Science and technology: the essential way to keep sustainable development of world agriculture and trade

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Abstract
Nowadays world food security and agricultural product trade are confronted with new challenges. On the one hand, growth of gross food output has come to a standstill, and gross food output in 2002 declined compared with that in 1997. On the other hand, per capita food consumption increases continuously. Therefore, the prospects of world food security are not very bright. In recent years, world food trade increased rapidly, but the growth was chaotic, liberalization progressed slowly and was largely independent of the world multilateral trade system. The imbalance between developing members and developed members was serious. To comprehensively solve the problems in world agriculture and agricultural product trade, firstly, it's necessary for developing countries to use more science and technology, to improve traditional agricultural technology, build modern biotechnology, and strengthen technologies associated with food safety, environmental ecology, and efficient water resources utilization, while extending the agricultural industries value-chain and guaranteeing stable and efficient growth of food output. Secondly, it's necessary to establish a fair and free international environment for agricultural product trade. We must pay close attention to the existence and development of small farmers, to establish a fair and reasonable environment for agriculture development, strengthen international exchanges and cooperation, and promote the construction of agricultural organizations. All these measures are needed for better world food security and trade in agricultural products.

Key Words
Science & tech, food security, agricultural trade

Introduction

Since the 1950's, production of world grain has achieved rapid growth. However, under the influences of population growth, per capita volume of grain has not increased remarkably. Moreover, due to the unequal distribution of world agricultural natural resources, the agriculture development level of different countries in very unequal and the gaps have widened and have become a serious threat to world food security. For better world agricultural development and food security, important measures are to enhance agricultural technology development, especially the utilization of new technologies in all aspects of agriculture in developing countries, and to promote world agriculture trade. This paper will expand on these vital subjects, with some emphasis on the actions that China is taking with respect to them.

1. New challenges that world food security and agricultural trade are facing

Challenging factors

Challenges to world food security and agricultural products trade come from several aspects, including domestic resources condition, restriction of economic development level, international markets and price (Figure 1). However, from a comprehensive view, the gap between food production and consumption is still the determinant factor in international food price and trade. Meanwhile, food price and trade affect world food production and consumption. At present, many developing countries are confronted with the situation that per capita resources are in shortage because of large populations, and domestic food production can not meet the consumption demand, which needs international trade to reach a balance. International trade has made a great contribution to world food security. However, restricted by factors like policy, tariff, technology and price etc., world agricultural production and trade are confronted with new challenges.

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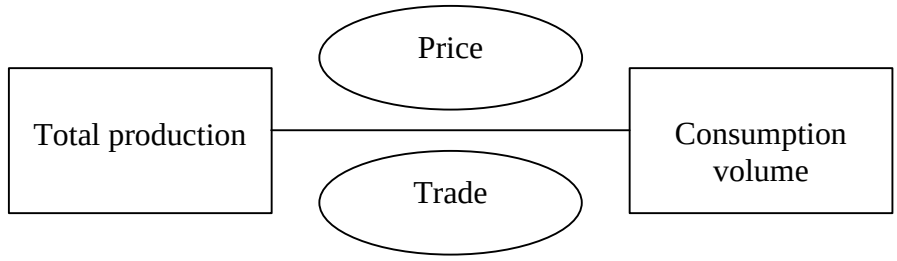

Figure 1. Challenging Factors that Food Security is facing

1.2 Trends in world food production

1.2.1 Output increase higher than population growth

Since the 1950's, world grain production has achieved unprecedented growth. For example, from 1950 to 2002, world grain output increased by 321%, from 631 million tons to 2029 million tons, while in the same period, world population grew by 240% from 2555 million to 6130 million (Figure 2), and the average per capita grain went up by 134% from 247 kg to 331 kg (see also Figure 5).

