

REDISCOVERING COTTON BREEDING IN THE BEIYANG ERA:
THE CRUCIALITY OF HUMAN CAPITAL

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ABSTRACT

This paper aims to revisit cotton breeding projects undertaken by governments, industrialists, and universities between 1914 and 1926. Specifically, it seeks to explain how and why Jinling University and National Southeastern University achieved remarkable success in the early 1920s. Whereas the economic aspect of Republican China's cotton textile manufacturing has been thoroughly discussed in existing research, little, if any, has been said on cotton breeding—the fundamental solution for agricultural inefficiency paralyzing large-scale cotton textile manufacturing. This paper seeks to fill this vacuum. It finds that, in the Beiyang era, the outcomes of cotton breeding projects depended heavily on human capital. To be more specific, U.S educated cotton experts who acquired advanced agricultural know-how were at the heart of universities' success; governments' efforts did not translate into satisfactory direct results, because government-owned experimental farms were not managed by personnel equipped with know-how pertaining to the cultivation of American cotton species; the outcomes obtained at cotton industrialists' experimental farms were inadequate successes, because the amount of quality human capital available to them was inadequate.

BIOGRAPHICAL SKETCH

Mengxi Sun is a graduate student of Asian Studies at Cornell University. Before coming to Cornell, she worked as an editor at the Chinese Academy of Social Sciences. At CASS, she assisted senior editors in reviewing and proofreading papers submitted to *Historical Research* and *Social Sciences in China*—CASS's flagship publications. She was also invited to present her paper on the life and thoughts of William A.P. James—an influential missionary in late Qing China—at a junior scholars forum organized by Social Sciences in China Press in November 2015.

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Introduction

The development of industrial capitalism has paralleled the formation of modern world; the wax and wane of cotton textile manufacturing has paralleled the development of industrial capitalism. For late-developing countries, such as China, machine-driven cotton textile production was usually the departure point for industrial, commercial, and financial modernization in the early 20th century. Constant consumer demands promised lasting returns. Compared to heavy industries, such as the steel industry, cotton textile manufacturing required lower capital intensity and technological capacity. It could emerge and thrive without systematic planning and support from a strong state. In a time of unceasing foreign intrusions, military and diplomatic setbacks, and political deterioration and chaos, for China, there were few remaining hopes for catch-up economic modernization. Cotton textile manufacturing was one of them. Perhaps it was the best one. Both the Beiyang bureaucracy and business communities in the Lower Yangtze River Basin were aware of this.

This paper aims to revisit cotton breeding projects undertaken by governments, industrialists, and universities between 1914 and 1926. Specifically, it seeks to explain how and why Jinling University and National Southeastern University achieved remarkable success in the early 1920s. Whereas the economic aspect of Republican China's cotton textile manufacturing has been thoroughly discussed in existing research,

little, if any, has been said on cotton breeding—the fundamental solution for agricultural inefficiency paralyzing large-scale cotton textile manufacturing. This paper seeks to fill this vacuum. It finds that, in the Beiyang era, the outcomes of cotton breeding projects depended heavily on human capital. To be more specific, U.S educated cotton experts who acquired advanced agricultural know-how were at the heart of universities' success; governments' efforts did not translate into satisfactory direct results, because government-owned experimental farms were not managed by personnel equipped with know-how pertaining to the cultivation of American cotton species; the outcomes obtained at cotton industrialists' experimental farms were inadequate successes, because the amount of quality human capital available to them was inadequate.

Literature Review

Although Sven Beckert does not pioneer the research on the history of cotton industry, his *Empire of Cotton: A Global History* is probably the most influential book on the subject matter. According to his research, colonial expansion, slave trade, and resource extraction—the concomitant sins of capitalism were all associated with cotton trade; technological progress, the advancement and popularization of useful knowledge, financial innovation, and workforce management—the ingenious inventions of capitalism were all attributable to cotton industry. Globally, cotton textile manufacturing was the engine for the growth of modern economy from the early 18th century to the end of 20th century; for more than two centuries, it was the most potent

and durable force for economic globalization. Chinese cotton industry is not the focus of *Empire of Cotton*. Nevertheless, Beckert's book inspired the author to rediscover technical and scientific advancements beneath Republican China's cotton industry boom in the 1920s.

The development of Chinese cotton industry has been detailed in many Chinese and English academic publications, such as Yan Zhongping's *Outline of the History of Chinese Cotton Textile Industry* and Kang Chao's *The Development of Cotton Textile Production in China*. This category of research is interested in tracing the development of China's cotton textile production in a chronological order. Yan's book focuses on the capital stock, production capacity, market sales, technological borrowing, organizational evolution, spatial distribution, and foreign rivalry of cotton textile manufacturing in late Qing and Republican China. The scope of Chao's book is wider, in that it starts with the introduction of cotton into China in 200 BC and offers a detailed explanation on how political and military factors stimulated the growth of cotton textile production during Yuan and Ming dynasties. As for the development of modern cotton textile manufacturing after the First Opium War, Yan's book tends to interpret it through the lens of "impact-response" model. Elaborate as it is, this category of research often overlooks the agricultural foundation of cotton industry.

The earliest machine-powered modern cotton mills emerged in the late 1880s and were usually categorized as "mandarin enterprises"—industrial complexes founded with state tax and controlled by reform-minded, high-level officials. Scholarly publications on mandarin enterprise are abundant. Perhaps the most influential one is Albert

Feuerwerker's *China's Early Industrialization: Sheng Hsuan-huai and Mandarin Enterprise*. According to Feuerwerker's research, the organizational structure, managerial mechanism, and underlying ideology of bureaucrat-led industrial complexes, such as the Shanghai Mechanical Textile Bureau—the first machine-powered cotton mill in China, were modelled upon these of the monopolistic salt administration which, by and large, was an instrument for tax farming and other forms of state exactions upon merchants; the education and career experience of bureaucratic founders and managers of mandarin enterprises did not “qualify them to take direct charge of the management of the business that they were helping to set up.”¹ (182) In Feuerwerker's view, the failures of most mandarin enterprises were inevitable. This view is challenged in Peng Juanjuan's doctoral dissertation titled “Yudahua: The Growth of An Industrial Enterprise in Modern China 1890-1957.” According to Peng's research, many governmental enterprises, such as the Hubei Mechanical Textile Bureau founded by Zhang Zhidong (1837-1909), were “either rented to or purchased by Chinese merchants,” and thus “nurtured the first generation of China's industrial capitalists during the warlord period, men who later built the foundation for China's economic development during the twentieth century.”² Therefore, in Peng's view, even though they did not achieve notable success, their contribution and influence

1 Albert Feuerwerker, *China's Early Industrialization: Sheng Hsuan-huai (1844-1916) and Mandarin Enterprise* (Cambridge, MA.: Harvard University Press, 1958), 182.

2 Peng Juanjuan, “Yudahua: The Growth of An Industrial Enterprise in Modern China 1890-1957” (doctoral dissertation, 2007), 7.

should not be underestimated. Synthesizing Feuerwerker and Peng's view, we may conclude that mandarin enterprises were late Qing China's imperfect yet meaningful experiments. It is unrealistic to expect bureaucratic founders and managers to figure out the solutions to all the challenges facing the newborn cotton textile manufacturing sector. Understandably, the problems concerning the agricultural foundation of cotton industry remained unaddressed until the Beiyang era.

Zhang Jian (1853-1926) and his Dasheng No. 1 Cotton Mill marked the partial transition from bureaucrat-led industrialization to private industrial capitalism in the Lower Yangtze River Basin. In *From Cotton Mill to Business Empire: The Emergence of Regional Enterprises in Modern China*, Elisabeth Köll explains its reliance on Western technology and equipment, practice of workforce training, assessment, and regulation, and corporate governance structure characteristic of privately owned and managed enterprises. The mill developed into a conglomerate encompassing a wide range of subsidiaries and affiliated companies. Köll scrutinizes the account and balance sheets of the conglomerate, which shows that the Dasheng No.1 Cotton Mill and its various branches had realized stable profit in the early two decades of the 20th century. Furthermore, Köll shows that Zhang Jian's overwhelming power over other shareholders and his unchecked, exclusive liberty over the conglomerate's account sowed the seed of its sliding to the red which descended into a fiasco in 1922. Nevertheless, in my opinion, the success of Dasheng No. 1 Cotton Mill, though short-

lived, was still an inspiring chapter in the history of Chinese capitalism. Despite of his arbitrary managerial practice, Zhang Jian still played a pivotal role in the modernization of Chinese cotton industry. In fact, it is Zhang Jian who started the promotion of cotton cultivation and cotton breeding while serving as the Minister of Agriculture of the Beiyang regime from October, 1913 to March, 1915.

