2001.

tivity of agriculture in the Jiangnan region was higher than that of the north.¹⁶ After the An Lushan Rebellion (755–763), the military chaos, associated with land grabbing by commanding officers at the northern frontier, deprived the court of tax income from northern China. However, the Tang court managed to survive this, owing to taxes and cereals sent from the Jiangnan region. The peace maintained in the region during the Five Dynasties (907–960) thus created favourable conditions for developing agriculture and craft industries, while unceasing military troubles ravaged northern China.

Since its foundation in 960, the court of the Northern Song was busy not only with administrative and military affairs but also with ensuring peace at the northern and western frontiers of the empire by paying large amounts of tribute to its neighbours every year.¹⁷ Agricultural policy constituted one of the main measures to raise the income of the Imperial Treasury. In 1006, a system for encouraging agriculture and sericulture was created; it worked by naming local civil officers as commissioners for encouraging agriculture (*quannongshi* 勸農使) and by regularly publishing treatises on agriculture.¹⁸ After the disorders of the Jingkan period (*Jingkan zhi bian* 靖康之變, 1127), the government settled its capital in Lin'an. The arrival of large crowds of people from the Northern region who carried with them rich know-how and considerable capital increased the available manpower and boosted consumption thus stimulating the development of artisanal industries. The sudden multiplication of population in a territory of the Empire reduced under the Southern Song dynasty (1127–1279) to a half of what it used to be

16 Cf. Li Bozhong 1990, 216f. In this work, the author also analyses in great detail the growth of productivity and of land use.

17 For example, in 1004, the Northern Song court and the Liao court negotiated a peace treaty known as the Shanyuan Treaty (*Shanyuan zhi meng* 澶淵之盟) concluded the next year. It was decided that the Northern Song court had to offer the Liao court an annual tribute, *sui* 歲幣, of 100,000 *liang* of silver and 200,000 pieces of silk. See Twitchett and Fairbank 2009, 267. In 1141, the court of Gaozong concluded with the Jurchen the treaty of Shaoxing (*Shaoxing heyi* 紹興和議) and obtained twenty years of peace, for which the Southern Song court sent to the Jin court an annual tribute of 250,000 *liang* of silver and 250,000 pieces of silk. See Twitchett and Fairbank 2009, 684.

18 A discussion of the origins and the development of the system of encouragement of agriculture can be found, for example, in Bao Weimin and Wu Zhengqiang 2004.

raised serious problems.¹⁹ The government took measures in different fields to solve the emerging problems; one of them was the encouragement of both land clearing and agriculture in order to raise the surface of farmland and its productivity, while the others were encouraging maritime trade and the development of craft industries.²⁰ Owing to flourishing maritime trade, in which Islamic and Chinese merchants played the leading role, large quantities of foodstuff, raw materials and luxury products were imported, bringing with them foreign cultures, know-how, tools, and plant seeds.²¹ One of the most famous cases was the introduction and the spread of the culture of a new kind of rice from Champa that helped to relieve the pressure caused by the need to feed a large population.²² Unfortunately, the history of Eurasian economic and cultural exchanges of this period still awaits further research.²³

-
- 19 Wu Songdi 吳松弟 argued that, during the Jiankang era (1126–1127) and the early Shaoxing (1131–1162) period, the immigration only compensated for the loss of population during the wars against the Mongolians. After the mid-Shaoxing period, one could observe the rise of population for some cities. See Wu Songdi 1993.
 - 20 For some measures of Song governments for encouraging maritime trade, see Quan Hansheng 1991, 484f.
 - 21 Some recent archaeological excavations provide evidence of the importation of spices and other products from foreign countries, thus confirming the information found in the documents of the Song and Yuan periods. See, for example, Huang Tianzhu and Lin Zonghong 1983; Fujian Sheng Haiwai jiaotongshi bowuguan 1987, 24–52.
 - 22 See Shiba Yoshinobu 1968, 149–152; Francesca Bray 1984, 492–495.
 - 23 In his works Thomas T. Allsen deals with the cultural exchanges between China and the Islamic world in the Mongolian empire. His *Commodity and Exchange in the Mongol Empire: A Cultural History of Islamic Textiles* (1997) focuses on the cross-cultural influences following the textile exchanges, while *Culture and Conquest in Mongol Eurasia* (2001) depicts exchanges between the Chinese and Islamic worlds in various fields such as medicine, agriculture and cuisine, etc. These works represent a starting point for any further research on the topic, especially for those historians of China who are not familiar with Islamic culture. Nevertheless, the reader has to take precautions as far as some details of Chinese history and civilization are concerned. For example, despite the fact that the contents of *Qimin yaoshu* were reproduced in the *Nongsang jiyao*, the latter treatise was not based essentially on the former one, as Allsen (1997, 118) suggests; as a matter of fact, many more excerpts came from numerous agricultural manuscripts and their personal observations sent to the Court by local officers of every province of the empire. The latter officers also collected and recorded oral reports concerning the rich know-how of renowned farmers who lived in the regions under their jurisdiction in Northern China. Moreover, the compilers added their own personal suggestions. See Mau Chuan-hui 2010b, 197f; 210–215.

As Chinese silk products were among the most appreciated articles in foreign trade, the flourishing maritime trade favoured the development of the silk industry and accelerated its specialization.²⁴ In many historical sources active commercial exchanges with Southern Asia are attested. A great number of Islamic merchants engaged in trade with China and even resided in Chinese ports, such as Guangzhou 廣州 and Quanzhou 泉州, where even special areas for housing foreign merchants and their families were created. Some Muslim merchants played an important part in Chinese history, and Pu Shougeng 蒲壽庚 (1245–1284) provided an interesting example.²⁵ It is worth noting that from the ninth to the fourteenth centuries, when Islamic merchants were active in the maritime trade between the Far East and Europe, the Islamic silk industry was thriving.²⁶



Fig. 1: Stele of a Daruhachi supervisor (Seal-holding official) of Yongchun district (Quanzhou Maritime Museum 泉州海外交通史博物館)

The local production of raw silk in the Near East may not have been sufficient both in quantity and in quality, in spite of the introduction of

24 The active maritime trade incited the raising of silk weaving centres in regions adjacent to neighbouring the trade ports (*shibosi* 市舶司), such as Quanzhou and Guangzhou. Nevertheless, for weaving high quality silk goods, the manufacturers had to purchase the raw silk from the Jiangnan region. For more details, see Schottenhammer 1999, 26f; Mau Chuan-hui 2006, 8f.

25 In his eminent work entitled *Pu Shougeng kao* 蒲壽庚考, Kuwabara Jitsuzō 桑原隲藏 studies the maritime trade with Islamic merchants. In the Maritime Museum in Quanzhou, there are several steles of Mongolian officials which were of Islamic origin (fig. 1).

26 Pariset 1890, 310; Mazahéli 1951, 273; Mackie 1984, 127.

sericulture into Constantinople since the mid-sixth century.²⁷ Mixed silk products, such as silk mixed with woollen yarn, were made in the western part of the continent. Chinese silk cloth and raw silk continued to be in demand in the markets of the Near East and Europe.²⁸ In the ninth century, following the extension of the Islamic World, the silk industry was spreading to Southern Europe, such as Andalusia and Sicily, and this process coincided with the progress of agriculture in the Islamic World²⁹ as well as the remarkable development of agriculture in the Western side of the Eurasian continent, which, in turn, may have had positive influences on the development of Islamic sericulture and helped increase the production of raw silk.³⁰ As shown by Endrei, in the eleventh and twelfth centuries, when silk weaving started blossoming in Lucca, the necessary raw silk was imported from abroad. The major part came from the Caspian Sea; Syrian silk was in the second place, followed by the silk imported from Greece and China.³¹

-
- 27 The history of the introduction of *Bombyx mori* into Constantinople goes back to two monks who hid cocoons inside their walking sticks. See, for example, Liu Xinru 1996, 1-24; 73-79. It is highly probable that there existed some silkworm breeding but with species similar to wild ones. The cocoons brought from the East side of the Eurasian Continent allowed the Romans to improve the quality of their raw silk.
- 28 Several pieces of Chinese cloth were found among the archeological excavations. See Liu Xinru 1995, 25-48; Louise Mackie 1984, 131f; 139-143.
- 29 Watson (1974) assumed that there was an Arab agricultural revolution during the period of 700 to 1100, owing to the diffusion of new crops (including cotton planting), fertilization and irrigation systems. I share the viewpoint of Michael Dekker that the Arabs inherited both the Roman and Persian agriculture methods and thus obtained fruitful results. See Michael Dekker, 2009.
- 30 Up to now, the technological exchanges in sericulture production on the Eurasian continent before the eighteenth century have not systematically been studied. Some pieces of evidence show influences from one side of the continent to the other that had existed for a long period. The work *Art de la cueillette des vers à soie* (1599) by the French agronomist Olivier de Serres contains excerpts which strongly remind one of Chinese sericulture knowledge and know-how. For instance, in his book an analysis of quality and usage for silkworm breeding of different mulberry trees, black and white, shows striking similarities with the discussion of *jing* and *lu* in the Chinese official handbook *Nongsang ji yao* 農桑輯要 (pref. 1273). It is known that the French learned sericulture practices from the Italians who had themselves borrowed from inherited Islamic knowledge and know-how. It would be therefore worthwhile to conduct a systematic comparative study of the manuals on sericulture written in different languages and in different countries.
- 31 Endrei 1968, 13. In her article, Louis Mackie explained that the Syrian sericulture supplied raw material for both local and Egyptian weaving (1987, 128).

The active maritime trade and the spread of silk weaving must have been an incentive for the Chinese silk industry to improve its techniques in order to raise both productivity and quality. One can observe considerable progress of silk techniques in every section: mulberry cultivation, silkworm breeding, silk reeling, silk making, silk weaving and style of decoration. The improved techniques demanded more and more skilful artisans and accelerated specialization in the silk work. The advanced knowledge and know-how of sericulture spread quickly, especially with the support of the policy to encourage agriculture and sericulture undertaken by the Song and Yuan governments. After the beginning of the Southern Song, some villages almost wholly specialized in the silk industry. In the first half of the twelfth century, Chen Fu – the author of the *Nongshu* – mentioned that the inhabitants of Anji 安吉 (a district in Huzhou 湖州) lived totally on silk works,³² while traditionally the culture of hemp and ramie was widespread in the Huzhou Prefecture. During the Kaiyuan 開元 era (713–741) of the Tang dynasty, the inhabitants used cloth made with mixed silk and ramie yarns (*sibu* 絲布) as tribute payments and cloth made from hemp and ramie (or Chinese grass)³³ for fiscal collections.³⁴ Several pieces of ramie produced from Anji were found in the excavations at Dunhuang.³⁵ It seemed that silk had not developed enough for inclusion among the fiscal articles of the region. It seems evident that the silk industry spread quickly in the region from the mid-eighth century to the mid-twelfth century.

The specialization of raw silk production allowed the placing putting on the market of a large quantity of raw silk of a better quality. Silk weaving enterprises and family workshops little by little replaced domestic silk weaving. At the same time, demographic growth entailed the rise of both the demand for textiles and the supply of manpower. The very active maritime trade and immense domestic market encourages persons or families with considerable capital to invest in setting up silk weaving enterprises, especially for making figured silk, which demanded not only

32 Chen Fu, *Nongshu* 陳旉農書 3.4a-b (“Zhong sang zhi fa pian” 種桑之法篇).

33 In Chinese language, the term *ma* 麻 refers to several kinds of textile plants, such as hemp (*dama* 大麻 or *huoma* 火麻, *cannabis sativa*), jute and ramie (*zhuma* 苧麻). In the Jiangnan region, both the hemp and the ramie had been the local specialties since antiquity.

34 *Yuanbe junxian tuzhi* 元和郡縣圖志 25.605.

35 Wang Binghua 1993, 335; 340.

special skills, but also capital for acquiring sophisticated weaving looms that in turn offered ideal opportunities for engaging the landless population. Some rich families and aristocrats took on servants for mulberry culture on their own lands and invested in sericulture and silk weaving manufacture. The family Pu 濮 was the most well-known. After efforts to improve sericulture and the techniques necessary for making silk goods, they produced highly estimated silk cloth, which was signed with their family name “silk goods of family Pu” (*Puyuan chou* 濮院綢).³⁶ The very profitable benefits of silk manufactures lured some officers, among whom Tang Zhongyou 唐仲友 (1136–1188)³⁷ – the founder of the Jianhua school (*Jinhua xuepai* 金華學派) – was the most well-known case, due to an accusation by Zhu Xi 朱熹 (1130–1200). It was said that Tang Zhongyou took the opportunity as magistrate of Taizhou 台州 (in Zhejiang province) for embezzling local funds, manpower and raw materials to invest in silk manufacture.³⁸ Since it was possible to purchase raw silk from markets or to collect it from farmers who temporarily rented the farmlands, some temples undertook silk weaving.³⁹ The Lotus Temple in Fuzhou 撫州 (Jiangxi province) produced a kind of gauze, called Lotus gauze (*Lianhua* 蓮花紗), which was very much sought after.⁴⁰ The development of large scale manufacturing also favoured the expansion of family weaving workshops. Since production was insufficient to cover demand, workshops around the temple imitated this product, albeit a lower quality.⁴¹ Private silk weaving establishments and

36 *Puchuan suowen ji* 濮川所聞記 88.296. See also Zhu Xinyu 1985, 41.

37 Tang Zhongyou was a native of Jinhua 金華 in Wuzhou 婺州 (nowadays in Zhejiang province) and is known as Mister Yuezhai 說齋先生. He has no biography in Chinese historiography. We owe his biography to the study of Deng Guangming 2005.

38 Cf. *Hui'an xiansheng Zhu Wengong wenji* 晦庵先生朱文公文集 18.33a-36b (274f). For more details see Quan Hansheng 1991, 443-446. He provides more examples showing how officers got rich through silk cloth trade and silk making. For accusing Tang Zhongyou, Zhu Xi had addressed six memorandums to Emperor Xiaozong (r. 1162–1189) of Southern Song and drew the attention of the later. Numerous contemporaries of Zhu Xi and Tang Zhongyou gave advice on this affair. For more details, see *Song Yuan xue'an* 宋元學案 60.1951-1965.

39 During the silk reeling process, the cocoons were dipped into hot water to find the ends and to kill the chrysalides. That might have prevented some Buddhists from undertaking the silkworm breeding. This point deserves further studies.

40 *Pingzhou ketan* 萍洲可談 8.351.

41 *Pingzhou ketan* 8.351.

professional family workshops thus developed.⁴² The success of Lotus gauze was due to their special twisting techniques, which required raw silk of high quality.

The professionalization of silk weaving favoured, in turn, the trade of raw silk, especially during the Southern Song period where the land clearing could not keep up with demographical growth. A part of the population had no access to land for cultivation. Otherwise, apart from some rich families, those who had a chance to farm possessed only small plots of land.⁴³ The technical progress that was taking place in sericulture required more skilful manpower both for intensive mulberry farming and silkworm breeding, especially in the early stages of breeding (before the third moulting). After the third moulting, the silkworms need less care so it is possible to entrust the operations to a less skilful person. Originally landowners sold their surplus mulberry leaves on the market. The two essential steps of raw silk producing, the mulberry culture and the silkworm breeding, demanded paradoxically different weather conditions: warm and rainy days are favourable for mulberry trees' growth, but also bring about silkworm illnesses; while a season suitable for the silkworms' development is not really helpful for the mulberry tree foliage to supply enough leaves to feed the silkworms. In a suitable season for silkworm breeding, it appeared very often that there was a lack of mulberry leaves during the last (fifth) stage)⁴⁴ during which silkworms need great quantities of leaves in order to achieve a good quality cocoon. That meant the characteristic of sericulture was a very lucrative but speculative activity, and encouraged landowners to devote their lands to mulberry culture and sell all or part of the leaves. Landless people, especially women and the elderly, could thus undertake silkworm breeding and contributed to the development of the market in leaves. The increasing commercial interest in raw silk and the specialization of silk production (e. g. appearance of silk weav-

42 Shiba Yoshinobu reconstituted the organisation of silk production during Southern Song period in his *Sōdai shōgyōshi kenkyū*, 1968, 289-293.