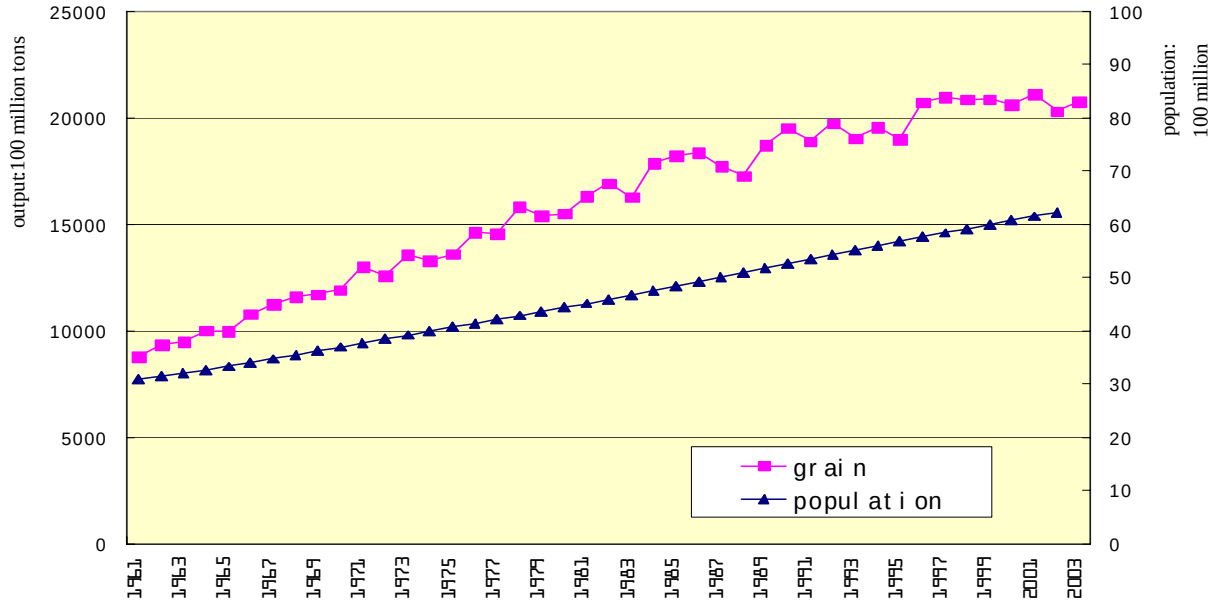

Figure 2. World food output and population trends from 1961-2002

1.2.2 Growth of yield is main factor in output increase

Since the 1960's, world grain yield has become the main factor to enhancing gross food output. The average yield per hectare was 3.12 tons in 2003, 2.27 times of that in 1961, with annual growth rate of 3.63%. And the yield per hectare of wheat, corn and rice increased 1.27, 1.26 and 1.08 times respectively, with annual growth rate of 1.94%, 1.92% and 1.72%. But, over the whole period, world farm land only increased by 9.62% from 1279 million ha. to 1402 million ha.(Figure 3)

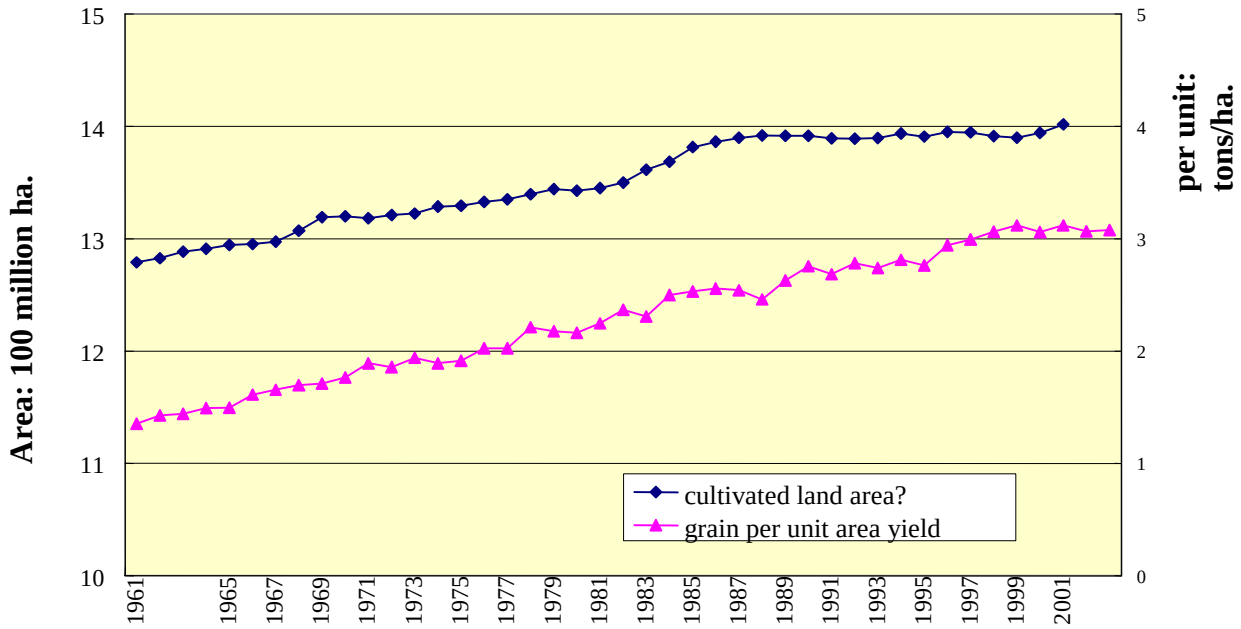

Figure 3. World grain planting area and per unit area yield

1.2.3 Yield growth slows and reaches standstill

From the 1960's, generally world food production has grown. But the growth rate in yield declined recently (Figure 4). In 2002, world food gross output was 2.09 billion tons, more than twice that in 1961, with average annual growth rate of 2%. It can be divided into three stages:

1961-1985: rapid increase period with the result a doubling

1985-1997: slow increase period with growth of only 16.3%

After 1998: standstill period. Gross output declined gradually. For example, food output in 2002 only 2.09 billion tons, decreasing 14% compared with that in 1997.

