



# Increasing wage, mechanization, and agriculture production in China



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## ABSTRACT

As the population bonus disappeared, the wage rate has increased significantly since the early 2000s in China. Increasing wages have significantly affected export-oriented industries as well as agriculture. Mechanization is another factor affecting China's agriculture. This study shows the increasing wage and the mechanization have a negative impact on land area devoted to labor-intensive crops but a positive impact on land area devoted to labor-extensive crops. Based on nationally representative data, the empirical results conform well to the theoretical predictions.

## 1. Introduction

As China's population bonus disappeared, the wage rate in China has increased significantly since the early 2000s. According to the National Bureau of Statistics of China (hereafter NBSC), the number of laborers decreased by 3.45 million in 2012, marking the first “absolute decrease” in China's labor force. This number increased to 21.44 million in the next two years (NBSC, 2014a, 2015). As a result, wage levels have risen significantly. During the last decade, the index of the average real wage of employed persons in urban units has increased by 176% (NBSC, 2014b). The wage increase indicates that China has passed the Lewis turning point, and the era of surplus labor is over (Cai & Du, 2011; Golley & Meng, 2011; Li, Li, Wu, & Xiong, 2012; Zhang, Yang, & Wang, 2011).

Increasing wages have brought great changes not only to export-oriented industries, but also to agriculture. As cheap labor has been considered as the major component of China's high levels of exports in the international market, increasing wages could have a profound impact on the sustainability of China's rapid growth, especially in export-oriented industries and foreign direct investment (Adams, Gangnes, & Shachmarove, 2006; Akyz, 2011; Banister, 2005; Peng, 2011; Yang, Chen, & Monarch, 2010). On the other hand, increasing wages have also brought great changes to agriculture. Some crops (for example, cotton and vegetable) are labor-intensive, while some (for example, wheat and rice) are labor-extensive.<sup>1</sup> As the wage rate increased, the comparative advantage of labor-intensive crops and labor-extensive crops changes significantly. To maximize total profit, farmers would like to decrease the sown areas of labor-intensive crops and increase the sown areas of labor-extensive crops.

Mechanization is another factor affecting China's agriculture. As the wage rate increased, agricultural machinery became more

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<sup>1</sup> According to the statistics of the All China Data Compilation of the Costs and Returns of Main Agricultural Products, labor input of cotton production is 31.40 days per mu (15 mu = 1 ha), which is more than twice higher than that of grain crops during 1990–2014 (National Development and Reform Commission, various year).

widely used as an important substitute for labor input. During the same time period, Chinese government increased the subsidy for agricultural machinery purchases, which further accelerated the development of mechanization (Yang, Huang, Zhang, & Reardon, 2013). As a result, the mechanization rate of farming, breeding, and harvesting increased from 33% in 2003 to 61% in 2014 (Ministry of Agriculture, hereafter MOA, 2015). The Chinese government predicts that the general mechanization rate will increase to 65–70% for all crops and to 100% for major grain crops by 2020 (Wang & Chu, 2012).

Similar to rising wage rate, the mechanization also affected the variety of sown crops and crop structure. The mechanization levels of different crops differ significantly. For example, the comprehensive mechanization levels of wheat and corn for 2013 are 94% and 80%, respectively (MOA, 2014). On the other hand, except for Xinjiang Uyghur Autonomous Region (northwest of China), harvesting machines were rarely used in cotton production.<sup>2</sup> It is expected that different mechanization levels have significant impact on sown areas of labor-intensive crops and labor-extensive crops and hence the crop structure.

Increasing wages and mechanization have caused significant changes in sown areas and crop structure. As wages rise and mechanization increases, the amount of land devoted to labor-intensive crops has been decreasing significantly over the last decade. For example, according to national statistics, cotton-sown area decreased from 5.69 million ha in 2004 to 4.35 million ha in 2013, a reduction of nearly 25% (NBSC, 2014b). On the other hand, the sown area of grain crops increased by 10.34 million ha (or 10.18%) during the same time period (NBSC, 2014b).