The rise of Zhang Jian and his business kingdom announced the end of bureaucratic monopoly over industrialization. Following his lead, cotton mill owners in the Lower Yangtze River Basin transformed cotton industry into one of the most vibrant sectors in Republican China's economy. In *Shanghai: China's Gateway to Modernity*, Bergère summarizes the characteristics of these cotton mill owners: versatile leadership, awareness of technical factors on the performance of their business, intense focus on economic objectives, and shrewd involvement in politics. These characteristics gave them the "air of modern entrepreneurs."³ Bergère is particularly interested in how indigenous traditions, such as emphasis on family solidarity and regional links, incubated and buttressed the business ventures of cotton mill owners in Shanghai. She shows that kinship and regional networks were the most reliable source of financial and

³ Marie-Claire Bergère, *Shanghai: China's Gateway to Modernity* (Stanford, Calif.: Stanford University Press, 2009), 177-178.

human capital, without which private business and civilian business associations would not have emerged.

The most meticulous study on China Cotton Mill Owners Association is done by Richard Bush. His research analyzes the interests, socioeconomic composition, and factional politics of the association. In *The Politics of Cotton Textiles in Kuomintang China (1927-1937)*, he exhausts the family background and industry experience of almost all founding members of the association. He draws distinction between heirs of mandarin clans and sons of small business owners, and the distinction often overlapped with Shanghai origin versus Jiangsu or Zhejiang origin. His classifications enables a deep understanding on social mobility in a turbulent age. However, his research, as well as Bergère's, does not give concrete examples on the association's engagement with science, technology, and higher education.

China's cotton industry has been thoroughly studied from many perspectives. There are comprehensive, chronological studies. There are case studies focusing on mandarin enterprises, private business, and cotton industrialists. However, little, if any, has been said on cotton breeding. This paper will fill this vacuum by unearthing crucial facts and data published on contemporary newspapers, magazines, and government bulletins between 1914 and 1926. In particular, it will draw on news, reports, and board resolutions published on the *Quarterly of China Cotton Mill Owners' Association*

which chronicled worldwide cotton market trend and industry dynamics, knowledge import from the West, progress of agricultural research and industry-university partnership, the update of factory and labor management system, and government involvement from 1919 to 1934.

The Golden Opportunity

It is necessary to explain the international and domestic contexts of Republican China's cotton industry boom before moving into the subject matter. Republican China's cotton industry boom arose from a unique historical background where an array of favorable factors converged. Since the late 19th century, unrelenting price competition and rising production costs in Britain, continental Europe, and North America continued to encroach the profitability of cotton textile manufacturing. Among all sorts of production costs, labor wage might be Western cotton industrialists' worst headache. As of 1910, Chinese wages were just 10.8 percent of those in Great Britain and 6.1 percent of those in the United States. Moreover, Chinese workers, willingly or unwillingly, labored nearly twice as many hours as their New England counterparts—5302 hours versus 3000 hours—every year.⁴ At the rudimentary level, since 1904, the devaluation of silver relative to British pound had gradually eaten up the competitive edge of foreign cotton products, among which Indian cotton yarns along once occupied

⁴ Sven Beckert, *Empire of Cotton: A Global History* (New York City: Vintage Books, 2015), 390.

two thirds of the total amount of cotton yarns consumed in China's countryside—the locality of traditional, household-based cotton textile production.⁵

The First World War devastated cotton textile production in Britain and disrupted maritime transportation throughout the Atlantic world. British export of cotton yarn and cotton cloth to China thus plummeted.⁶ Indian cotton industry did have the potential to fill this vacuum. But that potential was drained by heavy taxation levied by the British government whose priority was safeguarding the competitive edge and interest of domestic cotton industrialists in Manchester, Liverpool, and Lancashire.⁷ Japan, as a rising industrial power, would not pass up this opportunity. But expanding production and business in China was not an easy task that could be accomplished overnight. Due to undersupply, the prices of manufactured cotton goods had persisted on an upward trajectory in the Shanghai Cotton Exchange market from 1915 to 1920.⁸ Thanks to this persistent trend, low wages, the devaluation of silver, and decreasing competition, import substitution gained enough momentum. Domestic production of crude cotton yarn soared particularly fast, because of low fixed cost on machinery and a huge market in both coastal and inland provinces.

⁵ Mori Tokihiko, *A Study of Modern Chinese Cotton Textile Industry* (《中国近代棉纺织史研究》) (Beijing: Social Sciences Academic Press), 2.

⁶ Yan Zhongping, *Outline of the History of Chinese Cotton Textile Industry* (《中国棉纺织史稿》) (Beijing: The Commercial Press, 2011), 203 -204.

⁷ *Ibid*, 125-126.

⁸ Mori Tokihiko, *A Study of Modern Chinese Cotton Textile Industry* (《中国近代棉纺织史研究》), 4.

The creation of new cotton mills, once hampered at the beginning of the war by the lack of equipment, speeded up after 1914. Between 1914 and 1918, eight factories had been set up; 1919 saw the establishment of four, followed by nine more in 1920. In 1922, the number of new cotton mills rose to 49. The expansion of already existing firms was no less remarkable. In Nantong, Zhang Jian, the doyen of Chinese industrialists, ordered 4000 English spindles and 3000 looms in preparation for setting up the seventh subsidiary branch of his Dasheng Cotton Mills and a large weaving factory. In Ningbo, the Hefeng Cotton Mills, with a total capital of 900,000 silver dollar, was ready to reinvest in acquiring new equipment with the 700,000-silver-dollar surplus they accumulated. Overall, the quantity of spindles possessed by Chinese cotton mills surged from 866 thousand to 3.01 million from 1914 to 1922, registering a 317 percent growth rate.⁹ And, the quantity of crude cotton yarns produced by Chinese cotton mills rose from 2.2 million piculs to more than 5.5 million piculs.¹⁰

The political climate was also favorable to homegrown cotton mills and other enterprises. The Beiyang regime sent thousands of workers to labor on French battlefields in WWI. Yet, imperial powers did not return favor with favor . At Versailles, Britain, France, and the U.S. consented to reward Japan with Germany's colonial

⁹ Zhao Gang and Chen Zhongyi, *History of Chinese Cotton Textile Industry* (《中国棉纺织史》) (《中国棉纺织史》) (Beijing:Chinese Agriculture Press, 1997), 153.

¹⁰ Mori Tokihiko, *A Study of Modern Chinese Cotton Textile Industry* (《中国近代棉纺织史研究》),14.

concessions in Shandong. Chinese public was enraged. Anti-Western, anti-Japanese sentiment erupted. Political nationalism soon gave rise to consumer patriotism that fueled boycotts to Western and Japanese products. For domestic industries, this was a godsend for furthering the painstaking project of economic construction.¹¹ In tandem with anti-foreign boycotts were well-organized popular campaigns in favor of national products, known as “patriotic products.” Cotton textile manufacturing, as the single most important industry in Republican China, benefited handsomely from the all-encompassing patriotic fervor. “Patriotic yarn” and “patriotic fabric” evoked passionate responses from the public. This fervor had lasted for quite a while. The boycotts of 1919-1921, directed against Japanese products in particular, were followed by that of 1923, which persisted into 1924, and then, in 1925-1926, became generalized. Boycotting was more than a measure of retaliation against Japan and other invasive foreign powers. It was a deliberate “strategy in the service of economic development seen as a long-term method of reconquering the market.”¹²

The Necessity of Modernizing Cotton Breeding

Undoubtedly, the international situation during the First World War expedited import substitution in the consumer goods sector, and this momentum was fundamental to the

¹¹ Marie-Claire Bergère, *Shanghai: China's Gateway to Modernity*, 163.