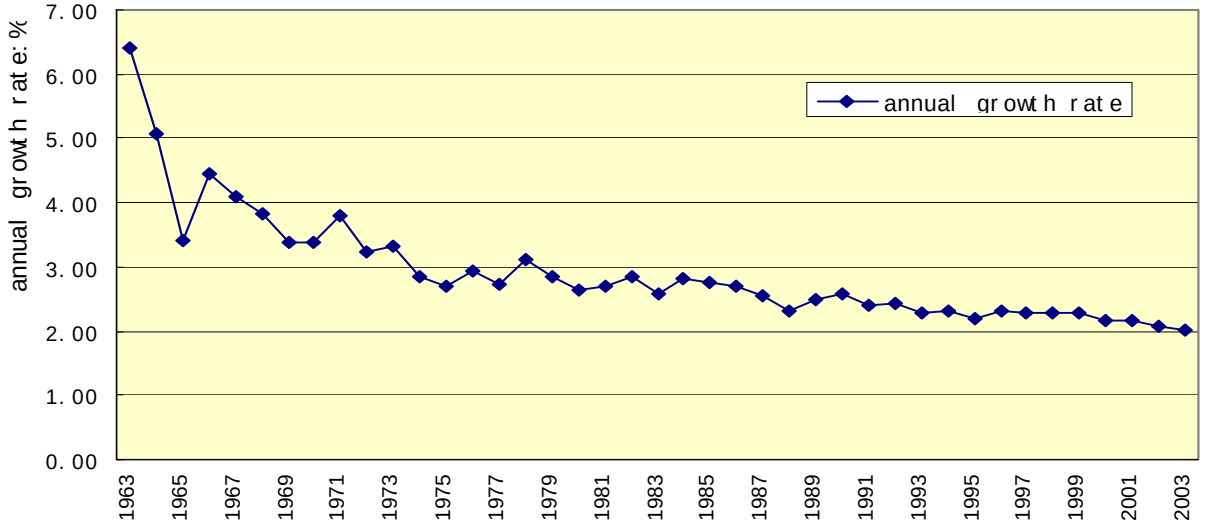

Figure 4. world grain annual growth rate of per unit area yield

1.2.4 The prospects of world food security is not very bright

According to current situation of world agriculture and food production, it's difficult for food production to meet the demand of population growth and economic development. World food security is not very bright, because of the following reasons:

Food production declined in countries short of food. According to statistics, 15 top countries for grain output such as China, USA, India, France, Indonesia, Canada, Russia, Germany and Brazil cover 73.8%

of world food output. Among the 86 low income countries (less than $1,345 per capita), there are 34 countries where per capita food decreased.

Food stocks are unstable. World grain stock was 336 million tons in 1991, 265 million tons in 1995. But grain stock of main exporting countries declined from nearly 200 million tons in 1991 to 109 million tons in 1995. World food security index was 19% in 1991, 18% in 1994 and 14-15% in 1995, the lowest level in history. Such a situation reflects a worldwide food crisis. Besides 20% of population, about 840 million, in developing countries can not obtain enough food. Now, food security has aroused wide international attention.

In the future, the world food security situation will become even more serious. World agriculture is confronted with a dilemma, on one hand, it has to meet the mission of food security for 10 billion people in the future, and supply enough food for 1 billion people in poverty or undernourished; on the other hand, it has to lessen the pressure on soil, water, and biological resources .

1.3. World food consumption situation

World food consumption grows steadily. In 2003, world grain consumption was 1915 million tons, increasing 8.12 million tons compared with that in 2002. Demand was 85.22 million tons more than output. The main reasons for grain consumption growth include population rise and growth of per capita grain consumption, especially of feed grains. As the key source of feedstuff for animals, corn is one of the main supporters for animal husbandry. In 2003, corn for feedstuff took 68.3% of the whole corn consumption.

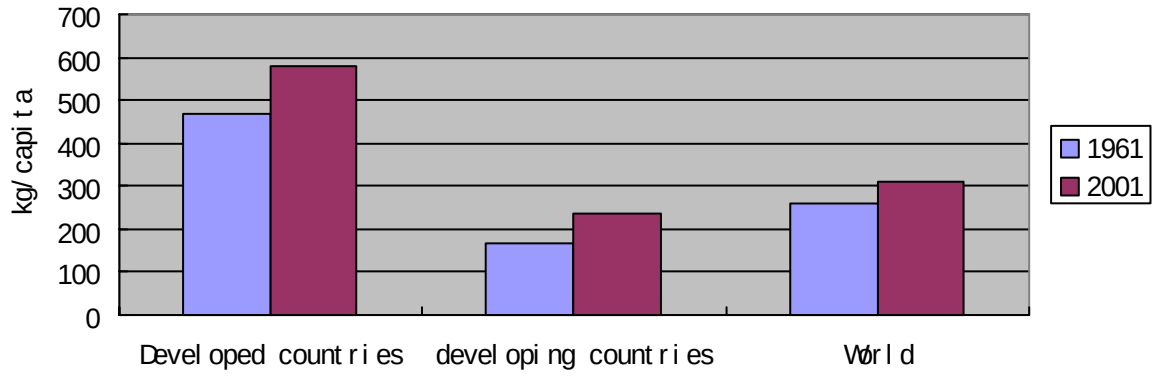

Figure 5. world grain consumption per capita

Grain consumption in developing countries shows rapid growth. In 1961, world average grain consumption per capita was 262kg, being 469kg in developed countries and 165kg in developing countries. But in 2001, world average grain consumption per capita increased to 310kg, with 579kg in developed countries and 236kg in developing countries, with a bigger gap between these of 343kg (Figure 5). For the future, consumption growth in developing countries will become the main force for world food trade growth.

