

CHINA



PREFACE

With its social and economic development, China will become a modern, wealthy, civilized country in the 21st century. It is predicted that the population of China will reach a peak in about 2030 and the total population will probably exceed 1.6×10^9 . In light of the cereal consumption at that time, the total cereal consumption for 1.6×10^9 people in 2025 will be 640×10^6 tons. However, the total cereal production at present is only about 500×10^6 tons, therefore, cereal production in China must be increased by 140×10^6 tons in the coming quarter century, namely 28% of the current cereal production in order to meet the demand for the increase in population and standard of living.

Water and soil are the most important resources for cereal production. In China, the cereal yield of irrigated farmland is 1 to 2 times more than that of rainfed farmland, approximately 92% of cereal is produced on irrigated farmland and 8% of cereal is produced on rainfed farmland. The average cultivated area per capita in China is only 0.08 ha, less than one third of the world average, however, the irrigated area is 21% of the world's irrigated area. The average irrigated area per capita is 0.04 ha and approximately the same as the world average. Thus it can be seen that the future agricultural development in China will depend, to a great extent, on the extension of the irrigated area and on an increase per unit area of yield. Food security is closely related to the use of water and soil resources.

1. OVERVIEW OF NATIONAL POLICIES AND DEVELOPMENT PLANS

Overall National Vision And Macro Economic Policies

Chinese premier Zhu Rongji pointed out in his report of March 1999 that China will continually carry out positive financial policies and realize a faster economic development on the basis of expanding domestic demand, optimizing structure, improving quality and increasing income. She will promote a comprehensive agricultural and rural economic development, earnestly implement the rural basic policies of the Party, regulate and optimize the agricultural structure and facilitate the combination between town and township enterprises and agricultural industrialization in addition to several other measures.

Policies For Agriculture And Rural Development

Since the Fourteenth National Congress of the Communist Party of China, the Central Committee had regarded safeguarding the farmer's legitimate rights and interests and mobilizing the farmer's initiatives as the starting point and foothold for agricultural and rural economic development and issued a series of significant policies and measures.

Policies For Agricultural And Rural Water Development

China will tighten its fundamental agricultural construction based on water conservancy, reinforce the embankments in some key sections of the Yangtze and the Yellow Rivers and correct some defective reservoirs on the basis of controlling catastrophic flood and resisting catastrophic drought. She will construct irrigation and drainage projects with the participation of the masses and encourage collectives and farmers to construct and manage small-sized water installations in various ways. In addition, China attaches importance to planned water use and water saving and therefore will devote a major effort to develop water saving agriculture and popularize various types of water saving techniques. Finally China will prevent pollution and conserve water resources.

2. PRESENT STATUS OF WATER

Water Resources

The water resources in China have the characteristics of an abundant total water volume, less in per capita holding and an extremely uneven distribution in both space and time. The mean annual water resource in China is about $2812 \times 10^9 \text{ m}^3$ which ranks sixth in the world, of which the mean annual river runoff is about 2700×10^9 , the recharge of groundwater is about $828.8 \times 10^9 \text{ m}^3$, the duplicative part of the river runoff and the recharge of groundwater has been deducted from the total water volume. However, the per capita holding of water resources is only 2300 m^3 for large populations and approximately one-fourth of the world average. According to the water resources statistics for 153 countries and regions in 1997 undertaken by the Sustainable Development Commission of the United Nations, the average water resources volume per capita in China was 121st and designated as one of the 13 water short countries.

Rivers

There are numerous rivers in China, of which over 1500 have catchment areas of more than 100 km^2 , seven of which are large rivers (shown in Table 1). Most run into seas in the east and the south and are called external rivers. There are also many internal rivers in north and west China, the longest being the Talimu River in Xinjiang Uygur autonomous region with a length of 2179 km. The longest canal in the world, the Grand Canal, rises in Hangzhou in the south and reaches Beijing in the north. It is a great water conservation work of ancient times and has a total length of 794 km.

Precipitation

Most districts of China have a monsoon climate with an uneven precipitation which decreases gradually from southeast to northwest. The precipitation in the southeast coastal areas is more

than 1,600 mm, 400 to 800 mm in north and northeast China and less than 250 mm in the widespread areas of northwest China. It changes dramatically both seasonally and annually, especially in the arid areas. In some northern districts, the precipitation from June to September reaches 80% of the mean annual precipitation, and in some places during summer from July to August, it will reach 50 to 60% of the annual precipitation. However, it is less than 5% during the winter from December to February. The ratio of the maximum to the minimum annual precipitation differs greatly over the country. It will be two to three times in south China, three to four times in northeast China, four to six times in north China and as high as eight times in northwest China. Continuous high-flow years and drought years occur frequently and the unevenly space-temporal distribution of precipitation is the main reason for the frequent occurrence of flood and drought disasters.