¹² *Ibid.*

growth of mechanized cotton yarn production. Yet, such an enviable windfall was not a full-fledged blessing. It drained Republican China's agricultural sector which remained hamstrung by antiquated practices, and thus simply could not bolster industrial growth with abundant supplies of raw cotton. The prospect of large-scale, mechanized cotton production in coastal cities was in fact hampered by a structural deficiency—"the inability of Chinese agriculture to progress at the same rate as the modern industrial sector"¹³

Yet, China and the U.S were almost equally well-endowed for cotton farming. Both the Yangtze River Basin and the Yellow River Basin were suitable for the cultivation of first-rate raw cotton. The combined area of high-potential cotton farming zones in China is perfectly comparable to the legendary Cotton Belt spanning more than a dozen states in the American South. Chinese landowners were supposed to be more strongly incentivized to expand the output of their land, since the average agricultural wage rate in China was no greater than a single-digit percentage of the American standard. But the output disparity could not be more staggering. It was estimated that China's annual cotton yield was only 7.6 percent of the U.S. one. As observed by Mu Ouchu (1876-1943)—a prominent Shanghai-based cotton industrialist, the inherent defects of

¹³ Ibid, 153.

Chinese cotton species were at the root of such disparity, which foredoomed the inferior quality and yield of raw cotton.¹⁴

Top-notch cotton is defined by seven features: uniform length; high resilience; rich in fiber; rich in fiber twists; bright in color; pure in content; characterized by hollow structure. Chinese raw cotton was not shy of length uniformity, resilience, and brightness, but fell short of fiber quality and purity. The truly fatal deficiency is inadequate fiber length. Cotton of such kind could only be used for manual production of low-quality crude cotton yarns. It cannot be used for machine production of refined, high-value cotton yarns.¹⁵ If such problem remained unresolved, Republican China's cotton industry would never experience a productivity surge, no to mention competing with foreign cotton textile manufacturers—Japanese ones in particular.

Government's Involvement

The Beiyang regime in Peking set on improving the quality and yield of raw cotton at the moment when Zhang Jian became the Minister of Agriculture and Commerce in

¹⁴ Mu Ouchu, "The Formation of the China Cotton Cultivation Improvement Association" ("中华棉植改良社缘起"), *Eastern Miscellany* vol.14 no.11 (《东方杂志》) (1917.11), 192.

¹⁵ Yan Zhongping, *Outline of the History of Chinese Cotton Textile Industry* (《中国棉纺织史稿》), 317.

October, 1913. Feeble as it was, the Beiyang regime did not shy away from necessary investments in promoting cotton cultivation, simply because a prosperous cotton industry could serve as its cash cow. From 1914 to 1926, different administrations made multiple attempts at cotton breeding.

Under Zhang's leadership, the Ministry of Agriculture and Commerce took many concrete steps to solve the problem through introducing top-grade foreign cotton species. Famous for their outstanding quality, extensive distribution, and long history of cultivation, American cotton species were deemed the salvation for Chinese cotton industry. To be more specific about "outstanding quality," American cotton strains—Acala, Lone Star, and Trice in particular—were known for superior fiber strength, fiber length, and raw yield. The fiber length of a cotton species determined whether it could be used for machine-powered textile production. According to an experiment report published on the *Quarterly of China Cotton Mill Owners Association*, the average fiber length of the best class of uncontaminated Acala and Lone Star exceeded one inch, whereas the average fiber length of the best class of Changyin Sha Mian and Jijiao Mian—two most promising Chinese cotton species—was 0.875 inch. In fact, the average fiber length of most Chinese cotton species was no larger than 0.75 inch.¹⁶ The Beiyang regime's high expectation for American cotton species was not unreasonable.

¹⁶ Guo Tanxian, "Problems Facing China's Cotton Production" ("吾国之棉产问题"), *Science* vol.6 no.5 (《科学》)(1921), 510.

The ministry purchased cotton seeds from the U.S., produced instruction manuals detailing the must-dos and taboos for cotton cultivation, and distributed seeds and manuals to cotton industrialists in the Lower Yangtze River Basin and farmers across the country.¹⁷ Logically, American cotton experts were expected to play the savior role. In March, 1915, the ministry hired H. Jopson (dates of birth and death unknown), a senior advisor at the United States Department of Agriculture, to advise cotton domestication projects initiated by the ministry. From 1915 to 1918, five government-owned experimental farms were set up in Hebei, Jiangsu, Hubei, Henan, and Peking, aiming at culling the best American cotton species from all that had been introduced and obtaining their seeds for reproduction. Government efforts intensified from 1919. Xu Shichang (1855-1939), the then president of the Beiyang regime, issued an executive order reiterating the centrality of the cotton industry in the national economy, the imperative of mitigating China's mounting trade deficit rooted in the comparative inefficiency of indigenous cotton sector, and the regime's resolution in promoting cotton cultivation and strengthening cotton textile manufacturing. The executive order also announced the founding of the Bureau of Cotton Industry. Zhou Xuexi (1866-1947), a prominent official and industrialist, was vested with direct authority over the

¹⁷ Gu Zhongxiu, "The 26th Order from the Ministry of Agriculture of the Republic of China" ("部令：農商部訓令第二十六號") *Government Bulletin vol.245* (《政府公報》) (1916) , 7.

bureau's operation. Gong Xinszhan (1871-1943), the then minister of finance, and three military potentates were appointed as inspectors of cotton affairs.¹⁸

The Bureau of Cotton Industry ordered nearby agricultural associations to observe the cultivation of American cotton species at the experimental farms built and owned by the Ministry of Agriculture. These associations were expected to instruct peasants with the knowledge and techniques imparted to them. Moreover, the ministry and the bureau also motivated provincial governments to promote the cultivation of American cotton species. Although provincial governments were controlled by local warlords, they answered the Peking-based Beiyang regime's call for transforming the cotton industry. After all, a prosperous cotton industry could increase local fiscal revenue too. Judging from government orders and news published in contemporary newspapers, at least five provinces, namely Jiangsu, Shandong, Shanxi, Zhejiang, and Yunnan, set on promoting the cultivation of American cotton species.¹⁹

¹⁸ "Presidential Order"("大总统令"), *Bulletin of Government of Jiangsu vol.1826* (《江苏省公报》)(1919), 2.

¹⁹ See "A Blueprint for Improving and Promoting Cotton Cultivation in Jiangsu Province" ("改良推广江苏棉作之计划"), *Agricultural Science vol. 2 no.1* (《农学》)(1924), 16-18; "Government Affairs: Please Turn in Results of American Cotton Cultivation Projects" ("政事: 催填种植美棉成绩表"), *China Industry Herald vol.3* (《中华实业丛报》)(1921), 27-28; "Political and Education News: Provincial Politics and Education" ("政教述闻:本省政教"), *Lai Fu vol. 233* (《来复》)(1920), 2-3; Yang Xiguang, "The Past, Now, and Future of the Domestication of American Cotton Species in Shandong" ("山东种植美棉之经过与将来"), *Journal of China Agricultural Association vol.3 no.10* (《中华农学会报》)(1922), 59-62; "The 248th Order from the Bureau of Industry and Commerce of Yunan" ("云南实业厅指令: 第二百四十八号"), *Bulletin of Industry and Commerce of Yunnan vol.2* (《云南实业公报》)(1927), 28-29.

The measures adopted by different provincial governments were more or less the same.

To give a concrete example, the government of Jiangsu broke the promotion project down into five steps:²⁰

1. Based on climatic and soil conditions, partition the province into different experiment zones.
2. Set up one cotton cultivation experimental farm in each experimental zone; provide ten thousand silver dollar to each experimental farm.
3. Gradually expand the scale of experimental farm.
4. Set up one seed breeding farm in every county which has a long tradition of cotton cultivation; provide two thousand silver dollar to each seed breeding farm.
5. Appoint one expert to each farm.

At the county level, county magistrates assigned concrete tasks to village heads. Instruction manuals were distributed to them, and they were made responsible for persuading peasants to switch to growing American cotton species, distributing American cotton seeds to peasants, and instructing peasants during the course of cultivation.²¹ The promotion project was implemented in line with contemporary top-down bureaucratic logics of hierarchical responsibility.

²⁰ “A Blueprint for Improving and Promoting Cotton Cultivation in Jiangsu Province”, 16-18.

²¹ *Ibid.*, 18.