43 Liang Gengyao 1997, 101-111.

44 Before a silkworm reaches maturity to form its cocoon in which it will metamorphose into a chrysalis, it must pass through three or four periods of moulting, depending on its breed. The step between their hatching and the first moulting is called the first age, that between the first to the second moulting is called the second age; the second to the third moulting is called the third age, and so on.

ing centres, the separation of mulberry tree plantations from silkworm breeding) reinforced the speculative character of sericulture. Some land-owners devoted their lands to mulberry culture and sold either a part or all of their mulberry leaves. A dismissed officer, Gao Side 高斯得 (fl. 1229), lived on income from silkworm breeding when he was old and had no land.⁴⁵ He described how poor families had to give up their breeding when the price of mulberry leaves became excessive. In the second half of the twelfth century, Hong Mai 洪邁 (1123–1202) related in his *Yijian zhi* 夷堅志 similar episodes, but he described how land-owners decided to abandon their fourth stage silkworms in order to gain more profit by selling their own leaves.⁴⁶ This shows a division of work in the silk production. As one can observe, the specialization in raw silk production, thus, increased the costs of production for the silkworm breeder, especially for those who had insufficient or no cultivable land. They had to purchase mulberry leaves, silkworm eggs or even caterpillars after the third moulting; also the implements demanded some monetary layout.⁴⁷ Silkworm egg production and the breeding of young silkworms (before the third moulting) demanded advanced knowledge and know-how.⁴⁸ Without these, it would be difficult for eggs to hatch or silkworms to reach the phase of forming cocoons. Moreover, it seems that due to the unwillingness of house owners to produce silkworm eggs or to the fact that eggs were kept in poor conditions, it frequently happened that eggs did not hatch. In his *Nongshu*, Chen Fu encouraged silkworm breeders to produce their own

45 *Chitang cunqao* 恥堂存稿 6.108.

46 *Yijian zhi*, *bingzhi* 15.11a-b (“Zhushi qican” 朱氏棄蠶); *dingzhi* 6.12a-b (“Zhangweng shacan” 張翁殺蠶).

47 Shiba Yoshinobu 1968, 286.

48 A general description of *Bombyx* as well as the practices in ancient China is provided by Kuhn in his work (1988, 301-345). Nevertheless, it is necessary to note that the length of the period from the hatching of silkworms to the formation of cocoons varies according to the species, the conditions of the breeding environment (e. g. temperature and humidity) as well as the techniques of breeding. Moreover, the eggs of the monovoltine silkworms (that is, the worms producing only one generation a year) have to be submitted to a temperature around 0°C for a few days in order to induce hatching some time later (see Maillot and Lambert 1905, 56ff). The process described by Kuhn showed only the practices found in famous sericulture treatises in China; in reality, the methods used in different regions, even in different families, may have been quite different from each other.

silkworm eggs in order to ensure their quality.⁴⁹ The benefits obtained by landless persons from silkworm breeding were thus obviously less than those obtained by farmers who possessed cultivable land. And, above all, peasants who were at the same time landowners could increase their income by cultivating plants that were compatible with the trees in mulberry plantations.

The income gained from raw silk production allowed some landless persons to meet the fiscal duties demanded by the government. Some literary works of the Southern Song period depict an active trade in raw silk at the end of the silk season.⁵⁰ Fan Chengda 范成大 (1126–1193), a famous Southern Song poet described in one of his poems how breeders rushed to sell the silk recently reeled and even had no time to weave silk cloth for their own clothes.⁵¹ Poor persons had to replace silk by other textile fibres, especially for winter attire. This provided an opportunity for introducing cotton production into the Jiangnan region and therefore to ensure the winter clothing for common people. Some local officials of the Southern Song, such as Zhu Xi, when he was governor of Zhangzhou 漳州, encouraged cotton plantation in order to ensure winter clothing for ordinary people who did not manage to produce silk.⁵²

Textile Policy, Social Change and Textile Industry Development

The land policy and the tax system reflected the evolution of society, but it also had a deep influence on the development of the textile industry. The period from the mid-Tang to the Song dynasty witnessed an important change both in land distribution and tax systems. One can also observe that silk goods gradually lost their importance as currency and became luxury merchandise. Around the mid-eighth century, coins tended to dominate natural products in the exchange, in which textiles (silk goods, hemp and ramie cloth) also occupied an important place.

The Tang government inherited from the Six Dynasties the equal-field system (*juntian zhi* 均田制) granted to

49 Chen Fu, *Nongshu* 3.5a-5b.

50 Cf. *Shibu jushi shiji* 石湖居士詩集 3.18, “Saosixing” 縑絲行.

51 *Shibu jushi shiji* 3.18: 今年那暇織絹著，明日西門賣絲去。

52 *Hui'an xiansheng Zhu Wengong wenji* 100.11a (“Quannongwen” 勸農文): 更加多種吉具[sic.]麻苧，亦可供備衣著免被寒凍。

[...] the taxable persons and boys aged older than eighteen years, each for one *qing* of cultivable land, among which eighty *mu* were state fields (*koufen tian* 口份田) and twenty *mu* of inheritable land (*yongye tian* 永業田). [...] On the inheritable land, it is compulsory to plant a quantity of elm, jujube, mulberry or other trees suitable to local conditions.⁵³

The size of the state fields depended on the statute of inhabitants: gender, age, health, etc. But the surface of the inheritable land was generally maintained at 20 *mu* for each person, who was asked to plant an average 2.5 mulberry trees per *mu*, a number fixed by several imperial edicts beginning with Emperor Xiaowen 孝文 (467–499) of the Northern Wei 北魏 (386–534).⁵⁴ During the seventh century, the mulberry trees planted in Northern China still seemed to be a kind of tall tree, since Jia Sixie advised, in his *Qimin yaoshu*, to keep a distance of ten steps between two plants while pricking out.⁵⁵ In order to completely exploit the land, farmers cultivated other compatible plants under mulberry trees, mainly hemp and cereals. As well as its usage as a textile fibre, the hemp provided a source of oil and raw material for papermaking.⁵⁶ In northern China, hemp was found scattered throughout the countryside. It was easy to plant and won the appreciation of peasants for its

53 *Xin Tangshu* 新唐書 51.5341 (“Shihuo” 食貨 1): 授田之制, 丁及男年十八以上者, 人一頃. 其八十畝為口份, 二十畝為永業. [...] 永業之田樹以榆、棗、桑及所宜之木, 皆有數. The term *dīng* included males and females who had reached the age of twenty-one years. According to the Tang system, one *qing* consisted of 100 *mu*; one *mu* comprised one step in length and 240 steps in width of land. One step (*bu* 步) was equal to five *chi* (equal to 30.3 cm on average, according to Qiu Guangming 1992, 88). One *mu* was thus equal to 18.18 m².

54 The number of mulberry trees demanded by the Court of Tang to plant in each *mu* of land was discussed by several modern historians on the basis of an imperial order promulgated in the Year 25 of the Kaiyuan era (737). It encouraged the families of farmers to cultivate more than fifty plants of the mulberry tree per *mu* of inheritable land. Cf. *Tongdian* 通典 2 (“Shihuo” 2, “Tianfu” 田賦 2): 永業田 [...] 每畝課種桑五十株以上. The result of such a proceeding was that there would be a distance of less than 30cm between two mulberry trees; it seems to be too dense even for dwarf mulberry plantations cultivated nowadays.

55 *Qimin yaoshu* 5: 率十步一樹. In the comment, the author explains: 陰相接者, 則妨禾豆. “If the trees are too close to one another and thus make an extensive shadow, it will disturb cereals and beans from growing.” See also Miao Qiyu 1982, 230.

56 The hemp constituted one of the essential raw materials for paper making before the Song period in Northern China. After the economic centre had moved to the Jiangnan region, other materials, especially bamboo fibre, were widely used and paper production thus increased considerably. See Zhang Xiumin 2006, 159f.

acclimatization. One can read frequently in Tang literature that the landscape was covered both by mulberry trees and hemp plants (*sang ma pianye* 桑麻遍野) or by mulberry trees and wheat (*sang mai yiye* 桑麥翳野).⁵⁷ It is worth noting that during the Tang dynasty there was apparently a large number of forests of wild mulberry trees and silkworm thorn trees (*zhe* 柘, *Cudrania triloba*) that grew in non-cultivated areas. Several authors of agricultural manuals advised that the leaves of the latter could be used as a substitute for the mulberry leaves for breeding silkworms.⁵⁸

According to *Tang liudian* 唐六典 (*Compendium of Administrative Law of the Six Divisions of the Tang Dynasty*), each male adult had to pay

[...] two *zhang* of *ling*, *chou* and *shi*; [if the tax is paid in the form of] hemp or ramie cloth, [one should pay] an additional fifth [of this amount]. [Those who pay with] *ling*, *chou* and *shi* also should deliver three *liang* of floss silk; [those who pay with] hemp or ramie cloth [also should deliver] three *jin* of fibres.⁵⁹

The fiscal regulations thus favoured silk and silk products. One can suggest that at that time the ordinary silk goods were considered to be 20% more valuable than hemp cloth and that the hemp fibre production was much higher than the production of silk floss (the data in the excerpt even suggest that it was sixteen times higher, since one *jin* is equal to 16 *liang*).

After the An Lushan Rebellion, the equal-land system was completely destroyed and the payment of three kinds of taxes (in grain, textiles or other materials, in labour duty or military service) was re-

57 In *Quan Tangshi* 全唐詩 and *Quan Tangwen* 全唐文, several poems give similar descriptions. These materials have been widely used by modern historians; see for example Zhao Feng 1992, 28-38; Lu Huayu 1995, 4f.

58 Miao Qiyu 1982, 231f.

59 *Tang liudian* 3.25: 綾綢絕各二丈, 布加五分之一。輸綾綢絕者, 兼調綿三兩, 輸布者麻三斤。 *Ling*, *chou* and *shi* mentioned in the text are kinds of ordinary silk goods, with or without little patterns formed during the weaving, for which raw silk, with or without torsion, was used before being dyed. In the Tang dynasty, the values of the units of measure used by the population were larger than those used by the administration. The fiscal collectors might have adopted the popular system: ten *chi* (foot, 29.5 cm in average) made one *zhang*, equivalent to 2.95 m; sixteen *liang* (41.3 g in average) made one *jin*, around 661 g. See Qiu Guangming 1992, 87ff; 444ff.

placed by the “Two-Taxes System” (*liangshui fa* 兩稅法) designed in 780 by Yang Yan 楊炎 (727–781). The fiscal calculation was then based on the wealth of the population; and the payment of taxes by currency instead of raw materials or labour service was allowed by the regulations. Several scholars have shown that the system was better adopted in Southern China where trade was more active, for example, in the Jiangnan and Lingnan regions. Moreover, payment by currency coexisted with payment in kind (e. g. cereals and cloth).⁶⁰ However, due to the development of foreign trade and the increasing number of coins in circulation, currency more and more replaced the natural exchange in economic activities. Merchants frequently demanded that buyers pay in cash; the number of persons who paid money to the state instead of performing obligatory public works steadily increased. Several officers criticized the increasing importance of currency in trade claiming that it disadvantaged ordinary people, and tried to rectify the situation. Emperor Dezong 德宗 (r. 785–805) even felt forced to declare in an edict that silk goods, hemp cloth and other kinds of textile had the same value as currency for the trade.⁶¹

During the Tianbao 天寶 (742–756) era, the currency occupied only 3.9 % among the total of incomes for imperial Treasury; while in the year 2 of the Zhiping era (1066) the percentage rose to 51.6 %.⁶² However, in the Northern Song the largest part of the taxes in natural products collected by the Imperial Treasury was still obtained according to the Two-Taxes System, while income in currency mainly came from the monopoly trade of salt, alcohol and tea.⁶³ Under the reign of Emperor Renzong 仁宗 (r. 1022–1063), natural products were for the first time not used to pay taxes for exclusive rights of the salt trade (salt monopoly, *yanque* 鹽權); silver and copper coins were the only

60 The Two-Taxes System introduced the payment of taxes in the form of money instead of payment in crops and textile products or labour service. For further research, see Funakoshi Taiji 1996; Li Zhixian 2002 and the works of Hino Kaisaburō 1981–1982.

61 *Mingyi daifanglu*, 42a (“Caiji” 財計 1): 貞元二十年，命市井交易以綾羅絹布雜貨，與錢兼用。For the use of silk goods as payment method, see Katō Shigeshi 1965, 119–162; Quan Hansheng 1991, 14–99.

62 Quan Hansheng 1991, 230.

63 Quan Hansheng provided a detailed analysis of this phenomenon in the chapter “Tang Song zhengfu suiru yu huobi jingji de guanxi” 唐宋政府歲入與貨幣經濟的關係, see Quan Hansheng 1991, 209–263.

kind of payment that was officially allowed.⁶⁴ The payment of taxes in kind caused great inconvenience for the regions where economic activities were highly specialized. In order to pay in cereals and cloth, as demanded by the government, people had to sell their own products to be able to purchase the articles required for tax payment and, several days before the date when the tax used to be collected, charged merchants or agents to purchase the products that were necessary to pay the taxes. This practice increased the inhabitants' expenses, and the government could not receive silk products of good quality.⁶⁵ In 1129, the vice-fiscal commissioner of the "Two Zhe Provinces" circuit (*Liang Zhe zhuan yun fushi* 兩浙轉運副使), Wang Cong 王琮, obtained the authorization of the court to replace the tax in silk products by a tax levied in cash. The measure to switch the tax from silk to money thus started in the south-east of China (*Dongnan zheboqian* 東南折帛錢).⁶⁶ Two years later, the measures spread to other regions.⁶⁷ The measures met the needs of the regions specializing in the production of particular goods to free themselves from the activities imposed by the system of tax collection in natural products. In the Southern Song, owing to the geographical conditions of Southern China where the land is fragmented on a smaller surface than in northern China as well as a lack of land, ordinary peasants generally cultivated on small plots of land. Thanks to the progress both in agriculture and in manpower, productivity increased considerably. Also the flourishing maritime trade permitted the import of abundant foodstuffs from Southeast Asia. The reformed fiscal system granted the population more liberty to choose more profitable cultures and thus reinforced specialization of work. At the same time, the system also granted central and local governments a legitimate way to increase tax revenue by setting a more attractive exchange rate in favour of the government.

In northern China, in 1236, Ögedei Khan (Ogodai 窩闊台, 1186–1241) created a taxation system according to which those families to

64 Cf. Wang Wencheng 2001, 144–154.

65 Cf. *Beishan xiaoji* 北山小集 37.626f, "Qimian Xiuzhou hemaijuan zouzhuang" 乞免秀州和買絹奏狀; [*Xianchun*] *Pilingzhi* 咸淳毗陵志 13.3b (3059). For more examples see Shiba Yoshinobu 1968, 283ff.

66 *Jiannan yilai chaoye zaji* 建炎以來朝野雜記 14.290ff ("Caifu" 財賦 1), "Dongnan zheboqian" 東南折帛錢.

67 Wang Zengyu 2006, 504.

whom the task of silk production was assigned were obliged to pay taxes only with raw silk, but not with cloth.⁶⁸ While the Mongolian government and aristocratic families often put Islamic (*Huihui* 回回) merchants in charge of foreign trade,⁶⁹ the production of silk goods targeted not only the tastes of the imperial court and noble families as well as the domestic market, but also the market of the Islamic world. The silk production of the Yuan dynasty thus experienced Islamic influence both in silk making techniques, such as the *nasisher*, *nasij* or – in Chinese – *nashishi* 納石矢, and in decorative styles.⁷⁰ For making pattern silk goods, silk yarn of a high quality was indispensable. The so-called “*lengpen*” 冷盆 technique developed in Northern China, which followed the modifications of mulberry tree plantation and silk-worm breeding (cf. *infra*) in the early thirteenth century, was imposed by the Imperial Institutions. But it did not seem to be seriously complied with, since in the late Yuan the emperor had to admonish his subjects to follow the regulations.⁷¹ The technique, however, was soon abandoned by the population. In the late Ming, Xu Guangqi claimed

68 During the Yuan Dynasty, the families were not only registered according to their social situation, but also according to their economic activities. Every two families registered as a “silk household” (*sihu* 絲戶) had to pay two *jin* of raw silk to the central government, called *erhusi* 二戶絲, and the same amount of raw silk called *wubusi* 五戶絲 was paid by every five families to their nominal seignior. For more details on this topic, see Gao Shulin 1997, 35-40.

69 Xiao Qiqing 蕭啟慶 evoked the role of Muslims and Uighurs in the Mongolian economy. Cf. Xiao Qiqing 1966, 10-16. He provides several examples that illustrate how Mongolian sovereigns and nobles lent money or goods to and obtained certain benefits from the Muslim merchants and people from Central Asia who designed their financial policy or traded for them. Cf. Xiao Qiqing 1966, 89f. These persons did not have a close relationship with Ortoq merchants among whom Islamic and Uighurs merchants were the most active. For more precise information on Ortoq merchants’ activities, see Endicott-West 1989.

70 Several scholars have studied this topic, for example Allsen 1997, 95-98; Shang Gang 2003; Ma Jianchun 2005. In reality, the Chinese and Islamic silk industries mutually influenced each other, as far as the patterns and techniques are concerned. Louise Mackie adduced several examples of this process in her article (1984). See also Wardwell and Watt 1997, preface. Nevertheless, there is no clear definition yet about the nature of *nasisher*.

