CHINA:

COUNTRY REPORT TO THE FAO INTERNATIONAL TECHNICAL CONFERENCE ON PLANT GENETIC RESOURCES

(Leipzig,1996)

Prepared by:

Ministry of Agriculture

Beijing, May 1995

Note by FAO

This Country Report has been prepared by the national authorities in the context of the preparatory process for the FAO International Technical Conference on Plant Genetic Resources, Leipzig, Germany, 17-23 June 1996.

The Report is being made available by FAO as requested by the International Technical Conference. However, the report is solely the responsibility of the national authorities. The information in this report has not been verified by FAO, and the opinions expressed do not necessarily represent the views or policy of FAO.

The designations employed and the presentation of the material and maps in this document do not imply the expression of any option whatsoever on the part of the Food and Agriculture Organization of the United Nations concerning the legal status of any country, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

Table of contents

CHAPTER 1
China and its Agriculture

The People's Republic of China is situated in the east of Asia, adjoining Korea in the east, and Viet Nam, Laos, Burma in the south, bordering on India, Bhutan, Sikkim, Nepal, Pakistan and Afghanistan in the southwest and west, the former Soviet Union in the northwest and northeast, and Mongolia in the north, and close to Japan, Philippines, Malaysia, Indonesia, Brunei and other countries and regions. With an area of about 9.6 million square kilometres, China is the largest country in Asia. With a population of 1.2 billion, China occupies the first place in the world.

High in the west, and low in the east, China has a varied topography, among which mountainous regions cover 33% of area, plateau 26%, hills 10%, basin 19%, plain 12%. Most of rivers such as the Heilongjiang River, the Haihe River, the Huanghe River, the Huaihe River, the Changjiang River and the Zhujiang River, etc. flow into the Pacific Ocean. With a vast territory, China stretches across the temperate zone and torrid zone. Most of the areas are located in the north temperate zone and Subtropical zone and controlled by the monsoon climate of east Asia. Because of varied topography and great difference of the elevation and the distances between land and sea, China has varied climates. For example, there is no summer in the north part of Heilongjiang Province. On the contrary, in Hainan island, there is no winter. In the Huaihe River valley the four seasons of the year could be identified easily. It is like spring all the year round in the south part of the Yunnan-Guizhou Plateau. The Qinghai-Tibet Plateau is covered with snow all the year round. In the inland of the northwest China it is hot in summer and cold in winter, with a great difference in temperature. From September or October every year to March or April next year, China is controlled by the dry monsoon and it is cold and dry in the whole country, with the range of temperature between the North and the South over 40°C. The temperature in winter in China is about 5-18°C lower than that in the other areas with the same latitude. From April to September every year, influenced by the humid and warm air current blew from the sea, it is mostly very hot and rainy in the broad areas in the Southeast of the mountain chain constructed by the Greater Xing'an Mountains, the Yinshan Mountains, the Helan Mountains, the Bayar Har Mountains and the Gangdise mountains. In July the temperature range between Guangzhou and Harbin is only 6°C. There are great differences in annual rainfall among different areas in China. The annual rainfall could get to over 1,500 mm in the coastal areas of Southeast China, and gradually get some decreases in the inland areas, with that in

Northwest under 50 mm. The wet monsoon prevails from July to August, and brings much rainfall.

China is the country whose intercropping and relay intercropping area (about 159%) is the largest in the world. The multiple cropping system is mainly practiced in the southeast part of China and the middle and lower reaches of the Huanghe River with a temperate climate and sufficient rainfall and a quite long frost-free period. Some areas even keeps frost-free all the year round, with the rainy season and the hot season at the same period, and less cultivated land for supporting more people so that the multiple cropping system is beneficial. There are manifold forms of intercropping relay intercropping, multiple cropping and rotation. The two-crop a year system of rice-wheat, rice-cotton, rice-sweet potato, and the rotation of rice-peanut, rice-green manure, and the double cropping of rice and three cropping rotation of rape are practiced in the middle and lower reaches of the Changjiang River, with cropping intensity generally between 200% to 250%. The growing areas of winter wheat, cotton, corn, soybean in China are centralized in the lower reaches of the Huanghe River and the areas north to the Changjiang River, where two-crop a year system or three-crop two years system is practiced, with interplanting of corn in wheat and potato, intercropping of sesame in peanut and intercropping of black soybean in sorghum, etc.

The distribution of crops in China is region specific. The Northeast is the centralized growing areas of corn, soybean, sorghum, sugar beet, where only one-crop a year system can be generally practiced because of the cold climate and short frost-free period. The Northwest is in the arid and semiarid area, where one-crop a year system is generally practiced and three-crops two years system in small basin area, with spring wheat, corn, millet, highland barley, potato, beet, melon and fruit, etc. as the major crops. The plain area of north China is in the warm temperate zone where two-crops a year system or three-crop two year is practiced. This area is the major growing area of winter wheat, corn, cotton, peanut and tobacco because of the connected farmland, low elevation, quite sufficient heat and developed irrigation. The Liaodong Peninsula, the old river course of the Huanghe River, the areas of the north China, northwest and southwest of China, etc. are the major growing areas of apple, pear, peach and grape. With abundant rainfall, various kinds of crops, large area of paddy fields, intensive and meticulous farming, and high cropping index, the middle and lower reaches of the Changjiang River with developed economy are the major centralized growing areas of grain, cotton, oil crops, silk and tea. Guangdong, Guangxi, Fujian and some areas of Yunnan where are in the subtropics and tropics keeping a warm and wet climate all the year round have three crops a year and abound in sugar cane and rice. They are also the production base of rubber, coffee, sisalhemp, coconut, oil palm, and other tropical cash crops in China. Moreover, many

kinds of subtropical and tropical fruits could grow there as well, and oranges and tangerines, banana, pineapple, litchi, longan and shaddock, etc. are well-known at home and abroad. In the Southwest, because of the shortage of rainfall during the springtime, medium rice of one crop a year is planted in a large area. Corn, sweet potato and broad bean occupy a quite large proportion in the upland grain crops. This area is also one of the major growing area of tobacco, rape, tea, drug crops and other cash crops.

China is a country with a very large population. Since the founding of New China, the governments at all levels keep paying great attention to developing crop production and solving the problem of feeding the people in the course of socialist revolution and construction, and make indefatigable efforts so as to promote the overall development of crop production and increase the production of grain and cotton by a big margin, and solve the problem of supporting over 1 billion people. The flourishing agriculture brings about the rapid development of the national economy. Now it is universally acknowledged that as an amazing achievement, China supports a quarter of the total population of the world. However, we must keep a clear head and realize that at present the material base and technical base are still quite weak, the productive level is still low and grain supply is not very sufficient, and there are more and more needs of people for grain with the development of food industry and feed industry and the changes of people's diet structure. From now on we should make up our mind and make great efforts to adopt powerful measures so as to ensure the sustained and steady increase of the production for grain and other agricultural products and continuously maintain the self-sufficiency of grain.