The Beiyang regime's continuous efforts and investments did give rise to higher yields in certain regions. For example, Zhili produced two million piculs of raw cotton in 1918; in 1921, its raw cotton yield almost tripled. However, this did not mean that governments' efforts brought in successful domestication of American cotton species; nor did it mean that the agricultural bottleneck impeding China's cotton industry was resolved. Instead, it is highly likely that the threefold growth in Zhili arose from the sheer expansion of cotton acreage. In provinces where cotton cultivation had been practiced for long and cotton acreage remained stable, the introduction of American cotton species did not give rise to dramatic growth in raw yield. For example, in an administrative order, the government of Jiangsu admitted that the quality and yield of newly introduced American cotton species were not particularly impressive; the reason lay in "peasants' poor grasp of seed breeding and sprout transplantation."²²

A more precise diagnose was offered by John. B. Griffin (dates of birth and death unknown), head of the Department of Agriculture at Jinling University, and O. F. Cook (dates of birth and death unknown), senior advisor at the U.S. Department of Agriculture. They together visited 20 government-owned experimental farms where the domestication of American cotton species had been carried on. They found that many experimental farms were set up in places characterized by low temperature and high

²² "Approved: The 2574th Order from the Office of the Governor of Jiangsu" ("批: 江苏省长公署批第二五七四号令") *Bulletin of Government of Jiangsu* vol.3384 (《江苏省公报》) (1923), 9-10.

humidity. Compared with Chinese species, American cotton species were more susceptible to epidemic plant diseases and infestations in cold and humid environments, which were not atypical in both the Yangtze River and the Yellow River basins. More importantly, they discovered that, at most experimental farms, unclassified cotton seeds were distributed to peasants in a casual manner; different cotton species were unwittingly planted at the same field in a hybridized mode; it seemed that no one was aware of the necessity of preventing cross-pollination—the foremost cause of the deterioration of American cotton species. Consequently, Griffin and Cook found nothing but a variety of retrograde sub-strains of “Trice” and “Lone Star” at experimental farms and other cotton plantations they visited.

There were at least three reasons underlying the mass deterioration of American cotton species at government-owned farms. First and foremost, there were few in Republican China with the requisite expertise in domesticating American cotton species. It was difficult for the Beiyang regime and provincial governments to adequately staff their experimental farms. A more detailed explanation will be offered later. Also, most agricultural associations suffered from fund shortages. Although instruction manuals were distributed to them, they were unable to incentivize peasants to learn and practice the knowledge and techniques taught in the instruction manuals. Consequently,

expertise deficits remained unresolved.²³ Moreover, the strength of existing hierarchical managerial mechanisms was rather dubious, as was revealed by an administrative order complaining that experiment results were not being reported in a timely manner. The Bureau of Industry and Commerce of Zhejiang once urged counties to report results obtained at their experimental farms. According to the bureau's order, a total of twelve counties failed to file report on time.²⁴ The results of governments' efforts showed that, to achieve success in cotton breeding, the gaps in scientific, technical, and managerial expertise must be resolved first.

Cotton Industrialists' Endeavors: Trials and Fruits

Among all government agencies, it is the Office of Jiangsu Governor that first acknowledged the inadequacy of governments' efforts, and praised the achievements of privately owned experimental farms. In an administrative order of 1918, Qi Yaolin (1863-?), the governor of Jiangsu lauded Mu Ouchu, a prominent cotton industrialist and influential member of the China Cotton Mill Owners Association. Mu Ouchu travelled to the U.S. in person to study American cotton species and their cultivation.

²³ Qi Yaolin, "The 930th Order from the Government of Jiangsu" ("训令：江苏省长公署训令第九百三十号"), *Bulletin of The Government of Jiangsu vol.1521* (《江苏省公报》) (1918), 2-3.

²⁴ "Government Affairs: Please Turn in Results of American Cotton Cultivation Projects" ("政事：催填种植美棉成绩表"), *China Industry Herald vol.3* (《中华实业丛报》) (1921), 27-28.

In 1916, he set up an experimental farm in the outskirts of Shanghai to domesticate American cotton species. According to the administrative order, in 1918, the most productive field in Mu's farm achieved 100 kg per acre yield; the average per acre yield was 80 kg. Under standard conditions, the per acre yield of the best class of Chinese cotton species was no higher than 50 kg. Many cotton industrialists and agricultural associations were attracted to Mu's farm to learn federalization, soil aeration and improvement procedures, and de-watering techniques.²⁵

In 1917, Mu published a brochure titled *An Elementary Introduction to the Improvement of Cotton Cultivation*. The brochure detailed the standard process of cotton breeding and cultivation as were adopted at Mu's experimental farm. The framework and procedures of Mu's project were not dramatically different from measures that were supposed to be implemented at governments' experimental farms.²⁶ What made the difference was the quality of implementation, not paper work. At the heart of quality implementation was expertise. At Mu's farm, the process of domestication and selective breeding was instructed and overseen by Huang Shoumin (1890-1976)—a U.S educated agricultural expert.²⁷

²⁵ Qi Yaolin, "The 930th Order from of the Government of Jiangsu", 2-3.

²⁶ Mu Ouchu, *An Elementary Introduction to the Improvement of Cotton Cultivation* (《植棉改良浅说》) (Shanghai: Zhonghua Book Company, 1917), 2-15.

²⁷ In the Republican era, obtaining degrees from Universities in the West was a laudable achievement. Therefore, on many publications, if an author possessed a degree from Western universities, his name and education qualification were usually juxtaposed under the title of his article.

In 1912, under Sun Yat-sen's (1866-1925) recommendation and Nie Yuntai's (1880-1953) sponsorship, Huang was admitted into the Department of Agriculture at the University of Alabama. He focused on cotton cultivation while studying there. Later on, he enrolled in Columbia University to study business management. After obtaining masters degrees from the two universities, Huang returned to Shanghai and devoted himself to the modernization of the cotton industry in 1917.²⁸ In Shanghai, He supervised the cotton breeding project conducted at Mu's farm.²⁹ Meanwhile, he also worked served as manager at Nie's Heng Feng Cotton Mill.³⁰

Under Mu's instruction, Huang tripped to Nantong and Wusong to counsel local experimental farms and to distribute selected seeds and instruction manuals to local peasants.³¹ Mu Ouchu and Nie Yuntai did not perceive quality human capital and expertise as personal possession. Instead, they were more than willing to share such precious resources. The urgency of improving the quality, acreage, and yield of homegrown raw cotton did not allow them withholding such resources. This urgency stemmed from Japan's double-barrelled economic aggression. On one hand, Japanese companies purchased China-grown raw cotton in large quantity to make raw material acquisition more difficult for Chinese cotton textile manufacturers. On the other hand,

²⁸ "Huang Shoumin", China National Knowledge Infrastructure (CNKI), Accessed June 25.
<http://xuewen.cnki.net/read-r2013091280002598.html>.

²⁹ "Results of American Cotton Domestication Projects" ("美棉移植事业之成效"), *Anhui Industry Magazine* vol.6 (《安徽实业杂志》)(1917), 12-13.

³⁰ "Huang Shoumin."

³¹ Ibid.

Japanese companies expanded export to Chinese market and rushed to set up factories in mainland China. Mu warned that, if governments and cotton industrialists could not act promptly, Japan would control the bulk of China's cotton textile market in a decade.³² Nie Yuntai echoed Mu's warning in multiple occasions. He urged that, "Chinese cotton industrialists must refocus on refined cotton yarns, for its vast market potential and stable profitability."³³ He knew, before anything else, that the prerequisite for such a critical shift is improving the quality and yield of Chinese raw cotton.

In October 1917, under Mu Ouchu and Nie Yuntai's leadership, Chinese cotton industrialists in the Lower Yangtze River Basin gathered together and founded the China Cotton Cultivation Improvement Association and purchased large chunks of land in the outskirts of Shanghai to set up experimental farms. Later on, it became an important subsidiary of the China Cotton Mill Owners Association. In 1919 and 1920, the association extended the geographical scope of its cotton breeding project to other provinces. A total of 17 experimental farms were set up in Jiangsu, Zhejiang, Anhui, Hunan, Hubei, Hebei, and Henan.³⁴

³² Mu Ouchu, "Experiment Report on the Productivity of Transplanted American Cotton Species" ("试验移植美棉纺纱能力之报告"), *China Industry Newspaper vol.2* (《中国实业新报》)(1919), 19.

³³ Nie Yuntai, "A Blueprint for the Cotton Industry" ("棉业计划书"), 18.