71 *Da Yuan shengzheng guochao dianzhang* 大元聖政國朝典章 58.561 (“Xuanmai xisi shiyi” 選買細絲事宜).

that this procedure was completely forgotten and nobody was capable of reconstituting it.⁷²

In order to increase the textile fibres production, Chinese emperors and empresses presided over ceremonies devoted to deities of agriculture and sericulture to demonstrate the population how much importance they assigned to these industries. From time to time, civil officers were sent to the countryside with the mission to encourage agriculture and sericulture.⁷³ Compilation and publication, as well as copying and re-printing of ancient agricultural treatises, were also frequently undertaken. In 1006, Emperor Zhenzong 真宗 (968–1022) ordered the appointment of local officers as “commissioners for encouraging agriculture” and the system for encouraging agriculture was thus established. Thanks to this system, several treatises on sericulture were preserved and have thus come down to us. Even though the system received criticism from contemporary officers, several local officers, such as Zhu Xi and Huang Zhen 黃震 (1213–1281), successfully introduced the advanced technology of Jiangnan into regions that were under their jurisdiction.⁷⁴ The progressive development of agriculture considerably increased productivity, and the manpower employed in the industry was consequently growing.

The Mongolian government followed both the Chinese traditional agriculture and sericulture and the system invented by the Jurchens for setting up their own encouragement policy. In 1260, Kubilai Khan (Qubilai 忽必烈, 1215–1294) ordered the Pacification Commission (*xuanfusi* 宣輔司) of each administrative unit *lu* 路 (literally “route”)⁷⁵ to assign the encouragement of agriculture to experienced inhabitants who had mastered the techniques. The next year, an office that specialized in agriculture and sericulture development and hydraulic works, named *quannong si* 勸農司 (Office for Encouraging the Agri-

72 *Nongzheng quanshu* 31.38b (457).

73 A great number of local officials seem to have taken this as an opportunity for personal leisure activity and thus brought upon peasants additional obligations. Several officials of the Song were severe critics: One can read for example “Shang zhizheng shu” 上執政書 by Fan Zhongyan 范仲淹 (989–1052) and “Lin min pian” 臨民篇 by Hu Taichu 胡太初 (obtained the title of juren in 1238). Several modern historians have already mentioned these phenomena, for example, Liang Gengyao 1977, 41–50; Bao Weimin and Wu Zhengqiang 2004.

74 Cf. the examples with detailed comments in Bao Weimin and Wu Zhengqiang 2004.

75 According to Hucker 1996, 322.

culture), was set up in the capital. In 1270, the title was changed to Office of Agriculture (*sinong si* 司農司), then, in the same year, to General Office of Agriculture (*da sinong si* 大司農司). Three years later, the *Nongsang jiyao* 農桑輯要 – the first specialized treatise on agriculture and sericulture compiled on imperial order – was published with the preface by Wang Pan 王磐 (style Wenbing 文炳, c. 1202 – c. 1293).⁷⁶ With the information collected by local officers, the compilers of *Nongsang jiyao* gathered the essential know-how of north China concerning foodstuffs and textile cultures as well as domestic animal breeding.⁷⁷ One also finds in it detailed descriptions of the techniques of cotton plantation and cotton yarn production. During the Mongolian reign, *Nongsang jiyao* was regularly reprinted on imperial order for distribution among the provincial and local officers as well as among the agents assigned to encourage agriculture. From 1286 to 1329, more than 15,000 copies of *Nongsang jiyao* were printed and distributed among the provincial and local officers. Several provincial and local officers republished fully or in part the copies that they received from the Court;⁷⁸ some of them, such as Wang Zhen and Lu Mingshan 魯明善, were inspired by *Nongsang jiyao* and compiled their own works.⁷⁹ Wang Zhen added the techniques he extracted from other treatises, like *Nongshu* by Chen Fu (which he re-

76 The preface was preserved in the edition of *Nongsang jiyao* found in the *Siku quanshu*, but not in the 1339 edition.

77 For more details on the compilation of *Nongsang jiyao* and the policy for encouraging agriculture and sericulture undertaken by the Yuan government, see Mau Chuan-hui 2010b.

78 For example Hao Siyi 郝思義 and Wu Ding 吳鼎 (ca 1253–1316). When Hao Siyi governed Huizhou prefecture, he published *Nongsang jiyao* and distributed copies to the chiefs of rural communities for encouraging agriculture and sericulture. See [*Hongzhi*] *Huizhou fuzhi* 弘治徽州府志 4.72b-73a (718). As for Wu Ding, he published a compilation composed of excerpts of the *Nongsang jiyao* and distributed it among the inhabitants under his jurisdiction when he fulfilled the functions of magistrate at Hejian 河間 (in Hebei province). See [*Jiajing*] *Guangping fuzhi* 嘉靖廣平府志 12.409.

79 Lu Qi 魯奇 (1992, 110-115; 142-154) gives a detailed analysis of the influence that the *Nongsang jiyao* had on the two other agricultural treatises compiled in Late Yuan times.

ferred to as *Nanfang canshu* 南方蠶書),⁸⁰ as well as his personal observations and thus compiled an illustrated treatise describing agricultural techniques suitable for the areas under his jurisdiction.

However, the mere distribution of the treatises was not sufficient to spread advanced techniques. The rural community system (the system of *she* 社) had the potential to contribute to the spread of advanced techniques and to encourage agricultural and sericultural activities. According to the instructions the chief of *she* had to be chosen from among the experienced and elder persons of the communities for teaching advanced techniques to the members. Nevertheless many of them had to obey or collaborate with local officers for additional duties. It happened also that some chiefs abused their power for extorting bribes from the members.⁸¹ In 1270, when he was nominated as the director of the General Office of Agriculture, Chang Shiwen 暢師文 (*style* Chunfu 純甫, c. 1247–1317) worked out the “Fourteen articles controlling Agriculture and Sericulture” (*nongsang zhizhi shisi tiao* 農桑之制十四條) which was later published on imperial order. Chang Shiwen was inspired by the Jurchen system and hoped to reinforce agricultural activities by forming units of fifty families each for mutual supervision and assistance. In case of insufficient manpower, neighbouring families of the same community had to provide assistance to the families in need. Communities were also obliged to help their neighbouring communities. The particularity of the Mongolian system was the practice of appointing a person with agricultural experience as the leader of the community whose duties would not include tax collection, which was previously required by the Jurchen system.⁸² Such a person was supposed to read the treatises and explain techniques described in them for the members of his community, but also resolve technical problems. For example, the compilers of *Nongsang jiyao* suggested collecting silkworm eggs from the community

80 See Wang Zhen, *Nongshu* 22.22a. Sudō Yoshiyuki 周藤吉之 listed the passages of Chen Fu's *Nongshu* mentioned by Wang Zhen, see Sudō Yoshiyuki 1962, 48-64. The work of Chen Fu was neglected by the compilers of the *Nongsang jiyao*.

81 There were further shortcomings or abuses of the *she* system. Yang Ne 楊訥 (1965) has refined an analysis in his article entitled “Yuandai nongcun shezhi yanjiu” 元代農村社制研究.

82 *Tongzhi tiaoge* 通制條格 16.1b. For more discussion on the topic, see Yang Ne 1965.

members and keeping them in a cool and smokeless room, which seemed difficult for villagers to provide in their own habitats.⁸³

Apart from the encouragement of sericulture, the Mongolian government paid special attention to the development of other textile industries. In the early Yuan dynasty, the government succeeded in introducing cotton cultivation in the province of Shaanxi (Shanyou 陝右) and ramie (*zhuma* 苧麻, *Boehmeria Nivea*) in Henan,⁸⁴ regions not far from Turfan and Dunhuang where cotton had already been introduced since the sixth century (cf. *supra*). The cotton wool produced was used for

[...] spinning and weaving with silk or wool as well as for making winter clothes. The clothes were particularly light and warm.⁸⁵

However, the development of the cotton industry in Northern China was not comparable with that in Southern China. Wang Zhen reports that,

After the unification of the Empire [in 1279], the cotton goods of the Southern region, [which were of better quality,] were imported into the northern regions and had a wide diffusion.⁸⁶

Kubilai Khan continued the measures introduced in the Southern Song period for governing the newly conquered territories and established in 1289 the Cotton Supplies Offices (*mumian tiju si* 木棉提舉司) in five provinces (namely, in Zhedong 浙東, Jiangdong 江東, Jiangxi 江西, Huguang 湖廣 and Fujian 福建).⁸⁷ For the first time in Chinese history, cotton wool and cotton goods were found among the textile products listed for tax collection. Even though the records found in the *Yuanshi* 元史 (History of the Yuan Dynasty) are incomplete, one can observe an important growth in cotton tax collection. In 1265, 85,412 pieces of cotton cloth were collected; in 1328, 72,015 pounds of cotton and 211,223 pieces of cotton goods were collected (see table below).⁸⁸

83 *Nongsang jiyao* 4.5a-b (124) ("Yulian" 浴連).

84 Meng Qi 孟祺 (1241–1291), ("[Lun] Zhuma, mumian" [論]苧麻木棉), in *Nongsang jiyao* 2.34b (106), 36a-b (108).

85 *Nongsang jiyao* 2.32a (106) ("Mumian" 木棉): [...] 捻織毛絲, 或棉裝衣服, 特為輕暖。 *Nongsang jiyao* 2.32a (106) ("Mumian").

86 Wang Zhen, *Nongshu* 25.454 ("Mumian xu" 序): 海南諸種蓺制作之法駁駁北來, 江淮川蜀既獲其利。至南北混一之後, 商販于北, 服被漸廣, 名曰吉布, 又曰綿布。

87 *Yuanshi* 元史 15.18a (192) ("Benji" 本紀 15).

88 *Yuanshi* 93.13a-14a (1153) ("Shihuo zhi" 1).

Table 1: Collection of tax in silk and of cotton during the Yuan period⁸⁹

	Silk yarn (<i>jīn</i>)	Silk goods (<i>pí</i> , pieces)	Cotton wool (<i>jīn</i>)	Cotton cloth (<i>pí</i> , pieces)
1263	712 171			
1265	986 912			85 412
1266	1 053 226			
1267	1 096 489			
1328	1 098 843	350 530	72 015	211 223

From this table, now including the tax levied in the Jiangnan region where the centre of the silk industry was located, one does not see a rise in the quantity of silk products (unlike cotton), because the inhabitants of Jiangnan paid taxes in money instead of raw silk.⁹⁰ Up to 1299, the Yuan Imperial Treasury received every year more than 15,000 pieces of cotton cloth;⁹¹ this fact bears witness to a considerable development of the cotton industry during the Yuan dynasty.

Today, the fiscal collecting and tribute registers are a precious source providing details about the production of textile fibres (*e. i.* silk, hemp and cotton), but these should be used with caution, because the criteria of fiscal collecting differed from one period to another (*cf. supra*). But if we compare the highest incomes of textile products gathered for the imperial treasuries of the Tang, Song and Yuan dynasties, it is not difficult to observe some differences regarding the nature of textile products and also regarding their quantity. In his *Tongdian* 通典 (*General History of Institutions*), Du You 杜佑 (735–812) recorded the fiscal duties collected for the year 8 of the Tianbao 天寶 era (749):

The Empire held in total around some 8,900,000 families. [...] The taxable adults of the silk producing commanderies and districts comprised some 3,700,000 who paid around 7,400,000 pieces of tabby silk as well as more than 1,850,000 *tun* of silk floss. [...] As for hemp cloth, it came from hemp cloth making commanderies and districts that hold some 4,500,000 of taxable adults, around 10,350,000 pieces were collected. From the commanderies and districts of Jiangnan, around 5,700,000 pieces of hemp were collected.⁹²

89 Source: *Yuanshi* 93.13a-14a (1153) ("Shihuo zhi" 1).

90 Gao Shulin 1997, 45.

91 *Da Yuan shengzheng guochao dianzhang* 58.560 ("Guanfang qina pibo" 關防起納疋帛).

92 *Tongdian* 6.229f: 按天寶中，天下計帳，戶約有八百九十餘萬，[...] 其庸調租等約出絲綿郡縣，計三百七十餘萬丁，庸調輸絹約七百四十餘萬疋，綿則百八十五萬餘屯。[...] 約出布郡縣計四百五十餘萬丁，庸調輸布約千三十五萬餘端，[...] 江南郡縣折納布約五百七十餘萬端。According to the notification, one *tun* 屯 consisted of six *liang*, equal to 247,8 g. 1,850,000 *tun* equal to 458,430,000 g.

In the Northern Song, the textile products were collected according to the Two-Taxes System and based on the land surface possessed by each tax payer.⁹³ According to a report of Li Tao 李燾 (1115–1184), at the end of the Tianxi period (1017–1021), the empire collected 4,170,020 *liang* of silk, 18,991,000 or so *liang* of flosses, 1,552,000 or so pieces of tabby silk, 9,415,000 or so pieces of *chou*, 344,000 or so pieces of *ling*, 137,000 or so pieces of *shi*, 25,000 or so pieces of gauze, 28,000 or so pieces of figured silk as well as some 3,057,000 pieces of hemp cloth.⁹⁴ Compared with the fiscal records of Yuan period, one can easily observe a considerable decrease in textile products, owing to a progressive replacement of natural products by money for fiscal payment. One can also observe the appearance of refined silk goods and raw silk among the Northern Song fiscal collection, as well as cotton yarn and cotton cloth during the Yuan dynasty (tab. 1). Even though the existent fiscal records of the Yuan do not mention either hemp or ramie products, some local monographs evoke the production of these textile products in some regions, such as Hezhong 和眾, Longshan 龍山 and Lizhou 利州 in Liaoyang province 遼陽行省 for hemp cloth, as well as Zhenjiang 鎮江 and Kunshan 崑山 (nowadays in Jiangsu province) for ramie.⁹⁵ The tradition of Kunshan sending ramie cloth to the Court was suspended during the Mongolian reign.⁹⁶ What the central administration favoured as shown by its fiscal collection may have had some influence on the choice of crops and production activities by local inhabitants and reduced the cultivated areas of both ramie and hemp. Technical progress, prospering maritime trade and access to wider markets (domestic and foreign) may also have encouraged the population to choose more profitable and stable forms of production. Compared to the cotton goods production, hemp has the advantage of being more productive on the same area of land, but for obtaining the fibre, it demanded more space and time for the rotting

93 Quan Hansheng 1991, 237ff. During the late Tang period, many civil officers argued in favour of a textile amount for tax collection. This became part of a general tax policy during the Song period. See Li Jinxiu 2001, vol. 2, 661–664.

94 Li Tao, *Xu Zizhi tongjian changbian* 97.2259: 天禧末, [...] 而天下總獲 [...] 絲四百一十七萬二十餘兩, 綿一千八百九十九萬一千餘兩, 絹一百五十五萬二千餘匹, 紬九百四十一萬五千餘匹, 綾二十四萬四千餘匹, 絁一十三萬七千餘匹, 紗縠二萬五千餘匹, 錦綺二萬八千餘匹, 布三百五萬七千餘匹

95 *Da Yuan yitong zhi*, “Jiben 2” 17, 21b” 17; “Liaoyang xiangsheng”; [*Zhishun*] *Zhenjiang zhi* 4.3b, 29b (184f and 236); [*Zhizheng*] *Kunshan junzhi* 至正崑山郡志 6.1 (2634).

96 [*Zhizheng*] *Kunshan junzhi* 6.1 (2634).

process.⁹⁷ The farmers needed to consider several factors for planning their cultures and activities.

Table 2: Taxes on textile products collected by Tang, Northern Song and Yuan dynasties

	Tianbao era	Tianxi era	Tianli era
tabby silk (<i>juan</i>)	7 400 000 + (<i>pi</i>)	1 552 000 + (<i>pi</i>)	
silk yarn (<i>si</i>)		4 170 020 + (<i>liang</i>)	1 098 843 (<i>jīn</i>)
flosses (<i>mian</i>)	1 850 000 + (<i>tun</i>)	18 991 000 + (<i>liang</i>)	
gauze (<i>sha</i> , <i>bu</i>)		25 000 + (<i>pi</i>)	
figured silk (<i>jīn</i> , <i>qī</i>)		28 000 + (<i>pi</i>)	
hemp cloth (<i>bu</i>)	10 350 000 + (<i>duan</i>)	3 057 000 + (<i>pi</i>)	
cotton cloth			211 223 (pieces)
cotton wool			72 015 (<i>jīn</i>)

Specialization in Sericulture

Frequent military conflicts in the Yellow River Valley since the end of the Han Dynasty (206 BCE – 220 AD) have provoked waves of immigration into southern China where the inhabitants enjoyed relatively long periods of peace and thus found suitable conditions to develop agriculture and craftsmanship. In the Southern Song, the significant reduction of land surface and the increase in density of population pushed the cultivators and *literati* to develop a suitable technology for adapting particular geographical and climatic conditions in southern China, which was different from that used in the north.⁹⁸

Through the treatises published during the Song and Yuan periods, one can see that the technology relating to silk production underwent essential improvements in every section from the mulberry culture to silk yarn making, which included: land management;⁹⁹ cultivation of mulberry trees, especially the cultivation of the dwarf mulberry (*disang* 地桑)

97 For obtaining textile fibers from hemp, ramie and flax, it is necessary to dip their stem in still water for several ten-day periods, after which the fleshy part has decomposed and only the fibers are preserved.

98 Chen Fu's preface of *Nongshu* illustrates well the necessity to modify techniques and knowledge inherited from Northern China; in it he explains how he experimented with new procedures inspired by the new techniques he had found in *Qimin yaoshu*. For further details, see Mau Chuan-hui 2010a, 315f.