The land ecological system of China has 640 kinds, among which 185 kinds belong to forest ecological system. At present there is 115 million ha. of forest in China, with 13.36% of coverage rate. There are about 8,000 species of arbor and bush, among which the arbor has about 2,000 species including over 1,000 species of high quality timber and special economic one. There are also many rare species such as metasequola, ginkgo, golden larch, yew, Chinese katsura tree, Chinese dove tree, masson pine and tetracentron, etc. In addition, there are some representative vegetation varieties of primeval forest distributed in various kinds of physical geographical regions and their varied secondary varieties, and the pedigrees of the hilly vertical forest in the temperate zone and subtropical zone which are the most integrate ones in the world, and the tropical rainforest in the northern tip of the world. With the steep rise in population and the rapid development of construction, the excessive and unreasonable development and utilization of forest are bringing about many serious ecological and environmental problems such as the shortage of available forest resources, the reduction of the forest coverage rate, the decrease and extinction of the varieties of living things, the worsening of forest environment and the ruin and deterioration of ecological environment,

etc. Therefore, it has become a very urgent task which is of momentous significance in theory and social practice to study on the technology of protection and restoration for living things' varieties in the ecological system of forest in China.

It has solved the great problem of socialist rural system of China to do away with the people's commune and keep away from private ownership of land and practice the contracted responsibility system based on the household with remuneration linked to output and combine collective leadship with individual responsibility and carry out double economy. The 800 million farmers in China have gained management right of land and the state monopoly for purchase has been abolished and the prices for most of agricultural products have been adjusted by the supply and demand in market so that the agricultural production could be extricated from a difficult position of long-term stagnation, and the rural economy is rapidly developing towards specialization, commercialization and socialization, and its development has greatly benefitted the broad masses of people in city and countryside and pushed the whole economic reform and construction forward. After the founding of the People's Republic of China, some state farms of grain and cotton were set up in Heilongjiang and Xinjiang and some state rubber plantations were set up in Guangdong, Yunnan, Guangxi, Fujian and other provinces, and there were some state farm in Liaoning, Jiangsu, Hebei, Hunan, Hubei and other inland provinces (municipalities). In the farms of China the state ones occupy a small proportion but they could provide a great number of high-quality varieties of crops and livestock and fowl so as to help farmers acquire wealth through production. They took the lead in applying the advanced science and technology in agricultural machinery, chemical weeding, plastic-sheet-covered cultivation and agricultural aviation, etc., and planting rubber and other tropical crops in a scientific way so as to take a demonstration effect on the rural areas around. Moreover, they summed up experiences in increasing the production of staple agricultural products and the non-staple foodstuffs of city and industrial and mining regions, providing high-quality varieties, and feed and technology, helping farmers develop farming and breeding and carry out purchasing and processing the raw materials and selling the products. In the coming historical period the state farms are assigned to do new tasks of building up the production bases for internal and external trade products and the non-staple foodstuffs of city, the demonstration bases of agricultural modernization and the centres for the popularization and service of advanced agrotechnics. It will be a long-term historical mission for the state farms to serve the broad masses of farmers with advanced techniques and equipments and make their economic and technical strength play a positive role in rural area and promote the rural economy and agricultural modernization in China.

There are about 95,425.8 thousand ha. of areas under cultivation in China, with per capita 0.082 ha. In 1992 the total sown area of the country was

149,007 thousand ha., with 110,560 thousand ha. for grain crops and 451,297 thousand tons of total production. The sown area of rice was 32,090 thousand ha. with 189.92 million tons of production and 5,918 kg of yield per ha. The sown area of wheat was 30,496 million ha., with 103.44 million tons of production and 3,392 kg of yield per ha. The sown area of corn was 210,435 million ha., with 98.16 million tons of production and 4,665 kg of yield per ha. That of cotton was 6,835 million ha., with 4,508,392 thousand tons of production and 660 kg of yield per ha. In 1994, under the conditions of suffering serious natural calamity, rich harvest was still gathered in, with the total production of grain reaching 444.6 million tons. Such good achievements in agriculture are due to not only the policy and input, but also the scientific and technical progress to a great extent. It is a important measure with good effects in scientific and technical progress to unceasingly breed and change new varieties. Over the past 40 years there have been nearly 5,000 new varieties and combinations of over 40 kinds of crops and cash crops for 3-5 times in the scope of whole country. The yield could be generally increased by 10-30% after change of variety once and the quality and resistance could be greatly improved. In the course of the breeding of new varieties, besides the native germplasm resources, some high yield and good quality ones introduced from abroad were utilized as the parents so that a lot of new varieties with high yield, good quality, strong resistance and wide adaptability could have been bred and great breakthroughs have been made in the respects of crossbreeding and heterosis utilization, etc. and a great progress has been made in the research and application of crops breeding in China.

In order to popularize the new varieties, the China Seed Corporation was set up in 1978 and the corresponding local seeds corporations were established as well. As the result, the seed service system and its fundamental equipments and quality of seeds have got remarkably improved, and the techniques of seed-coating, etc. have been popularized, and the proportion of commercial seeds in the seeds for use of farming has risen by a big margin. Up to the end of 1992, there had been 2,549 seed corporations at different levels and nearly 70 thousand staff and workers in China, among which 600 county seed corporations had taken shape. The high-level seed supply stations had been set up in 2,500 villages and towns and some specialized group corporations had appeared. There had been 2,278 thousand ha. of land for seed breeding in high-quality seed breeding gardens, state farms and specialized base of breeding, with 5,873 billion kg of annual seed production and 1.88 billion kg of selected one, and the annual sales volume of seeds could reach 3.5 billion kg, accounting for 24 % of total seed consumption of the whole country. Over 95% of seeds of hybrid corn and hybrid rice could be supplied by the state-owned seeds corporations. It has come true that farmers purchase seeds for farming instead of reserving seeds themselves. The seed corporations set up by agricultural departments at different levels have become the main source of seed production and supply and undertaken the social responsibility

of ensuring the seed supply for agricultural production. In order to meet the needs of agricultural production for seed supply, the state set up the seed storing system at different levels and the government could provide financial subsidies for making up for the loss caused by the storing. The corporations which got the authority of seed import and export from the Ministry of Foreign Trade were in charge of the foreign trade of crop seeds. In 1989 the State Council promulgated the "Regulation of Seed Management of the People's Republic of China" so as to make the seed management work in China under the control of law.

Though China has gained great achievements in developing agricultural production and solving the problem of feeding the people, on account of the large population and the progressively decreasing cultivated land, the problem of food is still serious and how to increase the grain production is the most important problem to which the government pays close attention. From now on, it should be regarded as the central task of agricultural production to ensure the effective supply of agricultural products and keep the farms' income increasing, with the grain production as the key. The guiding principle of grain production is "ensuring the planting area, optimizing the planting structure, increasing yield and total production". In the crop acreage, we should lay the stress on corn and rice and keep wheat acreage steady. As for the major measures, we should attach major importance to the construction of breeding system, the forecast and control system for crop diseases and insect pests and the agrotechniques popularization system, and pay great attention to the popularization of important agrotechniques with notable results of increasing yield, and increase the cropping index and enlarge the crop acreage, and struggle against natural calamities, relying on sciences and technology. Over the past 40 years, the damages of disaster to agricultural production have been becoming more serious. With an overall consideration, the strategic stress of the prevention and control for the disaster should be put on the serious drought, waterlogging, windstorm and major crop diseases and insect pests, etc. Besides the farmland water conservancy, farmland capital construction, shelter-forest and other measures, the prevention and control of disasters are closely related to crop variety. After perennial practices, farmers gradually recognized that the high-yield, good-quality and strong-resistant hybrid species from the local species and the adventitious species could produce some tangible effects on lightening the damage caused by disaster.

Recently, the government departments concerned are paying great attention to the species introduction from abroad as well as the research work at the native species. It is believed that in the not too distant future we would surely have bred more and more valuable crops, species and germplasm from high-quality germplasm at home and abroad so as to make new contributions to the greater development of agriculture in China.