³⁴ "An Overview of China Cotton Mill Owners Association's Experimental Farms" ("本会棉植树场概况"), *Quarterly of China Cotton Mill Owners Association vol. 2 no.1* (《华商纱厂联合会季刊》)(1920), 231-247.

Indeed, American cotton species outcompeted indigenous ones in many respects. But, due to limited availability, domesticated American cotton could not produce enough cotton seeds to meet market demand. Especially, before 1917, only Mu's farm recorded convincing success in domesticating American cotton species. Therefore, the China Cotton Cultivation Improvement Association decided to adopt a two-pronged approach, i.e., domesticating American cotton species and enhancing Chinese ones simultaneously.

Similar to how the domestication project was implemented at Mu's experimental farm, the association's cotton breeding project was implemented in an orderly, methodical, and scientifically controlled manner; experimental outcomes were systematically recorded and regularly published on the *Quarterly of China Cotton Mill Owners Association*. The entire project consisted of nine steps: partitioning experimental fields; classifying soils; applying fertilizer; sowing seeds (dibble seeding, drill seeding, and broadcast seeding); preventing plant disease epidemics; monitoring germination rate; calculating output; applying insecticidal measures; and recording experiment outcomes.

The experimental outcomes obtained in 1919 were not praiseworthy but revealing. Judging from records of breeding experiments undertaken by different farms, newly introduced American species were not necessarily more productive than high-caliber

Chinese species in the harvest. To give a concrete example, at an experimental farm in Wuxi, “Jiaying Mozi”—a Chinese species—yielded 35.1 kg of raw cotton per acre; the per-acre yields of “Acala,” “Lone Star,” and “King”—three American species—were 36.35 kg, 35.5 kg, and 30.1 kg respectively. “Acala” and “Lone Star” only outperformed “Jiaying Mozi” by a narrow margin, whereas King lagged far behind the later in terms of productivity.³⁵ This outcome proved the merit of Chinese cotton species. Although they fell short in fiber quality and purity, the association decided not to give up efforts on improving them. This outcome was highly valuable, considering the repeatedly substantiated observation that domesticating American species was difficult, and the costs in time and money of purchasing American cotton seeds was overwhelming. Later on, it provided valuable guidance to cotton breeding projects undertaken by universities.

Jinling University and the Domestication of American Cotton Species

The China Cotton Mill Owners Association also pioneered industry-university partnership which would not reappear in China until the 1990s. In 1919, it provided

³⁵ “Experiment Outcomes Obtained at the Rong Family Commonwealth Farm in Wuxi” (“附无锡荣氏公益农事试验第一届植棉成绩表”), *Quarterly of Chinese Cotton Mill Owners Association* vol. no..3 (《华商纱厂联合会季刊》) (1919.6), 258.

600 silver dollars to Jinling University to fund research on domesticating American species. This might be meant to remedy the mediocre outcomes obtained at the association's own experimental farms.

As a prestigious higher education institution, Jinling University did possess more human and intellectual capital. The Department of Agriculture purchased eight types of American cotton strains and distributed them to 26 experimental farms in Jiangsu, Zhejiang, Jiangxi, Anhui, Hunan, Henan, and Hebei.³⁶ Two years later, the long-awaited success finally came.

In 1921, J.B. Griffin joyfully wrote that, “we have been focusing on optimizing the process of domesticating American cotton breeds. This year, for the first time, success was granted.”³⁷ He attributed this success to correctly pinning down the root cause of the deterioration of American cotton species—cross pollination—and formulating a workable prevention solution accordingly.

³⁶ Yan Zhongping, *Outline of the History of Chinese Cotton Textile Industry*, 326.

³⁷ J.B. Griffing and Chan Yu, “1921 Jinling University Annual Report on Cotton Cultivation Project” (“金陵大学一九二一年棉作报告”), *Quarterly of Chinese Cotton Mill Owners Association* 3.2 (《华商纱厂联合会季刊》) (1922.6), 222.

Griffin's solution consisted of seven steps and spanned three years:³⁸

1. Select 200 to 300 fine cotton bolls.
2. Obtain their seeds.
3. Sow these seeds sparsely; the field shall consist 300 short rows.
4. Nurture these seeds and watch them grow into cotton plants; use small paper bags to cover the flowers of these plants to prevent cross pollination.
5. Select three rows of the finest cotton plants among all
6. Plant them in three separate fields.
7. Repeat the first five steps to obtain fine cotton plants and their seeds.

According to a report Griffin published in the *Quarterly of China Cotton Mill Owners Association*, about one third of the cotton crops harvested from the university's experimental field surpassed average American cotton crops in terms of fiber quality; about one tenth of them achieved the optimal standard.³⁹ Griffin also proposed that universities and the industry must train more Chinese peasants to identify inferior cotton plants and remove them at the early stage of cultivation, so that high-caliber cotton plants could be protected from genetic contamination and thus preserved for

³⁸ Wang Shanquan, "Research on Optimizing Chinese Cotton Species" ("中棉改良之研究"), *Agriculture Journal* 1.3, (《农业丛刊》)(1922), 66-73.

³⁹ Ibid.

further selective breeding and wide-ranging promotion.⁴⁰ Moreover, the Department of Agriculture recruited several experienced peasants and equipped them with skills in plant and seed selection, field-plowing, fertilization, flower-cutting, and cotton boll-picking. Overall, the Department of Agriculture at Jinling University achieved notable results in domesticating American cotton species and expanding the acreage for their cultivation.

National Southeastern University and the Optimization of Chinese Cotton Species

In 1921, the China Cotton Mill Owners Association allowed the agricultural division at the Nanjing Normal School of Advance Studies to be merged into the Department of Agricultural Science at the prestigious National Southeastern University founded in 1920. The association sponsored the division for the purpose of spreading practical knowledge and skills crucial for cotton trade. It donated 20,000 silver dollars, tripling the amount of research fund it provided to the Jinling University,⁴¹ and assigned 1500 acres of experimental farms to the newly expanded department.⁴²

⁴⁰ Ibid.

⁴¹ “National Southeastern University’s Endeavors in Cotton Breeding” (“东南大学农科改良全国棉作事业述要”), *Magazine of Industrial Affairs* 51 (《实业杂志》)(1922), 32.

⁴² Li Yibo and Wang Siming, “On Cotton Industry Organizations in the Yangtze River Delta during the Period of the Republic of China” (“民国时期长三角棉业组织研究”), *Agricultural History of China* no.3 (《中国农史》)(2012), 87.

After four years of concerted efforts led by the Sun Enlin (1893-1961), a graduate of agriculture departments at University of Illinois and University of Louisiana, the department succeeded in cultivating four high-caliber Chinese species, “Qingjing Jijiao,” “Xiao Baihua,” “Jiangyin Baizi,” and “Xiaogan Guangzi.”⁴³ The success arose from preventing cross pollination too. The key of the prevention measures was also similar to that adopted by the Department of Agriculture at Jinling University—covering cotton flowers with paper bags.

The new department’s achievement, though delayed, was impressive. In the first year, the results were rather mediocre. The average per acre yield of “Qingjing Jijiao,” “Jiangyin Baizi,” and “Xiaogan Guangzi” were 35kg, 23 kg, and 30 kg respectively. Four years later, the department succeeded in cultivating a new strain of “Xiaogan Guangxi” whose fiber strength, fiber length, and brightness were comparable to Acala and a new strain of “Xingjing Jijiao” whose per acre yield tripled the per acre yield of unimproved varieties.⁴⁴

⁴³ Yan Zhongping, *Outline of the History of Chinese Cotton Textile Industry*, 327.

⁴⁴ Geng Xuan, “Collaboration between Agricultural Scientist and Local Powers in Early Republican China—Zou Bingwen and the College of Agriculture at Southeastern University” (“民初农学精英与

More than a research hub for agriculture, the National Southeastern University was also a gathering place for other many other disciplines of modern knowledge, advanced skills, and social and political influence, all useful to the cotton breeding project.