Storage Capacity

Since the foundation of the People's Republic of China, large-scale water conservancy works have been constructed. The numbers of reservoirs have been increased from 20 to 804 and the total storage capacity is more than $460 \times 10^9 \text{ m}^3$.

Water Consumption

Water consumption has increased by approximately $100 \times 10^9 \text{ m}^3$ each ten years from 1949 to the 1990s. Agricultural water consumption gradually increased before 1980 and has been unchanged or even decreased a little since 1980. The proportion of agricultural water consumed in relation to total water consumption has reduced over time from 97% in 1949 to 73% in 1993. On the contrary, the industrial and municipal water consumption has increased from $3 \times 10^9 \text{ m}^3$ in 1949 to $140 \times 10^9 \text{ m}^3$ in 1993 and its proportion has increased from 2.91% in 1949 to 26.67% in 1993. The per capita water consumption increased by 8.16 m^3 each year before 1970 and has remained unchanged since 1980. Details of water consumption are provided in Table 1.

Table 1. Conditions on water consumption in each year

Year	Water consume per capita (m^3)	Total water consumed (10^8 m^3)	Out of which					
			Agri. water consumed (10^8 m^3)	Ratio to the total water consumed (%)	Industr. water consumed (10^8 m^3)	Municipal water consumed (10^8 m^3)	Sum of industr. & municipal water consumed (10^8 m^3)	Ratio to the water consumed (%)
1949	187	1031	1001	97.06	24	6	30	2.91
1957	316	2048	1938	94.63	96	14	110	5.37
1965	378	2744	2545	92.75	181	18	199	7.25
1980	450	4437	3912	88.17	457	68	525	11.83
1993	451	5250	3850	73.33	1150	250	1400	26.67

SALINITY INGRESS

There is 22.4×10^6 ha of low-lying and waterlogged land and 7.7×10^6 ha of saline land which are mainly in north China. There are also 7.688×10^6 ha of waterlogged farmlands in south China. After allowing for the duplicate areas, there are approximately 33.3×10^6 ha of waterlogged and saline and waterlogged farmlands in China. Even though most of the farmlands have been improved to a certain extent, they are still at the middle to low yield level but have great potential for further development.

Water Shortage

The development and utilization of water resources in China is very low and cannot meet the demand for the national economic development. The difference between supply and demand for fresh water is being aggravated day by day. In medium arid years, the annual water shortage throughout the whole country is $30 \times 10^9 \text{ m}^3$. Three hundred cities are short of water, of which, 108 cities are seriously short. The annual water shortage is $5.8 \times 10^9 \text{ m}^3$.

Groundwater Overdraft

Because there is not sufficient surface water in the north plain of China, groundwater has been extracted to a great extent and resulted in a serious overdraft. The groundwater level has been reduced by over one metre each year. A total of 1450 m^2 have been ingressed by salt water in the Bohai Sea districts because of the reduction of the groundwater level. The yield of water from wells has been reduced and will be continuously reduced with no recharge.

Irrigated Area

At present, there are 50.4×10^6 ha nominally irrigated in China. However, the real annual irrigated area is only 43.2×10^6 ha. It is predicted that the cereal yield will be reduced by at least 35.40×10^9 kg each year because of a shortage of water.

The Yellow River Dry

The Yellow River (YR) is the second largest river in China and the main source of water for the northwest and north China. The Yellow River Basin (YRB) is an important agricultural area. It has 130×10^6 people (10% of the country's total), 16×10^6 ha of cultivated land (16% of the country's total), but only $58 \times 10^9 \text{ m}^3/\text{year}$ of available water, corresponding to 2% of the country water resources.

However, the Yellow River has frequently been dry during the past ten years due to a water shortage and unreasonable water diversions. This phenomenon has not occurred before and its duration and involved river sections are becoming longer and longer.

3. ECOSYSTEM PRESERVATION

Because economic development largely depends upon the input of resources and frequently results in an excessive exploitation of resources, serious pollution and deterioration of the natural environment has resulted in some areas. At present, the management system is dispersed which has resulted in the lack of effective and coordinated management of resources.

The policies of "preserving, saving and rationally utilizing resources", "exploiting, utilizing and increasing its value" should have equal importance and "who exploits and who will preserve, who destroys and who will recover, who will utilize and who will compensate" are carried out in China based on these issues. The objectives are to depend on the results of science and technology to exploit the potentials of the agricultural resources, increase its efficiency, reduce its occupation and consumption, improve and preserve its self-recovering capacity, and increase the value of the natural resources within the ecological system.