CHAPTER 2
Plant Genetic Resources Originated from China

As mentioned in the first chapter, China covers a vast area with complicated topography, soils and diversified climates. It has a long history in agriculture and practices many cropping systems. All these have provided suitable conditions for the growth and evolution of various plants and rich plant genetic resources are produced through a long time of natural and artificial selections. According to the statistics, there are more than 600 kinds of crops are cultivated in China at present with more than 30 kinds of grain crops, about 70 kinds of industrial crops, about 140 kinds of fruit trees, more than 110 kinds of vegetable crops, about 50 kinds of hay crops, more than 130 kinds of flowers, more than 50 kinds of medicinal crops, and about 20 kinds of green manure crops. Among these cultivated crops, 290 of them originated from China and 23 kinds of which are grain crops, 47 kinds are vegetable crops and spice crops, 53 kinds are fruit trees, 13 kinds are fibrous crops, 31 kinds are industrial crops, 62 kinds are ornamentals, 42 kinds are medicinal crops, and 21 kinds are bamboo and liane .

Most of the plant genetic resources from China are local varieties which account for 85% of the total. However, there are great differences among various crops. Generally speaking, the proportion of local varieties of staple crops is less than that of secondary crops. This is because of the large numbers of breeders thrown themselves into the breeding work of staple crops for a long time and a great deal of varieties (lines) have been developed. For example, there are 14,000 local wheat varieties, 47,000 local rice varieties, and 21,000 local soybean varieties which account for 54%, 77%, and 75% respectively while the overwhelming majority of varieties of edible beans, oats, buck-wheat, sesame, bird rape (*Brassica juncea* and *B. chinensis*). Chinese cabbage, *B. chinensis*, turnip, cucumber, tea, mulberry and many other fruit trees are native. For these reasons most varieties of staple crops used in production are nearly improved ones. With the development of breeding work, some local varieties of secondary crops will be replaced by the improved ones although they are still extensively used in production now. Another feature of the use of local varieties in production is that most of them are cultivated in remote mountainous areas where not only large numbers of varieties are planted, but also large numbers of crops of different kinds are grown. The main reasons for farmers to grow local varieties continuously are: 1) Farmers have to use old local varieties because there are no improved varieties to replace them. 2) The improved varieties are not adaptive to

diversified ecosystem areas, especially to the areas with cold climate, dry or flooded areas and the areas with saline alkali soil, poor soil or acid soil. 3) Some local varieties possess very good adverse resistance or disease resistance or high quality and some ones have special utility values such as the purple glutinous rice has a certain pharmaceutical effects. The local varieties that grown by farmers play an important role to farmers in economic income and food supplies.

The local varieties of staple crops such as Xiaohong Mai (red grain wheat), a local wheat variety from Inner Mongolia, and Hongmangmai (red awn wheat), a local wheat variety from NingXia Hui Autonomous Region, have been used for more than 100 years in production. They have a strong drought resistance and are mainly grown in dry and hilly areas. They are still used in production till now and the sown area was 2 million mu (1 ha= 15 mu) in 1991. The cultivated Yunnan wheat of primordial wheat is peculiar to Yunnan Province. It is characterized by its extremely hard glume and so it is also called Tiekemai (iron glume wheat). It is mainly grown in mountain area with all elevation of 1,500-2,000 m in south Yunnan. It was named subspecies of Yunnan Wheat (*Tritictim aestivum ssp. yunnanense* King) by professor Jin Shanbao. Damage to crops by wild birds and animals or domestic birds can be avoided by planting Yunnan wheat and this wheat resists to drought and head sprouting. Among, the distinctive local varieties of rice, some of them are fragrant rice. These kinds of rice have a rich perfume and there is a saying that the whole village can smell the fragrance when a family makes meals with fragrant rice. The varieties of fragrant rice are Yunnan fragrant rice, Guizhou fragrant rice, Yangxian fragrant rice, etc. The black rice and purple rice, with black, purple or brown colour on surface of their grains, have a tonic effect to man's body as well as the medicinal effect on setting a fracture and muscular growth. The varieties of black rice and purple rice are Purple rice from Yunnan, Black rice from Donglan, Guangxi, Black glutinous rice and Yaxue glutinous rice from Guizhou, etc. The quality of soft rice is between the glutinous rice and the non-glutinous rice. The cooked rice is soft, sweet, tasty and refreshing after having it. This kind of rice is peculiar to Yunnan Province. There are many varieties of this kind of rice and most of them are late hsien rice (*Oryza sativa, subsp. hsien*) indica such as Haomuxi, Haomulei. Only one or two varieties are early rice such as Haobawan, etc. The traditional quality rice was used as tribute to pay to imperial court due to its high quality. These varieties are Shuiputao, Babao, Simiao, etc. which are produced in Shandong, Anhui, Henan, Hubei, Guangdong, Yunnan, Jiangsu, etc. The local varieties of maize (*Zea mays*) are mainly grown in the remote mountainous area where the production level is low. The major characteristics of these varieties are cold resistance and early maturity, such as Erhuangbaogu, Xiaohuangbaogu, Baituanke, Erjizao, Liushiri, etc. In addition, a maize genetic resource which is peculiar to China is glutinous maize or waxy maize. China has more than 900 varieties of

glutinous maize and the major ones are Tengchong Nuobaogu, Xinping BaiNuo, Nuo maize. The major production areas of glutinous maize are Guangxi, Yunnan, and then are Sichuan, Guizhou provinces etc. The composition of endosperm of the seed of glutinous maize is amylopectin. Amylopectin, with special fragrance, is glutinous, soft, fine, and supple. So the glutinous maize is good for eating freshly and making cakes. It is very important for the foods of the local people. Some local varieties of other grain crops are still used in production and most of the popularized ones of certain crops are local varieties, such as edible pulse crop, broom, corn millet, (*Panicum miliaceum L.*), Common buck wheat (*Fagopyrum esculentum Moench*).

There are more local varieties of industrial crops are still remained for use in production. The local varieties are major varieties in soybean cultivation in Guangdong, Yunnan, Guizhou, Sichuan, Jiangxi, Fujian, etc. Such as Liuyuehuang in Liuzhi, Guizhou, Dahuangdou in Jinning, Yunnan, Heibidou in Guangdong, and Daqingsi in Shangrao, Jiangxi etc. There are many local varieties of Brassica juncea and B. chinensis and they are highly region adapted. The representative varieties in western plateau of China are Menyua rape, Yili yellow rape, Xiao Riqi, Lintan Dahuangjie. The well-known varieties in the central Shaanxi plain are Shangdang rape, Bachiman, Heze rape. The varieties in the Yangtse River valley are Xishui rape, Qixingjian, and Dongkou sweet rape. The leading, varieties of Ramie (*Boehmeria nivea* (L.) Gaud.) are local varieties and the well-known ones are Heipidou Luxhuqing, and Xiyelu. The leading local varieties of green ramie are Daqingye, Zantianhui, Anxin, and Erfuzao. The leading local varieties of hemp fimble (*Cannabis sativa L.*) are Huating hemp, Wuchang No. 40, etc. There are still many local varieties of other industrial crops, especially that of tea and mulberry are used in production.

