Field Crops Research 155 (2014) 99–110

Contents lists available at ScienceDirect

Field Crops Research

journal homepage: www.elsevier.com/locate/fcr

Review

Intensive cotton farming technologies in China: Achievements, challenges and countermeasures☆

Jianlong Dai, Hezhong Dong*

Key Laboratory of Cotton Breeding and Cultivation in Huang-Huai-Hai Plain, Ministry of Agriculture; Cotton Research Center, Shandong Academy of Agricultural Science, Jinan 250100, Shandong, PR China

ARTICLE INFO

Article history:
Received 22 August 2013
Received in revised form
23 September 2013
Accepted 23 September 2013

Keywords:
Cotton
Intensive farming technology
Challenges and countermeasures
Sustainable development

ABSTRACT

Cotton (*Gossypium hirsutum* L.) production in China has developed rapidly during the last 60 years. In 2012, the planting area and total output in the country were 5.3 million hectares and 7.62 million tons, respectively, and the unit yield was 85% higher than the world average. China currently accounts for about 30% of the world's cotton output with only 15% of the world's cotton land. Enhanced cotton production, particularly the high unit yield is largely due to adoption of a series of intensive farming technologies and cultural practices. The intensive farming technologies for cotton production in China mainly include seedling transplanting, plastic mulching, double cropping, plant training and super-high plant density technique, which have played important roles in promoting unit yield and total output. Although such intensive farming technologies meet the need of a growing population under limited arable land in China, they are labor-intensive and involve large input of various kinds of chemical products like fertilizers, pesticides, and plastic films. Thus, there are increasing challenges from soil pollution and labor shortage. Here, the achievements, challenges, countermeasures and prospects for intensive cotton cultivation in China are reviewed. An important conclusion from this review is that the establishment of a new farming technology through reform of the current intensive technology is inevitable to support sustainable cotton production in the nation. A series of comprehensive countermeasures should be taken to reduce soil pollution through rational use of plastic film and chemicals, labor saving through simplifying field managements and mechanization and increasing benefits by reforming the cropping system and management mode. China's cotton production would be sustainable with a bright prospect if supported by new farming technologies.

Contents

* Corresponding author. Tel.: +86 531 83179255; fax: +86 531 88960327.
E-mail addresses: donghz@saas.ac.cn, donghezhong@163.com (H. Dong).

0378-4290/$ – see front matter © 2013 The Authors. Published by Elsevier B.V. All rights reserved.
http://dx.doi.org/10.1016/j.fcr.2013.09.017

1. Introduction

China is the largest cotton producer and consumer in the world (Wang, 2009a). The area planted to cotton in China was 5.3 million hectares in 2012 with an average lint yield of 1438 kg ha^{-1} and total output of 7.62 million tons (mt). Based on cotton type, distribution and growth environment, the cotton growing area in China can be divided into three major agro-ecological zones, including the northwest inland cotton region, the Yellow River valley region and the Yangtze River valley region. It was reported that 99.7% of output and 99.5% of cotton growing area in China occur in the three main cotton regions (Yang and Cui, 2010).

Cotton cultivation has a long history in China. However, scientifically based cultivation methods were adopted only after the founding of People's Republic of China in 1949. Great progress in cotton production has been achieved during the last 60 years from 1949, with an average unit yield increasing by 3.12% annually, from 160 kg ha^{-1} in 1949 to 1280 kg ha^{-1} in 2009 (CRI, 2013) (Fig. 1). China has become one of the countries with the highest unit yield of cotton in the world. In 2012/13, the average lint yield was 769 kg ha^{-1} in the world, while it was 1438 kg ha^{-1} in China, being 45, 194, 113 and 87% higher than the yield in the US, India, Pakistan and the world average (USDA, 2013) (Table 1). Many factors have contributed to the increased average yield, including adoption of improved varieties and intensive farming technologies. These technologies include seedling transplanting, plastic mulching, and plant training which have played more important roles than cotton varieties and other contributors to the significant increase in lint yield for the past 60 years (CRI, 2013). Hereafter, we summarize and review these intensive farming technologies with Chinese characteristics, not only to further the improvement of China's cotton production technology, but also other countries' cotton production globally. In this paper, we review the achievements, challenges, countermeasures and prospects of cotton cultivation technology in China.

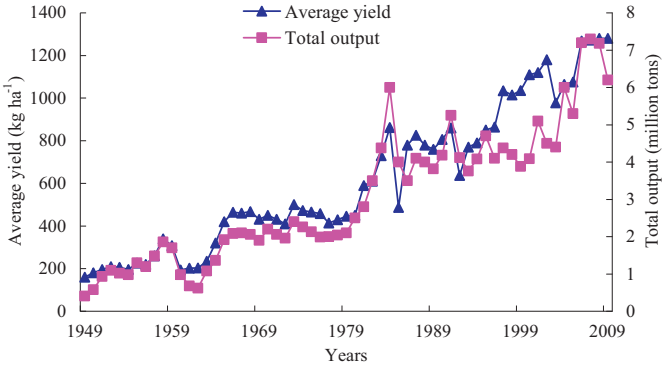

Fig. 1. Average lint yield and total output of cotton in China (1949–2009).

Table 1
Cotton area, average yield and total output for 2012/13 in the world.

Country	Area (million ha)	Average yield (kg ha^{-1})	Total lint yield (million tons)
World	34.32	769	26.4
United States	3.79	994	3.77
India	11.80	489	5.77
Pakistan	3.00	675	2.02
Brazil	0.89	1427	1.26
China	5.3	1438	7.62

2. Achievements

2.1. Transplanting and double cropping

Cotton-growing regions in China are also the main food crop-growing regions; hence the competition for land between grain crops and cotton has become increasingly serious. The grain-cotton double cropping that improves farmland and solar energy use efficiency has become the main cropping system. It ensures higher total output than monocropping, particularly the cotton–wheat (*Triticum aestivum*) double cropping system (Zhang et al., 2008), because it meets the need of farmers to grow a profitable cash crop and secure food supply (Smith and Varvil, 1982; Zhang et al., 2007). Based on time (season) of cotton planting, the double cropping system is classified into spring cotton double cropping and summer cotton double cropping. Due to the short growth period, the summer cotton double cropping has obvious advantages in earliness and alleviating plant diseases and insect pests by using short-season cotton varieties (Lu, 1991). It was once widely adopted in the Yellow River valley and Yangtze River valley cotton regions from 1980s to 1990s. However, double cropping of summer cotton and wheat began to be replaced by spring cotton and wheat due to the relatively lower lint yield and poor fiber quality of short-season cotton (CRI, 2013). Double cropping of spring cotton and wheat occupies a dominant position in the cropping system in both the Yellow River valley and Yangtze River valley cotton regions (Fig. 2a and b). Compared with sole cotton cropping, wheat–cotton intercropping as an intensive cultivation technology has significantly increased multiple crop index and reduced the competition between grain and cotton for land in China. For example, the average yield of seed cotton under wheat–cotton system in Huang-Huai-Hai Plain in China since 1959 was 2836 kg ha^{-1}, being roughly 88% of that under sole cotton cropping system. It should be noted that an extra harvest of 3861 kg wheat per hectare was also obtained compared to monocropping (CRI, 2013). Thus the total benefits were increased.

Although double cropping of wheat–cotton significantly increased economic benefit relative to sole cropping, there are also some disadvantages in the conventional process of cotton production. In such a system, winter wheat is harvested in early or