4. PRESENT STATUS OF FOOD

The total cultivated area has not changed much since the foundation of the Peoples Republic of China. Although it increased a little along with the extensive reclamation of wastelands in the first decade, it has decreased gradually since 1980 to or a little below that in 1949. However, cereal production has increased gradually and steadily from 113.2×10^6 tons in 1949 to 494.2×10^6 tons in 1997 due to the development of irrigation and the improvement of agricultural science and technology. It has increased approximately to 3.25 times that of 1949. There are many factors that resulted in the increase of cereal yield, out of which, the most important is the development

of irrigation. The second is the increase in per unit area yield, and this increase is closely related to the proper use of irrigation water, reasonable fertilization and scientific on-farm management.

5. LAND RESOURCES

China is an agricultural country with a large population and a small per capita area of cultivated land. This results in a contradiction between the demand and supply of agricultural product. Cereals, in particular, will be short for a long period. The cultivated area per capita is only 0.08 ha, about one third of the average of the world. In the recent half century, irrigation has been developed quickly in China. The irrigated area in China in 1949 was only 16×10^6 ha, which was about 16 % of the total cultivated area. In addition, yields were very low and cereal consumption was only 209 kilograms per capita. However, the irrigated area of the whole country was about 53.3×10^6 ha in 1998, about 53% of the total cultivated area. The increased irrigated area during the past 50 years has resulted in doubling that of 1949 and cereal consumption has reached 400 kg per capita.

Table 2. Conditions of irrigation development and cereal yield

Year	Irrig. area (100 million mu)	Total agril. acreage (10 ⁸ mu)	Ratio irrig. area to agril. acreage (%)	Total cereal yield (10 ⁸ kg)	Total irrign. water consu. (10 ⁸ m ³)	Ratio of irrign. water consu. to total water consu. (%)	Population (100 million)	Average irrigated area per capita (mu)	Average area of culti. land per capita (mu)
1949	2.40	14.68	16.35	1132	956	92.0	5.40	0.44	2.72
1965	4.81	15.54	30.95	1945	2350	85.0	7.25	0.66	2.15
1980	7.33	14.90	49.19	3206	3580	80.5	9.87	0.74	1.51
1993	7.46	14.26	52.31	4565	3440	66.5	11.85	0.63	1.20
1997	7.84	14.20	55.21	4942	3598	65.0	12.36	0.63	1.15

6. WATER FOR FOOD

With an increase of the irrigated area, the consumption of irrigation water for the whole country has also increased from 100×10^9 m³ in 1949 to 358×10^9 m³ in 1980. The total consumption of irrigation water has been unchanged since. However, the proportion of irrigation water to the total water consumption has decreased year by year with the increased demand by industry and municipalities. The effective use, efficiency and productivity of irrigation water has been increased gradually in the past decades, especially since 1980. Calculated as the real irrigated area, the average irrigation water consumption per ha for the whole country has decreased from 8745 m³ in 1980 to 7800 m³ in 1995 due to adopting various water-saving measures. Cereal yield per cubic metre of water has increased from 0.4 kg in 1980 to 1.0 kg in 1997.

7. AGRICULTURAL DEVELOPMENT

The total cereal yield of China in 1996 was 504×10^6 tons, an increase of 69.25×10^6 tons since 1991, 3.0% annually, 1.9% more than the increased rate of population in the same period. Rice, wheat and maize are the three major cereals, the yield of the three cereals in 1996 had set an historic record, of which the yield of rice was 195.1×10^6 tons, increased by 11.29×10^6 tons over that of 1991 amounting to 6.1%; the yield of wheat was 110.57×10^6 tons, increased by 14.62 tons more than that in 1991 and amounted to 15.2%; and the yield of maize was 127.47×10^6 tons, increased by 28.7×10^6 tons over that in 1991 and amounted to 29.1%. The proportion of the yield

of rice, wheat and maize to the total cereal yield was 38.7%, 21.9% and 25.3% respectively, the proportion of the yield of rice and wheat to the total cereal yield has decreased by 3.5% and is 0.1% less than that of 1991 and the proportion of the yield of maize had increased by 2.6%, which played an important role in realizing the balance between cereal supply and demand and promoting the development of aquaculture.