China is also rich in local varieties of vegetables and fruit trees. At present, large amount of local varieties are still used by farmers in production. For instance, the local varieties of Chinese cabbage (*Brassica pekinensis Rupr.*) are Zaohuangbai, Zhang pulei, Fanxinhuang, Qingmaye. The local varieties of *Brassica chinensis* are Siyueman in Shanghai, Aijiaohuang in Nanjing. The local varieties of radish (*Raphanus sativus L.*) are Xinlimei and Dahongpao. The local varieties of eggplant (*Solanum melongena L.*) are Damin eggplant, Zaoqing eggplant, and Shijimei eggplant. Many local varieties of other vegetables are still used in production, especially almost the leading cultivated varieties of fistular onion (*Allium fistulosum*), garlic (*Allium sativum L.*) and tuber onion (*Allium tuberosum Rottl.* ex Spreng) and that of aquatic vegetables are local varieties. China has about 140 species of fruit trees and those with local varieties as major ones are pear (*Pyrus L.*), hawthorn (*Crataegus L.*), peach (*Prunus persica* (L.) Batsch), apricot (*Prunus armeniaca L.*), hairy chestnut (*Castanea mollissima* Blume), ginkgo (Ginkgo biloba L.),

Chinese date (*Ziziphus jujuba* Mill), filbert (Corylus L.), walnut (*Juglans regia L.*), Lychee (*Litchi chinensis*) longan (*Dimocarpus pongan* Lour.), and loquat (*Eriobotrya japonica*). etc. The well-known varieties of pear are Pingguio pear, Tangshansu pear, Ya pear, Jinhua pear, Xuehua pear. The varieties of peach are shanghai shuimi, Bahua, Fenghua Yulu, Shenzhou Shuimi. The varieties of Chinese date are Li date, Ban date, and Jinsi Xiaozao date. Most of the varieties of cultivated fodder grasses, green manure crops, flowers and medicinal plants are domesticated from wild species. There are many old varieties among, them and some are rare varieties such as Yaohua which is acclaimed as the King of subshrubby peony (*Paeonia suffruiticosa* Andr). Indian azalea (*Rhododendron simsii* Planch) enjoies great reputation among various flowers and China has a tall Indian azalea tree of 500 year old and it is really the king of Indian azalea. Dasajin, a traditional variety of Hindu lotus (*Nelumbo nuclifera*), has bright and colourful flowers at blooming period and it ranks the first among lotus flowers. Alfalfa (*Medicago* L.) Is the king of fodder grasses. China has more than 100 local varieties of *Medicago*, and of which are popularized in production.

China not only has many kinds of crops, but also has many wild species and wild kindred plants. According to the statistics, there are about 20,000 accessions of germplasm resources of wild crops collected and preserved, and more than 10,000 of them are grain crops, 6,400 of them are oil crops, 2,000 of them are fruit trees, mulberry and tea, about 1,500 of them are bast fibre plants, sugarcane, and fodder grass, etc. Among grain crops there are wild rice (*Oryza meyeriana subsp. granulata*) (including common wild rice, wart grain wild rice, and medicinal wild rice) and common cutgrass (*Leersia hexandra var. japonica* (Makino) keng f.), the 11 species of semi-wild wheat and wild kindred plants of wheat such as goatgrass (*Aegilops squarrosa* L.), Tibet roegneria (*Roegneria thoroldiana* (Oliv.) Keng), dahuria wildryegrass (*Elymus dahuricus* Turcz.), common aneurolepidium (*Aneurolepidium dasystachys* (Trin.) Nevski), and wheatgrass (*Acropyron cristatum* (L.) Gaertn.) from Tibet. Wild barley consists of 2-rowed barley and 6-rowed barley (the Inner Mongolian barley is the ancestors of cultivated barley). The wild kindred plant of maize is jobstears (*Coix lacryma*-jobi L.). The wild kindred plant of foxtail millet (*Setaria italica* (L.) Beauv.) is green bristlegrass (*Setaria viridis* (L.) Beauv.). Wild buckwheat has perennial buckwheat (*Fagopyrum Mill.*) and tatarian buckwheat (*F. tataricum (L.) Gaertn.*), yearly common buckwheat and yearly tataricum buckwheat. Wild broomcorn millet is the kindred plant of broomcorn millet (*Panicum miliaceum* L.). In addition, there are also wild compean, wild red bean, wild mung bean, wild amaranth (*Amaranthus spinosus L., A. lividus* L., and *A. retroflexus* L. etc.) semi-wild gigant goosefoot (*Chenopodium giganteum*) and semi-wild prince's-feather (*Polygonum orientale* L.). Among oil crops, there are wild soybean (*Glycine soja* with purple flowers and white flowers), wild rape, wild oiltea camellia (*Camellia L.*), and yellow Elshotzia (*Elsholtzia flava*),

etc. Among the fibre crops, there are 8 kinds wild ramie, such as white falsenettle (*Boehmeria clidemioides* Miq), greeleaf falsenettle and planetreeleaf falsenettle (*B. platanifolia* Franch et Sav.). The wild jute consists of 1ongpot jute (*Corchorus L.*), roundpod jute (*C. capsularis* L.) acuteagular jute (*C. acutangulus* Lam.) and wild hemp. The wild flax (*Linum stelleroides* Planch) consists of perennial root flax, drooping pod flax, and wild flax, etc. The wild kindred plants of sugarcane are Geshoumi, Banmao, Hewangba and Jinmaowei, etc. Tea bush has 37 species, and only one third of them are domesticated as cultivated varieties. Mulberry (*Morus L.*) has 15 species in China and most of them are wild mulberry. The most extensively distributed and cultivated varieties are white mulberry and Lu mulberry. Among vegetable crops, tuber onion has 8 wild species such as Luange tuber onion, Taibai tuber onion, Cugen tuber onion, Qinggan tuber onion, Mongolian tuber onion. Wild Onion (*Allium L.*) consists of altai onion (*A. altaicum* Pall.), yellow flower onion (*A. chrysanthum* Regel), and longroot onion (*A. victorialis* L.). The wild kindred plants of garlic (*A. sativum* L.) are wild Tian Garlic, Xiaoshan Garlic, Xinjiang Garlic, Xinghua Garlic, Duozi Garlic. Most of the longstamen onion (*Allium macrostemon* Bunge) are growing wildly. There are also wild caddice, lanceleaf lily (*Lilium lancifolium* Thunb.), wild orange daylily (*Hemerocallis* L.), Yejiaobanshu, Taro (*Colocasia antiquorum* Schott), wild toona (Toona Roem.), Moso bamboo (*Phyllostachys pubescens* Mazel ex H. de Lehaie), wild carrot (*Daucus carota* L.). The wild species of wild aquatic vegetables are wild water dropwort, wild watechestnut, thickculm spikesedge (*Eleocharis Plantagineiformis* Tang et Wang), wild arrowhead (*Sagittaria L.*), etc. The varieties of aromatic crops are flatspine pricklyash (*Zanthoxylum simulans* Hance), wild spicebush (*Lindera* Thunb.), wild anisetree (*Illicium L.*), wild mint (*Mentha haplocalyx* Briq.). China is very rich in wild fruit resources. The species of Mallus Mill. are Siberia crabapple (*Mallus baccata* (L.) Borkh), pearleaf crabapple (*M. prunifolia*), Xinjiang crabapple (*M. mill*), Hupeh crabapple (*M. hupehensis* (Pamp.) Rehd.), Honan crabapple (*M. honanensis* Rehd.), Sievers apple (*M. seversii* (Ledeb.) Roem.). The wild species of pear are birchleaf pear (*Pyrus betulaefolia* Bunge), Dusky pear (*Pyrus phaeocarpa* Rehd.), callery pear (*P. calleryana* Dcne.), ussurian pear (*P. ussuriensis* Marim.). Twelve wild speices of hawthern (*Crataegus L.*) have been collected and preserved and most of them have not been developed and used. The varieties of wild peach are david peach (*Prunus davidiana* (Carr.) Franch.), Kansu peach (*P. kansuensis* Rehd.), and smoothpit peach (*P. Mira* Koehne). There are 10 wild species of Chinese date (*Ziziphus Mill.*), more than 20 wild species of grape (*Vitis L.*), 50 wild species of persimmon (*Diospyros L.*), and 57 wild species of Chinese gooseberry (*Actinidia* Lindl.). Both Xinjiang and Tibet autonomous regions has wood lots of Chinese walnut (*Juglans cathayensis* Dode). In addition, there are also some wild species of apricot (*Prunus armeniana* L.), falsesour cherry (*Prunus pseudocerasus*), hairy chest (*Castanea Mill.*), filbert (*Corylus L.*), Citrus (*Citrus L.*), lychee (*Litchi chinensis* Sonn.), loquat (*Eriobotrya*

