

THE COTTON SECTOR IN CHINA

Introduction

China is the largest cotton producing country in the world. Among 31 provinces in mainland China, 24 provinces produce cotton, and about 300 million people are involved in cotton production. From 1978 to 1984, China's cotton output increased steadily, and reached a historic high of 6.26 million metric tons in 1984; afterwards the cotton output fluctuated between 4.1-5.7 million metric tons, but dropped to 3.8 million metric tons in 1999. After China joins the WTO, both opportunity and challenge will exist in the agricultural sector. The opportunity for agricultural exports could be a potential in the future, but in the early period of China's WTO accession, the biggest challenge is the large agricultural import (TRQs) which could bring huge impacts. The Jiangsu Agricultural Policy Analysis (JAPA) model was applied to make a scenario analysis of the economic, social and environmental impacts of agricultural imports. The model scenario analysis results showed that the trade liberalization could bring the following positive and negative impacts:

Economic impacts

- help solve the shortage of some commodities;
- sown area and output decrease;
- prices of agricultural products decrease;
- producer surplus and farmers' income decrease.

Social impacts

- promote agricultural production structure adjustment;
- utilization rate of cultivated land decrease - valuable land lies waste;
- reduction in the self-sufficiency rates of the agricultural commodities;
- agricultural employment decrease;
- poverty and problems of social instability.

Environmental impacts

- reduction in application of chemical fertilizers and pesticides;
- valuable cultivated land may lie waste or could be used for non-agricultural purposes, which will impair the sustainability of Chinese agricultural production.

On the basis of integrated assessment and cost-benefit analysis, a series of policy recommendations are made:

- support agriculture with 'green box' policies;
- promote new cotton variety breeding;
- promote the production of special purpose cotton;
- adjust regional distribution;
- establish cotton production cooperatives (sector association);
- analyse the impacts of China's WTO accession, deciding on cotton production, scale and distribution;
- complete the multi-channel cotton marketing system promoting lateral cooperation among different cotton marketing entities;
- promote cotton production to order;
- improve the cotton wholesale market;
- establish a textile exporter association;
- establish an agricultural consulting system;
- decrease the applied quantity of chemical fertilizers;
- establish a pest and disease prevention service;
- adopt Integrated Pest Management;
- strengthen administration of GM cotton production;
- ban the production, marketing and application of all highly toxic, high residue pesticides;
- levy an environmental pollution tax;
- promote the research and development of pesticides made by Chinese herbal medicine;
- increase the efficiency of irrigation;
- promote the production of organic cotton.

Project objectives

The objective of this study was to make an integrated assessment of the economic, social and environmental impacts of China's WTO accession with a focus on the cotton sector, and provide policy recommendations for a transition to the sustainable development of the cotton sector in view of China's entry into the WTO.

The project sought to:

- Enhance the country's understanding of the implications of WTO membership, promote cotton sector trade liberalization in China in a sustainable manner, and enhance its negotiation capacity in future rounds of trade talks.
- Assess the environmental as well as the social and economic impacts of China's potential trade liberalization in cotton.
- The established Jiangsu Agricultural Policy Analysis Model (JAPA) is used to assess the impacts of trade liberalization on cotton production, and to identify optimal resource allocation adjustments after trade liberalization.
- Formulate a policy package to mitigate the identified negative impacts of liberalized trade and to maximize the positive ones, with both economic and regulatory instruments.
- Contribute to enhancing coordination between related national entities and to increasing national expertise in using integrated assessment tools to identify and quantify both negative and positive environmental, social and economic impacts of trade liberalization.
- Enhance and support national capacity in international trade policy-making and research.

The research methods include the application of the JAPA model to make a scenario analysis of the impact of large agricultural imports; integrated assessment and cost-benefit analysis is then applied to assess the social, economic and environmental impacts of the trade liberalization; on this basis a series of specific policy packages are recommended.

The cotton sector in China

Cotton is one of the most important cash crops in China. Cotton is a pillar agricultural commodity in many regions, and benefits a large rural population. Cotton is also an important raw material in the textile industry. The cotton textile industry is the biggest sector, with over 10 million workers in China, while textiles and garments are the most important export commodities. China's WTO accession brings favourable opportunity to the textile industry, but on the other side it may have a huge impact on cotton production.

The last five years have seen a continuous decline in China's cotton acreage. A sharp fall occurred in 1996 of 12.91 per cent, from 5.4 million hectares in 1995 to 4.7 million hectares. In 1999 the cotton acreage declined by 15 per cent to only about 3.7 million hectares. Since 1982, China's cotton output has ranked first in the world, accounting for more than 20 per cent of the world's total production. From 1978 to 1984, China's cotton output increased steadily, and reached a historic high of 6.26 million metric tons in 1984; afterwards the cotton output fluctuated between 4.1-5.7 million metric tons. Finally the cotton output dropped to 3.8 million metric tons in 1999. Broadly speaking, China has three major cotton growing regions, the Xinjiang

Autonomous Region, the Yangtse River Basin Region (which includes principally Jiangsu and Hubei), and the Huang-Huai Region (principally, Hebei, Henan, and Shandong).