The comprehensive production capability of livestock products in China has been increased remarkably. The outputs of meat and eggs in China in recent years has always ranked first in the world and the output of meat makes up one-third of that of the world, an increase of 10 % in the last five years. The output of aquatic products have doubled and reached 28.13×10^6 tons in 1996, increased by 14.62×10^6 tons over that of 1991, increased by 108% and has ranked first for the world for seven years.

The mechanization of agriculture has improved notably and the work undertaken by agro-machinery has resulted in an increase of more than 40% in agricultural production.

8. WATER FEES

At present, the water fees in China are very low. Therefore, the present management systems of irrigated areas should be reformed, people's water-saving consciousness should be improved and water fees should be charged according to the volume of water used.

9. PRESENT STATUS OF RURAL DEVELOPMENT

Land

The People's Republic of China has a large area of land. However, the farmland resources are relatively small, the cultivated area per capita being only one mu (0.08 ha), about one-third of the world level. The reserved resources of farmland that can be reclaimed is only a little more than 100×10^6 mu (8×10^6 ha) being very limited for the more than 1×10^9 people.

Land Contracted Responsibility System

The land contracted responsibility system is one where the farmlands of collective farms are contracted by farmers. It is the basic system in China's countryside. It has three major patterns for contracting :

1. contracting by population, i.e. all farmlands for contracting are averaged by population at first and then allocated to farmers according to the number in each household.
2. contracting by labour force where there are also three kinds of contracting patterns, i.e.
 - a. all farmlands to be contracted are averaged by natural labour forces and then allocated to farmers according to the labour force in each household; or,
 - b. farmlands prepared for contracting are averaged by the labour force intensity and then allocated to farmers according to the quantity of labour force converted from the marking results;
 - c. contracting is by the ratio of population and labour force, i.e. some of the farmlands prepared to be contracted are contracted by populations and some are contracted by labour force.
3. the third is contracting by the ratio of the population to labour force, i.e. some of the farmlands prepared for contracting are contracted by populations and some are

contracted by labour force. The responsibility farmlands where commodity grains and other crops are planted are contracted by the labour force.

The common characteristics of the above three contracting patterns are that the former production teams have been replaced with family organizations which are the decisive sectors for agricultural production and management; the contracting structure of turning over enough to the state, reserving enough for the collective and the surplus is the farmer's, has been carried out on the whole; that the collective ownership of lands should be unchanged is stressed during contracting the lands of the collectives to each peasant household. The Central Committee stipulated in November 1993 that the contracted period of farmlands will be prolonged to 30 years on the basis of the original contracted period in order to stabilize the contracting relations of farmlands, encourage farmers to increase input and improve the productivity of farmlands.

Populations

China is the most populous country in the world. According to the State Statistical Bureau, the population had reached 1.22×10^9 by the end of 1996 (not including Tibet, Hongkong and Macaw), out of which, males were 50.8% and females 49.2%. The municipal and town populations made up 29.4% and the farm populations consisted of 70.6%. The birth rate was 16.98%, death rate was 6.56%. The average population density of the whole country is 126 persons per km^2 . Distribution of the population is uneven. It is at a minimum in northwest China which is one-sixth of the country's average; the maximum is in the southeast coastal area which is five times that of the country's average; the second is in north China which is 3.5 times of the average.

More and more water is demanded with population growth. Cereal yields at the end of this century will be 500×10^6 tons and the irrigated area will be 53.4×10^6 ha. It is predicted that the cereal yield will be increased to 567×10^6 tons, the irrigated area is estimated to be 60×10^6 ha and the water demand will also increase correspondingly.

Flood and Drought Disasters

China has a vast territory with complicated and various climates. There is no summer annually in the north of Heilongjiang Province, there is no winter annually in Hainandao, the four seasons are evident in the Huaihe River Basin, snow accumulates annually on the Qingzang Plateau. The four seasons are like spring in the south of the Yungui Plateau and the day and night temperatures differ notably in northwest China. Divided on the 400 mm isohyet line running through the continent from north west to south east, southwest of the line are arid and semi-arid areas which are 45% of the national area, the climate is dry and the precipitation is low. Precipitation increases gradually from northwest to southeast and changes remarkably southeast of the line. The maximum mean annual precipitation in four months is from June to September in the north and from April to July or from May to August in the south. The proportion of the maximum continuous precipitation of four months in the annual precipitation is 60% in the south, two to three times in the north, four to six times in north China, three to four times in northeast China and exceeds eight times in northwest China. Continuous flood or drought, day and night disasters, occur frequently.