99 In his *Nongshu* Chen Fu summarized the essentials of the land management in the Jiangnan region and discussed the main factors, such as the situation of the land, the climate, the fertilization, and the tools. See Chen Fu, *Nongshu* 1.2a-19b.

and of new species of the mulberry tree; silkworm eggs production; “industrialization” of silkworm breeding;¹⁰⁰ fabrication of a “silkworm spinning frame” (*cu* 簇); silk reeling and silk yarn making procedures.

The improvement of land management also becomes apparent in the advanced knowledge related to the nature of plants used by cultivators to choose crops suitable for the quality of their land as well as in the intensification of land use (i. e., the extended duration of use in a calendar year, and the increasing number of plants per *mu*). Chen Fu advised taking 20 to 30 % of the surface area of regions of low altitude to dig a pond around which high and wide dykes were to be set up.¹⁰¹ Then mulberry trees were to be planted on the digs. This allowed the rainwater to be kept during the transition period from spring to summer in order to prevent floods and to reserve water for the dry season. At least in the last quarter of the thirteenth century, some *literati* concluded that

The alluvial deposits of plain, which was fertile and friable, was suitable both for the cultivation of the Lu mulberry trees (Lu *sang* 魯桑) and of the Jing mulberry trees (Jing *sang* 荊桑).¹⁰²

100 Chen Fu also emphasized the importance of keeping the whole batch of silkworms in the same breeding room in order to ensure the same development by monitoring the conditions of the breeding rooms (i.e. luminosity, temperature, humidity) but also the feeding. That means they should all enter the moulting phase and leave it simultaneously. Thus it would be possible to raise a great number of silkworms using less manpower and to reduce the consumption of mulberry leaves and still achieve a better result (cf. Chen Fu, *Nongshu* 3.6b-7a). One will find more detailed descriptions of how this goal was achieved in *Nongsang jiyao* (*juan* 4) and Wang Zhen, *Nongshu* (6.1a-5a; 22.10a-12b).

101 Chen Fu, *Nongshu* 1.2b-3a (“Dishi zhiyi pian” 地勢之宜篇).

102 *Nongsang yaozhi* 農桑要旨: 平原淤壤, 土地肥虛, 荊桑、魯桑種之俱可。The passage is inserted in the commentary of *Nongsang jiyao* 3.9a-b (113). It might have been added before 1273 by the compilers of the first edition of *Nongsang jiyao* or at least before 1286 by Chang Shiwen 暢師文 (*style* Chunfu 純甫, c. 1247–1317) who in that very year had presented to the throne a manuscript of the same title that historians think is the second edition of the previous one (see, for example, Liu Yuquan 1958, 216 and Amano Motonosuke, 1975, 113). The authors of *Nongsang jiyao* described the Jing mulberry tree as a plant with leaves that were thin, pointed and lobate, and a trunk, branches and foliage that were tough. As for the Lu mulberry tree, it had leaves that were round, thick and full of sap, a lush trunk and branches as well as dense foliage, and it was cultivated in the Jiangnan region as a dwarf mulberry tree. The Lu mulberry tree was a kind of *Morus multicaulis*; as for the Jing mulberries

Due to its high resistance to floods, planting the mulberry tree was ideal for relatively low regions where floods occurred frequently in summer and which were not suitable for rice plantations or other textile crops. Moreover, the sediments deposited by the floods constituted the perfect manure for fertilizing the mulberry trees. The mulberry was extensively planted on banks of rivers or in low areas, such as Anji, where the inhabitants extensively practiced silk industry. In spring, peasants removed the sediment from the rivers and piled it up around the roots of mulberry trees.¹⁰³ The rivers were thus drained and the risk of flooding was reduced. At the same time, the mulberry trees enjoyed good quality fertilizers and aerated soil. The cultivators could thus obtain considerable profits from sericulture. In the Jiangnan region, a particular Chinese sericulture model was developed, which made it possible to produce refined white raw silk in the plains or in regions of low altitude, while elsewhere in the world, sericulture was developed on hills or in mountainous regions.¹⁰⁴ The cultivators could choose whether they wished to engage themselves in sericulture or cotton and hemp cultivation, depending on the quality of their land. Conversely, the cotton plants competed with the hemp and ramie since all of them required similar sandy soil.

The warm and rainy climate in the Jiangnan region offered several advantages for the development of sericulture. Large quantities of rain offered sufficient water for the cultivation of dwarf mulberry trees, which again greatly increased the density of plantation and eased the harvesting of leaves. The time span between the planting of the mulberry trees and the first harvest decreased considerably. The trees could also foliate several times in a year and were thus fulfilling the needs of *polyvoltine* silkworm¹⁰⁵ breeding. The cultivation of the dwarf Lu mul-

they must also be a kind of *Morus alba*, like the Lu, but stayed in a state close to the native species.

103 Up to the late 1980s, this practice persisted in the Huzhou region. I thank Mr. Zhu Jianming 朱建明, the retired director of the Museum of Deqing 德清 in Zhejiang province, for his private communication (May 2010).

104 In the 19th century, Ernest Pariset (1826–1912) skimmed through the silk industry in the world. The raw silk of the best quality produced in the areas he mentioned came from mountainous regions. See Pariset 1890, 163–203.

105 This is a species of silkworms that can reproduce several generations in a year. Those who can reproduce a second generation the same year are called bivoltine silkworm, *yuancan* 原蠶 or *wancan* 晚蠶 in Chinese.

berry was invented in Northern China¹⁰⁶ and then underwent great development in the Jiangnan region because of the favourable natural conditions. The species and advanced techniques may have been introduced from northern China by the immigrants in the early twelfth century or earlier and spread quickly in the Jiangnan region, since Chen Fu had already mentioned the cultivation techniques of high trunk mulberry trees (*shusang* 樹桑) in his *Nongshu*.¹⁰⁷ The highly productive Lu mulberry tree with its dense foliage of big, fleshy, juicy leaves, resulted in the silkworm that were fed on them producing thin and soft silk. Some *literati* advised their readers to feed young silkworms with the Lu mulberry leaves, which were more tender and to use the Jing mulberry leaves to feed the silkworms after the third moulting in order to obtain abundant silk that was elastic and resistant.¹⁰⁸ The development of the Lu mulberry in the Jiangnan region may have influenced the quality of silk and stimulated the improvement of silk reeling since the quality of cocoons thus increased (cf. *infra*).

In the Southern Song period, the number of the new species of mulberry trees cultivated in the Jiangnan region was rapidly growing.¹⁰⁹ Some species were more resistant to a cold climate and gave leaves earlier than others; some species grew fleshier leaves. The peasants could purchase on the market young plants of suitable species matching the quality of their land. The adoption of grafting also allowed improvement in the quality of the leaves. Some *literati* of north China encouraged the peasants to select the Lu mulberry as the scion and the Jing mulberry as

106 In the *Qimin yaoshu*, Jia Sixie had mentioned the cultivation of the dwarf mulberry trees. Nevertheless the modern version of his treatise available nowadays is not authentic, and the excerpt under consideration may have been added later, even though one cannot rule out the possibility that the cultivation of the dwarf mulberry trees started about that time. The *Nongsang jiyao* provided explanations of the techniques of dwarf mulberry cultivation borrowed from the *Wuben xinshu* 務本新書 and *Shinong bijyong* 士農必用, two lost treatises possibly written between 1187 and 1233; see Shi Shenghan 1982, 76f, 108f.

107 Chen Fu, *Nongshu* 3.3a-b ("Zhongsang zhifa pian" 種桑之法 1).

108 In the *Nongsang jiyao*, the compilers commented on the different quality of *lu* and *jing* mulberries. They expressed their preference for the silk produced by the caterpillars fed with the latter because in this case the worms produced strong and elastic silk. In the 19th century, French scientists conducted several experiments to prove that; see Bonafous 1829, 32.

109 In several local gazetteers of Jiangnan, the authors listed the species of mulberry trees produced in their regions; see Shiba Yoshinobu 1968, 286.

rootstock in order to obtain resistant trees with fleshy leaves.¹¹⁰ They gave a detailed description of grafting procedures. The development of plant cloning via cutting the stem or layering not only allowed the reproduction of trees of the same good quality, but also cut the time necessary to develop the leaves ready for harvesting. The land could thus bring benefits to peasants faster than before. Also, the reduction of the size of mulberry trees facilitated the collection of the leaves used for feeding silkworms. Improvement in the methods of protecting the mulberry trees from harmful insects also allowed increasing production of mulberry leaves, yet required a larger number of skilful workers. Chen Fu and other *literati* observed that the gaps between mulberry trees, if left untreated, created favourable conditions for various diseases, as well as for harmful insects, and encouraged the farmers to keep the gaps clean.¹¹¹ They also indicated ways to protect the trees from various species of insects and proposed prevention methods, such as piling up earth around the trunks of mulberry trees, and coating the trunks with *perilla* seed oil (*zisuzi* 紫蘇子 or *suzi* 蘇子, *Fructus Perillae* seeds). *Nongsang jiyao* provides the modern reader an opportunity to read the most ancient detailed descriptions of harmful insects, especially the long-horned-beetle (*Cerambycidae*). The authors of the treatises included in *Nongsang jiyao* observed that in mid-summer, long-horned beetles laid eggs around the trunks of the mulberry trees and, after the hatching, the young caterpillars ate themselves into the body of the mulberry, leaving wet tracks. The cultivators thus had to examine the trees frequently, find the young caterpillars following the tracks, and remove them. Several authors suggested planting compatible vegetation between mulberry trees in order to keep the ground clean around the mulberry tree roots and reduce efficiently the risk of disease and also prevent the damage caused by harmful insects.

At the same time, the progress made in silk egg production, synchronized silkworm breeding techniques, silkworm spinning frame construction, and silk reeling techniques favoured the pre-industrialisation of silk making. Some crucial elements of this process, especially silk egg production, young silkworm breeding and high quality raw silk reeling, demanded high skill and advanced knowledge. Conversely, simpler op-

110 *Nongsang jiyao* 3.1a-b (109) ("Lun sangzhong" 論桑種).

111 Chen Fu, *Nongshu* 3.3b; *Nongsang jiyao* 3.15a-17b (116f) ("Xiushi" 修蒔).

erations were reserved for individuals who had neither special skills nor important capital and land. The progress in silkworm breeding allowed breeders, especially those who had a sufficient amount of mulberry trees, spacious breeding rooms, capital and manpower,¹¹² to increase the scale of their breeding industry and thus considerably raise the quantity of cocoon harvests. Some experienced persons also realized the importance of having healthy butterflies for silkworm egg production. The author of the *Shinong biyong* 士農必用 suggested a selection of well-formed cocoons be used to produce eggs which would have been later kept in a suitable place to ensure obtaining healthy butterflies.¹¹³ The author of *Wuben xinshu* 務本新書 specified that

The butterflies that have [one of the following syndromes:] crumpled wings, bald antennae, black feet or tail, smoky yellow colour, red abdomen, lack of down, black stains, black body or head, and those who come out of their cocoons too early or too late, will be eliminated. Only the robust butterflies and those in a good/healthy state will be kept.¹¹⁴

In northern China, the silkworm egg sheets were hung up in a well-aerated cool room protected from sunlight or were rolled loosely and kept in a jar (fig. 2).¹¹⁵

Chen Fu criticized the tradition of the Jiangnan region of keeping silkworm egg sheets in closed containers that damaged the eggs owing to the hot and rainy climate in southern China and advised hanging the sheets up in an aerated place.

112 Several *literati* recommended considering the capacity of mulberry trees to produce leaves, the available house space, tools and manpower before deciding on the projected quantity of eggs to hatch; there are several excerpts in the *Nongsang jiyao*, *juan* 4, devoted to this issue. The commentator of the treatise specified that 每蟻一錢，可老蠶一箔也 “one *qian* of the recently hatched silkworms can yield one tray of spinning silkworms”. Cf. *Nongsang jiyao* 4.16a (130). One *qian* equals 3.95 g, according to the estimate obtained by Qiu Guangming, *op. cit.*, 471. I was not able to find more precise information on the quantity of leaves necessary for feeding a certain quantity of silkworms from their hatching to cocoon formation before the Ming dynasty. Cf. Zhang Lüxiang 張履祥, *Bu Nongshu* 補農書 1.19a-b (11) (“Canwu” 蠶務).

113 *Nongsang jiyao* 4.1b (122), cit. from *Shinong biyong*.

114 *Nongsang jiyao* 4.2a (123), cit. from *Wuben xinshu*: 若有拳翅，禿眉，焦腳，焦尾，熏黃，赤肚，無毛，黑紋，黑身，黑頭，先出莫後生者，揀出不用，止留完全肥好者。

115 *Nongsang jiyao*, 4.3a-5b (123f) (“Yulian” 浴連): *shouzhū canlian fū* 收貯蠶連附。

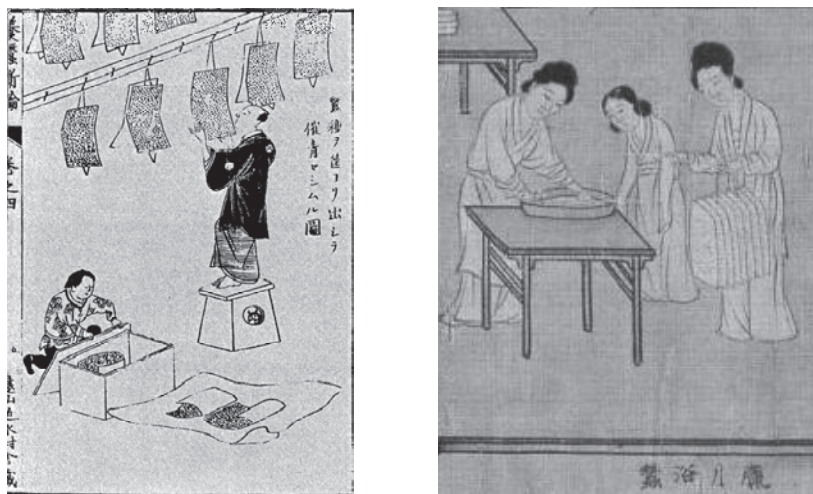


Fig. 2a [left]: The illustration showed the way to hang up silkworm egg sheets and their conservation which inspired the method held in *Nongsang jiyao*, in *Yosan shinron* 養蠶新論 (1872).

b [right]: “Yucan” 浴蠶, details of *Canzhi tu* 蠶織圖. Reproduction of the original held in the Provincial Museum in Heilongjiang¹¹⁶

The methods to synchronize the growth of the silkworms, from hatching to the formation of cocoons, by managing the temperature and luminosity of breeding rooms, facilitated not only the work of breeders but also allowed them to save on the quantity of leaves and increase silk production. In order to offer the silkworms adequate space to live, the breeders prepared spacious, clean, aerated and bright (but protected from direct sunbeams) rooms for silkworm breeding. Some breeders protected entrances (windows, doors) by straw curtains or heavy paper in order to facilitate the control of brightness and temperature inside the breeding rooms.

The combination of the silkworm net (fig. 3) with the methods of synchronization considerably raised the efficiency of manpower and turned silkworm breeding into a fully-fledged pre-industrial activity, even though usually only one or two, and at any rate no more then

116 In Hammers 2011 several versions of *Gengzhi tu*, including the *Canzhi tu* held in the Heilongjiang Provincial Museum (Heilongjiang sheng bowuguan 黑龍江省博物館) and the copy by Chen Qi after the *Gengzhi tu* by Lou Shou, are reproduced. For *Canzhi tu*, see also: <http://www.鹿山會館.tw/~xnrtw/EastCapital/viewthread.php?tid=347>.

three silkworm breeding cycles took place every year.¹¹⁷ The silkworm net may have been invented in the Jiangnan region, probably during the Southern Song period, since it was not mentioned in any sericulture texts before the *Nongshu* of Wang Zhen (preface 1313).¹¹⁸ (We know that fishing was a main activity in the region.) This author provided a detailed description of the making of the silkworm net.

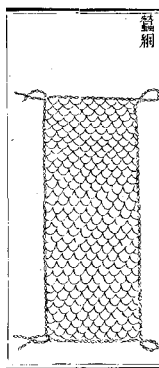


Fig. 3: Silkworm net (Wang Zhen, *Nongshu* 22.19a-b)

The invention of the silkworm net was based upon a deeper knowledge of the life cycle and behaviour of the silkworms. When breeders needed to move silkworms from one place to another in order to clean up the debris of leaves mixed with the excrements of the silkworms or to place them in a more spacious place, they covered the silkworms with the net and placed fresh leaves upon it. Healthy silkworms quickly climbed up to eat the leaves, while the weak or sick ones stayed under the net. The

117 The silkworm breeding in Song and Yuan China was of an industrial character essentially because of the rational way the work was organized. As for the timing, since the breeding was practiced only during the season of sericultural activities, the duration was no longer than the period from April to October for a maximum of three breeding cycles (spring, summer and autumn), but more often one to two cycles, which left the breeders time to pursue other activities for raising family incomes.