How will the increasing wage and mechanization affect agricultural production? More specifically, will the sown area of the labor-intensive crops continue to decrease while the sown area of the labor-extensive crops continues to increase? Will cotton follow soybean's footsteps and become an agricultural product that is heavily dependent on the international market? To the best of my knowledge, these questions are still waiting for satisfying answers.

This paper tries to answer these questions. Specifically, this paper quantifies the impacts of increasing wages and the mechanization on the sown areas of cotton and grain crops in China's major cotton production regions. Based on theoretical and empirical analyses, this paper identifies how increasing wages and mechanization affect crop structure and if China's cotton production is safe from being substituted towards more labor-extensive crops.

This study has important implications for China, as well as other countries. First, grain and cotton play critical roles in China's agricultural production. Unlike other crops, grain crops and cotton are considered as important strategic materials in China. Hence, grain and cotton production not only affects China's more than two hundred million small, rural households but also play a critical role in national security and the economy. In addition, as the world's most populous country, China's food security is also a world issue (Brown, 1995). Further, as the largest cotton consumer and importer, China imported 4–5 million tons of cotton annually, which is about half of total world trade (NBSC, 2014b). Hence, this study benefits China as well as other countries where grain crops and cotton play important roles.

Second, China's agriculture is experiencing a rapid expansion of machines and mechanization will be dominant China's agriculture in the future. Recognizing the increasing need for mechanization, Chinese government had implemented encouraging policies and providing massive subsidy to promote the full agricultural mechanization since early 2000s (Zhang, Quingguo, & Xu, 2004). Hence understanding the impact of mechanization on sown area of different crops and crop structure is important not only for farmers and China's domestic market, but also for policy makers.

Finally, because of its high economic growth rate for nearly four decades, China has been considered as a role model in the developing world (Song, Storesletten, & Zilibotti, 2011). However, since China's economic growth stems in large part from its relatively low wages for workers, its sustainability is in question given the population bonus has disappeared. As previous studies focus on the impact of increasing wages on export-oriented industries and foreign direct investment, this study provides more evidence of the impact from the perspective of agriculture.

The rest of the paper is organized as follows. In the next section, I develop a theoretical model and analytically discuss the impact of increasing wages and mechanization on the sown areas of labor-intensive crops and labor-extensive crops. In the third section, I apply econometric models to nationally representative data to test whether the analytical results conform to the theoretical model. The final section concludes the paper.

## 2. Theoretical model

Grain crops represent the largest amount of sown area in China. On the other hand, more area is devoted to cotton than other non-grain staple crops. In addition, the grain crops rice (in southern China) and corn and wheat (in northern China) are the most important competitors for cotton in major cotton-producing regions. Hence, in this section, cotton represents labor-intensive crops, while all the grain crops are classified into one group (referred to as “the grain crop”) and represent the labor-extensive crops.

As wage rate increased, more farmers migrated to cities and agricultural machinery became more widely used as an important substitute for labor input. However, the effect of wage rate and mechanization on labor-intensive crop (i.e. cotton) and labor-extensive crop (i.e. grain crop) differs significantly for at least two reasons. First, cotton plots are usually very small and are planted with other crops even in the most intensive cotton producing regions (Qiao, Huang, Rozelle, & Wilen, 2010). On the other hand, grain crops are usually monotonously planted. Second, due to the existence of the large amount of non-dominant cotton varieties, the physiological performance of cotton plant varies significantly (Huang et al., 2014; Huang, Chen, Mi, Hu, & Osir, 2009). Especially

<sup>2</sup> The mechanization rate of cotton harvesting is 27.94% in Xinjiang Uyghur Autonomous Region and 0.23% in all the other major cotton-producing regions (China Association of Agricultural Machinery Manufacturers, 2014).

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