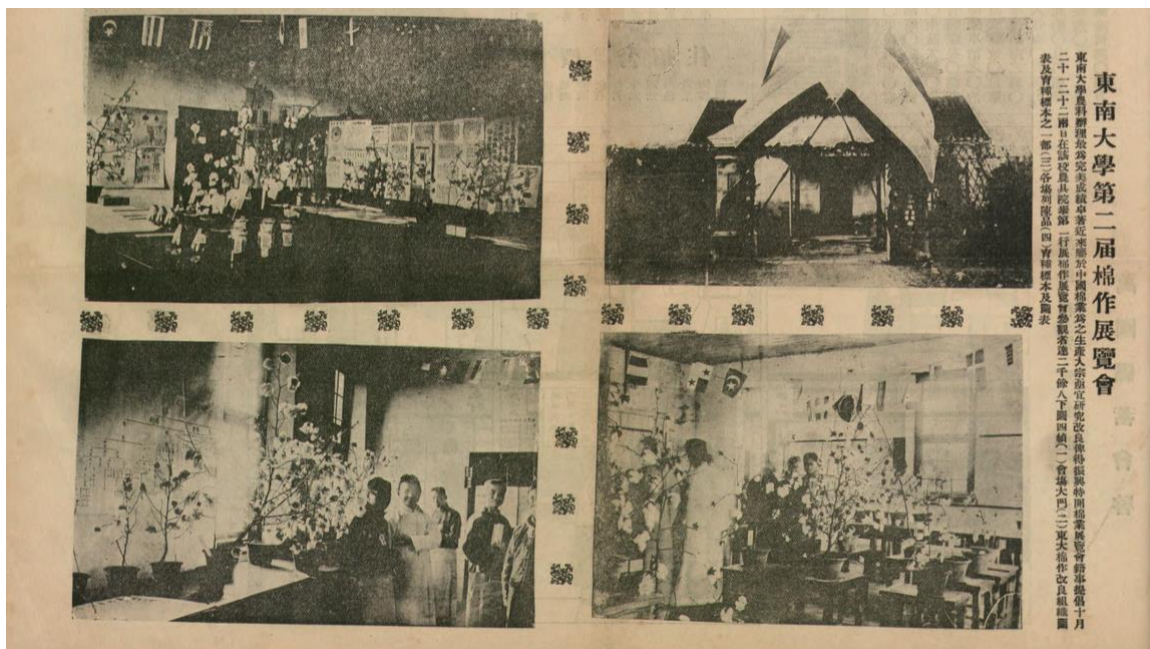
For example, throughout the project's life cycle, workshops run by the Department of Engineering at the university had been responsible for making farm implements, such as seed drills and rakes. The weeding rakes they made sold for 14 silver dollars, whereas similar products imported from America were on average 6 silver dollars more expensive.⁴⁵ Considering that selective breeding experiments were multi-year projects and would require a large number of farm implements, the engineering workshops at the university helped the Department of Agricultural Science and the association reduce a significant amount of expenditure. Out of the university, such help was unlikely to be available for free.

Blessed by the University's reputation and resources, the Department of Agricultural Science was able to popularize knowledge of cotton cultivation. In addition to toils at

地方实力派的合作—邹秉文与东南大学农科的创建”), *The Chinese Journal for the History of Science and Technology* vol.38 no.2 (《中国科技史杂志》) (2017), 152.

⁴⁵ “National Southeastern University's Endeavors in Cotton Breeding” (“东南大学农科改良全国棉作事业述要”), 34.

experimental fields and laboratories, academic staff and students were also engaged in offering free public lectures, distributing booklets, and holding exhibitions.⁴⁶ In 1921, the department initiated training curriculums for experienced farmers. Moreover, it held three exhibitions to educate the public on the basics of cotton farming.⁴⁷ In 1922 and 1923, academic staff at the department inspected more than 60 counties in Jiangsu and formulated detailed plans to boost agricultural production in the populous province. The department also set up four experimental farms in the outskirt of Nanjing. To make the best of these farms, the department distributed quality cotton seeds to local peasants, promoted newly invented farm implements, organized seminars on cotton cultivation, and instructed peasants to learn basic agricultural knowledge and newly developed techniques.



⁴⁶ Ibid., 33-34.

⁴⁷ “The Second Cotton Cultivation Exhibition at National Southeastern University” (“东南大学第二届棉作展览会”), *Times Illustrated* vol.128 (《时报图画周刊》) (1922), 1.

The Second Cotton Cultivation Exhibition held at National Southeastern University in 1922.

The university also aided the China Cotton Mill Owners Association at the political end. Throughout the Republican era, universities were usually leaders of public discussion and opinion. Such a leadership role was the fountain of their political energy. The combined political influence of industry and academia outweighed the leverage of the industry alone over the Beiyang regime. Together with the All-China Federation of Cotton Textile Industry, the Chinese Cotton Mill Owners Association and the university submitted a petition to the congress in Peking. They urged the Beiyang regime to increase taxation on raw cotton export and use that increment to fund cotton cultivation projects at home.⁴⁸ Although the Beiyang regime did not adopt their policy recommendation, it did pump funds into the association to support cotton breeding projects. The government of Jiangsu followed suit and provided 15,000 silver dollars to support the association and the university in 1923.⁴⁹ Suffice it to say that the contribution of the Department of Agricultural Science at National Southeastern University went beyond successfully optimizing Chinese cotton species. Its promotional, technological, and political capacities contributed greatly to the overall progress of Republican China's cotton industry.

⁴⁸ "Government Should Increase Taxation on Raw Cotton Export to Promote Cotton Cultivation" ("请加棉花出口附税推广植棉"), *Banking Weekly* vol. 7 no. 48 (《银行周报》)(1923), 28.

⁴⁹ Geng Xuan, "Collaboration between Agricultural Scientist and Local Powers in Early Republican China—Zou Bingwen and the College of Agriculture at Southeastern University," 154.

Human Capital Advantage of Universities in Lower Yangtze River Basin

The cotton breeding projects undertaken by cotton industrialists and universities achieved better results than those initiated by Beiyang and provincial governments. The reasons lay in the human capital advantage of the two Nanjing-based universities.

Such advantage was firmly rooted in the history, culture, and geographic edge of the Lower Yangtze River Basin. After the First Opium War (1840-1842), Shanghai was forced to become a “treaty port” city under the Treaty of Nanjing (1842), which decisively changed the economic fabric, cultural milieu, and education landscape of the town and surrounding regions. In the wake of cross-border trade and inflow of foreigners, foreign languages, books, ideas, education systems, life and architectural styles, governance structure, and laws flooded and gained popularity in the Lower Yangtze River Basin. As the Qing Dynasty became increasingly feeble due to incessant military and diplomatic setbacks, local elites became increasingly attracted to “new-style education” which was modelled upon western education and emphasized the teaching of practical disciplines such as foreign languages, arithmetic, geometry, physics, chemistry, because, under the influence of local reformist intellectuals, such as Wang Tao (1828-1897) and Ma Jianzhong (1845-1900), elites gradually realized that “new-style education” was prerequisite for economic, technological, and military catch-up as well as cultural, political, and societal transformation. For example, Zhang Jian made it clear on multiple occasions that commercial and industrial prosperity relied

heavily on “new-style education.”⁵⁰ After the signing of Boxer Protocol in 1901, such realization materialized into hundreds of new-style education institutions in an incredible speed. Between 1902 and 1911, more than 2000 “new-style schools” emerged in Jiangsu, including universities, high schools, primary school, professional school, normal schools, part-time schools, and many of them were concentrated in Nanjing, Wuxi, Suzhou, and Nantong.⁵¹ Such boom arose from collaboration between wealthy provincial elites, such as Zhang Jian, and reform-minded high-level officials, such as Liu Kunyi (1830-1902) and Zhang Zhidong.⁵²

Under the influence of local elites and governments, more and more families recognized the value of Western education and decided to enroll their male offspring in “new-style schools.” Because of the gigantic development gap between China and imperial powers, most “new-style schools” conscientiously prepared students for overseas education in the hope that students would transform China with new ideas, knowledge, and technology learned from advanced countries.⁵³ The U.S. become the most popular destination for overseas education after 1918 when the U.S. Congress consented to provide scholarship to Chinese students with Boxer indemnities procured from the Qing government. Students from Jiangsu and Zhejiang were particularly eager

⁵⁰ Shi Quansheng, “On Late Qing Reform and Education Movement in Jiangsu”(“论清末新政与江苏的教育运动”), *Jiangsu Social Sciences* vol.6 (《江苏社会科学》) (2003), 135.

⁵¹ *Ibid.*, 136.

⁵² *Ibid.*, 135-136.