118 In 1304, Dai Biaoquan 戴表元 wrote a preface for the first edition of Wang Zhen's *Nongshu*, at that time the latter contained only two parts: the "Nongsang tongjue" 農桑通訣 (General Procedures of Agriculture and Sericulture) and the "Nongqi tupu" 農器圖譜 (Illustrated Catalogue of Agricultural Tools). In 1313 the complete version of the treatise in 37 *ji* and 370 items appeared, including the "Baigupu" 百穀譜. See "Wang Boshan Nongshu xu" 王伯善農書序 (Preface for Wang Zhen's *Nongshu*), in *Yanyuan wenji* 剡源文集 7.100; see also Miao Qiyu 1994, 1.

breeders then simply needed to raise the net and move the silkworms to another tray, and thus were able to clean up the litter. An accumulation of litter was one of the origins of multiple diseases of the silkworms. Prior to the invention of the net, breeders moved the silkworms by taking them during the moulting phase together with leaf debris or directly off the leaves.¹¹⁹ The operation was slow and there was always a risk of dropping the silkworms and hurting them. This was one of the reasons for the low production of cocoons.

In the Song-Yuan period, the silk reeling techniques also went through important improvements, which not only increased productivity but also raised the quality of raw silk. In the late Mongolian empire two procedures were commonly used: the *refu* 熟釜 (literally, “hot cauldron”) and the *lengpen* 冷盆 (literally, “cold basin”). In the late Northern Song, Qin Guan gave a detailed description of the method of *refu* in his treatise *Canshu*. It contained essential elements for a reeling machine: a basin for boiling cocoons for finding the ends of fibres; a guiding-eye for gathering a determined number of fibres to form a yarn; a pull-up lance used to arrange reeled silk on the silk-roller (fig. 4).

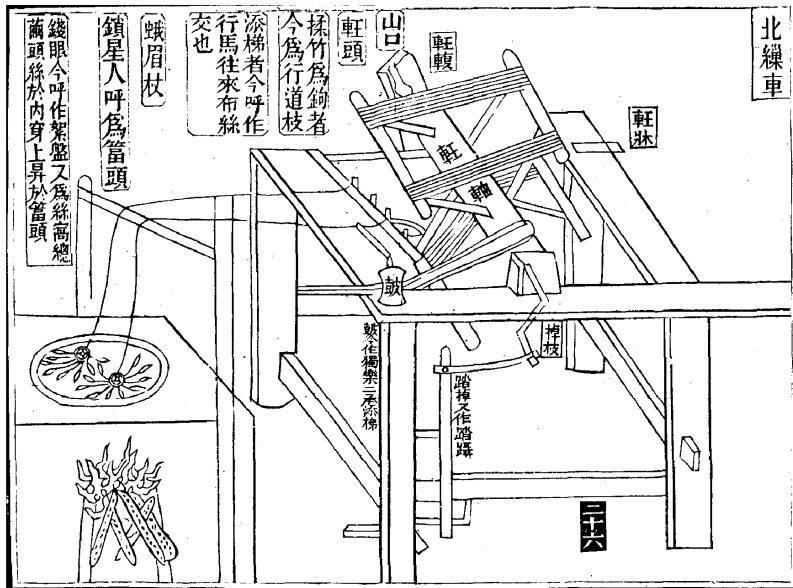


Fig 4: Silk reeling tour (Wang Zhen, *Nongshu* 22.27a-b)

119 *Nongsang jiyao* 4.20b-21a; 23b-24a (133f).

Unfortunately, Qin Guan did not explain how to form the *croisure*,¹²⁰ as one can observe in the paintings and illustrations published in this period, the *croisure* was often absent.

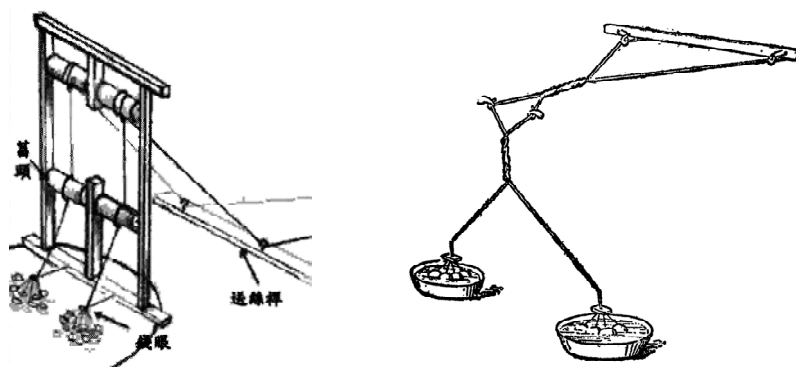


Fig. 5 a [left]: The *croisure* according to the description held in *Nongsang jiyao* (*futon* 蓄頭: pieces for forming the *croisure*; *qianyan* 錢眼: guiding-eyes; *liansi gan* 連絲桿: pull-up lance)

Fig. 5 b [right]: “Chambon method of *croisure*” after Pariset (Vignon 1890, *La soie*, 104)

The *lengpen* procedure was the most advanced technique, which may have been invented at least in the early thirteenth century in north China, since it was mentioned for the first time in *Nongsang jiyao*. However, in the late thirteenth century the procedure was more widely spread in southern China than in the north. The essential element of the invention consisted of separating the boiling water necessary for picking up the ends of silk fibres from the lower temperature water used for operating the so-called silk reeling (fig. 6).

The first basin was heated directly by fire, while the second was heated by the hot smoke circulating in a circular space under it, before being evacuated through a chimney. This technique prevented the silk fibres from losing too much sericin¹²¹ and thus allowed production of a fine, strong and elastic silk yarn. A *croisure* was placed between the

120 The *croisure* is a device of silk reeling loom which is placed between the guiding-eye and the to-and-fro. It allows the silk yarn to cross on itself or to cross two yarns (European systems before the 19th century); see fig. 5.

121 Sericin is a sticky substance surrounding the relatively harder central parts of the silk fibre. It can be dissolved in hot water and stick to the reeled silk again when drying. Because of this particularity it was possible to operate the silk reeling by dipping cocoons in hot water to find the end of fibres before unreeling the silk from cocoons. The fibres will be stuck together due to the sericin remaining on the silk.

guiding-eye and the pull-up lance by crossing the yarn on itself. It made it possible to remove water from the yarn and thus to produce a better formed round-shaped silk yarn. The reeled silk was wound up on a silk-reel, which was moved by a pedal. The person responsible for reeling could thus have his or her hands free to take care of the formation of silk yarns. In the early Mongolian empire, Yang Huan 楊奐 (1186–1255) mentioned in his poem that the people

[...] reeled silk by *lengpen* for submitting it to the authorities, and in the night time span [the cotton or hemp fibres] to make dresses for female members of the families.¹²²

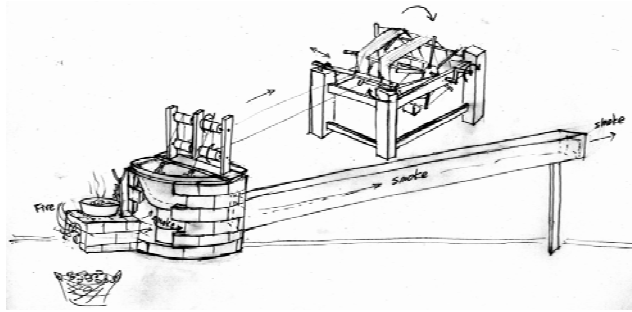


Fig. 6: System *lengpen*, sketched after the description in *Nongsang jiyao*

In the late Yuan, this method seemed to have been abandoned by silk producers. In 1301, the officials of each Route were ordered to strictly supervise the families assigned to pay tax in silk to provide the raw silk reeled with the *lengpen* procedure.¹²³ Wang Zhen in his *Nongshu* offers evidence that in his time the *lengpen* was employed by the silk makers of Jiangnan and the *refu* by their counterparts in Northern China.¹²⁴

The development of the *lengpen* system in the Jiangnan region during the Yuan period may have been closely linked with the extension of improved dwarf mulberry tree cultivation in this region. The dwarf mulberry tree was cultivated with the *Lu* mulberry tree. The silkworms fed with the leaves produced by this kind of mulberry tree gave a silk charged with a lower quantity of sericin, a sticky substance around the two filaments of fibroin secreted by *Bombyx mori*. Since sericin is partly

122 *Huanshan yigao* 還山遺稿, *buyi* 補遺, 3a (“Qigu” 七古): [...] 冷盆繰絲給公上, 挑鐙紡績裏妾婦。

123 *Da Yuan shengzheng dianzhang* 58.561 (“Xuanmai xisi shili” 選賣細絲事理).

124 Wang Zhen, *Nongshu* 22.28b-29a (447) (“saoche” 繰車).

soluble in hot water and the remainder allows the coagulation of the filaments to make yarn, a particularity of this silk is that one can reel the silk yarn from cocoons. If the silk fibre is dipped in water that is too hot for too long, the fibre will lose too much sericin so that it will not be possible to make a yarn of good quality. While the silkworms bred in the Jiangnan region produced lower sericin charged silk, it was necessary to take much more care with the temperature and the duration of dipping the cocoons in hot water. Appreciation of this kind of silk may be the consequence of both the appreciation of Mongolians' love of the colour white and of the creation of *satin*.¹²⁵

Except for some light cloth dyed in piece,¹²⁶ before weaving, raw silk had to be submitted to doubling and twisting according to the requirements imposed by the nature of the products required. The operation was done manually with the help of spooling-reel and spindle-wheel.¹²⁷

In the late thirteenth century, the twisting frame (*da fangche* 大紡車) (fig. 7) was adopted by silk makers; originally it was used for twisting a large number of spindles of hemp or ramie yarn.¹²⁸ The device was first mentioned by Wang Zhen in his *Nongshu*; as for the late Qing, one can also read more detailed descriptions in the *Cansang cuibian* 蠶桑萃編 by Wei Jie 衛杰.¹²⁹ Moreover, we owe a detailed description of the construction and the function of this device to Isidore Hedde (1801–1880), the silk expert who joined the Embassy of Lagrené (1843–1845).¹³⁰ The twisting frame was used for making the warp yarn (*organsin*) by “dou-

125 The making of *satin* is one of three basic binding systems or weaves. By a composition of interlacing threads which allowed as few binding points as possible to show by crossing the warp and weft yarns, the weavers could obtain a smooth surface. Different suggestions were made regarding the appearance of satin structure. Most modern historians thought that satin first appeared in the Song dynasty, but without convincing evidence. Nevertheless, several examples of samite (a kind of weft-faced compound weave) with satin found in archaeological excavations of Liao 遼 (907–1125) tombs show that satin may have been developed from figured weaving. See Zhao Feng 1999.

126 A kind of cloth, which is dyed after the weaving. This kind of silk goods is generally a light and lower cost article.

127 For more details concerning these operations, see Kuhn 1988, 171–184.

128 Wang Zhen, *Nongshu* 26.6a–b (“Da fangche” 大紡車).

129 *Cansang cuibian* 11.40a–43b (700f) (“Fangzhiqi tui lei” 紡織器圖類).

130 A precise description was made in Hedde 1848, 143–147. For further details concerning the mission of Hedde, see Mau Chuan-hui 2004, 41, 32–42.

bling” (putting together two or even three yarns), which thus gave various qualities due to different ways of torsion.

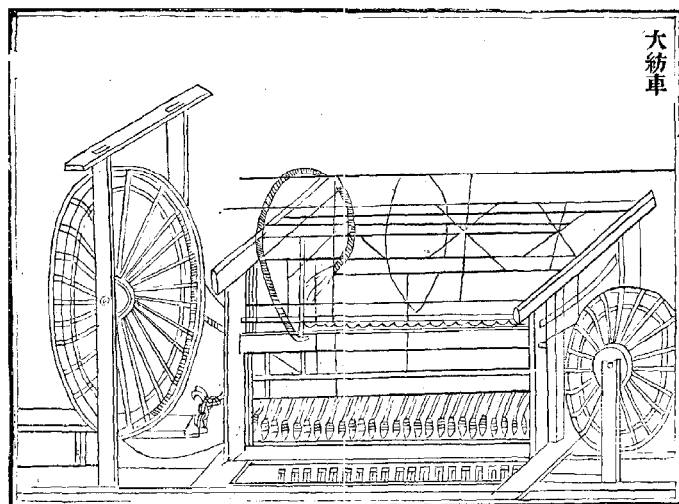


Fig. 7: Silk reeling frame (Wang Zhen, *Nongshu* 26.6a-b)

The spindles charged with the silk yarn that was to be processed were set in two rows (difficult to know without seeing the picture...) opposite each other at the lower level of the frame (fig. 8).

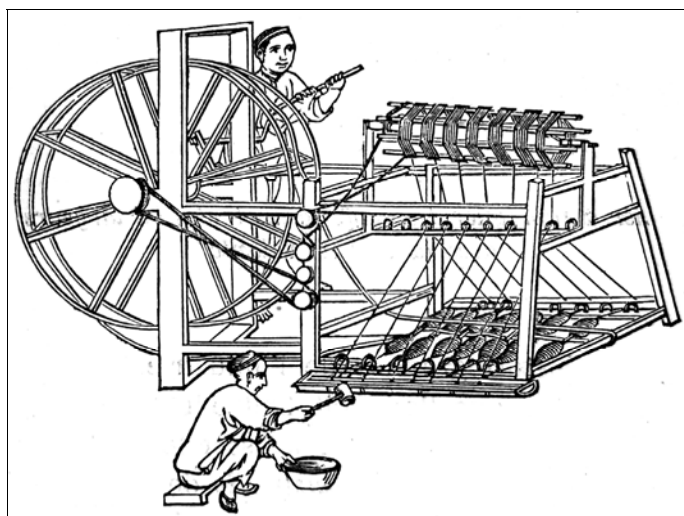


Fig. 8a: Silk reeling frame (reproduced from Hedde 1876, 29)

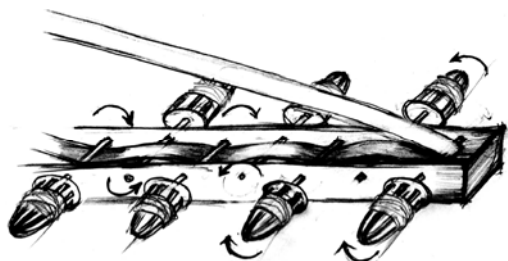


Fig. 8b: drawn after the description by Hedde (1848, 144f), and the observation of the small scale model carried by the author from his mission in China and now conserved at the Musée National des Arts et Métiers (St-Denis)

They were moved by a circular belt, which passed alternatively above one rod of the spindle and then under the other to give the yarns opposite torsions. The belt was driven by a wheel placed outside the frame and moved by a crank, but not by hydraulic power as one can observe it in the illustration of *Nongsbu* by Wang Zhen. The silk yarn thus received torsion in opposite directions before being doubled in a twisted yarn.

The operation was much more efficient than the manual procedure,¹³¹ but neither the quality nor the diversity were comparable with a yarn manually prepared by skilful artisans. The adoption of the spinning-frame in the silk industry showed how the silk weaving was thriving; also the raising of raw silk productivity. While the spinning-frame needed fewer persons for moving the device, placing and removing reels as well as for supervising a satisfactory working of the device, it was possible for the owners to hire less skillful manpower. In this way, the owners of silk weaving manufactories could reduce the cost of fabrication and raise productivity. However, the twisting frame coexisted with the manual procedure. The former allowed a considerable increase in the production of the kinds of regular yarns, such as *organsin* and weft, while the latter had the advantage of producing yarns with special effects for a particular purpose demanded by some kinds silk clothes. Besides, family weaving workshops could thus reduce the costs of fabrication.

131 Wang Zhen evoked a big spinning-frame fitted with thirty-two spindles which allowed a productivity of 100 *jīn* (equal to 661 kg, see note 59) per day. See Wang Zhen, *Nongsbu* 26.8a.

Progress in Cotton Production

Compared with silk production, cotton cultivation had the following advantages: it benefitted from agricultural technology and demanded less agricultural know-how specific to its production. Also, cotton spinning, unlike silk reeling, could be done at any time, for example, in the evening after the daytime work in the fields. The latter operation, moreover, had to be carried out within a few days after the formation of cocoons; otherwise the chrysalises would have started their transformation into moths and thus this would damage their cocoons which would consequently lose their quality and value. However, cotton spinning also had certain constraints caused by the ginning and carding operations,¹³² which were not sufficiently well known to Chinese craftsmen who had a rich experience of working with long fibres, such as silk, hemp and ramie.

In the Song-Yuan period, cotton cultivation benefited from advanced agricultural technology and important developments did take place. No later than in the late 1280s, Chinese peasants observed that the cotton plants grew well in earth mixed with sand and concluded:

[...] choose a fertile and wet land composed of half-earth and half-sand for cotton plantations.¹³³

The species of cotton plant introduced in the Jiangnan region was a kind of *Gossypium arboreum*, which came from Southern India via Yunnan, Guangdong and Fujian provinces.¹³⁴ The fibres provided by this species were of a better quality than those of *Gossypium herbaceum* – the species spread across the north-western border of China through the Silk Road – and allowed the spinning of finer yarn. After a long period of cultivation in the south of China, the *Gossypium arboreum*, originally a tall tree, was successfully modified and became a one-year plant of small size.¹³⁵

132 The ginning process aims to remove the seeds from raw and hence tight cotton. The carding operation allows to aeration of the fibres and the removal of dirt from them.