Cotton is grown or used in virtually every country in the world. The largest producers, consumers and exporters are China, the United States, the former Soviet Union, India, and Pakistan. China is one of the largest cotton producing and consuming countries, accounting for more than 20 per cent of world production and nearly 20 per cent of world consumption. Any development in China will have a significant impact on the world cotton market. In 1997 China imported 783 thousand metric tons of cotton, which was about 13.6 per cent of the world's total import, but in 1999 it became a net exporter of 330 thousand metric tons. While the increase in China's exports was not extraordinarily large by historical standards, and its decrease in imports was not its largest ever, on a net basis, the impact of these two changes was extraordinary.

Before 1993 China's domestic cotton price was very low, about 32.91 US cents/pound. The Government increased the cotton purchase price by 47 per cent in 1994, and again in 1995 by 29 per cent, which caused an enormous increase in domestic cotton prices, going up to 76.79 US cents/pound. Since 1999 the Chinese Government decided to free the cotton price, and the domestic cotton price dropped to 42.02 US cents/pound, but the price fluctuated around 54.72 – 63.47 US cents/pound in 2000. This means that Chinese cotton has lost its competitive advantage in price. After China opens its cotton market, foreign high quality and low priced cotton could be imported, which may influence Chinese cotton production.

Production costs is one of the key factors in competing in the international cotton market. According to the survey of the International Cotton Advisory Committee (1998), China still has a comparative advantage in cotton production. The average cotton production cost was US\$ 1110.1 per hectare, which was lower than that in the USA, Australia, and Israel, but was higher than in Pakistan and India. Among the different items of the costs in China, the physical costs were high, but the labour costs were relatively low.

Textiles and clothing as a main foreign trade earner

China is traditionally a textile exporter; while basically satisfying the people's demand for clothing, a considerable proportion of textile production is exported. Textile exports have accounted for a very large share of total export revenues since the early fifties. As of 1990, the amount of foreign exchange earned from the export of textiles and clothes reached US\$ 12.5 billion, accounting for 20.1 per cent of China's total export earnings, but in 1997 the amount of foreign exchange earned from the export of textiles and clothes reached US\$ 45.6 billion, accounting for 24.93 per cent of the total export earnings. The textile export earnings was US\$ 42.9 billion in 1998, a decrease of 6 per cent compared with 1997; its share in total export revenue fell to 23.34 per cent. This fall in textile exports was largely attributed to the Asian financial crisis.

The world ranking of China as a textiles and clothing exporter has moved steadily up over the past 20 years, rising from tenth place in 1980 to number one position in 1995. According to WTO figures, the value of China's textiles and clothing exports accounted for 4.6 per cent of the world total in 1980 and 12 per cent in 1995. It reached 13.7 per cent of the world total in 1997. In terms of volume, China has been the world's top exporter of textiles and clothing since 1997. China's comparative advantage in textile and clothing production is based on its large labour force. According to an estimate by the World Bank, China's working population was 723 million in 1995, which was 29 per cent of the global total, and half the working population of low-income countries. Compared to other large textile and clothing exporters of the world, the labour cost is very low in China - lower than all the other countries for its labour costs in textile production and the second lowest in labour costs of apparel production.

The impact of China's accession to the WTO on agriculture

The provisions and commitments defined by the Agreement on Agriculture include a number of important elements. These can be roughly divided into the following four areas: market access, domestic support, export subsidy, and sanitary and phytosanitary measures (SPS). The agricultural market access commitments include tariffication and tariff reductions. After China joins the WTO, both opportunity and challenge will exist in the agricultural sector. The opportunity of agricultural exports could be a potential in the future, but in the early period of China's WTO accession, the biggest challenge is the large agricultural imports (TRQs) which could bring huge economic, social and environmental impacts.

The impact of China's accession to the WTO on agricultural environment

After its WTO accession, China should find its position in the global agricultural market, and adjust its agricultural production structure according to the comparative advantage. Although China possesses comparative advantages in some agricultural products, the low quality (especially the environmental quality) of the commodities could limit export competitiveness. Many countries have increased their sanitary and phytosanitary standards and the inspection measures are becoming stricter, which constitutes a method of Technical Barriers to Trade (TBT). If China wants to export agricultural products in the international market, it must urgently improve the quality of the products to meet international standards.

The environment could be a serious problem in China's sustainable agricultural development, therefore environmental considerations should be taken into account in agricultural policy formulation. Promotion of 'green agriculture' could be the ideal solution for China to maximize the benefits of trade liberalization and achieve sustainable agricultural development. The main environmental problems in cotton production are the following:

- pesticide pollution;
- chemical fertilizer pollution;

- plastic film pollution;
- irrigation problems;
- transgenic cotton production.

Scenario analysis: policy simulation

This model scenario analysis tries to find what kind of impacts large agricultural imports could bring to China. According to the Compilation of the Legal Instruments on China's Accession to the World Trade Organization, China will adopt tariff-rate quotas (i.e. a system in which imports up to the quota level are charged a minimal tariff and imports above that level a high tariff). Three examples are chosen for simulation:

- Wheat – According to the schedule of the Compilation of the Legal Instruments on China's Accession to the World Trade Organization, the TRQ of wheat for year 2002 should be 8.468 million metric tons.
- Corn – According to the schedule of the Compilation of the Legal Instruments on China's Accession to the World Trade Organization, the TRQ of corn for year 2002 should be 5.58 million metric tons.
- Cotton – According to the schedule of the Compilation of the Legal Instruments on China's Accession to the World Trade Organization, the TRQ of cotton for year 2002 should be 818,500 metric tons.