⁵³ *Ibid.*, 137.

applicants to the Boxer Indemnity Scholarship Program, and many studied agriculture. Among 348 individuals who studied agriculture in American universities between 1909 and 1949, 63 of them were Jiangsu natives, and 31 of them were from Zhejiang. Students from any single northern province only counted for less than 4 percent of the agriculture student population.⁵⁴

The preponderance of agriculture students from the lower Yangtze region mattered for two reasons. First, students from Jiangsu, Zhejiang, and other southern provinces, such as Hubei and Anhui, to choose universities or commercial organizations in the Lower Yangtze River Basin as career destinations after obtaining degrees from the U.S, for their geographical proximity to home and locational advantage that promised a wider range of career opportunities and higher living standard.⁵⁵ Most graduates would choose universities over commercial organizations, not only because universities enjoyed higher social prestige than commercial organizations, and professors were more respected than factory managers, but also because sophisticated research and projects could only be done at universities.

⁵⁴ Zhao Shihong and Zhou Mian, “The Group of the Agricultural Overseas Students and the Development of Agriculture in Modern China” (“留学生群体与民国时期的农业发展”), *Journal of Jiangsu Normal University (Philosophy and Social Science Edition)* vol. 39 no.5 (《江苏师范大学学报(哲学社会科学版)》) (2013), 3.

⁵⁵ Yang Min and Zhu Shijia, “Jiangsu-based Agricultural Scientists in Republican China” (“民国时期江苏农学家群体研究”), *Agricultural Archaeology no.1* (《农业考古》) (2014), 267-271.

The human capital advantage of universities in the Lower Yangtze River Basin was also rooted in the social network of U.S. trained agricultural experts. It caused experts to gravitate toward career opportunities in the urban centers of the Lower Yangtze River Basin. For example, among 170 students who studied agriculture in the U.S. between 1912 and 1927, nearly a quarter of them studied at the College of Agriculture at Cornell University, including two Jiangsu natives—Guo Tanxian (1886-1929), principal of the Jiangsu No.1 Agriculture School and head of the Department of Agriculture at Jinling University, and Zou Bingwen (1893-1985), head of the agricultural division at the Nanjing Normal School of Advance Studies and the Department of Agricultural Science at the National Southeastern University.⁵⁶ Between 1921 and 1925, both Guo and Zou worked at the Department of Agricultural Science at the National Southeastern University. Their Cornell connections contributed greatly to cotton breeding projects undertaken by the department. Many academic staff at the agriculture departments of the department were recruited from Cornell's College of Agriculture. By 1925, among 26 professors at the Department of Agriculture at the National Southeastern University, 10 of them were Cornell graduates. Many graduates of University of Iowa and University of Georgia joined the department later.⁵⁷

⁵⁶ Zhao Shihong and Zhou Mian, "The Group of the Agricultural Overseas Students and the Development of Agriculture in Modern China", 2.

⁵⁷ Geng Xuan, "Collaboration between Agricultural Scientist and Local Powers in Early Republican China—Zou Bingwen and the College of Agriculture at Southeastern University", 149.

A sense of mission augmented the power of alumni connections in concentrating quality human capital and expertise. The mission was reviving China with science, education, and industrial strength.⁵⁸ This mission was solidified and popularized by the influential China Science Society which was founded at Cornell University in November, 1914.⁵⁹ Guo and Zou were the society's founding members.⁶⁰ Students at other American universities soon joined the society and established branch organizations. In 1918, as more and more members returned to China, the society's headquarter was moved to the Nanjing Normal School of Advanced Studies.⁶¹ The majority of the society's members were recipients of the Boxer Indemnity Scholarship. Students who benefitted from this scholarship often felt obliged to dedicate to the revival of their country, because the money they received from Ministry of Education of the Beiyang regime was "token of national humiliation" and constantly reminded them of their responsibility on leading China out of humiliation and backwardness.⁶² This explained why more than 70 percent of recipients of Boxer Indemnity Scholarship decided to study various disciplines of science, engineering, medicine, and agriculture.⁶³ Because these the knowledge and practice taught by these practical disciplines could bring in material

⁵⁸ Qu Tiehua and Yuan Yuan, "On the Creation and Influence of China Science Society" ("论中国科学社的创办与影响"), *Journal of Northeast Normal University* no.3 (《东北师大学报》) (2007), 5-6.

⁵⁹ *Ibid.*, 5.

⁶⁰ Geng Xuan, "Collaboration between Agricultural Scientist and Local Powers in Early Republican China—Zou Bingwen and the College of Agriculture at Southeastern University", 144。

⁶¹ Qu Tiehua and Yuan Yuan, "On the Creation and Influence of China Science Society", 5-6.

⁶² Zhang Qi, "An New Interpretation on Boxer Indemnity Scholarship" ("‘庚款兴学’新探"), *Academic Monthly* no.11 (《学术月刊》) (1991), 80

⁶³ *Ibid.*

wealth, industrial strength, military might, and mass enlightenment which were central to the goal of national revival.⁶⁴ The China Science Society was built upon this idea. To actualize this idea, it vowed to support and institutionalize scientific research, promote scientific education, and defeat superstition and metaphysics with science.⁶⁵ The majority of the society's members chose to start their careers not at governments but at universities and manufacturing companies,⁶⁶ because major universities were at the frontline of research, education, and public debates, while manufacturing companies were engines of industrial growth. Considering that Cornell was cradle of China Science Society and its ideals, we can develop a deeper understanding on why many graduates of Cornell's College of Agriculture chose to join National Southeastern University whose prospect was rather uncertain in the early 1920s. More importantly, the society's membership provided another channel for networking and recruitment. Other than Cornell graduates, Guo Tanxian and Zou Bingwen were also able to hire agriculture students graduated from the University of Iowa, University of Georgia, University of Illinois, and University of Minnesota.⁶⁷ An educated guess might be that the membership network of China Science Society amplified Guo and Zou's recruiting capacity.

⁶⁴ Ibid.

⁶⁵ Ren Hongjuan, "Forward" ("发刊词"), *Science vol.1 no.1* (《科学》) (1915), 6-7.

⁶⁶ Geng Xuan, "Collaboration between Agricultural Scientist and Local Powers in Early Republican China—Zou Bingwen and the College of Agriculture at Southeastern University", 144.

⁶⁷ Geng Xuan, "Collaboration between Agricultural Scientist and Local Powers in Early Republican China—Zou Bingwen and the College of Agriculture at Southeastern University", 148-149.

Addressing the agricultural bottleneck constraining Republican China's cotton industry required systemic efforts from experts of different sub-disciplines. Therefore, without functioning academic communities, complex project, such as cotton breeding, would not come to successful conclusions. The agricultural departments at Jinling University and National Southeastern University hired professors who specialized in plant pathology, genetics, and soil science. Their expertise was indispensable for diagnosing ails of experimental cotton plants, prescribing remedies, and synthesizing the key points of cotton breeding to assist extensive promotion of cotton cultivation. Moreover, both departments also professionalized the promotion of cotton cultivation. At the Department of Agriculture at Jinling University, the task was overseen by academic staff who were trained in agricultural economics and rural education. At the Department of Agricultural Science at National Southeastern University, the promotion of cotton cultivation was integrated into research and teaching. Zou Bingwen made it clear that, the research-teaching-promotion integrative mode was emulated from the Cornell's agriculture college. This mode in which universities played the central role in driving agricultural progress was also widely adopted by many state universities across the U.S..⁶⁸

But unlike many American universities secured by generous land grant and funding from federal and local governments, Chinese universities could not expect ample and stable monetary support from governments, because of frequent political reshuffles and

⁶⁸ Ibid., 147.

epidemic corruption. To give one concrete example, the government of Jiangsu promised to provide 100 thousand silver dollars to found the Nanjing Normal School of Advanced Studies. But Zou Bingwen and other founders only got 50 thousand silver dollars. From 1914 to 1917, the school only obtained 87 thousand silver dollars from local governments, yet the amount of revenue promised by the government was more than 210 thousand silver dollars. If it had solely relied on unreliable government funding, the National Southeastern University would never come into being, not to mention its Department of Agricultural Science and the department's cotton breeding project. The stable monetary, political, and policy support came from local industrialists, bankers, and education leaders who had powerful influence over not only local society and government but urban centers across China. Among the 14 members of the University's board of trustees, Zhang Jian, Nie Yuntai, and Mu Ouchu were cotton industrialists; Chen Guangfu (1881-1976) was a banker; Cai Yuanpei (1868-1940), Yuan Xitao (1866-1930), Yan Jiachi (1885-?) , Jiang Qian (1876-1942), Shen Enfu (1864-1949), Huang Yanpei (1878-1965), and Jiang Menglin (1886-1964) were education leaders.⁶⁹ All of them were natives of Jiangsu and Zhejiang where elites' involvement in education remained a respectable tradition.