As a result of the complicated topography, changeable climate and seriously uneven temporal and spatial distribution of precipitation, water and land resources lead to frequent flood and drought disasters. The stricken area of the agricultural disaster in 1997 was 30.31×10^6 ha and the area without any harvest was 6.43×10^6 ha. The drought area of crops of the whole country was 33.51×10^6 ha and the lost cereals from drought disasters are 75% of that of the total disaster area. An exceptionally catastrophic flood disaster occurred in 1998 in the Yangtz, Nenjiang and Songhuajiang River Basins the direct economic loss of which exceeded 200×10^9 RMB yuan and resulted in a great loss in rural and agricultural production.

Rural Economic Structure

Viewed from the rural industrial structure, the proportion of agriculture is decreasing and the proportion of non-agriculture activity is increasing.

Viewed from the agricultural economic structure, the proportion of plantation and forestry decreased and the proportion of husbandry and fishery increased. The agricultural output value in 1996 was $1,354.7 \times 10^9$ yuan calculated at current prices, which was 1.6 times that of 1991. The output of forestry was 77.9×10^9 yuan, which was 1.1 times that of 1991. The output of husbandry was 708.3×10^9 yuan, which was 2.3 times of that of 1991. The output of fishery was 202.0×10^9 yuan, which was 3.2 times of that of 1991. The proportions of the output value of agriculture, forestry, husbandry and fishery in 1996 to the total output value were 57.8%, 3.3%, 30.3% and 8.6% respectively. Compared with the output in 1991, the proportions of the output of agriculture and forestry decreased by 5.3% and 1.2% respectively while husbandry and fishery increased by 3.8% and 2.7% respectively.

Viewed from the productive structure of plantations, the proportion of cereals and cash crops decreased and the proportion of other crops increased.

Viewed from rural employment structure, the proportion of people engaging in agriculture decreased and those engaged in the non agricultural sector increased.

Rural citizen's food structure has changed remarkably. Farmer's cereal consumption was by and large stable from 1992 to 1997 and non-staple food consumption increased, of which the consumption of oil increased by 7.4%, meat by 6.2%, eggs by 15.2%, aquatic products by 66.5% and fruits and melons increased by 130%. With the increase of food consumption and the improvement in food quality, the consumption of other commodities increased markedly.

Rural poor populations have decreased gradually year by year. The size of the poor population in China at the end of 1996 had decreased to 58×10^6 , which was 22×10^6 less than in 1993. The average annual elimination of poverty has been 7×10^6 persons per year. The ratio of the poor population to the total population has decreased from 6.28% in 1992 to 4.7% in 1996.

In general, the farmer's standard of living and quality of consumption has improved after many years of development. However, the farmer's level of consumption is still very low and their income is the key factor that constrains an improvement.

Rural Urban Migration

At present, the population in China exceeds 1.2×10^9 including 920×10^6 in the rural areas, which are the majority. The rural labour force is about 450×10^6 . However, presently agriculture can only use 150×10^6 labourers and therefore 300×10^6 labourers are surplus. There were 24.53×10^6 town and township enterprises at the end of 1993 which absorbed 123×10^6 rural labourers; moreover, there are still 70×10^6 rural labourers who go out to work or for business. Therefore, there are still 110×10^6 surplus rural labourers in China.

Agricultural Mechanization

The mechanization of agriculture in China is developing rapidly with the introduction of motor power. Hence the service industry for machinery is also developing at the same rate.

Fundamental Construction of Irrigation and Drainage

The State Council issued "Policies for the Water Industry" in October 1997. This policy clarified the importance of China's water resources, its infrastructure and associated industries. It outlined the scope and policies for the construction and development of water resources.

The total investment for the major construction of water resources in 1997 was 37×10^9 RMB yuan. This provided for the completion of $11.2 \times 10^9 \text{ m}^3$ of earth and rock work, an increase of 6.3% and 7.7% respectively over the previous year. As a result, 857.1×10^3 ha of irrigated land was added bringing the total to 4.249×10^6 ha of irrigated land consisting of :

- 1.395×10^6 ha of newly constructed water-saving irrigated areas,
- 1.144×10^6 ha of newly constructed and improved water-logged controlled areas,
- 1.851×10^6 ha of improved middle and low yielding fields and
- 2.40×10^6 ha of improved soil and water in lost areas.

It also:

- provided 15.85×10^6 people with drinking water,
- rehabilitated 348×10^3 water-destroyed works,
- constructed, maintained and reinforced 13×10^3 reservoirs and 280×10^3 km of embankments and canals,
- constructed 1584 new water supply works in township which increased the daily water supply by 235 tons, and
- increased the capacity of small hydroelectric power plants by 650×10^3 kilowatts.