The nature of grain consumption structure in developing countries is changing significantly. When a country's economic development is at a low level, grain consumption of residents in this country will be mainly focused on grain rations for subsistence or survival. With further development of the national economy, consumption gradually moves towards a diversified grain ration and grain for animal feedstuff. And the food requirements of residents will also turn to more healthy and nutritious foods, with implications for production and trade.

At present, food consumption in developing countries is at a low level, below 400kg per capita. And food shortage exists, where food production is less than consumption. Developing countries in general are becoming net food importers. In the contrast, food production and consumption in developed countries stays at a high level of more than 500kg per capita. Food production is much higher than consumption, and food is exported. With further development of world economy and trade, if world average food

consumption reaches to 600kg, the gap between food supply and demand will reach to 1.6 billion tons and global trade will increase to 1.9 billion tons, almost equal to current global food production volume (Table 1).

Table 1. food demand forecast in different consumption levels, based on population in 2001. Unit: million tons

Consumption per capita	Demand	Gap	Trade volume
340kg/c	2011	0	23
400gk/c	2454	443	719
500kg/c	3067	1056	1333
600kg/c	3680	1670	1946

In short, as world economy and trade liberalization develop, world food consumption will remain in continuous growth. But its speed and form will depend on global situation of food production and trade. To improve global food consumption, especially that of developing countries, we must tie up the relations between food production and distribution. On one hand, it's necessary to strengthen scientific cooperation and exchanges among different countries, and promote food production level of developing countries; on the other hand, it's necessary to promote food trade between developed and developing countries.

1.4. The existing situation of world agricultural products trade

In the past half century, international agricultural products trade increased rapidly. WTO negotiation processes promoted its further development to a great extent. Generally, the trade situation presents the following features:

1.4.1 Trade develops by stages

From 1961 to 1971, there was a slow increase in trade of agricultural products, with a growth rate of 4.97%. Since 1972, as world economy developed, demand from international market for agricultural products enlarged quickly, which promoted development of exporting trade. And growth rate reached to13.01% from 1972 to 1980. After 1980, because world economy development slowed down, world agricultural products trade shrank seriously, and reached to the lowest level, global exporting value only $208.5 billion in 1985. From 1986, world economy started to recover and the Uruguay Round negotiation was entered. World agricultural products trade came into the unprecedented prosperity and trade value enlarged $19 billion every year.

1.4.2 Trade order is in chaos

The price gap between export and import in the main food exporting and importing countries is widening (Table 2). Exporting and importing prices of developed countries were relatively high. For example, Japan had the highest exporting prices for rice, wheat and potato. USA, France and Germany had the highest importing price for rice. And the importing prices for wheat and corn in Australia were the highest ones. In export, the standard deviation of exporting price for wheat was 6 times the average price. In import, the standard deviation of importing price for wheat was 2 times the average price.

1.4.3 Trade liberalization makes a slow progress

For a long period, agricultural trade was separated from international multilateral trading system. Its tariff was always kept between 40-50%, but tariffs for industrial products were cut to the current 4% from 40% in the 1950's. This difference caused different a large difference in the growth of agricultural and industrial trade. During the same period, trade value of industrial products enlarged nearly 17 times, and that of agricultural products only increased less 6 times.

The *Agriculture Agreement* reached in the Uruguay Round in 1993 brought agricultural product trade into world multilateral trading system for the first time, setting the foundation for agricultural trade liberalization. However, *Agriculture Agreement* was only a planned reform in line with the trend of trade liberalization, and has played a limited role in international market access for agricultural products. For developing countries, unfair treatments in domestic agricultural support, export subsidies, and poor market access in developed countries still exist.

Table 2. Prices of import and export in 2001 Unit: Yuan/kg.

	Rice		Wheat		Corn		Potato	
	export	import	export	import	export	import	export	import
India	2.67	1.97	0.93	1.15	1.48	1.4	1.7	2.91
Japan	13.79	2.53	23.46	1.56		1	18.83	2
Brazil	2.08	1.61	1.63	1.03	7.28	0.82	1.44	1.34
Indonesia	1.66	1.74	14.19	1.22	0.96	1	2.4	1.74
China	1.45	3.04	0.85	1.55	0.86	1.06	2.57	1.71
Egypt	1.66	3.48	5.06	1.25	6.44	0.95	8.28	1.88
Mexico	3.99	1.88	1.25	1.04	2.81	0.87	8.86	1.57
Germany	5.59	4.05	1.1	1.1	1.31	1.69	2.28	1.66
Russia	1.55	1.29	1.73	0.92	3.02	1.07	1.54	3.14
France	4.91	4.01	0.96	1.26	1.23	2.72	2.09	9.72
USA	2.27	4.05	1.09	1.18	0.82	5.76	1.56	2.53
Canada	6.36	3.15	1.19	1.1	1.41	0.81	1.92	1.47
Australia	2.49	3.78	1.19	3.11	1.23	10.54	2.72	4.73
Mean	2.18	2.32	1.06	1.24	0.93	1.05	1.51	1.71
SD	3.4	1.03	6.85	0.56	2.2	2.83	5.01	2.28
SD	1.56	0.44	6.46	0.45	2.37	2.69	3.32	1.33