The reason for selecting the import of three products for scenario analysis is based on the following consideration. The JAPA model is an equilibrium model, all resources are movable. If only cotton is imported into the Chinese market, the resource (land, labour etc.) can move to the production of wheat, corn and other products, which means the import of one product would not bring a huge impact on Chinese agriculture. Wheat, corn and cotton are three important products which have no competitive advantage in China. When large imports of the three agricultural products enter the Chinese domestic market at same time, it could bring enormous impacts to Chinese agricultural production, the agricultural resources surplus may happen and the prices of agricultural products may decrease.

The scenario analysis tries to find if the import TRQs for the above three commodities can fully enter Chinese markets, and what could be the consequences. Actually the JAPA model is designed only for Jiangsu province, so it is necessary to divide the total TRQs into the different provinces in China. Jiangsu province gets its shares of TRQs according to its production share.

Integrated assessment of trade liberalization

The integrated assessment aimed to assess the consequences of the first couple of years of China's WTO accession, when large agricultural imports enter the Chinese market, with the assumption that China has not make obvious progress in agricultural

exports because of technical limitations and green barriers. The model scenario analysis showed following results:

Economic impacts

- Helps to solve the shortage of two commodities

The baseline projection shows that in 2002, Jiangsu will have shortages in cotton and corn, but not in wheat. The import of cotton and corn can help Jiangsu to solve the shortage, bringing a positive impact evaluated as a benefit of about 871.56 million RMB.

- Sown area and output decrease

The wheat, corn and cotton imports will bring a great pressure on agricultural production, therefore the production structure should be adjusted to adapt to the change. According to the optimal solution of the partial equilibrium model, compared with the baseline projection, the sown area of wheat will decrease by 4.91 per cent, that of corn by 2.48 per cent and that of cotton by 3.82 per cent, and as a result of structural adjustments, the sown areas of other crop products may increase. For example, the sown area of rice will increase by 0.24 per cent, and soybean by 0.86 per cent, but this sown area expansion will be limited by the levels of consumption. In any case, the total sown area will decrease by 1.11 per cent, about 92,624 hectares.

The production structure adjustments will also cause output decrease, so farmers will face loss. For example, after production structure adjustments, the output of wheat will decrease by 436,294 metric tons, evaluated as -521.37 million RMB; that of corn decreases by 58,106 metric tons, evaluated as -71.12 million RMB; that of cotton decreases by 22,707 metric tons, evaluated as -296.42 million RMB; on the other hand, the output of rice increases by 42,902 metric tons, evaluated as 51.56 million RMB; that of soybean increases by 4,475 metric tons, evaluated as 12.67 million RMB; that of rapeseed increases by 16,355 metric tons, evaluated as 48.13 million RMB; that of fruit increases by 35,168 metric tons, evaluated as 26.77 million RMB. The aggregated impact of the outputs change for all agricultural products is evaluated as -703.62 million RMB.

- Prices of agricultural products decrease

The wheat, corn and cotton imports will cause price decreases, not only the prices of the three commodities, but also the prices of all other crop commodities, because the production structure adjustment increases the sown area and output of other crop production. The model scenario analysis results shows the price of wheat will decrease by 3.89 per cent, corn by 0.57 per cent, cotton by 2.84 per cent, rice by 0.52 per cent, soybean by 1.01 per cent, rapeseed by 2.99 per cent and fruit by 1.23 per cent, comparing with the baseline projection. The price decrease of agricultural commodities is favourable to consumers, and is also favourable to animal production because some main products and by-products can be used as feed, but it is unfavourable to producers of agricultural commodities.

- Producer surplus and farmers' income decrease

The wheat, corn and cotton imports cause farmers to reduce the production of the three products, and at same time increase the production of other products to a small extent. Although it could bring positive income effect accruing from increased production of rice, soybean, rapeseed, fruit and barley, in general after agricultural production structure adjustment, the producer surplus for crop products will decrease by 3.2 per cent. The price decreases are negative to the producer of agricultural products, but they are positive to consumers. The impact of aggregated price decrease is evaluated as 921.75 million RMB.

After China's accession to the WTO, China will reduce the tariff to 1 per cent within TRQs, so the Government tariff income will decrease. The tariff decrease for importing the three commodities within TRQs is evaluated as 1,018.55 million RMB.

China should pay foreign currency to import agricultural commodities, the cost for importing the three commodities is evaluated as 1,626.90 million RMB. This should be netted for current expenditures on the three agricultural products, roughly 703.62 million RMB, therefore the net outlay on imports would be 923.28 million RMB.

Social impacts

- Promote agricultural production structure adjustment

The trade liberalization should promote agricultural production structure adjustments according to the comparative advantage. China needs to find its position in the global market, and reallocate resources to the products which have comparative advantage.

- Utilization rate of cultivated land decrease; valuable land lies waste

Jiangsu province in south-eastern China, carries out a multi-cropping system of production, so there may be two or three harvests in one field. There are many combinations of cropping patterns, so sown area and cultivated land usage are differentiated. Planting-packages for multi-cropping systems are used in the JAPA model. After agricultural production structure adjustments according to the import increase, the model scenario analysis results indicated that the valuable cultivated land can not be sufficiently used, and about 92,624 hectares of cultivated land will lie waste. The average shadow price of the cultivated land estimated by the partial equilibrium model is 155 RMB per hectare. Therefore the opportunity cost of cultivated land which lies waste is 14.36 million RMB.