Lindl.), and longan (*Dimocarpus* Lour.). There are several hundred wild species of aromatic crops, crops for starch use, flower plants, medicinal plants, and fodder grass. China has a long history of agriculture, so there are large numbers of old resource materials of wild species, such as ginkgo trees of 3,000 years old; the spine date (*Ziziphus jujuba var spinosa* (Bunge) Hu), walnut (*Juglans L.*), and tea tree (*Camellia L.*) of 1,000 years old; litchi trees of 1,200 years old; smoothpit peach trees of 1,100 years old; mulberry trees of 1,600 years old ; pomegranate (*Puilica L.*), grape (*Vitis L.*), pear (*Pyrus L.*), persimmon (*Diospyros L.*), citrus, Japanese apricot trees (*Prunus mume*) trees of 200-300 years old. There are old flower and trees such as Han Lingnan artocarpus trees (*Artocarpus* Forst.) of 1,700 years old, wintersweet trees (*Chimonanthus praecox* (L.) Link) and Indian azalea trees (*Rhododendron Simsii* Planch.) of 500 years old. There are also large numbers of valuable wild germplasm resources that have not been developed and utilized effectively, such as wild vegetalbes, wild starch plants, wild sugar plants, wild oil plants, wild aromatic plants, and wild medicinal plants. It is reported that there are at least 400-500 wild species of wild vegetibles, 300 wild species of oil plants, more the 200 wild species of starch plants and sugar plants, and about 200 wild species of aromatic plants. Most of the Chinese goosebreey are growing, wildly and the potential yield of it of the whole country is about 150,000 tons per year and the potential yield of wild grape is about several ten thousand tons per year. Moreover, some wild species containing anticancer substances, new antibiotic substance, and hormones, etc. have been discovered one after another. In addition, there are lot of wild speices accumulated in forest ecosystem that have not been developed and utilized or their, economic values even not been recognized. China also has large numbers of primordial germplasm resources of wild species, such as the wild germplasm resources of yam (*Dioscorea L.*), wild rice (*Oryza meyeriana subsp. granulata*), and tropical fruit trees in tropical forests in Hainan Island.

Some of the wild species and wild kindred plants mentioned above have been damaged seriously. For example, wild groundnut (*Glycine soja sieb. et Zucc.*), which was distributed in large areas in Yellow River Islet, is very hard to be seen at the moment. Wild rice could be seen at 21 sites in Jinghong Country, Yuannan Province during the 1960s, but very few can be seen now. Similarly, it is hard to see the Inner Mongolia barley (*Hordeum L.*), the ancestor of cultivated barley. In addition, 102 species in the tropical zone were found to be in seriously danger status, and most of them are species of tropical forest and tropical monsoon forest. There are also many endangered species in subtropical and temperate zones. All these problems are common to the whole world. Effective measures on a global scale should be taken as early as possible.

CHAPTER 3
National Conservation Activity

Up to now 300 thousand accessions of genetic germplasm produced naturally and locally including 208 thousand accessions of grain crops, 61 thousand accessions of rice, more than 1 thousand accessions of apple, pear an peach respectively, 25 thousand accessions of vegetables, and 3 thousand accessions of grass and green manure crops have been collected and stored in China. However, the genetic germplasm of flowers and medicinal crops have not been included yet. It is reported that there are 5,000 species of medicinal crops in China with about 500 species for conventional use. There are 130 families and more than 500 species of cultivated flowers with many varieties belonging to each species. For examples, there are 3,000 varieties of chrysanthemum,
1,000 varieties of China rose, 300 varieties of peony, 200 varieties of Chinese herbaceous peony and 177 varieties of lotus.

3.1 *EX SITU* CONSERVATION (CONSERVATION IN EXOTIC LOCATION, MIGRATORY CONSERVATION)

For most of the crops propagated by seeds, the conservation of their genetic germplasm resources is made through centralized storage of their seeds. For some crops of vegetative propagation, perennial fruit tree forest wood and ornamental plants, the genetic germplasm resources are conserved through establishment of field germplasm nurseries and botanic gardens. China attaches great importance to these works which result in remarkable achievements in recent more than 10 years.

3.1.1 Collection

More than 350 thousand accessions of genetic germplasm for various kinds of crops have been collected through the activities of two times of national collection and supplemental collection on the large scale, and through the professional survey and investigation in priority areas of Tibet and Yunnan Province on wild, rice, wild soybean, wild Chinese gooseberry an feed crops. In recent 10 years annually teams are sent to Shennongjia, Darbar Mountain, Qin Mountain, south part of Guizhou Province and west part of Guangxi

Province etc. for collection. Each team consists of experts with various specialties, with unified technique targets and index, standard for check and accept, and registering items. The seeds are required to be collected this year or newly multiplied with dryness and purity and over 50% of germination rate. 1,000 grains for small grain seeds, 5,000 grains for middle grain seeds, 1,000 grains for middle to large grain seeds and 500 grains for large grain seeds are required. Cross pollinated crops, like corn are required to collect seeds from more than 5 ears. Vegetative propagated crops are required to collect and preserve plants or vegetative organs (including, twigs, root tuber, stem tuber and bulb, etc.) with 3-5 pieces for woody plants and 10-20 pieces for herbaceous plants. The collection of germplasm is made through roadside picking-up, purchase from markets and farm households. All the collections without discard must be hand in the national gene banks or germplasm nurseries for long- term preservation after experimental plant, evaluation and certification. Averagely 3,000 accessions of various kinds of genetic germplasms are collected each year without duplication. In recent 20 years in China more than 50 thousand accessions of varieties and seedlings have been collected from abroad and stored at home after experimental planting and screening. So more than 85% of genetic germplasm for crops collected and preserved in our country is originated from China.

We have scored great achievements in investigation and collection. However, there are still many problems mainly dealing with too many regions and locations to be investigated and explored for collection of germplasm without sufficient fund, resulting in the risk of extermination for large number of valuable genetic germplasm from rare plants. For examples, the construction of great detention dam for Three Gorges in the east part of Sichuan Province will flood 54 thousand square kilometres of 19 counties and municipalities along the Changjiang River. In the area covered by reservoir of Three Gorge there are rich germplasm of various kinds of plants with more than 3,000 species of higher plants making up 20% of total amount all over the country among which plants of vascular bundle cover 197 families, 861 genera and 2,787 species. In the area 49% of plants have been classified as the rare plants of national priority for protection which make up 11.9% of total rare plants all over the Country. So it is of great urgency to salvage the genetic germplasm resources in the reservoir area of Three Gorges. Besides, in the mountainous areas of Wulin, Wuyi and Wuzhi and on the Changbai Mountain, with the development of tourism to endanger the preservation of genetic germplasm of plants, it is of great urgency too to salvage the genetic germplasm in these area.