The new Doha Round, commencing in 2001, was mainly concerned with three areas for agricultural trade, market access, domestic support, and exportsubsidies, aiming at significantly reducing, with a view to phasing out all export subsidies, and domestic support as well, while broadening market access for agricultural products, resulting in a fair and market-oriented agricultural trading system and boosting agricultural trade. But, for the reason that contradictions in agricultural subsidies existed between member countries, it has made slow progress. The core of Cancun Conference in September 2003 was focused on agricultural product trade liberalization. It ended without consensus. But some progress has been made in Geneva in August 2004.

1.5. Key issues in Agricultural products trade

The development of world food production and agriculture has influenced agricultural. Nowadays, world agricultural product trade mainly focuses on the following aspects:

1.5.1 Serious imbalance between developed members and developing members

First, the *Agriculture Agreement* allowed developed members to use *AMS* valued $146 billion, 90% of the total *AMS*. After the Uruguay Round, export allowances used by developed members of WTO were $12.5 billion, but only $1.1 billion by developing members. Secondly, most of the developing members have an insufficient support for agriculture, some even negative support. Thirdly, current Green Box policy is not reasonable, lacking of full consideration of the real situation for the developing members. Furthermore, in tariff level and structure, imbalances between members also exist, especially the differences between new members and others.

1.5.2 From a long-term point of view, food supply is in shortage, and contradiction still exists

Since 2000, grain stock have fallen. For example, grain stock in 2003 was 327 million tons, reducing by 85 million and 2.6 million tons compared with that in 2002 and 1997, respectively, only equal to the normal world consumption volume for two months. Moreover, stock took just 17.1% of the annual grain consumption volume, lower than the food security standard of 18%. Thus world food security issues aroused wide concern again.

1.5.3 Agricultural allowances, domestic support, tariff and trade discrimination

Issues on agricultural product trade have obsessed international goods trade market for a long time. In their own interests, countries compete with each other for market share, which resulted in trade barriers and serious instability of the world agricultural product market. In Doha Round, contradictions in agricultural allowances between negotiating parties existed. Developed countries with strong comparative

advantages in agricultural products advocated cutting domestic support to a great extent, abolishing export allowances and promoting agricultural product trade liberalization. Developed countries with lack of comparative advantages held the view that tariffs and domestic support follow the Uruguay Round, so as to maintain a high level protection and support to domestic agriculture. And most of the developing countries, then, emphasized the severe imbalance between domestic support and export competition, and claimed for special and distinction treatments, such as exemption policies and protection measures. For the above reasons, Doha Round has not made substantial progress.

1.5.4 Gap in science and technology development

Science and technology have made great contributions to the development of modern agriculture. At present, the contribution of S&T to agricultural growth in China is around 45%, and above 70% in developed countries. Compared with developed countries, weaknesses of developing countries appear as relatively poor background research, insufficient research achievements, unstable research staffs, slow adoption of achievements, slow speed of industrialization, and fund shortages in high-tech R&D, etc.

1.6. Methods to solve problems

In order to solve problems existed in world agriculture and trade, it's necessary to depend on S&T, as well as establish fair and unrestricted agricultural products trading environment:

1.6.1 Reduce agricultural product support in developed countries

The policies to protect agriculture in developed countries have distorted normal international agricultural trade order, obstructed its growth and seriously damaged the interests of developing countries. According to statistics, if developed countries abolish price supports for agricultural products, the benefits obtained by developing countries will greatly exceed the aid they get from foreign countries.

1.6.2 Reduce tariff on agricultural trade and eliminate technology barriers

High tariff and technology barriers are the two biggest obstacles for the development of world agricultural products trade. Developing countries have appealed to developed countries to reduce and abolish tariffs on agricultural products. However, the fact still is, even the least developed countries have to deal with the unchanged high tariffs when trading with developed countries. At the same time, in the all protection measures, non-tariff barriers are the least transparent and have the deepest influences. To reduce tariff and abolish non-tariff (so called technology based) barriers are the premises for rapid and healthy improvement for agricultural trade.

1.6.3 Depend on S&T advancement

First, developing countries should increase investment in agriculture and strengthen their scientific research. Papers issued by FAO emphasized that, in order to solve the problems of food security for the world especially for developing countries, it's necessary to pay great attention to investment in agriculture and food production in these countries. Under the premise of sustainable development, it's necessary to fully utilize and save resources, improve food production, profit, and products' quality and keep competition power in international market.

Secondly, with predominant agricultural technology and plenty of experiences with rural area development, developed countries should provide aid to developing countries, and make contributions to agricultural technology transfer. Through communications between agricultural experts, research achievement transfer, and cooperation projects, we can strengthen co-operation and exchanges between developing countries in agricultural technologies, so as to promote the development of world agriculture.