- Reduction in the self-sufficiency rates of agricultural commodities

Owing to the three commodity imports, after the production structure adjustment, the self-sufficiency rate of the three agricultural commodities will decrease, i.e. the

self-sufficiency rate of wheat decreases from 144 per cent to 137 per cent, that of corn decreases from 40 to 38 per cent, and cotton from 91 to 87 per cent, while the self-sufficiency rate of rice increases from 124 to 125 per cent, that of soybean from 35 to 36 per cent, rapeseed from 81 to 82 per cent, and fruit from 159 to 160 per cent.

- **Agricultural employment decrease**

The model scenario analysis result also shows that after the production structure adjustment, owing to the decrease of agricultural production, the agricultural employment decreases by 16.55 million working days, farmers do not have enough farm work to do. Unemployment in the agricultural sector will increase. Calculated according to the current agricultural labour force wage rate, the opportunity cost of the increased unemployment is 148.95 million RMB.

- **Poverty and social instability**

Poverty is still a big problem in China. About 60 million rural residents are still below the poverty line, mostly located in less developed areas where agricultural production constitutes their main source of income. Any decrease in farmers' income could worsen the poverty in rural areas. Decrease in farmers' income and increase in unemployment could be factors for social instability. Additionally, if large numbers of farmers move to urban areas to find jobs, it could also worsen unemployment in urban areas.

Environmental impacts

- **Reduction in the application of chemical fertilizers and pesticides**

The wheat, corn and cotton imports will necessitate agricultural production structure adjustments. According to the optimal solution of the partial equilibrium model, the sown area of crop products will decrease. This could result in a decrease in chemical fertilizer and pesticide application. The reduction may include two parts: firstly, the production structure change causes the sown area decrease, which will reduce the inputs that include chemical fertilizers, pesticides, water, etc. The model scenario analysis shows that the usage of chemical fertilizer will decrease by 1.01 per cent and pesticide by 1.39 per cent, comparing with the baseline projection. Secondly, owing to the decrease in prices of agricultural products, farmers could reduce the quantities of applied chemical fertilizer and pesticide. If the reduced quantities caused by the decrease of sown area are considered, the reduction of pesticide application can be evaluated as 0.10 million RMB, and the reduction of chemical fertilizer application can be evaluated as 1.11 million RMB.

- **Cultivated land may be lost**

Cultivated land is a very important revival agricultural resource. China is a 'cultivated-land-scarce' country; cultivated land per capita is 0.11 hectares. In Jiangsu province, the cultivated land is even less, only 0.07 hectares per capita and

0.185 hectares per agricultural labour force in 1999. The average rate of cultivated land decrease was 0.3 per cent for the last 15 years, meaning that China has lost on average 282 thousand hectares of valuable cultivated land each year. In such circumstances, the waste of cultivated land could be a very serious problem for sustainable agricultural development. If cultivated land lies waste, this valuable land could be occupied for non-agricultural purposes, such as city extension, industry and building, which will impair sustainability of China's agricultural production capacity. In north-western China, if the cultivated land is not used and irrigated, it may simply turn to wasteland. The decrease of cultivated land has been a serious phenomenon in China.

Cost-benefit analysis

Cost-benefit analysis (CBA) is a framework that allows the monetized costs and benefits of a project or policy to be compared, using the various valuation tools. It is a useful way of converting all the information relevant to the assessment of a proposed action into a comparable and easily understood form. The CBA can be undertaken ex ante or ex post, which could help policy makers understand the net benefit of a project or policy. In this section, the CBA will be applied to assess the impact of the import TRQs of the three agricultural commodities. Because it is very difficult to assign economic values to some indirect social and environmental impacts, the CBA only includes impacts which can be evaluated. The result of the CBA is listed in Table 1.

Table 1: Cost-benefit analysis of the impacts in the agricultural sector in Jiangsu

	million RMB
Costs of the import TRQs of the three agricultural commodities	
Agricultural output value changes	703.62
Prices of agricultural products decrease (for producer)	921.75
Agricultural employment decrease	148.95
Tariff loss	1,018.55
Cultivated land lies waste	14.36
Payment for the import	923.28
Total costs:	3,730.51
Benefits of the import TRQ's of the three agricultural commodities	
Solve the shortage of the two commodities (corn and cotton)	871.56
Prices of agricultural products decrease (for consumer)	921.75
Reduction of pesticide application	0.10
Reduction of chemical fertilizer application	1.11
Total benefits:	2427.20
Net cost:	1,303.31

Source: Author's calculation according to simulation results.

Table 1 shows that after the import of the three agricultural commodities (TRQs), the agricultural production structure change could cause the agricultural output value to

decrease by 703.62 million RMB; the price decrease will reduce farmers' income by 921.75 million RMB; the agricultural employment will decrease by 16.55 million working days, the opportunity cost is valued as 148.95 million RMB; after China decreases the tariff rate to 1 per cent, the tariff loss for the TRQ import of the three commodities is about 1,018.55 million RMB; the opportunity cost of the cultivated land which lies waste is evaluated as 14.36 million RMB, and the payment for the import of the three commodities is about 923.28 million RMB. Therefore the total cost is 3,730.51 million RMB in Jiangsu province.