133 *Nongsang jiyao* 2.31a (106) ("Mumian"): [...] 擇兩和不下濕肥地。

134 Zhao Gang provided a precise analysis of the species of cotton introduced into China and the paths of its transmission; see Chen Zhongyi and Zhao Gang 1977, 8-23. It might be interesting to compare the introduction of the cotton industry into the Islamic world with what happened in China. See Maurice Lombard 1978, 61-79.

135 Chen Zhongyi and Zhao Gang 1977, 26.

In the late Northern Song or early Southern Song, Fang Shao 方勺 (c. 1066 – after 1142) mentioned that

(i)n the provinces of Fujian and Guangdong, the plantation of cotton trees is very popular. The tree is seven to eight feet high (210cm to 280 cm) [...] and grows fruits similar to big water chestnuts but of a green colour. In late autumn, the fruit opens and white wool appears.¹³⁶

For Zhou Qufei 周去非 (1135–1189), who was appointed as a local official in the second part of the 1170s, the cotton plant in Guangxi

[...] looks like a mulberry tree of small size. The branches and the calyx are similar to those of hibiscus.¹³⁷

In the early Yuan Empire, with governmental encouragement, cotton cultivation spread into Shaanxi province from the Western regions. The techniques of cotton yarn making may have been very primitive. After the final conquest of Southern China by the Mongols in 1279, Hu Xingsan 胡三省 (1230–1287) showed that in his time cotton was planted in the Jiangnan region. The inhabitants

[...] sow it in the late second moon or in the early third moon of spring-time. [...] In autumn, it grows yellow flowers and then fruits.¹³⁸

Nongsang jiyao was the earliest treatise to describe in detail cotton plantation and fibre production techniques.¹³⁹ The article was apparently added to the edition of 1289 by Meng Qi 孟祺, since the entry was marked with the words *xintian* 新添, “recently added”. Meng Qi insisted on keeping a suitable distance between each plant and advised growers to “keep two plants at each step”. He also specified the ways to increase the number of fruits of cotton plants and to shorten their height. He advised to

[...] eliminate the straight stems, when the plant reaches two feet high. [...] Also, if the lateral branches grew over one and a half feet, it is necessary to

136 *Bozhai bian* 泊宅編 3.16: 閩廣多種木棉，樹高七八尺 [...], 結實如大菱而色清，秋深即開，露白綿茸然。

137 *Lingwai daida* 嶺外代答 6.14a (199) (“Fuyongmen” 服用門): [...] 吉貝木如低小桑，枝萼類芙蓉。

138 *Zizhi tongjian* 資治通鑑, “Liangji” 梁紀 15.4934 (“Wudi Datong 11 nian” 武帝大同十一年), notes by Hu Sanxing: 木棉，江南多有之。以春二三月之晦下子種之。[...] 至秋，生黃花結實。

139 *Nongsang jiyao* 2.31a-32b (106) (“Mumian”).

eliminate the straight stems. The leaves would not grow in vain and would give flowers and fruits.¹⁴⁰

This way, the productivity of cotton wool increased considerably. Several Song *literati* also mentioned cotton production in southern China. For instance, Zhou Qufei described the procedure of cotton yarn making he observed in Guangxi province:

The natives of the South take the wool [of cotton] and remove the seeds with an iron stick. They then take the wool by hand and spin it”.¹⁴¹

And in Guangdong and Fujian provinces, in autumn,

[...] labourers harvest [the cotton fruits] and remove the outer layer. They then roll an iron stick over the wool to eliminate the black seeds completely and subsequently slowly apply a small bow to aerate the fibres and then spin them and weave them into cloth.”¹⁴²

The techniques described in *Nongsang jiyao* are similar to those used in the Southern Song. After harvesting the cotton wool, farmers dried the wool in the sunlight and then removed the seeds by rolling it on a wooden board with an iron stick, which was

[...] two feet long, large as one finger [in the middle part] and thinner at the two extremities, and looked like a stick for spreading bread.¹⁴³

The cotton wool then underwent thorough carding with a small bamboo bowl of around 45 cm in diameter.¹⁴⁴

The techniques improved quickly in the late thirteenth century. Two *literati* of the late Yuan, Tao Zongyi 陶宗儀 (1329–1410) and Hu Guyu 胡古愚 (active in the first half of 14th century), attributed the improvements to Huang Daopo 黃道婆 who carried with her advanced

140 *Nongsang jiyao* 2.31a-32b (106) (“Mumian”): [...] 每步只留兩苗。[...] 苗長高二尺之上，打去衝天心；旁條長尺半，亦打去心。葉葉不空，開花結實。

141 *Lingwai daida* 6.14a (199) (“Fuyongmen”): 南人取其茸絮，以鐵筋取其子，即以手握茸就紡。

142 *Bozhai bian* 3.16: [...] 工人摘取去殼，以鐵杖趕盡黑子，徐以小弓彈令紛起，然後紡績為布。

143 *Nongsang jiyao* 2.31a-32b (106) (“Mumian”): [...] 長二尺，麤如指，兩端漸細，如趕餅杖樣。Several *literati* of the Southern Song, such as Zhou Qufei, Zhao Rugua 趙汝适 and Fang Shao mentioned similar practices. Cf. *Pozhai bian* 3.16.

144 In Hu Sanxing’s commentary to *Zizhi tongjian*, “Liangji” 15.4934 (“Wudi Datong 11 nian”).

techniques from Hainan in the early Yuan Dynasty.¹⁴⁵ Wang Zhen tried to instruct the inhabitants under his jurisdiction how to use advanced tools for preparing raw cotton suitable for spinning, among them were a ginning cart (*mumian jiaochē* 木棉攪車) (fig. 9) and a large bamboo bow (*tangong* 彈弓)¹⁴⁶ that he drew to show to his subjects.¹⁴⁷

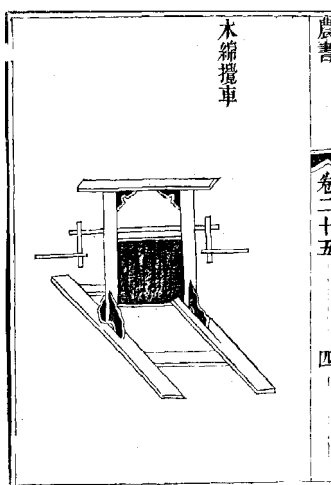


Fig. 9: *Mumian jiaochē* (Wang Chen, *Nongshu* 25.4b)

The ginning cart was an instrument comprising two cylinders inserted in a wooden frame being parallel and close to each other (fig. 10).¹⁴⁸

At the opposite sides of each cylinder, two crank-handles were attached. To handle the instrument, one labourer fed the wool into the cylinders with one hand and turned one of the crank-handles with the other. In front of the first, another labourer turned the other crank-handle in the opposite direction. The cotton wool advanced towards the other side of the cylinders while the seeds fell on the same side where the raw cotton wool was sent. The operation became considerably more efficient than before.

145 Tao Zongyi, *Nancun chuogeng lu* 南村輟耕錄 24.1919, 190; Hu Guyu, *Shuyi pian* 樹藝篇 1.1995.459 (“Caobu” 草部 1).

146 Wang Zhen, *Nongshu* 25.454 (“Mumian jiaochē” 木棉攪車 and “Mumian tangong” 木棉彈弓).

147 *Yanyuan wenji* 7.26a-27b (100) (“Wang Boshan *Nongshu xu*”). See note 118.

148 Wang Zhen, *Nongshu* 25.454 (“Mumian jiaochē”): 夫攪車，四木作框，上立二小柱，高約尺五，上以方木，管之立柱，各通一軸，軸端俱作掉拐，軸末柱竅不透，二人掉軸，一人餵上綿英，二軸相軋，則子落于內，綿出于外。

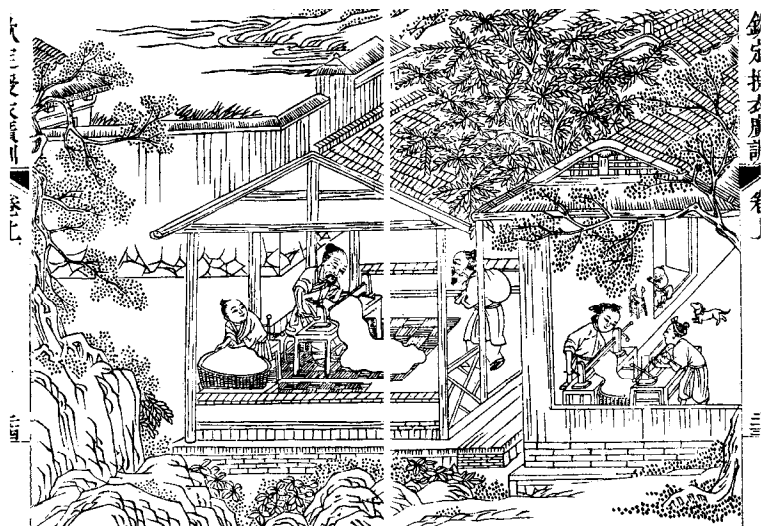


Fig. 10: Yamian 軋棉, in *Shouyi guangxun* (1808 edition)

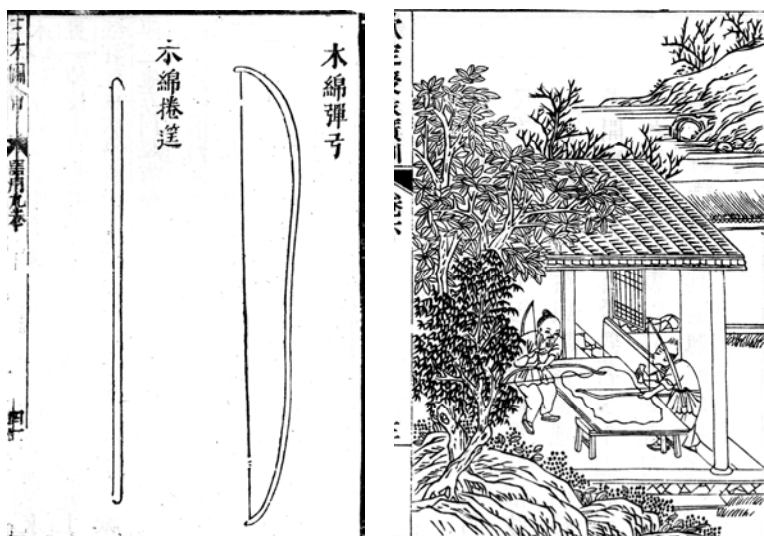


Fig. 11 a: Mumian tangong 木棉彈弓, in *Sancai tubui* (1607 edition)
b: Tanmian 彈棉, in *Shouyi guangxun* (1808 edition)

Moreover, the size of the bow for the carding operation was increased to more than four feet. One end of the bow was slightly bent in order to enforce the cord connecting the extremities of the bow (fig. 11). The string was struck by a small wooden hammer for loosening the wool.

The procedure was much more efficient than the manual one. The processed wool could be used directly for wadding. It could also be spun, but after undergoing a scrolling operation with a roller.

In 1289, ten years after the victory over the Southern Song, the Mongolian government followed the former one in implementing a tax system that included setting up in five southern provinces Cotton Supervisorate (*mumian tijusi* 木棉提舉司) and succeeded in collecting a great quantity of cotton wool and cloth (tab. 1). This shows that at the end of the Southern Song period, the cotton craft industry had made considerable progress. The price of cotton fell significantly during the Yuan dynasty and became cheaper than ramie:

As for the cotton goods, the best quality cost five *qian* a foot;¹⁴⁹ the middle quality four *qian*, and the lowest three *qian*. As for the ramie goods, the best quality cost seven *qian* five *fen* a foot, the middle, six *qian* a foot. As for the raw white taffeta of the South, the best quality costs six *qian* five *fen* a foot; the middle quality five *qian*; the lowest three *qian* five *fen*.¹⁵⁰

As can be seen above, ramie was a refined textile among luxury products. The hemp goods was products with more interesting price:

The fine hamp products cost three *qian* a foot; and the coarse ones, two *qian* two *fen* and five *li*.¹⁵¹

In 1302, the Imperial Secretariat (*zhongshusheng* 中書省) of Jiangxi province stated in an edict that

[...] the ancient institutions ruled to provide [every year] each poor person with two pieces of hemp for winter dresses. The hemp was sparse, how could they protect themselves from cold weather? That measure only wasted administrative funds and did not offer any help. Why did they not provide the people with cotton cloth? The people could thus have kept warm.¹⁵²

149 One *qian* is a quantity of silver, equal to one tenth of a *liang*, and one *fen*, one tenth of a *qian*.

150 Amano Motonosuke 1962, 497: 木棉上等每尺伍錢，中等每尺肆錢，下等每尺叁錢；苧布上等每尺柒錢伍分，中等每尺陸錢；生南白絹上等每尺陸錢伍分，中等每尺伍錢，下等每尺叁錢伍分”。

151 *Item. ibid.*: “麻布細麻布每尺叁錢，麤麻布每尺貳錢貳分伍釐；南生絹上等每尺陸錢伍分，中等每尺伍錢，下等每尺叁錢伍分。

152 *Tongzhi tiaoge* 4.14b: 大德六年（1302）中書省江西行省臨江路申：[...] 貧人冬衣布絮依舊例每名支給土麻布貳疋，稀疏豈能禦寒？徒費官錢，不得實惠，合無支給木棉布疋，庶望貧民溫煖。

Cotton production thus obtained the support of the government. Cotton goods directly competed with ramie and hemp cultivation and won the popular textile market.¹⁵³

Final Remarks

The exchanges between China and other regions of the Eurasian continent, especially by maritime routes, became very flourishing thanks to the encouragement policy conducted by both the Song and Yuan governments. In foreign trade, Chinese silk products occupied one of the highest positions. By the same means of commercial exchanges, advanced knowledge and know-how circulated from one side of the continent to the other; the silk industry was introduced step-by-step, especially through the “silk roads”, from China to Central Asia, then the Middle East to arrive finally in Western Europe; at the same time cotton production came into China from abroad, both by terrestrial and maritime routes. This exchange was simultaneous with the development of advanced silk techniques in China, and also made an impact on several aspects of Chinese technology and economics, such as textile fibre production and textile consumption.

The development of new silk weaving centres in the Western part of the Eurasian continent increased the demand for Chinese raw silk. Even though sericulture technology arrived in Constantinople around the mid-sixth century, the production of raw silk was far from being sufficient both in its quality and in its productivity. The proportion of raw silk grew slowly in Chinese foreign trade. This ran in concert with the remarkable progress of sericultural know-how that took place in the Song-Yuan period. The settlement of the Southern Song court in Hangzhou, that is, in the centre of sericulture, offered the Chinese silk industry an excellent opportunity to develop quickly and to become a production centre that involved a large number of workers. The advantageous natural conditions of the Jiangnan region as well as the advanced techniques developed in Northern China mixed with local knowledge and know-how resulted in a thriving sericulture industry. A particular “Jiangnan-model” for silk production – an intensified raw silk production system to produce high quality white and refined raw silk – was thus created.

153 Maurice Lombard has made the same observation about linen that was also outvalled by cotton in the medieval Islamic world. See Lombard 1978, 61.

Nevertheless, the separation of the mulberry tree plantations and silkworm breeding raised the cost of raw material production, especially for poor landless families. It is in this context that during the late Southern Song a market for mulberry leaves came into existence. The introduction of species of cotton plants of better quality and advanced techniques that came from the southern regions of China won the peasants' appreciation. Benefitting from the progress of agriculture, production grew considerably and made cotton cloth accessible for ordinary people. Cotton replaced silk waste for making winter clothes for soldiers and for the poor and this made a great quantity of silk available for export. Cotton production obtained the support of the government, which integrated it into the agricultural encouragement policy. Those peasants who did not have sufficient silk know-how to obtain attractive benefits thus engaged in cotton production, while only those who had advanced expertise and skills stayed in silk production.

The Song-Yuan period witnessed obvious technical progress in numerous fields, especially in agriculture and craft industries (i. e. tea, sugar, silk and porcelain). This was the consequence of a long period of frequent exchanges with multiple foreign cultures, such as the Roman, Indian, Persian and Islamic. Following traders, pilgrims, armies, as well as immigrants, new crops and handicraft know-how spread from one region of the Eurasian continent towards the others both through steppe and maritime "silk roads". The silk industry that spread from China towards Western Europe before the late-thirteenth century, as well as the cotton industry successfully introduced into China from India during the twelfth century, are very good examples. The development of these production and craft industries and the emergence of multiple centres led to a drop in textile prices: silk products no longer were equal to their weight in gold and progressively lost their worth as a measure of value and money; while cotton turned from an imported luxury textile for privileged classes to a commodity for ordinary people. Technical factors aside, this phenomenon was one of the happy results produced by several factors: demographic growth, improvement in medicine, science, agriculture, traffic convenience as well as relatively political and social stability in China, compared with other regions of the Eurasian continent.