⁶⁹ Ibid., 146.

Bearing these in mind, it is not difficult to understand why the results of cotton breeding projects conducted by the two universities were more satisfactory than the ones obtained at governments and the China Cotton Mill Owners Association's experimental farm. It is primarily because that cotton experts were scarce resource highly concentrated in a few research universities in Lower Yangtze River Basin—Jinling University and National Southeastern University in Nanjing in particular. The prosperity and educational milieu of the Lower Yangtze River Basin, social and emotional attachment to native place, school-year networks, sense of mission, and supports from local elites—all were conducive to such concentration.

Although it is difficult to prove that U.S.-educated agricultural experts were completely absent from governments' projects, it is highly doubtful whether the quantity and quality of human resource involved in governments' projects were on the same level as the human resource concentrated in Jinling University and National Southeastern University. As mentioned above, the Beiyang regime as well as the provincial governments of Jiangsu, Shandong, Shanxi, Yunnan, and Zhejiang invested in cotton breeding. Students from the capital area, Shandong, Shanxi, and Yunnan were not passionate about studying agriculture oversea. Research shows that, among 348 individuals who studied agriculture in American universities between 1909 and 1949, the number of students from each of these four regions only did not surpass 13.⁷⁰ If

⁷⁰ Zhao Shihong and Zhou Mian, "The Group of the Agricultural Overseas Students and the Development of Agriculture in Modern China," 3.

downscaling the time span, the number would be even smaller. Moreover, it is difficult for Shandong, Shanxi, and Yunnan to outcompete Jiangsu in terms of attractiveness to nonnative U.S.-educated agricultural experts, due to gaps in economic and cultural prosperity and agricultural development level. Compared to urban centers in the Lower Yangtze River Basin, Peking and Tianjin—centers of the capital area, though no less wealthy and sophisticated, were not desirable destinations for agricultural experts who sought accomplishments in their field, simply because the capital area was far less agriculturally developed than Jiangsu and Zhejiang in terms of crop diversity and output; agricultural economy in the two provinces were more prosperous than other regions.⁷¹ Consequently, although Peking and Tianjin hosted several renowned universities, the agriculture departments of these universities were never leaders in agricultural education and research. This was evidenced by the facts that, among 237 agriculture students who were awarded with scholarship to study masters and doctoral programs overseas, students from Peking University and Tsinghua University only counted for 8 percent and 7.6 percent, and the percentages of graduates of Yenching University and Nankai University were even smaller, whereas the proportion of graduates of Jinling University and National Southeastern University reached 22.4 percent and 19 percent respectively. Hu Shi (1891-1962) who studied agriculture at Cornell before switching to the humanities once commented that “after 1914, Nanjing remains the nerve center

⁷¹ Zhang Jian, “Development of Modern Chinese Agronomy: Analysis in Terms of Prosopography”(“中国近代农学的发展：科学家集体传记角度的分析”), *The Chinese Journal for the History of Science and Technology* vol.27 no.1 (《中国近代农学的发展—科学家集体传记角度的分析》)(2006), 13.

of agricultural education and research in China.”⁷² Now it is clear why the amount of quality human resource available to the Beiyang regime and provincial governments of Shandong, Shanxi, and Yunnan was rather limited. As for the provincial governments of Jiangsu and Zhejiang, their official bulletins, which were created to record major administrative orders and local issues, never mentioned that important government organs, such as governor’s office or the Bureau of Industry and Commerce, ever planned to assemble a team of trained agricultural experts to oversee cotton breeding projects. An educated guess is that officials of the two provinces underestimated the importance of scientific, technical, and managerial expertise at the very beginning.

Conclusion

Catalyzed by the combined effects of low production costs, low labor wages, the devaluation of silver, the First World War, and consumer patriotism, Republican China was poised for a phenomenal cotton industry boom in 1914. However, indigenous Chinese cotton species, characterized by low yields and inadequate fiber lengths, hampered machine production of cotton textiles, and thus dimmed the prospects of large-scale manufacturing. For governments, the cotton industry could proffer a stable stream of tax revenue. For the cotton industry, driving out foreign manufacturers—Japanese ones in particular—and reconquering domestic markets meant vastly

⁷² Shen Zonghan, *Autobiography: Middle Age* (《沈宗翰自述-中年自述》) (Taipei: Taipei Biographical Literature Publishing House, 1984), 2.

increased profits. Therefore, both governments and the industry were eager to resolve the agricultural bottlenecks resulting from the deficiencies in indigenous cotton species.

Both the Beiyang regime and provincial governments were engaged in setting up experimental farms to domesticate American cotton species. The frameworks and procedures adopted at government-owned farms were not all unreasonable. Bureaucrats purchased seeds and distributed them to cotton industrialists and peasants for free; they formulated blueprints, promoted cotton cultivation, tried to popularize relevant knowledge and techniques. Most importantly, both the Beiyang regime and provincial governments provided funds either to the China Cotton Mill Owners Association or to universities. The scale and continuity of governments' effort should not be overlooked. However, the experimental results obtained at governments' farms were far from satisfactory. The reason lay in human capital. Government-owned farms were not overseen by experts who received quality training on cotton cultivation and crucial areas of agricultural science. The dubious quality of human capital was evident in the fact that most government-owned experimental farms were ignorant of the necessity of preventing cross-pollination which was rather rudimentary in the eyes of U.S.-educated agricultural personnel. In this light, it is equally dubious whether frameworks and procedures described in published reports were correctly implemented.

The success of cotton breeding projects undertaken by Jinling University and National Southeastern University stemmed from the talent advantage of urban centers in the Lower Yangtze River Basin. Because of trade and commerce treaties, Jiangsu and Zhejiang were more open to Western education. Therefore, local students were eager to attend Western-style schools and go abroad for advanced studies. This is evident in the fact that more than a quarter of agriculture students who studied in the U.S during the Republican era were natives of the two provinces. After graduation, they brought home agricultural expertise on cotton breeding and related areas. With solid monetary, political, and policy support from native elites, they transformed Jinling University and National Southeastern University into research and talent hubs where Chinese and foreign agricultural experts could pool their knowledge, skills, and efforts, and tackle complex challenges with collective intellectual strength. With ample resources and collective intellectual strength, agriculture departments at the two universities conquered many conundrums that once debilitated Republican China's agricultural productivity. In addition to cotton breeding, the two departments were also involved in rice breeding and silkworm breeding.

As for cotton breeding projects initiated by cotton industrialists, the results were mixed. While the domestication of American cotton species went on smoothly at Mu Ouchu's farm, the 17 farms owned by the China Cotton Mill Owners Association failed to achieve satisfactory results. The disparity could also be explained from the perspective

of human capital. While it was relatively easy for a U.S-educated cotton expert to oversee one experimental farm, it was difficult to gather enough experts to manage 17 farms located in seven different provinces. Fortunately, the association soon solved the predicament. Instead of continuing fruitless efforts, it decided to pour land and monetary resources into National Southeastern University wherein enough experts were gathered. This decision was the necessary condition for the two universities' successful efforts.

While the combination of land, funds, and human capital could resolve shortcomings in indigenous cotton species, the potential of industry-university partnerships was limited in the Republican era. Industry-funded research was usually applied research focusing on specific local problems and aiming at short-term economic gains. Without social and political stability, far-sighted policy leadership, and ample funds, it is difficult to carry on fundamental research that aims at broader influence and long-term benefits.⁷³ Yet sponsoring basic research is by and large a government responsibility

⁷³ Ibid., 157.

which, in the Chinese context, remained unfilled until the initiation of the 12th Five-Year Plan in 2011.⁷⁴

⁷⁴ “Blueprint for the Development of Fundamental Research During the 12th Five-Year Plan Released”(“国家基础研究发展“十二五”规划发布”), *Tianjin Science & Technology* 3 (《天津科技》)(2012), 49.

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