On the other side, the imports can solve the shortages of corn and cotton in Jiangsu (Jiangsu does not have a wheat shortage), so the benefit for this is valued as 871.56 million RMB; and the price decrease of agricultural commodities is a positive impact to consumers, so it brings 921.75 million RMB in benefit to consumers. Additionally, the agricultural imports can reduce the application of pesticides and chemical fertilizers, reducing environmental pollution. The benefits are about 0.10 million RMB and 1.11 million RMB respectively, therefore the total benefit is 2,427.20 million RMB in Jiangsu. Because in Jiangsu irrigation water is abundant, there is no water quota used, therefore the irrigation factor is not evaluated here.

Comparing the total costs and total benefits, assessment of the net cost of importing the import of the three commodities is 1,303.31 million RMB in Jiangsu. However this estimated net cost applies only to the agricultural sector in Jiangsu, the benefits to city extension, industry and building, to textile industrial production and export are not included, which will be estimated by each sector. For example, if Jiangsu can increase textile exports by 5 per cent, the export revenue could increase by US\$ 230.45 million, roughly 1,843.6 million RMB.

Proposed policy recommendations

Increasing the competitive advantage of Chinese cotton

After China joins the WTO, both opportunity and challenge will confront the agricultural sector. China's domestic markets will become a part of the global market. As China imports some products, it should adjust its production structures and develop a long-term strategy for agricultural exports. Therefore it is important to increase the competitive advantage of cotton.

- Supporting agriculture with 'green box' policies

The agricultural basis in China is weak, and agricultural input is very low compared to other countries. Agricultural production has a low resistance to natural disasters such as drought, flooding, typhoons, and plagues of pest or disease. For example, the main cotton producing regions are located in the dry or semi-dry areas on the north side of the Yangtse river, and water shortage is a restrictive factor for the sustainable development of cotton production. It is important to use 'green box' policies to build water conservation projects and

improve irrigation systems to protect the agricultural environment, to improve rural infrastructure, to establish marketing information services and to invest in research, training and extension in agriculture. (Recommendation to MOA.)

- Promoting new cotton varieties

For long time now, Chinese cotton variety breeding has aimed at increasing yield without paying much attention to improving quality. After the China's WTO accession, Chinese agricultural products will face not only the competition of prices, but also the competition of variety and quality. Local governments should invest more to promote technological innovation in order to increase the product quality. The prevalent varieties of Chinese cotton have an average length of 29-31mm and an average fineness of 5500-6500m per gram, which are well above the world average level. There is a big demand for long-staple variety, medium long-staple variety, the variety with a fibre strength of 23-28 gf/tex, micronaire 3.7-4.2, and varieties which are resistant to blight, cotton wilt and pest. (Recommendation to MOA, research institutes.)

- Promoting the production of special purpose cotton

Because textile industries are required to produce high quality products, they impose increasing demands for special purpose cotton, such as long-staple cotton, medium long-staple cotton, colour cotton and organic cotton. Owing to climatic conditions, Xinjiang has the advantage in producing long-staple cotton and organic cotton. The Huang-Huai region and Yangtse river region may try to produce medium long-staple cotton and colour cotton. (Recommendation to MOA, farmers.)

- Adjusting regional distribution

Mainland China has 31 provinces, out of which 24 provinces produce cotton. Some provinces have a strong comparative advantage, while others do not. Production capacity and future demand should be analysed, and regional cotton distribution should be adjusted in order to shift production to regions that have the comparative advantage. There are 10 top cotton producing provinces, which can be considered as the cotton production zone. Local government should invest capital in the construction of farmland and in developing new varieties through technological extension to stabilize cotton production. (Recommendation to MOA, local government.)

- Establishing cotton production cooperatives (sector association)

China is a 'cultivated land scared' country, a situation that results in low land productivity and also low labour productivity. The low level of production cannot suit the big markets - it is not possible to increase production efficiency over small scattered plots. This restricts the demand for agricultural inputs and hinders the application of new technology, which is not favourable to improving the quality of agricultural products.

Establishing cotton production cooperatives is a possible solution. The cooperative is organized by farmers on the principle of voluntary participation. It should be an economic corporate organization and can assume a legal status. The cooperative will have the ability to purchase good quality cotton seed, cultivate one variety in one region in order to ensure the quality, and demand high prices for high quality products. Additionally, it can increase agricultural inputs, introduce new varieties and benefit from technical innovations. Finally it can negotiate production orders with cotton end users in order to stabilize production and ensure farmers' income. The establishment of cotton production cooperatives can be top down and bottom up at same time. (Recommendation to MOA, farmers.)

Maintaining a balance between supply and demand

The ultimate objective in government intervention in cotton production is to maintain a basic balance between supply and demand and avoid fluctuations. This balance includes regional balance and variety balance. Creating regional balance means that regional production quantities should be decided according to the regional processing capacity, transport capacity and cost, natural resources limitations, and it should try to minimize the risks of natural disasters.

Different textile industries require different grades and varieties of cotton. Some textile industries need long-staple cotton to produce high quality textiles, some need short-staple cotton to produce jeans, some need organic cotton and others require colour cotton. Given the need for variety, China should not only pursue the supply and demand balance of aggregate cotton quantity, but also balance the availability of the main grades and varieties.