3.1.2 Gene Bank of Germplasm Resources

With the great attention given by the governments at different ranks, a batch of modernized seed banks of genetic germplasm has been set up all over the country in recent years with the technology of low temperature, drying and hermetically-sealed containers, gradually resulting in the system of combination of national institutions of long-term conservation with local or professional institutions of medium-term conservation.

3.1.3 National Gene Bank

Research Institute of Crop Germplasm Resources, Chinese Academy of Agricultural Sciences is entrusted to build and manage two national gene banks in Beijing and one national gene bank for duplication in Xinin of Qinghai Province.

No. 1 National Gene Bank designed and constructed by Chinese technicians with all the equipments made at home has two cold storage rooms. One room, 18 meters long, 6.7 meters wide and 2.7 meters high, with temperature of -10°C $\pm$ 1°C, fixed metal shelves, metal hermetically-sealed containers or, aluminium foil bags, is able to contain 80 thousand accessions of seeds with three boxes for one accession. Another room, 18 meters long, 11.8 meters wide and 3 meters high, with temperature of 0°C $\pm$ 1°C and the same equipment as above, can contain 150 thousand accessions of seeds. These two cold storage rooms are used for preservation of conventional collections and distribution of seeds at home and international exchange.

No.2 National Gene Bank financed partly by Rockefeller Foundation in USA and IBPGR with main equipments introduced from foreign Countries has two big rooms with 17.11 meters of length, 8.92 meters of width and 4.65 meters of height, temperature of -18°C $\pm$ 2°C, relative humidity of 50% $\pm$7%, metal fixed portable shelves, metal hermetically-sealed containers or aluminium foil bags, each of which is able to contain over 200 thousand accessions (three boxes for each accession), with more than 450 thousand accessions for both rooms. Besides, there are 4 small cold storage rooms each of which is 7.1 meters long, 2.52 meters wide and 4.65 meters high with temperature of -8°C to -18°C adjusted at request. This bank at present is one of the gene bank with maximum storage capacity in the world. It's modernization in target of temperature and moisture and hermetically-sealed containers ranks advanced level in the world. The effects of NGB are as follows:

- Conserving in long term all the crop seeds of germplasm resource with preservative value collected at home and introduced from foreign countries.
- Providing stock seeds and related data and materials for multiplication to medium-termed gene banks of academies of agricultural sciences and professional institutions in provinces and municipalities.
- Tracing and monitoring the variation in vitality of seeds stored in gene bank, early predicting and forecasting seed longevity in storage and making plan of renewed restoration for multiplication of seeds.
- Carrying out the researches on technology and theory of long-term conservation of crop germplasm to improve the conservation method and quality.

3.1.4 National Duplication Gene Bank

National Duplication Gene Bank set up in Xining of Qinghai Province, with lowest temperature of -20°C and normal temperature of -10°C, net volume of 183.33, installed with two sets of two- row movable shelves and two sets of one- row fixed shelf can input 2,376 boxes with total amount of more than 400 thousand accessions of seeds. This gene bank is set up for emergency with close- shelf and storage of whole box.

In accordance with the national unified program, newly multiplied seeds with high germination rate are provided by gene banks in each provinces, municipalities and autonomous regions or professional research institutes to national gene banks. The seed quantity of each accession is varied with different kind of crops. Together with each accession of seeds, their basic data and evaluated and certified documents should be provided to the NGB for in putting into computer database.

Seeds are checked for duplication as soon as the NGB gets the seeds. Seeds would be sent back be sent back to original institution if they had been found being stored in the bank. The germination of seed is tested. Then the seeds are dried to reduce the moisture and hermetically sealed. The process of putting seeds into bank depends on various kinds of crops with longevous or short-lived seeds. With scientific arrangement and prior treatment the seed vigour is not affected by the process which is carried on unceasingly. Besides, NGB has carried out a lot of tests and research works. The seed vigour of 8 crops with 85%, 90% and 95% of three kinds of initial emergency rate, which had been stored for 8 years is traced to be tested in order to provide scientific basis for multiplication and regeneration of seeds. The research has been carried on for germination methods of some seeds without ready-made

testing, methods for germination, particularly for seeds of wild crops, in result of working out proper method for germination of fibrous couch grass, wild barley, wild sorghum and wild sunflowers. Temperature and time required for attaining low moisture of seeds for various kinds of crops are studied for basis of sealed packing.

3.1.5 Gene Banks in Agricultural Academies in Provinces, Municipalities and Autonomous Regions or Professional Institutes

Agricultural academies in various provinces, municipalities and autonomous regions or various related research institutes are responsible to preserve in mid-termed germplasm resources of related crops in their regions or their professional fields through constructing facilities and equipments for mid-termed conservation in line with local conditions, with about 0°C of temperature and 15 years for conservation.

The tasks of mid-termed gene banks are as follows:

- Being responsible for the conservation of all the germplasm resources in the locality (provinces, municipalities and autonomous regions) or the special field of study.
- Providing the seeds with high germination rate for the national long-term gene bank according to the unified program, with the quantity of every accession of germplasm varying from crop to crop. Providing seeds and germplasm resources for the breeders, scholars and the scientific research institutions concerned in the locality and the special field of study.
- Being responsible for breeding or coordinating the breeding work in the locality and the special field of study, and carrying out the work with respect to the comprehensive appraisal and identification in the meantime.
- Studying on the techniques for the conservation of crop germplasm resources and unceasingly improving the methods and quality of conservation.

In addition to those mentioned above, the scientific research institutions, universities and colleges, generally have their short-term working gene banks for developing research work, which have a temperature of 20°C or so and could conserve seeds for 5 years. The working gene banks are always kept frequent opening and closing for seeds in and out, and their forms vary from place to place and crop to crop, in accordance with their tasks and the characteristics of research work, so they could be simply equipped with storerooms as well as normal refrigerators.

The gene banks of crop germplasm resources now available in China are shown in the following tables:

National gene banks

Institute and address	Temperature of storehouse (°C)	Area of storehouse (m^2)
No. 1 Gene bank, Institute of Crop Germplasm Resources of Chinese Academy of Agricultural Sciences (CAAS) (Beijing)	-10	111
No.1 Gene Bank, Institute of Crop Germplasm Resources of CAAS (Beijing)	0	214
No.2 Gene Bank, Institute of Crop Germplasm Resources, CAAS	-18	300
National Duplication Gene Bank, Qinghai Academy of Agricultural Sciences (Xining)	-18	76.5

Gene banks of local academies of agricultural sciences or professional institutes

Institution and Address	Model III Storehouse		Model I Storehouse		Model I Storehouse	
	Temperature (°C)	Area (M^2)	Temperature (°C)	Area (M^2)	Temperature (°C)	Area (M^2)
Guangxi Academy of Agro. Sci. (AAS) (Nanning)	-10	23	-1	92	25	40
Hubei AAS (Wuchang)	10	23	0	39	10	22
Guangdong AAS (Guangzhou)	-5 to -10	27	0	18		
Shanghai AAS (Shanghai)	-10 -10	48 80	0 to 10	82		
Shaanxi AAS (Taiyuan)	-10	20	0	80		
Hebei AAS (Shijiazhuang)			0 to -5	150		
Beijing AAS (Beijing)	-10	25	0	57	20	40
Heilongjiang AAS (Harbin)	-5	70	0	70		
Qinghai AAS (Xining)					8.8	694
Gansu AAS (Lanzhou)			-1	80	.10	155
Xinjiang AAS (Urumqi)					5-8	80
Institute of Cotton, (CAAS) (Anyang)			0	66	10	66
Institute of Tobacco CAAS (Qingzhou)					Room temperature	20

Institution and Address	Model III Storehouse		Model I Storehouse		Model I Storehouse	
Institute of Application of Atomic Energy, CAAS (Beijing)			0	56		
Institute of Grasslands, CAAS (Huhhot)			0	56		
Institute of Vegetable Crops and Flowers, CAAS (Beijing)					4	25

3.1.6 Field Nursery for Germplasm Resources

The methods of conserving live plant in the field and agamogenesis are adopted to conserve germplasm of perennial crops such as fruit trees, mulberry, tea, etc. In recent years, there have been 25 national nurseries (including branches) for germplasm resources set up in China, where over 20 thousand accessions of germplasm for perennial and agamogenetic crops were conserved.