1. FUTURE SCENARIOS AND AIMS

Increasing the Efficiency and Productivity of Irrigation Water

China is a large agricultural country and the use of irrigation water (including the use of on-farm irrigation water and rural domestic water) is 81% of China's total water consumption. The current efficiency of irrigation is only 0.3 to 0.4, which differs greatly from the 0.7 to 0.9 efficiency in developed countries. This is due to a backward technical and management level of old irrigation facilities which have been in disrepair for a long time. The water productivity of crops is only 0.87 kg/m^3 . If we adopt scientific agricultural water-saving measures, increase the efficiency of irrigation water to 0.6 to 0.7 and increase the water productivity by 0.3, $120 \times 10^9 \text{ m}^3$ water will be saved based upon the present consumption of $400 \times 10^9 \text{ m}^3$. If two-thirds of the saved water is used for cereal production then the $80 \times 10^9 \text{ m}^3$ of saved water will increase the production of cereals by 112×10^6 tons, calculated using productivity at 1.4 kg/m^3 . Therefore, the saving of water and improvement of its efficient use are important ways to ensure China's food security during the next century.

Developing an Agricultural Water-saving Technology System

The efficiency and productivity of water use cannot be determined by using only one or a few engineering measures, but by establishing a comprehensive technological system combining rational water use, water saving irrigation engineering and management and agronomic measures. It is possible to greatly increase irrigation efficiency and productivity and thus increase grain production to ensure food security by improving these three factors.

Using rainfall water fully to develop a high efficiency dryland agriculture.

The area of cultivated land in China is 94.7×10^6 ha, of which 53.3×10^6 ha (56%) is irrigated and the balance, 44%, is dry land agriculture. There is a long history and plenty of experience in increasing the yield of dryland agriculture. Also experimental data and results on developing dryland agriculture in different areas are available and farmers have created various forms of storing rain water to combat drought. If these measures were applied to an area of 280×10^6 ha (70% of the total dryland area), an extra 21×10^9 kg of cereal grain could be produced resulting in an increased yield of 750 kg/ha. This would make a great contribution to food security in China in the next century.

Developing irrigation in dryland (rainfed) areas to further increase food security

Restoring water, maintaining soil moisture and establishing a soil water reservoir to increase the soil capacity for drought resistance and water supply are needed to develop irrigation on dryland. In addition, applying fertilizers to increase soil fertility, using soil water efficiently and retaining rainfall are significant methods of reducing the effects of drought and increasing yields.

Inter-basin water diversion in some areas of north China

In north China there is a lot of farmland with little water and in south China there is less farmland with lots of water. In the long term, from the agricultural and industrial development points of view, it is necessary to construct the South to North Water Diversion Project which will be an inter-basin water diversion. Preparation work for this project should be carried out actively and steadily and construction should start at the proper time. The aims of the East Line Plan and the Middle Line Plan are to supply water to the cities and industries. With the high cost of diversion the price of this water may be too great for farmers to use for irrigation. However, with the increase in the availability of water for industries and domestic use in the cities, it may be possible for agriculture to regain some water which was previously available but taken by industries and cities. The effluent from industries and cities will be increased and this may also be used for agriculture. This development will help to solve the water shortage problem in some areas of north China which are closely linked with food security. Water consumption in the Huang-Huai-Hai Rivers plain has exceeded its limit. However when the South to North Water Diversion Project is completed water use efficiency in north China is expected to increase and alleviate the water shortage situation in this area. If $42 \times 10^9 \text{ m}^3$ of water is diverted from the Yangtze River each year, it cannot only recover the ecological balance in this region (including the benefit of solving the Yellow River shortage problem), but can also meet the demand of further economic development of this region. Furthermore, the irrigated area can be increased by $3.33 \times 10^6 \text{ ha}$ resulting in an increased production of 14×10^6 tones, which is important for food security.

A further benefit will come by applying new biotechnology methods to modify the properties of crops biochemically and breeding new varieties for drought-resistance, high-quality and high-yield, so as to increase food production. One of the important ways to increase crop production on a large scale is to breed new varieties with drought-enduring, lodging-resistance and cold-enduring properties together with high yield and quality. With progress in biological science, studies should be conducted to understand crop biochemical mechanisms. By changing crop genetics, the physiological properties of water-loving and drought-resistant crops may be turned from "water-loving" to "drought-enduring". However, yield and quality must both remain excellent.

11. FUTURE OUTLOOK

Water Development

The pattern of water consumption up to 2025 for different sectors is indicated in Table 3.