- Analysing the impacts of China's accession to the WTO and deciding on cotton production scale and distribution

After China's WTO accession, the supply and demand situation of agricultural products could change, therefore the production structure and resource allocation should be adjusted. The production structure adjustment is not simply a matter of changing the ratio of grain products to cash crops, but deciding on the production quantities of main products according to the comparative advantage. There are many constraints for agricultural production, such as resources limitations, potential demand, import and export possibilities. The complement and supplement relationship among products are very complex, which could be solved by applying the CGE model. The next target is to establish a Chinese Agricultural Policy Analysis model (CAPA) to provide a quantitative basis for the agricultural structure adjustment of each province. (Recommendation to MOA.)

- Completing the multi-channel cotton marketing system and promoting lateral cooperation among different cotton marketing entities

After the old cotton-marketing monopoly system is abolished, chaos in the cotton markets can be expected. The 'cotton war' in 1999 was characterized by different

cotton marketing entities redividing shares in the cotton market. China is in the process of establishing a new, open cotton marketing system. It will be important to coordinate relationships between the different entities in order to avoid vicious competition.

In the current situation, the different cotton marketing entities have their advantages and disadvantages, and it is necessary to promote lateral cooperation amongst them. For example, the textile mills could cooperate with the cotton gin factories of the Supply and Marketing Cooperatives (SMC) in purchasing and processing the cotton; the textile mills could provide a purchase fund and the cotton gin factories of the SMC purchase and process the cotton, both of them benefiting from this cooperation. (Recommendation to SMC.)

- Promoting the production of cotton to order

One approach for balancing the production of cotton grades and varieties is to promote the production of cotton to order. The textile industries and cotton production cooperatives (or farmers) can contractualize cotton production and purchasing. The contract should indicate the purchase quantity, variety, grade and price; the purchase price will be decided according to the price in the wholesale market at the harvest season (for example 5 per cent higher than the price of the National Cotton Exchange). The textile industries will pay earnest money to the cotton production cooperative, both parties to the contract take legal responsibility. This method will ensure that the textile industries are supplied with the qualified cotton when they have special requirements, while at the same time it can stabilize the cotton production. (Recommendation to MOA, textile factories and farmers.)

- Improvement of the cotton wholesale market

A National Cotton Exchange was established in April 2000 in Beijing. It has 122 seats, 77 belong to SMCs, 35 seats to textile industry entities and 10 seats are allocated to cotton import and export companies. The Exchange sells 'old cotton' (cotton stocks and reserves) and Xinjiang cotton at auction, about 10 thousand metric tons per day. Although the Exchange has established 20 stations through its frame of networks, it is only allowed to deal in Beijing Central Station. In other stations it is only possible to observe the auction information.

There are still improvements to be made to the National Cotton Exchange. It is urgent to include 'new cotton' at the auction. There are only 122 seats in the National Cotton Exchange, which is too few for all the cotton marketing dealers in the whole of China. The future target of the Exchange should be that every cotton marketing dealer with a license is entitled to a seat in the Exchange, and any kind of cotton can be traded in any network station of the Exchange.

Besides the National Cotton Exchange, China needs 'on the spot' cotton transaction markets in the main cotton producing regions. For long time, the Chinese Government did not allow 'on the spot' transaction markets, in order to ensure SMC monopoly. After the monopoly marketing system is removed, it will

be necessary to establish on the spot transaction markets in the main cotton production regions. (Recommendation to SMCs.)

- Establishing a textile exporter association

After China's accession to the WTO, many enterprises could have licenses to export textiles and clothing, and it would be advisable to establish a textile exporter association in order to avoid vicious competition and to guarantee product quality. China's textile industry should change strategy from producing low-price products to producing medium price/medium quality products, and even high quality products (such as organic cotton or colour cotton products). (Recommendation to MOFTEC, textile companies.)

- Establishing an agricultural consulting system

After the economic reform, the production plans made by the Government in the agricultural sector were abolished. An agricultural consulting system can engage in the collection and analysis of marketing information, and provide a service to farmers to guide their agricultural production. As a semi-government organization, the agricultural consulting system works as an intermediary between the Government, the industrial processing enterprises of agricultural products, wholesale markets, agricultural cooperatives and farmers. After China's WTO accession, China will have to adjust the structures of agricultural production, and the consulting system can work with government policy makers, marketing research institutions, wholesale markets, agricultural cooperatives and farmers, to realize the agricultural production structure adjustments. (Recommendation to MOA.)

Stimulate sustainable development in the cotton sector

Sustainable production is defined as "production that meets the needs of the present and does not hamper the ability of future generations to satisfy their needs." Although the Government also has to consider other policy objectives concerning income, equality, technology, financial constraints and the priorities under such constraint, these objectives should be a part of policy making instead of only the definition of sustainable agriculture. China is a big agricultural country and large quantities of chemical fertilizers, pesticides, plastic film and irrigation water are used in agricultural production. For example more than 1.6 million metric tons of chemical fertilizers, 6.7 thousand metric tons of pesticides, 40 thousand metric tons of plastic film and 368 million m³ irrigation water are applied for cotton production annually in China, which must have enormous influence on the environment.

Different regions have different natural conditions and different degrees of dependency on unsustainable production methods. Therefore, in transition to developing sustainable cotton production, there should be alternative methods to choose from.

- Carrying out integrated assessment on environmental impacts

When a country tries to accelerate economic growth through trade liberalization, it should also consider the possible negative impacts on the environment. It is necessary to enhance any integrated assessment on the environment with the methodological approach suggested by UNEP, to increase government and public awareness on environmental issues, and to address the relationship between economic development and environmental protection.