In addition, the field nurseries for germplasm resources of wild grape, hawthorn, perennial grass, sugar cane, rubber, tropical cash crops, wild cotton, wild kindred plant of wheat, etc. have been placed on the plan and being under construction.

3.1.7 Botanical Garden

China is a country rich in plant resources. According to the statistics, there are over 30 thousand kinds of bryophyte, pteridophyte and spermatophyte in China, accounting for 10% of the sum total of the world. China is the most numerous country in plant variety in the Northern Hemisphere. In order to save those plants on the verge of extinction, a batch of migrant conservation centres for rare plants have been set up all over the country in recent years. Now there are 60 botanical wardens, 40 trees gardens and 255 plantations and breeding farms in China.

In the botanical gardens and trees gardens there are 200 kinds of crops which are part of the ones under the first focal protection. The magnolia family, ginger family and cycad family in the South China Botanical Garden, the hydrophilic plants in the Wuhan Botanical Garden, the rose family in the Beijing Botanical Garden, the azalea, camellia, ginger and cycad family in the Kunming Garden, the borneo camphor and nutmeg family in Xishuangbanna Botanical Garden are forming their distinctive features, and the establishment of these special botanical gardens has made active contributions to the protection for the wild plant resources in China.

3.1.8 Problems and Proposals on *Ex Situ* Conservation

- China National Gene Bank has made great efforts to eliminate duplicates from the collections, with the purpose of avoiding duplicates maintained in same bank and of saving space of the Bank. Yet, about 30,000 accessions of collections introduced from abroad are still preserved in the Bank. If the countries around the world preserved the same accessions, it would certainly waste the space of cold storage. So we propose that FAO should arrange or coordinate the work on germplasm conservation, and ask each country to protect the germplasm resources originated in their own country. Meanwhile, international exchanges and introduction of germplasm should be strengthened. If the countries all over the world are available to the materials originated in other countries, it is naturally no necessary to maintain the materials circulated in other countries in long term.
- The costs for operating storage facilities have become heavy burden for various gene banks, field germplasm nurseries and botanical gardens. It is particularly serious for the countries rich in germplasm resources and with large collections maintained in gene bank. But, to preserve well the treasure germplasm originated in their own country is not only to serve their own country, but also brings benefit to mankind in germplasm exchanges and utilization. Therefore, we propose that we should establish a globe funds for germplasm conservation on basis of global germplasm network. The funds distribution will be determined on the quantity and quality of germplasm conserved and facilities used in conservation. Thus, it will keep the operation of facilities for germplasm conservation in long term.
- We have sufficient spare space and land in various maintaining, facilities which can be open or rent to globe. According to the arrangement made by International Board of Plant Genetic Resources of world germplasm conservation network, our country is responsible for conservation of wheat, barley, etc. in East Asia. The organizations for the conservation of radish and coleseed (*Brassica napus*) crops in the world haven't determined so far, and the allowance haven't been put in position.
- For the seeds preserved in gene bank, seed vitality is controlled mainly by temperature and moisture contents in the seeds. The current research shows that when the moisture contents in the seeds reduce one percent, the storage life of seeds can be doubled. If the seeds with 5 percent of moisture contents were maintained at the temperature of -20°C, the storage life of the seed seems like that of the seeds which the moisture contents have been reduced two percent, the results seem like the seeds maintained at room temperature of 20°C. So you can see that the seeds maintained at low

moisture contents and moisture contents could be dried easily to optimum conditions, may maintain at room temperature conditions. By this way, the energy can be saved greatly. We have made some important progress in this field. Such technique can be applied by seed conservation organizations in the world. So we propose that we should strengthen the research on such energy-saving technique for seed conservation, and make it perfect, with complete equipment, and easy to be used. So that, it can bring social and economic benefit on crop germplasm conservation in the world.

3.2 *IN SITU* CONSERVATION

After the founding of New China in 1949, great attention has been given to the establishment of reservation. Since the establishment of first reservation in Dinghushan, Guangdong Province in 1956. By 1993, 763 reservations have been established in the country, 90 of which are national reservations, with more than 66 million hectares of land. They account for 6.9% of total cultivated land of the country. Generally speaking that they have played an important role in protection of wild species of animals and plants and in protection of natural traces. For instance, Wolong Reservation in Sichuan Province, where is very famous in China, has made an outstanding progress in protecting giant panda.

3.2.1 To Establish Farming Reservation by Stages and in Group

Our country is vast in territory and with different kinds of ecological environments. At present, many cultivated species, especially many wild relatives of crops in specific ecological environments haven't been received appropriate protection. Such wild relatives of crops are increasing crop gene source for improving properties of crops and increasing crop production. They have very important value at present and many years later. However, since the natural environment has been polluted and damaged, and many habitats for wild relatives of cultivated crops growth are degenerated and loss rapidly, a number of wild species are in imminent endangered conditions. Through investigation and demonstration by scientists, they think that we should establish reservations for crops by stages and in groups. First of all, i*n situ* conservation of wild rice, wild soybean, tea, citrus and Chinese gooseberry should be established. Thus it can keep various wild species with sufficient populations, avoid gene flow, and ensure that the genetic resources can be used reasonably and sustainably.

Therefore, the priority should be given to establish the following crop reservations which will be managed by agricultural sectors:

- Meadow reservation for Subtropical alpine red clover (*Trifolium pratense* L.) in west part of Hubei Province;
- Sheep reservation at Salt Pond Beach, Ningxia Hui Autonomous Region;
- Leishan quality tea reservations Guizhou Province;
- Nanfengmiju (C. kinokoni Hort. ex Tan) reservation in Jiangxi Province;
- Chinese date reservation at Leling, Shandong Province.