Table 3 Prediction on increase of water consumption in China over the years

Item Year	Agricultural water consumption		Industrial water consumption			Domestic water consumption		Total water consu. (10^8 m^3)	% of total water resor. volume
	Irrigated area (10^6 ha)	Water consu. (10^8 m^3)	Output value (10^8 yuan)	Cnsu. index ($\text{m}^3/10^4$ yuan)	Water consu. (10^8 m^3)	Consu. index (L/capita day)	Water consu. (10^8 m^3)		
1990	48	4400	23851	210	500	25	100	5000	17.86
2000	53.9	4750	69900	165	1153	35	167	6070	21.80
2025	60.3	5232	531460	90	4783	70	365	10380	36.10

Food Production and Demand

In the light of international experience, domestic cereal production that meets 90% of cereal demand is considered to be a high rate of self-sufficiency. If China can become 90% self-sufficient, she will make an enormous contribution to the world and humanity. Theoretically, the scale of China's cereal import should be approximately 10% of her total demand.

The experience in China is that there is no need for cereal imports to exceed 5% of the total demand. Thus, with China being 95% self-sufficient she stands in the fore-front of the world. Considering various adverse factors, the import scale can be extended from 6 to 10%. The total cereal demand will be 640×10^6 tons in 2025 on the basis of a population of 1.60×10^9 and 400 kg cereal consumption per capita. If the cereal production in 2025 reaches 620×10^6 tons, there is only 20×10^6 tons difference between cereal demand and production, which can be solved from cereal import. This would be less than 5% of the total cereal production. Therefore, the cereal import scale of China in 2025 will not exert any threat to cereal supply in the international market.

To sum up, the proportion of cereal importation amounting to 6 to 10% is within the scope of security. Therefore, the estimated scale of China's cereal importation still takes unforeseen circumstances into account.

Irrigation Development and Potentials for Yield Increase

The potentials for yield increase have a close relation with the development of irrigation in the 21st century. Under current conditions, there are no alternatives but to depend on developing irrigation, improving the conditions for agricultural production, giving full play to the function of agricultural science and technology and increasing the per unit area yield of crops. The potentials for yield increase in the 21st century mainly depend on the following three aspects.

1. It is predicted that the irrigated area in China will be increased by 9.9×10^6 ha by 2025, to 64.9×10^6 ha. If 65% of this increase is planted with cereals, the yield increase per ha will be 6000 kg, with about 38.6×10^9 kg of yield increase.

2. Improving the constructed irrigated area and realizing conveyance and modernization. Improving 13.3×10^6 ha of middle and low yielding fields, carrying out modernized irrigation in another 15×10^6 ha of cereal farmlands and, in association with advanced agricultural techniques, the yield will be increased by 2700 kg/ha and 1500 kg/ha respectively with 36×10^9 kg and 30×10^9 kg yield increase respectively with a total increase in yield of 66×10^9 kg.

3. The yield of more than 40×10^6 ha of rainfed land will be increased through drought-resistance techniques and rainfed agricultural techniques.

If 70% of rainfed land, i.e. 28×10^6 ha, is planted to cereals, the potential yield increase will be 21×10^9 kg calculated with 750 kg yield increase per ha.

The total potential yield increase of the above three aspects will be 10^9 kg.

Prediction of Cereal Production and Irrigation Water Consumption

As stated above, the total irrigated area in China had reached 51×10^6 ha on the basis of 95×10^6 ha of the total cultivated area in 1997, the total cereal production was 494.2×10^6 tons and the per capita holding of cereals had reached 400 kg with a population of 1.23×10^9 , which ensured basic food security (details are provided in table 4). The total cultivated area will be increased from 95×10^6 ha in 2000 to 100×10^6 ha in 2025 and the irrigated area will be increased step by step from 51.9×10^6 ha in 2000 to 60.3×10^6 ha in 2025 due to adopting various effective measures and intensified policies. It is predicted that the cereal yield will be increased from 494.2×10^6 tons in

1997 to 620×10^6 tons in 2025, increased by 125.6×10^6 tons after adopting various effective water-saving measures and agricultural techniques.