The success in introducing the cotton industry into China during the Southern Song period, which met difficulties on its path from the north-western part of the country, was due to technical progress in

cotton cultivation techniques and in yarn making, but technical progress in the silk industry in China, allowing a considerable increase in productivity in both raw material production and weaving constituted another important factor. It helped raising the production of raw silk on a reduced surface of mulberry land. Even though technical progress also led to the rise in the cost of production, sericulture was still one of the most lucrative among the agricultural activities. It provided landless women and elders a way to increase family income, since the cultivation of the dwarf mulberry tree permitted a considerable increase in productivity of mulberry leaves and the sale of mulberry leaves on the market. The drop in the price of silk and the rise in production costs were compensated by the increased productivity as well as the reduction of waste that silk generated. Nevertheless, breeders with low-incomes did not keep part of their crop for winter clothes or stuffing their blankets but preferred to sell them on the market in exchange for cotton fibre, which was cheaper but more efficient against cold weather than other vegetable fibres. The introduction of new textile plants was thus a consequence of both technical progress and increasing market demand caused by demographic growth. Also, the conversion of tax payment in natural products to currency gave farmers more flexibility to choose more profitable crops by considering not only the natural conditions (e. g. soil quality, climate), but also diverse factors, such as imperial tax measures, manpower availability, transport facilities and market conditions. Under these circumstances, the acquisition of advanced knowledge and know-how also played an important part in increasing the income for farmers.

From the example of the introduction of a cotton industry in China, one can observe that merchants and inhabitants in border areas played a pioneering role in introducing new crops with suitable techniques and knowledge for their production. While attempts at the cultivation of new crops were generally undertaken by ordinary people, the history of its introduction was long and fuzzy. One can read descriptions by local literati or officers written at a time when the attempts had obtained sufficient results and when the cultivation of new crops had spread more widely so that local inhabitants had benefited from these lucky outcomes. Since cotton cultivation offered promising ways both to address the clothing needs of ordinary people and to increase the imperial Treasury, the Yuan court decided to include the technical description of cotton cultivation and cotton yarn making in the agricul-

tural handbook *Nongsang jiyao*. This work presented all proven techniques collected across the Empire in order to help farmers who lived under different natural conditions to choose suitable crops and techniques. The court officials thus played a decisive role in collecting useful knowledge about the most advanced techniques. The circulation led to an increase in productivity and favoured the specialization of cultures in a historical background that supported the development of both the domestic market and foreign trade.

The Southern Song period marks an exceptional but also paradoxical period in Chinese history. As has been shown by a great number of modern historians, the Southern Song was politically speaking one of the weakest dynasties in Chinese history, with a rising population in a territory reduced to half of what it had been during the Northern Song. Nevertheless, that period witnessed an unprecedented development in several domains: agriculture, sciences and technologies as well as craft industries. Neglected by most modern historians, the latter progressed towards a rational organisation in Song China. With advancing knowledge and know-how, craft industries developed to a pre-industrial activity both by synchronizing the steps of operation and increasing the size of production, as can be observed in silkworm breeding. A large amount of manpower, a developed traffic network, the evolution of a tax system from payment in kind to payment in the form of money, as well as a thriving maritime trade with Southern Asia and the Western side of the Eurasian continent, allowed complete China to get all the food and raw material supplies it needed. It was in this context that the Chinese of the Southern Song developed a particular system of sericulture in the plains, which made it possible to have a high density of mulberry tree plantations and to considerably raise the quality and the productivity of silk. With new modes of production cost price increased and a more refined skill was demanded, which released a section of people who could not sufficiently benefit from the silk industry to other more lucrative work, such in cotton plantations. Before the maritime trade on the increase following the arrival of the Portuguese fleet in Chinese coastal regions in the 17th century, the production of silk in China sufficiently provided for the needs both in the Chinese domestic market and in trade around the China Sea. As one can observe, the narrative by Chinese literati declaring the decline of sericulture started to appear few years after the event.

Bibliography

Primary sources

- Beishan xiaoji* 北山小集, by Chen Ju 程俱 (1078–1144). Songji zhenben congkan 宋集珍本叢刊, 33. Beijing: Xianzhuang, 2004.
- Binfeng guangyi* 幽風廣義, by Yang Shen 楊岫 (1699–1794). Guanzhong congshu 關中叢書, 18 [reprint: Taipei: Yiwen, 1970].
- Bozhai bian* 泊宅編, by Fang Shao 方勺 (c. 1066 – after 1142). Tang Song shiliao biji congkan 唐宋史料筆記叢刊. Beijing: Zhonghua, 1983.
- Bu Nongshu* 補農書, by Zhang Lüxiang 張履祥 (1611–1674). Edition of 1782 [reprint: Siku quanshu cunmu congshu bubian 四庫全書存目叢書補編, 80. Jinan: Qilu, 2001].
- Cansang cuibian* 蠶桑萃編, by Wei Jie 衛杰 (late nineteenth cent.). Zhejiang guanshujū 浙江官書局 (1900) edition [reprint: Siku weishoushu jikan 四庫未收書輯刊, 4, 23. Beijing: Beijing chubanshe, 2000].
- Canshu* 蠶書, by Qin Guan 秦觀 (1049–1100). Siku quanshu 四庫全書, 730 [reprint: Taipei: Taiwan Shangwu, 1983].
- Chitang cungao* 恥堂存稿, by Gao Side 高斯得 (1199–?). Congshu jicheng chubian 叢書集成初編, 2040–2041. Shanghai: Shangwu, 1935 [reprint: Congshu jicheng xinbian 新編, 65. Taipei: Xin Wenfeng, 1985].
- Da Yuan shengzheng guochao dianzhang* 大元聖政國朝典章. Yuan edition [reprint: Xuxiu Siku quanshu 續修四庫全書, 787. Shanghai: Shanghai guji, 1995].
- Da Yuan yitong zhi, canben* 大元一統志殘本, by Bolanxi 李蘭盼. Liaohai congshu 遼海叢書, vol. 15, box 18 [reprint: Banqiao: Yiwen, 1970].
- Fan Wenzheng gongji* 范文正公集, by Fan Zhongyan 范仲淹 (989–1052). Ming recarving of a Yuan edition. [reprint: Sibu congkan chubian 四部叢刊初編; 811–820. Shanghai: Shangwu, 1929; Sibu congkan chubian suoben 縮本; 40. Taipei: Shangwu, 1975].
- [Songben] *Guangyun* 宋本廣韻, by Chen Pengnian 陳彭年 (901–1017). See: *Xinjiao zhengqie Songben Guangyun*.
- [Jiajing] *Guangping fuzhi* 嘉靖廣平府志, by Chen Fei 陳棐. Edition from 1550 [reprint: Tianyige cang Mingdai fangzhi xuankan 天一閣藏明代方志選刊, 2. Taipei: Xin Wenfeng, 1985].
- Huanshan yigao* 還山遺稿, by Yang Huan 楊奐 (1186–1255). Shiyuan congshu 適園叢書. [reprint: Congshu jicheng xubian 叢書集成續編, 133. Taipei: Xin Wenfeng, 1989].
- Hui'an xiansheng Zhu Wengong wenji* 晦庵先生朱文公文集, by Zhu Xi 朱熹 (1130–1200). Edition from 1532 [reprint: Sibu congkan chubian 四部叢刊初編, 1958–1107. Shanghai: Shangwu, 1929; Taipei: Taiwan shangwu, 1967].

- [*Hongzhi*] *Huizhou fuzhi* 弘治徽州府志, by Wang Shunmin 汪舜民. Edition from 1502 [reprint: Siku quanshu cunmu congshu 四庫全書存目叢書, *shibu*, 180. Tainan: Zhuangyan, 1996].
- Jiannan yilai chaoye zaji* 建炎以來朝野雜記, by Li Xinchuan 李心傳 (1166–1243). Tang Song shiliao biji congkan. Beijing: Zhonghua, 2000.
- [*Zhizheng*] *Kunshan junzhi* 至正崑山郡志, by Yang Hui 楊諱 (fourteenth cent.). Edition from 1909 [reprint: Zhongguo fangzhi congshu 中國方志叢書, Huazhong difang, 435. Taipei: Chengwen, 1983].
- “Lin min pian” 臨民篇, by Hu Taichu 胡太初 (obtained the title of juren in 1238), in *Zhoulian xulun* 2.1116–1119.
- Lingwai daida* 嶺外代答 (pref. 1178), by Zhou Qufei 周去非 (1135–1189). Siku quanshu, *shibu*, 589 [reprint: Zhongguo fengtuzhi congkan 中國風土志叢刊, 61. Yangzhou: Guangling, 2003].
- Lu Xuangong ji* 陸宣公集, by Lu Zhi 陸贄 (754–805). Liang Zhe zuojia wencong 兩浙作家文叢. Hangzhou: Zhejiang guji, 1988.
- Mingyi daifanglu* 明夷待訪錄, by Huang Zongxi 黃宗羲 (1610–1695). *Zhihai* 指海 [reprint: Baibu congshu jicheng 百部叢書集成, 54, 6. Taipei: Yiwen, 1967].
- Nancun chuogeng lu* 南村輟耕錄, by Tao Zongyi 陶宗儀 (14th cent.). Yuan edition. [reprint: Sibu congkan sanbian 四部叢刊三編, *zibu* 子部, 38, Shanghai: Shangwu, 1936].
- Nongsang jiyao* 農桑輯要. Edition from 1339 [reprint: Xuxiu Siku quanshu, 975. Shanghai: Shanghai guji, 1995]. [For annotated editions of *Nongsang jiyao* see Shi Shenghan 1982 and Miao Qiyu 1988.]
- Nongshu* 農書, by Chen Fu 陳旉 (1076–?). *Zhibuzu zhai congshu* 知不足齋叢書 [reprint: Baibu congshu jicheng, 29, 9. Taipei: Yiwen, 1966].
- Nongshu* 農書, by Wang Zhen 王禎. (1) *Ju zhenban congshu* 聚珍版叢書 [reprint: Baibu congshu jicheng, 27, 38. Taipei: Yiwen, 1966; edition in 36 chapters with trad. pagination].
- . (2) *Congshu jicheng chubian*, 1464–1467. Shanghai: Shangwu, 1935 [reprint: *Congshu jicheng xinbian* 新編, 47. Taipei: Xin Wenfeng, 1985; edition in 22 chapters with modern pagination. For an annotated edition of Wang Zhen *Nongshu* see Miao Qiyu 1994.]
- Nongzheng quanshu* 農政全書, by Xu Guangqi 徐光啓 (1562–1633). Siku quanshu, 731 [reprint: Taipei: Taiwan Shangwu, 1983].
- [*Xianchun*] *Piling zhi* 咸淳毗陵志. Recarved Song edition from 1820. [reprint: Song Yuan fangzhi congkan 宋元方志叢刊, 3. Beijing: Zhonghua, 1990].
- Pingzhou ketan* 萍洲可談, by Zhu Yu 朱彧. Siku quanshu, *zibu*, 1038 [reprint: Lidai biji xiaoshuo jicheng 歷代筆記小說集成, Songdai biji xiaoshuo 宋代筆記小說, 11. Shijiazhuang: Hebei jiaoyu, 1995].

- Puchuan suowen ji* 濮川所聞記, by Jin Huai 金淮. Edition from 1820 [reprint: Zhongguo difangzhi jicheng 中國地方志集成, Xiangzhenzhi zhuanji 鄉鎮志專輯, 21. Shanghai: Shanghai shudian, 1992].
- Qianshu* 潛書, by Tang Zhen 唐甄 (1630–1704). Beijing: Zhonghua, [1955,]²1963.
- Qimin yaoshu* 齊民要術, by Jia Sixie 賈思勰. Fragments of chapters 1, 5 and 8 of a Song manuscript edition of *Qimin yaoshu* [reprinted by Luo Zhenyu 羅振玉 (1866–1940) as *Qimin yaoshu canjuan* 齊民要術殘卷 in his *Jishi'an congshu* 吉石齋叢書. Shangyu, 1914–1916]. [For an annotated edition of *Qimin yaoshu* see Miao Qiyu 1982.]
- Sancai tuhui* 三才圖會, by Wang Qi 王圻 and Wang Siyi 王思義. Edition from 1607 [reprint: Xuxiu siku quanshu, 1232–1236. Shanghai: Shanghai guji, 1995].
- “Shang zhizheng shu” 上執政書, by Fan Zhongyan, in *Fan Wenzheng gongji* 8.2b–17b (62–69).
- Shihu jushi shiji* 石湖居士詩集, by Fan Chengda 范成大 (1126–1103). Sibucongkan chubian, 1180–1184 [reprint: Taipei: Taiwan shangwu, 1975].
- Shouyi guangxun* 授衣廣訓, by Dong Gao 董誥 (1740–1818). Wuyingdian 武英殿 edition from 1808 [reprint: Xuxiu siku quanshu, 977. Shanghai: Shanghai guji, 1995].
- Shuyi pian* 樹藝篇, by Hu Guyu 胡古愚 (14th cent.). Ming manuscript edition. [reprint: Xuxiu siku quanshu, 977. Shanghai: Guji, 1995].
- Song Yuan xue'an* 宋元學案, by Huang Zongxi 黃宗羲 (1610–1695), and Quan Zuwang 全祖望 (1705–1755). Beijing: Zhonghua, 1986 [4 vols.].
- Tang liudian* 唐六典, by Li Linfu 李林甫 (?–752). Japanese edition from 1724 [reprint: Taipei: Wenhai, 1974].
- Tongdian* 通典, by Du You 杜佑 (735–812). Beijing: Zhonghua, 1988.
- Tongzhi tiaoge* 通制條格, by Baizhu 拜柱, first issued in 1323. Ming manuscript copy [reprint: Xuxiu Siku quanshu, 787. Shanghai: Shanghai guji, 1995].
- Xinjiao zhengqie Songben Guangyun* 新校正切宋本廣韻, Song edition of *Guangyun*, recarved 1704, with critical annotations by Lin Yin 林尹. Taipei: Liming, 1976.
- Xin Tangshu* 新唐書, by Ouyang Xiu 歐陽修 (1007–1072). Beijing: Zhonghua, 1975.
- Xu Zizhi tongjian changbian* 續資治通鑒長編, by Li Tao 李燾 (1115–1184). Beijing: Zhonghua, 2004.
- Yan Yishan xiansheng wenji* 嚴逸山先生文集, by Yan Shukai 嚴書開 (c. 1612–1672). Early Qing edition. [reprint: Siku jinhuishu congan 四庫禁毀書叢刊, *jibu* 集部, 90. Beijing: Beijing chubanshe, 1995].

- Yanyuan wenji* 剡源文集, by Dai Biaoyuan 戴表元 (1244–1310). Siku quanshu, 1194 [reprint: Taipei: Taiwan Shangwu, 1983].
- Yijian zhi* 夷堅志, by Hong Mai 洪邁 (1123–1202). Shiwanzhuan lou congshu 十萬卷樓叢書 [reprint: Baibu congshu jicheng, 76, 4-5. Taipei: Yiwen, 1966].
- Yōsan shinron* 養蠶新論, by Tajima Kuniyasu 田島邦寧 (1822–1898). Tōkyō: Izumoji Manjirō, 1873.
- Yuanhe junxian tuzhi* 元和郡縣圖志, by Li Jifu 李吉甫 (758–814). Zhongguo gudai dili zongzhi congkan 中國古代地理總志叢刊. Beijing: Zhonghua, 1983.
- Yuanshi* 元史, by Song Lian 宋濂 (1310–1381). Sibubeiyao 四部備要, 317–326 [reprint: Taipei: Zhonghua, 1965].
- [*Zhishun*] *Zhenjiang zhi* 至順鎮江志, by Tuoyin 脫因 and Yu Xilu 俞希魯 (1279–1368). Edition from 1842, recarved by Mao Guangsheng 冒廣生 (1873–1959) in 1923 [reprint: Zhongguo fangzhi congshu, Huazhong difang, 171. Taipei: Chengwen, 1975].
- Zhoulian xulun* 畫簾緒論, by Hu Taichu 胡太初 [preface and afterword dated 1236 resp. 1253]. Reprint: Biji xiaoshuo daguan babian 筆記小說大觀八編, 2. Taipei: Xinxing, 1975.
- Zizhi tongjian* 資治通鑑, by Sima Guang 司馬光 (1018–1086). Beijing: Zhonghua, 1956.