2. Science and technology are essential to sustainable development of world agriculture and agricultural trade

2.1 S&T advancement in agriculture is an important guarantee for sustainable development of world agriculture and agricultural products trade

According to analysis made by some American experts, in the process of American agricultural modernization in 1929-1972, 81% of agricultural increment, and 71% of economy efficiency increment came from the contributions of S&T in the form of new terchnologies. Analysis conducted by some Chinese experts indicated that, in the 20 years from 1978 to 1997, S&T contributed 35-45% to food

output increment. It's clear that S&T is the key factor in increasing food yield, protecting food security and agricultural ecology, increasing farmers' income, and promoting sustainable development of agriculture.

In 2050 world population will rise to 9 billion from current 6.3 billion, and most of the incremental population coming from developing countries. Under this situation, agricultural production must be 2-3 times of current output. And another challenge is, we also need to protect farming land from damage, help countries in poverty turn wealthy, and make sure that agricultural production will develop in a right track favorable to environmental protection, sustainable development and income increase. Certainly, to achieve all these goals we must fully depend on S&T, upgrade efficiency of resources utilization, cut production costs, improve products quality, promote income growth of farmer, and enhance competition power of agricultural products.

2.2 S&T advancement is the only way for China's agricultural development

As an agricultural country, China has advantages in agricultural resources, agricultural products diversity, and labor forces, with plenty of opportunity for structural adjustment and international competition. However, simultaneously, China is a typical country with limited land resources and huge population, shortage in per capita resources. For examples, in China, per capita farming land area is only 0.1 ha, and per capita water resources is only 2,160 m^3, less than one quarter of average world water level.

After the foundation of the People's Republic of China, technology developments in upgrading crop strains, farming and fertilizing, low-output land improvement, and disaster prevention and alleviation, have contributed to constant increase of food yield from the base of 113 million tons in 1949, reaching 512 million tons in 1996, a historic record high. In recent years, the yield is steady at around 450 million tons. It's a common understanding in China now that full utilization of S&T and improved agricultural efficiency are the only way for us to overcome barriers of sources shortage, increasing production levels and continuously meet the demand for food.

2.3 Key S&T issues related with agricultural products trade

2.3.1 Normal agricultural technology improvement

China is ranked in the world leading position in research and application of heterosis in rice, corn, cotton and rape. Up until now, China's hybrid rice has been extended to more than 20 countries, increasing food over 35 million tons.

Modern new technologies are playing more and more important roles. However, we should have a comprehensive view of agricultural technology, avoiding a one-sided view. A realistic outlook is that, in a long term in developing countries, conventional agricultural technology will still play a dominant role. One important direction of agricultural technology is to integrate modern technologies with conventional ones, to create powerful new productivity. So, it's necessary to widely spread advanced and practical technologies, make full utilization of conventional agricultural techs, and harmonize conventional technologies with modern ones. In China, we should pay more attention to the applications of heterosis and breeding of stress resistant varieties.

2.3.2 Biotechnology

High-techs, such as biotechnology and information technology, have been widely utilized in agriculture, greatly changing traditional production and products structure, and have had significant effects on world agriculture and agricultural trade.

Genetic engineering, as the core of modern biotechnology, has been utilized in agriculture to breed a series of GM crop varieties. Since 1996 when genetically modified crops started to be planted in large scale, the annual growth rate of planting area stays above10%. In 2003, there were more than 7 million farmers in 18 countries planting GM crops, with acreage around 67.7 million ha, 40 times higher of that in 1996. In China, we have a similar situation: the planting of genetically altered crops rises rapidly. For example, the cultivation area of insect-resisting GM cotton reached to 2.7 million ha in 2003.

In order to establish reasonable international order in GM crop trade, the international communities have made great efforts. Currently, recognized international agreements include, *the Agreement on the*

Application of Sanitary and Phytosanitary Measures (the *"SPS"* Agreement), *the Agreement on Technical Barriers to Trade*(the *"TBT"* Agreement), and the *Cartagena Protocol on Biosafety* (the *"BSP"*). The *"SPS"* Agreement has the closest relations with the management of genetically engineered products in trade. As we strengthen research on genetically modified plant and its industrialization, China will pay close attention to the changing regulations for international trade in genetically-modified agricultural products.

2.3.3 Food safety

As a member of WTO, China is in the process to establish and improve the national food quality supervision system. Currently, food quality problems in China mainly include residues of fertilizer and pesticide; antibiotic, hormone and noxious materials; heavy metal pollution; poisonous and sensitive materials stored near to animal and plant production, and side effects from genetically engineered food materials. Aiming at these problems, Chinese government has taken a series of measures to continuously upgrade the management level and improve quality of agricultural products.