Table 4. Prediction on cereal production and irrigation water consumption in the 21st century

Scheme Year	Agrl. acreage (10 ⁶ ha)	Irrigated area (10 ⁶ ha)	Total yield (10 ⁸ ton)	Average yield based on culti. land (kg/ha)	Irrigation water consump. (10 ⁸ m ³)	Average (m ³ / ha)	Increased irrigation consump. (10 ⁸ m ³)	Total population (10 ⁸)	cereals per capita (kg)
1997	95	51.0	4.942	3937	3530	6922		12.36	400
2000	95	51.9	5.000	4116	3540	6820	0	13.00	385
2025	100	60.3	6.20	5670	3660	6070	750	16.00	388

It can be seen from the table above that it is possible to expand the irrigated area under the current stable cultivated area, reduce the per unit area of irrigation water consumption and increase the per unit area yield and the total cereal yield through planting and seeding appropriate cereal crops and adopting various water-saving and yield-increasing measures. It is also possible to obtain 620×10^6 tons of cereals from the irrigated area, which makes up 60% of the total cultivated area and from the rainfed area, which is 40% of the total cultivated area. The average cereal holding per capita will be 388 kg, which is nearly 400 kg. The population of 1.60×10^9 will need 640×10^6 t of cereals if 400 kg per capita is selected as the food security limit, the difference being only 20×10^6 tons, consisting of 3.2% of the total cereal production, which can be solved by importing cereals from the international market. The irrigation water consumption will be increased by only 75×10^9 m³ from that in 2000, making up 12.3% of the total irrigation water consumed. This can be solved through expanding water sources or properly exploiting shallow groundwater.

12. RURAL DEVELOPMENT

Overall National Vision

China is the most populous developing country of the world. Agriculture is the basis of the national economy and social development. Since the foundation of P. R. China, agriculture in China had not only met the demand for agricultural product by residents from cities and towns, but also provided a guaranty for basic life, welfare and employment for more than 70% of the rural population and provided a basic guaranty and capital accumulation for the development of industry and other undertakings. The increased value of its agricultural output in 1997 was 139.69×10^6 RMB yuan which accounted for 18.7% of the total domestic output. This is an important component of the national economy.

The tasks for agricultural and rural development are very arduous for the 21st century. It should continuously produce sufficient food to ensure security and support the 1.60×10^9 population. It should develop a rural economy and ensure the stable increase of farmer's income. It should create opportunities to migrate the massive rural surplus labour force and it should lay foundations for the whole national economy and social development. The agriculture action plan for China's agenda for the 21st century was worked out based on the issues of more population, insufficient resources and backward techniques as listed below :

- Implementation of sustainable development strategy to promote agricultural modernization.
- Development of agricultural production for food security.
- Realization of sustainable development of township enterprises and state farms.
- Proper readjustment of rural economic structure to satisfy social and market demands.

- Input increase and improvement to enhance production capacity of agricultural resources.
- Conservation and rational use of agricultural resources and improvement of agro-ecological environment.
- Promotion of coordinated regional development and elimination of rural poverty.
- Stronger research and education for sustainable agricultural development.
- Promotion of a legal system, public participation and international cooperation for sustainable agricultural development.

Constraints

The agriculture and rural legal system is still faced with many serious problems which are :

- A large population vs. limited arable land and other agricultural resources. Per capita availability of arable land has shrunk year by year. In past decades, it has dropped from 0.09 ha to 0.08 ha.
- Rural economy is underdeveloped and farmer's per capita income remains low with limited increases over the years; rural population is growing fast, creating a huge surplus labour force with a poor educational level.
- Poor agricultural infrastructure, low productivity, poor disaster resistance and a huge fluctuation in production.
- Irrational structure of rural economy, inefficient agricultural inputs, low use and efficiency of chemical fertilizer and irrigation water, rapid increases of agricultural production costs.
- Pollution of the agricultural environment is getting more and more serious, affecting nearly 20×10^6 ha of arable land, about one-fifth of our total arable land. Soil degradation is also getting more serious. Agriculture is affected by more frequent natural calamities.

High-tech Farming Techniques

Efforts shall be made to develop new high-yield and high-quality varieties and breeds of crops, livestock and aquatic products, develop and propagate genetic resources with famous, special and high-quality traits by the use of techniques like tissue culture, cell fusion, hybridization and monoclonal antibodies and development of new varieties resistant to pests, saline-alkaline soil, low temperature, drought, infertile soil, wind, flood or poor environmental conditions. In the meanwhile, efforts will be made to develop precision farming with geographic information system (GIS), global positioning system (GPS) and remote sensing (RS) as its key technologies.

Aquaculture

It is predicted that by the year 2010, we will increase our total animal product output in farming areas by 50% and maintain sustainable and stable development of animal husbandry in pasture areas. Fish farming will be developed rationally with focus on the development of sea and freshwater fish farming so that fishery output from aquaculture will reach 60% of the total meat production.

Eco-system

It is predicted that by year 2010, the total number of ecological counties at both the national and provincial levels will amount to 350 and their project achievements and technologies will be popularized in all counties.