Secondary sources

- Thomas T. Allsen, *Commodity and Exchange in the Mongol Empire: A Cultural History of Islamic Textiles*. Cambridge: Cambridge University, 1997.
- , *Culture and Conquest in Mongol Eurasian*. Cambridge: Cambridge University, 2001.
- Amano Motonosuke 天野元之助, *Chūgoku nōgyōshi kenkyū* 中國農業史研究, Tōkyō: Ochanomizu, 1962.
- , *Chūgoku konōsho kō* 中國古農書考, Tōkyō: Ryukei, 1975.
- , “Gen no Ō Jō Nōshō no kenkū” 元の王禎農書の研究, in Yabuuchi Kiyoshi (1967), 341–468.
- Bao Weimin 包偉民 and Wu Zhengqiang 吳錚強, “Xingshi de beihou: Liang Song quannong zhidu de lishi fenxi” 形式的背後：兩宋勸農制度的歷史分析, *Zhejiang daxue xuebao* 浙江大學學報 2004.1, 38–45.
- Bonafous, Matthieu, *Expériences comparatives sur l'emploi des feuilles du mûrier greffé et de celles du mûrier sauvage*. Lyon: J.-M. Barret, 1829.
- Boulnois, Luce, *La route de la soie: dieux, guerriers et marchands*. Genève: edition Odizan, 2001.

- Bray, Francesca, *Agriculture. Science and Civilisation in China* (ed. by Joseph Needham), vol. 6: Biology and Biological Technology, 2. Cambridge: Cambridge University, 1984.
- Chao Yea-shu [Zhao Yashu] 趙雅書, "Songdai cansiye de dili fenbu" 宋代蠶絲業的地理分佈, *Songshi yanjiu* 宋史研究 7 (1974), 573-605.
- Chen Weiji 陳維稷, *Zhongguo fangzhi kexue jishu shi: Gudai bufen* 中國紡織科學技術史—古代部分. Beijing: Kexue, 1984.
- Chen Zhongyi 陳鍾毅, and Zhao Gang 趙岡 (Kang Chao), *Zhongguo mianye shi* 中國棉業史. Taipei: Lianjing, 1977 [English version: *The development of cotton textile production in China*. Cambridge: Harvard University, 1977].
- Deng, Gang, "The Foreign Staple Trade of China in the Pre-Modern Era", *The International History Review*, 1997.19.2, 253-285.
- Deng Guangming 鄧廣銘, "Yuezhai Tang Zhongyou shengzu nianfen kao" 悅齋唐仲友生卒年份考, in *Deng Guangming quanji* 鄧廣銘全集 (Shijiazhuang: Hebei jiaoyu, 2005), vol. 8, 711-715.
- Deker, Michael, "Plants and Progress: Rethinking the Islamic Agricultural Revolution", *Journal of World History* 20.2 (2009), 187-206.
- Elvin, Mark, *The Pattern of the Chinese Past*. Stanford: Stanford University, 1973.
- Endicott-West, Elisabeth, "Merchant Associations in Yüan China: The Ortoy", *Asia Major*, 3rd ser. 2.2 (1989), 127-154.
- Endrei, Walter, *L'évolution des techniques du filage et du tissage du Moyen Age à la révolution industrielle*, translated from Hungarian to French by Joseph Takcs with collaboration of Jean Pilisi. Paris: Mouton, 1968.
- Fujian Sheng Quanzhou Haiwai jiaotongshi bowuguan 福建省泉州海外交通史博物館 (ed.), *Quanzhouwan Songdai haichuan fajue yu yanjiu* 泉州灣宋代海船發掘與研究. Beijing: Haiyang, 1987.
- Funakoshi Taiji 船越泰次, *Tōdai ryōzeihō kenkyū / Tangdai liangshui fa yanjiu* 唐代兩稅法研究, Tōkyō: Kyūko, 1996.
- Gao Shulin 高樹林, *Yuandai fuyi zhidu yanjiu* 元代賦役制度研究. Baoding: Hebei daxue, 1997.
- Hammers, Roslyn Lee, *Pictures of Tilling and Weaving: Art, Labor and Technology in Song and Yuan China*, Hong Kong: Hong Kong University Press, 2011.
- Hedde, Isidore, *Exposition des produits de l'industrie sérigène en Chine*. Saint-Etienne: Théolier Aîné, 1848.
- , *Etudes sérítechniques sur Vaucanson*. Paris: LaCroix, 1876.

- Hino Kaisaburō 日野開三郎, *Tōdai ryōzeihō no kenkyū* 唐代兩稅法の研究. Tōkyō: San'ichi, 1981-1982.
- Huang Shirui 黃世瑞, "Woguo lishishang canye nanyi de tantao" 我國歷史上蠶業南移的探討, *Agricultural Archaeology* 1985.2, 324-331; 1986.1, 360-365; 1987.2, 326-335.
- Huang Tianzhu 黃天柱 and Lin Zonghong 林宗鴻, "Quanzhouwan Songchuan chutu guohe de kaoshi" 泉州灣宋船出土果核的考釋, *Agricultural Archaeology* 1983.01, 198-202.
- Hucker, Charles O., *A Dictionary of Official Titles in Imperial China*. Stanford, CA: Stanford University, 1985 [reprint: Taipei: Nantian, 1996].
- Katō Shigeshi 加藤繁, *Tō Sō jidai ni okeru kingin no kenkyū* 唐宋時代に於ける金銀の研究. Tōkyō: Tōyō bunko, 1926 [reprint: 1965].
- Kuhn, Dieter, *Textile Technology: Spinning and Reeling*. Science and Civilisation in China (ed. by Joseph Needham), 5: Chemistry and Chemical Technology, 9. Cambridge: Cambridge University, 1988.
- Le Roy Ladurie, Emmanuel, *Les paysans de Languedoc*. Paris: Mouton, 1966.
- Li Bozhong 李伯重, *Tangdai Jiangnan nongye de fazhan* 唐代江南農業的發展. Beijing: [Nongye, 1990]; Beijing daxue, 2009.
- Li Jinxiu 李錦繡, *Tangdai caizheng shigao* 唐代財政史稿. Guoxue yanjiu congkan, 6. Beijing: Beijing daxue: 1995 [vol. 1]; 2001 [vol. 2].
- Li Qing 李卿, "Lun Songdai Huabei pingyuan de cansang sizhiye" 論宋代華北平原的蠶桑絲織業, *Xiamen daxue xuebao* 廈門大學學報 2001.1, 80-87.
- Li Zhixian 李志賢, *Yang Yan ji qi liangshui fa yanjiu* 楊炎及其兩稅法研究. Beijing: Zhongguo shehui kexue, 2002.
- Liang Gengyao 梁庚堯, *Nan Song de nongdi liyong zhengce* 南宋的農地利用政策. Wenshi congkan; 46. Taipei: Guoli Taiwan daxue, 1977.
- Liu Xinru 劉欣如, *Silk and Religion: An Exploration of Material Life and the Thought of People AD 600-1200*. Delhi: Oxford University, 1996.
- , "Silks and Religions in Eurasia, C. A.D. 600-1200", *Journal of World History* 6.1 (Spring 1995), 25-48.
- Liu Yuquan 劉毓琮, "Nongsang jiyao de zuozhe, banben he neirong" 農桑輯要的作者 版本和內容, in *Nongye yichan yanjiu jikan* 農業遺產研究集刊, Vol. 1 (Beijing: Zhonghua, 1958), 215-228.
- Lombard, Maurice, *Etudes d'économie médiévale, du VII^e au XII^e siècle: T. III, Les textiles dans le monde musulman*, Paris: La Haye, 1978.
- Lopez, Robert Sabatino, "China Silk in Europe in the Yuan period", *Journal of the American Oriental Society*, 72.2 (1952), 72-76.

- Lu Huayu 盧華語, *Tangdai cansang sichou yanjiu* 唐代蠶桑絲綢研究. Beijing: Shoudu shifan daxue, 1995.
- Lu Qi 魯奇, *Zhongguo gudai nongye jingji sixiang: Yuandai nongshu yanjiu* 中國古代農業經濟思想—元代農書研究. Beijing: Zhongguo jishu kexue, 1992.
- Ma Jianchun 馬建春, “Yuandai Xiyu fangzhi jiyi de yinjin” 元代西域紡織技藝的引進, *Xinjiang daxue xuebao* 新疆大學學報 33.2 (2005), 73ff.
- Mackie, Louise W., “Toward an Understanding of Mamluk Silks: National and International Considerations”, in *The Renaissance of Islam: The Art of the Mamluks* [Selected papers from a symposium sponsored by the Center for Advanced Study in the Visual Arts, National Gallery of Art; Freer Gallery of Art; Smithsonian Institution; and held at the National Gallery of Art, Washington, D.C., May 13–16, 1981] (New Haven: Yale University, 1984. = *Muqarnas: An Annual on Islamic Art and Architecture*, vol. 2), 127-146.
- Maillot, Eugène, and Lambert, François, *Traité sur le ver à soie du mûrier et sur le mûrier*, Montpellier: Coulet et fils, 1905.
- Mau Chuan-hui 毛傳慧, (2010a) “Song Yuan shiqi cansang jishu de fazhan yu shehui bianqian” 宋元時期蠶桑技術的發展與社會變遷, in Zhu Ping-yi 2010, 299-351.
- , (2010b) “Les progrès de la sériciculture sous les Yuan (XIIIe–XIVe siècles) d’après le *Nongsang jiyao* 農桑輯要”, *Revue de Synthèse* 131.2 (june 2010), 193-217.
- , “Isidore Hedde et la soie chinoise”, *La revue du Musée des arts et metiers* 41 (mai 2004), 32-42.
- , “La soie à Canton”, *La Revue du Musée des arts et metiers* 45 (février 2006), 4-15.
- , “Construction du savoir séricicole, Xe–XIVe siècles: étude des divers traités”, posted on the website of Réseau-Asie at http://www.reseau-asie.com/cgi-bin/prog/gateway.cgi?langue=fr&password=&email=&dir=myfile_colloque&type=jhg54gfd98gfd4fgd4gfdg&id=250&telecharge_now=1&file=xxv_mauchuanhui.pdf.
- Mazahéli, Aly, *La vie quotidienne des Musulmans au moyen âge, Xe au XIIIe siècle*, Paris: Hachette, 1951 [2nd ed.: *L’âge d’or de l’Islam*. Paris: Méditerranée, EDDIF, 2000].
- Miao Qiyu 繆啟愉, *Qimin yaoshu jiaoshi* 齊民要術校釋. Zhongguo nongshu congkan, zonghe zhi bu 中國農書叢刊綜合之部. Beijing: Nongye, 1982 [cited as *Qimin yaoshu*].
- , *Yuanke Nongsang jiyao jiaozhu* 元刻農桑輯要校注. Beijing: Nongye, 1988.

- , *Donglu Wangshi Nongshu yizhu* 東魯王氏農書譯註, Shanghai: Shanghai guji, 1994.
- Pariset, Ernest, *Les industries de la soie, sériciculture, filature, moulinage, tissage, teinture, histoire et statistique*. Lyon: Pitrat Aîné, 1890.
- Peng Zeyi 彭澤益, *Zhongguo jindai shougong ye shi ziliao, 1840–1949* 中國近代手工業史資料. Beijing: Xinhua, 1962, ²1984.
- Qi Xia 漆俠, *Songdai jingjishi* 宋代經濟史. Shanghai: Renmin, 1987 [vol. 1], 1988 [vol. 2].
- Qiu Guangming 邱光明, *Zhongguo lidai duliangheng kao* 中國歷代度量衡考. Beijing: Kexue, 1992.
- Quan Hansheng 全漢昇, *Zhongguo jingji shi yanjiu* 中國經濟史研究. Taipei: Daoxiang, 1991.
- , *Zhongguo jingji shi luncong* 中國經濟史論叢, Taipei: Daoxiang, 1996.
- Schottenhammer, Angela, “Local Political-Economic Particulars of the Quanzhou Region During the Tenth Century”, *Journal of Song Yuan studies* 29 (1999), 1-43.
- Shang Gang 尚剛, “Nashishi zai Zhongguo” 納石矢在中國, *Dongnan wenhua* 東南文化 2003.8, 54-64.
- Shi Shenghan 石聲漢, *Nongsang jiyao jiaozhu* 農桑輯要校注. Beijing: Nongye, 1982.
- Shiba Yoshinobu 斯波義信, *Sōdai shōgyōshi kenkyū* 宋代商業史研究. Tōkyō: Kazama, 1968.
- Shimai Kazuyasu 島居一康, *Sōdai zeisei shi kenkyū* 宋代稅政史研究. Tōkyō: Kyūko, 1993.
- Sudō Yoshiyuki 周藤吉之, *Sōdai keizaishi kenkyū* 宋代經濟史研究. Tōkyō: Tōkyō daigaku, 1962.
- Trombert, Eric, “Une trajectoire d’Ouest en Est sur la route de la soie: La diffusion du coton dans l’Asie centrale sinisée”, in *Convegno internazionale sul tema: La Persia e l’Asia centrale da Alessandro al X Secolo* (Roma: Accademia Nazionale dei Lincei, 1996), 205-227.
- Twitchett, Denis and Smith, Paul Jakov (eds.), *The Sung Dynasty and Its Precursors, 907–1279: Part One*. The Cambridge History of China; 5, 1. Cambridge: Cambridge University, 2009.
- Vignon, Léo, *La soie au point de vue scientifique et industriel*. Paris: Baillière, 1890.
- Wang Binghua 王炳華, *Sichou zhilu kaogu yanjiu* 絲綢之路考古研究, Wulumuqi: Xinjiang renmin, 1993.
- Wang Wencheng 王文成, *Songdai baiyin huobihua yanjiu* 宋代白銀貨幣化研究. Kunming: Yunnan daxue, 2001.

- Wang Yuhu 王毓瑚 (1907–1980), *Zhongguo nongxue shulu* 中國農學書錄. Beijing: Zhonghua, 1957, 2006 (rev. ed.); Nongye, 1964 [reprint: Taipei: Mingwen, 1981].
- Wang Zengyu 王曾瑜, *Zizhubian* 錙銖編. Baoding: Hebei daxue, 2006.
- Watson, Andrew M., “The Arab Agricultural Revolution and its Diffusion, 700–1100”, *Journal of Economic History*, 1974.34.1., 8-35.
- Wardwell, Anne E., and James C.Y. Watt (eds.), *When Silk Was Gold: Central Asian and Chinese Textiles* [Catalogue of the Exhibition Held at the Cleveland Museum of Art, October 26, 1997 – January 4, 1998, and at the Metropolitan Museum of Art New York, March 3 – May 17, 1998]. New York: The Metropolitan Museum of Art, 1997.
- Wu Chengluo 吳承洛, *Zhongguo du liang heng shi* 中國度量衡史, Shanghai: Shangwu, 1937.
- Wu Hongqi 吳宏岐, *Yuandai nongye dili* 元代農業地理, Xi'an: Xi'an ditu, 1997.
- Wu Songdi 吳松地, *Beifang yimin yu Nan Song shehui bianqian* 北方移民與南宋社會變遷. Taipei: Wenjin, 1993.
- Xiao Qiqing 蕭啟慶, *Xiyuren yu Yuan chu zhengzhi* 西域人與元初政治 [Hsi-yü Jen or the “Westerners” and the Politics of the Early Yuan Dynasty]. Guoli Taiwan daxue wenshi congkan 國立臺灣大學文史叢刊, 19. Taipei: Taiwan daxue, 1966.
- Yabuuchi Kiyoshi 藪內清 (ed.), *Sō-Gen jidai no kagaku gijutsushi* 宋元時代の科學技術史, Kyōtō Daigaku Jimbun Kagaku kenkyūsho, 1967.
- Yang Ne 楊訥, “Yuandai nongcun sheshi yanjiu” 元代農村社制研究, *Lishi yanjiu* 歷史研究 12.4 (1965), 234-241 [re-published in *Yuanshi lunji* 元史論集, ed. by Nanjing daxue lishixi Yuanshi yanjiushi 南京大學歷史系元史研究室 (Beijing: Renmin, 1984), 227-254].
- Zanier, Claudio, *Where the Roads Met*. Kyoto: Italian School of East Asian Studies, 1994.
- Zhang Jiaju 張家駒 (1914–1974), *Liang Song jingji zhongxin de nanyi* 兩宋經濟重心的南移. Wuhan: Hubei renmin, 1957 [reprint: Taipei: Boshu, 1985].
- Zhang Xiumin 張秀民 (1908–2006), *Zhongguo yinshua shi* 中國印刷史 [revised and enlarged edition, by Han Qi 韓琦]. Hangzhou: Zhejiang guji, 2006 [first published by Shanghai: Shanghai renmin, 1989].
- Zhao Feng 趙豐, *Zhongguo sichou tong shi* 中國絲綢通史. Jiangsu: Suzhou daxue, 2005.
- , *Tangdai sichou yu sichou zhi lu* 唐代絲綢與絲綢之路. Xi'an: Sanqin, 1992.

- , “Yuandai cansang quyu chutan” 元代蠶桑區域初探, *Bulletin of CIETA* 1999, 46-65.
- , “Liao Satin Samite: A Bridge from Samite to Satin”, *Bulletin of CIETA* 1999, 46-65.
- Zhu Ping-yi 祝平一 (ed.), *Zhongguo shi xinlun: Keji yu Zhongguo shehui fence* 中國史新論—科技與中國社會分冊. Taipei: Zhongyang yanjiuyuan, 2010.
- Zhu Xinyu 朱新予, *Zhejiang sichou shi* 浙江絲綢史, Zhejiang renmin, 1985.