In order to guarantee quality and safety of agricultural products, the Chinese government has issued and implemented some regulations or laws, such as *Food Hygiene Law, Goods Inspection Law, Animal and Plant Quarantine Law* and *Hygiene quarantine Law,* etc. In April 2001, Chinese government started the *Action Plan for food Without Social Effects of Pollution,* carrying out the *from farm land to table* project to supervise food safety. We plan to achieve consumption without social (health) effects of pollution for main agricultural products in 8-10 years. In April 2002, the Ministry of Agriculture and the State Quality Inspection Bureau jointly issued the *Management Regulation for agricultural products without environmental pollution.*

Since 1996, Chinese government issued *Security management regulation for genetically engineered products* and three complete administrative rules, to regulate the management for genetically modified food. In the second half of 2003, a project named *Food and medicine reassurance* was jointly developed by seven national departments. From 1 August 2003, in China, market license system for quality security on rice, flour, oil, soy sauce and vinegar came into effect. Quality system on ten kinds of products, include meat products, dairy products, instant products, freezing products, popped products, dressing and beverage will also be carried out. Within 3-5 years, a market license system will come into effect for the all 28 kinds of food.

2.3.4 Ecology and environment issues

With the development of global economy and urbanization, problems like farm land decrease and soil degeneration are increasingly becoming the threats to sustainable development of agriculture, ecology and environment. At the present time, global soil degeneration has reached 1960 million ha, which is a serious threat to world food security and sustainable development of agriculture.

Chinese government attaches great importance to farm land protection and environment construction. Laws issued include *Water &soil protection law, Environment protection law, Forests law, Agricultural law, Grassland law, Mineral resources law* and *Land management law*. One of the key contents of West Exploration Policy is construct ecology, which has already played great role in preventing soil degeneration in ecologically fragile areas. The newly brought forward idea, the *Scientific Development Idea Concentrated on People,* will be helpful to healthy development of agriculture and ecological environment.

2.3.5 Water resources issues

Farm land and water resources etc. are the basic factors limiting food security. However, currently, many developing countries are confronted with the situation that natural resources have seriously degenerated, with abandoned areas enlarging, water resources in shortage, environmental pollution worsening, and drought happening more frequently. Natural disasters lead to natural resources degeneration and stimulate further poverty in some developing countries, which forms a vicious circle. In particular, the worldwide water resources crisis has become the main factor to restrict development of food production.

Main uses of fresh water globally include 9% for human drinking, 20% for industry, and 71% for agriculture. Only taking 17% of the total acreage of farm land,, world irrigated land supplies around 40%

of world food output. Some institutes forecast that to guarantee world food security, water for agricultural irrigation needs to increase 15-20%. And one phenomenon is that although world water resources are in shortage, the efficiency is quite low, only 25-40%. Waste of water has also resulted in soil degeneration. Now, there are around 30 million ha of soil salinized in different extent, causing huge losses in agricultural production. Serious water resources shortage and waste now have become the most urgent problems and main factors for food insecurity in many countries and areas. Hence, the only way is to research and spread water-saving irrigation technologies for achieving food security and sustainable development of agriculture.

2.3.6 Agricultural industry value chain

The agricultural industry value chain includes all the stages and whole processes of the production of agricultural products, from breeding, processing, storage, to transport and marketing. To produce high value-added agricultural products in their natural state, it's necessary to pay great attention to the processing industry, increase S and T investment , improving processing techologies, instrument level and utilization efficiency, improve standard and quality control systems, and achieve agriculture industrialization.

The international competitive ability of modern agriculture is not only determined by the farm production system and the elementary product quality, as well it is determined by the whole industry value added. Without extension of the agricultural industry chain and value-adding at different stages, it's difficult to fundamentally boost economic benefits of agriculture. In developed countries, the processing rate of agricultural products is over 90%; its value is 2 times higher of agriculture itself, with employees of 6-800% more than employees directly engaged on farm; in China, the relevant data are 30%, 80% and 5%.

In China, the farmers' income is relatively low. One reason is scale of operation is small, the other is that the development and application of processing are not fully functioning, which prevents further development of agriculture industrialization and value-adding. This restricts marketing and trade. Thus it's important to develop the processing of agricultural products (including animal products) for improvement of the food industry chain, and growth of farmers' income in China.

2.3.7 Markets for agricultural technology

As a marketable commodity, agricultural technology has lots of limits. Its low level of commoditization means that it can not enter into the market completely. Some tangible technological achievements combined with agricultural production materials, such as seed, feedstuffs, new pesticide, fertilizer, and new machinery are relatively easy to commoditize and enter into market. Intangible technological achievements in the form of information, such as crop and animal management technologies, are difficult to commoditize. The effective way is to match them with tangible technologies, in the forms of contracts, share, and co-production etc. in order to promote them. Some other technological achievements, in the nature of service and public benefits, such as technologies of environment protection, water and soil maintenances are also difficult to disseminate via the market.

Generally, the Chinese agricultural technology market is still at its initial development stages, with the features that regulations and laws are not complete, the market agency system is imperfect, and dealings are not regulated, which restrict the spreading technologies. Therefore, it's necessary for us to adapt to the needs of agriculture and rural economic development, complete the demand and supply system of agricultural tech, and overcome the insufficiency of demand, supply and agency. Through training, farmers in China have made great progresses in science and culture quality. Their demands for scientific achievements and agricultural technologies are stimulated, which leads to their tighter linkages to technology and the market.