- Decreasing the application of chemical fertilizers

One of the environmental problems with cotton production is that the utilization rate of chemical fertilizer is very low (about 35 per cent), and a large proportion of the product is wasted and causes environment pollution. So China should therefore support research and extension into using chemical fertilizers more efficiently. If the utilization rates of chemical fertilizer can be increased to 45-50 per cent, the applied quantities could be reduced. Although all fertilizers have adverse effects on the environment, natural manures cause less problems than chemical fertilizers. Plant residues can remain in the field after harvesting so that the minerals within the crop stalks decompose back into the soil, lessening the pressure to apply chemical fertilizers. (Recommendation to SEPA and MOA.)

- Establishment of a pest and disease prevention service

The utilization rate of pesticides in China is also very low (about 30 per cent). There are several reasons for this; firstly, farmers cannot find the right time to kill the pests in the early stages, so after the pest plague become very serious they have to use large quantities of pesticides to control the situation; secondly, farmers like to use over the recommended dose of pesticide to be sure the pests are killed immediately; thirdly, when farmers do not apply pesticides at the same time, pests can move from one plot to another plot to avoid exposure; fourthly, farmers like to buy low priced pesticides, which tend to be highly toxic, high residue and harmful to the environment.

In order to increase the efficiency of applied pesticides, a pest and disease prevention service should be established. The service will have contracts with farmers and production cooperatives to provide a service to control plant diseases and eliminate pests. The advantage of the service is it will be able to predict plant diseases and plagues of pests, and use appropriate pesticides to effectively eliminate them, while at the same time minimizing environmental pollution. An experiment in Jiangsu showed that this method can decrease the applied quantity of pesticide by 50 per cent. (Recommendation to SEPA and MOA.)

- Integrated pest management

Integrated pest management (IPM) consists of a careful integration of a number of available pest control techniques that discourages pest population development and keeps the use of pesticides and other interventions to levels that are economically justified and safe for human health and the environment. IPM emphasizes the

growth of a healthy crop with the least disruption to agro-ecosystems, thereby encouraging natural pest control mechanisms. It seeks to reduce pest populations to economically manageable levels through a combination of biological control (use of pest-resistant varieties), culture control (e.g. crop rotation, inter-cropping), physical control (hand picking of pests) and less toxic chemical controls (use of pheromones to trap pests). However, it allows the use of chemical pesticides, even synthetic and toxic ones, only when there is a real need.

A few countries in Asia, including China, have adopted national IPM policies, with the help of national and international agencies. Although these policies were targeted at rice production initially, their effects have subsequently spread to other crop sectors. Presently, a 12 million euros project to enable small cotton farmers in Asia to cut their insecticide use by half and increase their production is to be implemented by the FAO. The European Union-funded project will train 90,000 small cotton producers in integrated pest management. Six Asian countries are participating in the project, China, India, Pakistan, Bangladesh, the Philippines and Vietnam. The EU/FAO project provides for 3,800 Farmers' Field Schools. The schools use the participatory learning approach to educate farmers in IPM techniques, as has been done by Indonesia. Farmers will learn more about cotton agronomy, cotton agro-ecosystems and alternative pest control techniques. The aim is to keep a balance between pests and their natural enemies and to keep the spraying of expensive and potentially damaging and dangerous insecticides to an absolute minimum. Pilot projects in China financed by the Asian Development Bank have shown that cotton farmers have reduced their use of pesticides and increased yields at the same time (FAO, 1999). The Chinese Government should also provide financial support to extend Integrated Pest Management. (Recommendation to SEPA and MOA.)

- Partial alternatives to pesticide

Partial alternatives to the use of pesticides exist that lead to more sustainable cotton production. Partial alternatives include biological control, microbial control, control through sex pheromones, physical removal of pests and cultivation of genetically modified cotton. The first two are based on the idea that every organism on earth has natural enemies; biological control emphasizes the importance of parasites and predators as natural enemies and microbial control usually involves a spray containing a bacterium or a fungus or a baculovirus. Pheromones are the substances female insects secrete to attract males for mating. It is possible to trap part of the pest population through imitating these pheromones by making a synthetic substance with the same effect. (Recommendation to SEPA and MOA.)

- Strengthen administration of GM cotton production

The acreage of transgenic cotton in China has been increasing fast. In 1998 the acreage was no more than 100,000 hectares, whereas in 2000 it skyrocketed to almost 1 million hectares. The proportion of the transgenic cotton out of the total cotton growing area has increased from 2.2 per cent in 1998 to 28 per cent in 2000.

Three series are dominant in China, accounting for more than 80 per cent of the total transgenic cotton grown.

Until now, China has not issued administration regulations for agricultural GMO products on commercial production, processing, marketing, import and export. In the initial period of GMO production, a series of practical administration regulations are essential for its stable development. The principle is that administration regulations should consider not only the benefit to producers, but also the benefits and rights of consumers, as well as the environmental impacts.