3. Proposals for strengthening international cooperation in agricultural S&T

Although S&T development has accelerated agricultural development, and improved agricultural labor efficiency to a great extent, on account of the differences of economy development, a wide gap in agricultural S&T between different countries still exists. In order to keep balance in international agricultural trade, we must strengthen international exchanges and cooperation of agricultural S&T, greatly upgrade development level of developing countries, and narrow the gap between developing and

developed countries. For these reasons, on behalf of Chinese government, I would like to make following suggestions:

3.1 Pay full attention to the existence and development of small farmer families; establish a fair, equal and reasonable environment for agricultural development
At present, about 96% farmers are living in developing countries, and the income of around 2.5 billion people is from agriculture. Although urbanization is progressing rapidly, 2/3 of the population in poverty are still living in rural areas. In the least developed countries, around 3/4 of labor forces are engaged in agriculture. Hence, agricultural development in developing countries is extremely important for the world to keep food security, to relieve poverty and to develop the economy. However, economic globalization and trade liberalization have brought irreversible changes to the operations of small farmers, with opportunities and threats for diversification versus sustainable self-sufficiency, and for human activities of the agricultural community, and for the environment as well. Traditional production methods of millions of small farmers are impelled to change.

To promote the existence and development of millions of small farmers in the world, in the agricultural negotiations of Doha Round, some developing members proposed to set up an independent Development Box, to strengthen domestic food production of developing members, guarantee their food security and rural labor forces employment, protect farmers from the impact of foreign cheap agricultural products, and prevent dumping. At the same time, it's necessary to regulate the existing Green Box, abolish the Blue Box, and set up a Development Box, giving larger space to them. Obviously, this proposal is important for the existence and development of small farmers in developing countries. We are on the ardent expectation that this proposal would be approved at an early time, enabling developing countries to make contributions to world food security and agricultural trade.

3.2 Further strengthen international exchanges and cooperation in agricultural S&T
International economic relationships are become increasingly close. Correspondently, international cooperation in agricultural S&T should be strengthened, especially in new strains selection and breeding, biotechnology, and information areas. Key points include genetic engineering; precision agriculture; high yielding new varieties of plants and animals; techniques for fertilizer utilization with high efficiency and water-saving irrigation; products processing, storage and transportation; facilitated agriculture; and environment friendly agriculture.

Because of the gap between developing countries and developed countries, developed countries should take more responsibilities for developing countries in the areas mentioned above, from the point view of promoting world social and economic development, via narrowing the gap in agricultural S&T between them.

3.3 Strengthen information exchanges and communications between members
China is now starting to construct five systems, including early warning system for agricultural inspection; system for agricultural products supply, demand and promotion; system for price information; system for joint scientific information service; and system for and market supervision. We plan to construct a rural information service network extended to county level, through constructing, developing and integrating national and international resources. We will build agricultural data centre in 31 provinces, set up agricultural information platform in 90% of county level and up, and set up rural information service station in 70% of township level. Moreover, we will try to achieve agricultural information share and integration internationally and nationally.

At the same time, China has made great achievements in *863 Plans* for researches on agricultural information, digital agricultural technology. *Computerized Agriculture* project was rewarded as one of the 40 top prizes in *World Information Summit*. Chinese government is willing to share and exchange all these achievements with other countries, to promote international information exchanges and communications.

3.4. Strengthen construction of agricultural organization system; improve the level of organized activities
To cope with impacts from WTO and improve the level of organized activities, organizations engaged in agricultural production and operation not only need government provision of basic public services, but

also need government provision of effective cooperation mechanisms. On one hand, it's helpful to establish agricultural organizations for coordinating internal competition and cooperation of agricultural enterprises, supplying information service, human resources service, and exploring domestic and international market. On the other hand, it's necessary to encourage setting up of farmer cooperation organizations or farmer associations, improving a level of organized activities of farmer, enhancing their bargaining power in market, and protecting their interests. And it's quite necessary to develop industrialized operations, establish stable union for key enterprises and farmers sharing risk and benefits. Therefore, all members should try their best to strengthen construction of agricultural organization systems, through cooperation between farmers themselves and cooperation between farmers and enterprises, to enhance farmer's ability coping with market risk and getting profits.

3.5 Strengthen service industries related to agriculture and the l industry value-chain
In developing countries, the level of agricultural productivity is relatively low; agriculture is still limited in traditional crops planting and animal breeding. In developed countries, agriculture not only includes planting and breeding industries, also includes the organization and management of farm, and agricultural products processing, transportation and sales etc. The agricultural industry value-chain is highly extended, and agricultural service industries are highly developed.

In developed countries, five big changes have arisen in traditional agriculture. First, agriculture is divided into three industrial departments, pre-production, on-farm production and after-production; second, the growth pattern mainly depends on quality and efficiency growth rather than the original pattern of output increase; third, there is integration of production, processing and sales, and integration of trade, industry and agriculture; forth, agricultural labor forces move to pre-production and after-production, and some labor forces turn to modern industry and service industries; fifth, income of agricultural labor forces turns to depend on peripheral agriculture, instead of growing and managing crops and animals.

Obviously, the aforementioned five changes in developed countries have provided positive and useful experiences. They are worthy of consideration and by developing countries.