- Prudently make extension of currently approved GM cotton varieties
Only after approval from the GMO administration body can farmers produce the currently approved GM cotton varieties, within isolated zones to prevent hybridizing with non-GM cotton varieties.
- Carry out an identity preservation (IP) system for GMO products
It is important to apply an IP system for GMO products. The storage, processing, transportation, and marketing of GMO products should be separated from non-GMO products, which could increase the costs by 6-17 per cent, but this is the best measure to be taken to prevent genes proliferation and pollution.
- Carry out labelling for GMO products
The GMO labelling should indicate which gene has been modified in the product (such as Bt), which makes it possible to identify the specific product when some transferred genes prove unsafe. Consumers have the right to information on GMO products and to make informed decisions.
- Promise not to export GMO products
China should promise not export GMO products, as this strategy could increase the competitive advantage of exporting non-GMO products.
- Apply the (AIA) procedure for the import of GMO products
The purpose of the Advanced Informed Agreement procedure (AIA) is to ensure that recipient countries have both the opportunity and the capacity to assess risks that may be associated with a living modified organism (LMO) before agreeing to its import. (Recommendation to MOA, SEPA and the private sector.)
- Ban the production, marketing and application of all highly toxic, high residue pesticides
Many highly toxic, high residue pesticides have been banned by developed countries, but they are still being used in China - farmers can still buy them and use them in agricultural production. It is important to ban the production, marketing and application of all highly toxic, high residue pesticides through legislation. The Government should offer subsidies to the factories that produce pesticides to compensate for the revenue decrease owing to the ban, and encourage

them to produce high efficiency, low toxicity, low residue pesticides. (Recommendation to SEPA and MOA.)

- Levy an environmental pollution tax
Agricultural area-source pollution is more difficult to control than the industrial point-source pollution. The low prices are the main reason that farmers like to apply low efficiency chemical fertilizers, and highly toxic, high residue pesticides; and on the other side, high prices hinder farmers from applying high efficiency fertilizers (such as compound fertilizers), and low toxicity, low residue pesticides. It is possible to use an environmental pollution tax to give farmers the economic incentive to reduce the applied quantity of chemical fertilizers and pesticides. The tax will increase the price of low efficiency chemical fertilizers, highly toxic, high residue pesticides, and revenue can be used to subsidize farmers in purchasing more environmentally sound products. (Recommendation to SEPA.)
- Promoting the research and development of pesticides using Chinese herbal medicine
Chinese herbal medicine is a great treasure, and it can contribute to the production of pesticides that are friendly to environment. The Chinese Government should provide financial support to research into producing low toxicity low residue herbal pesticides which can be degraded in the eco-environment. This would benefit not only the farmers, but also the consumers of agricultural commodities as an environmentally friendly industrial sector with bright future. (Recommendation to SEPA, MOA, research institutes and the private sector.)
- Increasing irrigation efficiency
In the north-western area of China it is very important to increase the utilization rate of irrigation water, from a current 30 per cent to 70 per cent (Mao, 1999). This calls for technological, institutional and policy changes. Drought-resistant varieties need be bred to reduce water requirements, and irrigation systems that reduce percolation and leakage should be developed. The various kinds of irrigation practices such as drip irrigation, furrow irrigation, sub irrigation, sprinkler irrigation and irrigation at night to reduce water evaporation, should be experimented with to discover the best methods in different regions. Research on optimal irrigation scheduling and irrigation volume should be encouraged and flood irrigation that is typical in many regions must be stopped as soon as possible.

More fundamentally, new laws governing the use of water should be established and the enforcement of laws be strengthened. Policies concerning subsidies on irrigation and water use must be reformed in most producing regions. In some regions, irrigation water quotas could be established, where quota price and above-quota prices of irrigation water could be settled in order to increase irrigation efficiency. (Recommendation to SEPA, MOA and farmers.)
- Promoting the production of organic cotton

Local governments should encourage the introduction of environmentally friendly cultivation practices. Organic cotton is the most sustainable alternative to conventional production and it comes close to this goal. Organic farmers use biologically-based rather than chemically dependent growing systems to raise crops. Organic cotton is produced without synthetic insecticides and fertilizers and defoliators, as well as other inputs prohibited by the certifying organization. Organic cotton farming is a high yielding and environment preserving farming method. However, the transition to organic farming is not an easy task. Much effort has to be made to facilitate the transition and address the aftermath. Due to variations in natural conditions, in-depth research needs to be conducted to find out if local conditions are conducive to organic farming and if so, what specific combinations should be chosen for organic farming. China has started building a base for encouraging the production of organic cotton in some regions, on a very small scale. In some other regions however, organic cotton farming is unheard of. For the Chinese Government and cotton growers, organic farming is a new challenge after years of dependency on chemicals for higher cotton yields. At present, organic farming is still conducted as pilot projects. However, further development can be expected from China's organically grown cotton. Since organic cotton farming is a highly labour intensive process, it will be to China's advantage to grow organic cotton, given its abundant labour resource and low labour costs, which is a bright way forward for sustainable agricultural production. The Xinjiang region has very good natural conditions for the development of organic cotton, and the local government can play a very important role in promoting organic production. (Recommendation to SEPA, MOA, private sector and farmers.)

Conclusions

This study developed an analytical framework with the JAPA model scenario analysis, integrated assessment and cost-benefit analysis to make an ex ante assessment of the economic, social and environmental impacts caused by China's accession to the WTO. The scenario analysis results show that trade liberalization policies do not always bring benefits, the economic benefits accruing from trade liberalization are not equal among sectors and countries, and at the same time trade liberalization may bring social and environmental impacts such as unemployment, poverty, and environmental pollution. Therefore, as policy makers draw up trade liberalization policies to increase economic gains, it is necessary to consider their impacts on social and environmental problems.