3.2.2 Encourage Farm (or Agricultural Technique Station) and Farmers to Preserve Germplasm Resources

Since the surviving sites of some rare crops and some wild relatives of crops are distributed fragmentally, it is suitable for local farms and farmers to preserve crop germplasm resources in these places. For instance, Dongtao Country in Shannxi Province has entrusted local farmers to preserve the, germplasm resources. The surviving sites which are needed to be preserved urgently are as follows:

1. Xima Town, Mengjiang Country, Yunnan Province: *O. meyeriana, O. rufipogon, O. officinalis*;
2. Ya County, Hainan Province: *O. meyeriana, O. rufipogon, O. officinalis*;
3. Dongyuan Township, Dongxian County, Jiangxi Province: *O. rufipogon*;
4. Hanguang Town, Yingde County, Guangdong Province: *O rufipogon*;
5. Menghai, Yunnan Province: Wild Dali tea tree and giant tea tree;
6. Chayu County, Tibet: Wild soybean;
7. Langtanhu Region, Wanghe County, Anhui Province: Wild soybean;
8. Xiang County, Hebei Province: Wild soybean;
9. Xinmiao Town, Yiguanghaomeng, Inner Mongolia: Wild soybean;
10. Guofu Township, Keshan County, Heilongjiang Province: Wild soybean;
11. Kenli County, Shandong Province: Wild soybean;
12. Yinan County, Shandong Province: *Heteromorphic* wild bean with white flower;
13. Ya County, Hainan Province: Heteromorphic wild bean;
14. Hua County, Shannxi Province: *Huashan Psathyrostachys huashanica*;

15. Shennongjia, Hubei Province: Initial Japanese mulberry (*Morus australis*), the Chinese gooseberry (*Actinidia chinensis*) and wild welsh onion;

16. Xingshan District, Xianfeng County, Hubei Province: Mulberry tree with long mulberry;

17. Fubaoshan, Lichuan County, Hubei Province: Wild leek;

18. Weining County, Guizhou Province: Wild buckwheat;

19. Zhenba County, Shannxi Province: Wild welsh onion and wild prickly ash (*Zanthoxylum*).

3.2.3 *In Vitro* Plantlet Conservation

The Institute of Crop Germplasm Resources, CAAS, has established two *in vitro* plantlet storage. One is for potato (3.95 m long, 2.8 m wide, and 3.35 m high). The temperature of conservation ranged from 6 to 10°C. By the end of 1990, more than 600 accessions of potato collections have been maintained in the storage. Another is for sweet potato (3.0 m long, 2.7 m wide and 4.2 m high). The temperature of conservation is 16°C to 18°C. By the end of 1990, over 1,000 accessions of sweet potato collections have been maintained in the storage. Additionally, Xuzhou National Gene Bank for Sweet Potato *In Vitro* Plantlets and Keshan National Gene Bank of Potato *In Vitro* Plantlets, which have been listed in the state plan and are under the construction, will be completed in 1995.

3.2.4 Cryopreservation

The seeds from 21 materials, including grain crops, vegetables, flowers, medicinal herbs etc. have been tested by tile Institute of Crop Germplasm Resources, CAAS. These seeds have been refrigerated and stored in liquid nitrogen with -196°C, and then thawed to room temperature for germination testing and field planting. The performance is normal. The Institute has also conducted the research on conservation of pollen of maize, rye, peach and pear, calIus of meristem of sugarcane, stem cutting of Chinese gooseberry, and recalcitrant tea seeds. The research has made success.

3.3 CHARACTERIZATION AND EVALUATION OF AGRO-ECONOMIC CHARACTERS

The scientists related to each crops have been invited to attend the national conference. According to the materials submitted by each germplasm conservation organizations on characterization and evaluation of agro-economic characters for each crop, the scientists will reject the materials with the same names but in different species or with the same species but in different names, and compete a unified list for that crop. Each organization for seed conservation is responsible for seed multiplication. The seeds will be divided into three parts, one with the information of agro-economic characters will be sent to National Gene Bank (NGB) for conservation and other two will be evaluated on disease and pests resistance, stress tolerance and quality testing. All testing and evaluation data should be sent to Information Processing Laboratory of the Institute of Crop Germplasm Resources, CAAS. They will be put into the database.

3.3.1 Data Processing and Utilization

According to the principle that a seed sample preserved must have a description, we have established a integrated database on crop germplasm resources. The contents recorded by the items recommended by IBPGR. Generally, a seed sample has 60-70 items to be recorded. At present, the data on 282,700 accessions of germplasm resources have been recorded in Database of National Gene Bank. The data on 11,000 accessions of germplasm resources have been recorded in Database of Field Germplasm Resource Nursery. We have also established the state database for duplicates of germplasm, and the database for germplasm distribution and exchanges. In order to make available for breeders to obtain timely the evaluation information on the characters of germplasm, we have provided with 12 million item volumes of evaluation data to provincial agricultural institutions and some research organizations concerned in the country during the period of 1991 to 1994. In addition, we will copy the software and establish 41 information networks around the country. Thus, it is convenient for some relevant organizations to inquire and use the information nearby. Besides, by taking wheat and millet as research objective, the computer analysis system for karyotype and isoenzyme has developed by C language. By taking county as a unit to count the quantity of germplasm, 270 maps on the germplasm distribution of major crops have been drawn out. They have provided the basis for the research of origin, evolution and classification of crops and diversity of crop genetic resources.

3.3.2 Multiplication and Regeneration

According to the International Seed Testing Regulation, we have made following monitoring research on seed vitality for eight crops which have been stored eight years. The results show that germination rate has declined in varying degree. The seeds with high initial germination rate have declined less, the seeds with low initial germination rate have declined more. But in recent years, the germination rate couldn't be declined to the level in which the seeds need to be multiplicated and regenerated by international standards. We, on the one hand, strengthen the regular monitoring on seed germination, and on the other hand, we began to conduct research with the financial support from IBPGR on the multiplication and regeneration of seeds stored in gene bank in 1994. Four varieties for each crop of buckwheat, Job's tear (Coix lacryma-Jobi), Chinese cabbage, sesame and polyanthous common bean were used with different sizes of population, various methods of isolation and pollination, and different quantity of seeds harvested, and through field investigation, seed roasting in the house and selection with some cell structural enzymes, to test the difference between stock seeds (parents) and progenies (offspring) in various population, and study the advantages of different kind of multiplication methods for different crops. The purpose is to provide the basis for seed multiplication and regeneration in the future.

CHAPTER 4
Utilization of Plant Genetic Resources in China

4.1 STATUS OF UTILIZATION OF PLANT GENETIC RESOURCES IN CHINA

China has a long history and rich experience in utilization of plant genetic resources. Since the founding of New China in 1949, a number of new crop varieties have been developed which can't be separated from the utilization of germplasm of landraces rich in China and elite germplasm introduced from abroad. Statistics indicates that, during the period from 1949 to 1979, China has developed 508 rice varieties. In 70's, following the discovery of the wild abortive, success in cytoplasmic male-sterile or A-line transfer, and identification of desirable fertility restore or R-line, China, for the first time in the world realized the combination of three lines in hybrid breeding. A large number of superior hybrids have been developed and used in production. By 1992, the cultivated areas of hybrids amounted to 140 million hectares. The production increased by 150 billion kg. This is a revolution in rice production in China. From 1949 to 1982, China developed 13 wheat varieties with planting areas of 670,000 hectares for each and 110 varieties with planting areas of 67,000 hectares for each. The height of plants changed from tall to short. The weight of 1,000 grains increased from light to heavy. The disease resistance increased continuously. Maturity time became more and more early. Since 1960's, China has strived to popularize hybrid maize. According to the statistics there are 20 maize hybrids with planting areas of 130,000 hectares for each, 10 varieties with planting areas of 65,000 hectares. The yield increased by 20-30%, and more than that of check variety. At present, the planting area of hybrid maize account for over 75% of total planting area of malze in China. China is extremely rich in genetic resource of soybean. A lot of local varieties are still major cultivars so far. Since 1949, nearly 200 superior varieties of soybean have been selected in China. They account for two third of varieties developed through cross. From 1960 to 1982, 225 varieties (lines) of rape (*Brassica napus* L.) were selected in China. As the new rape varieties have been spread in large areas, they have changed in face of rape production in China. Since 1949, 260 cotton varieties have been developed in China, of which 43 varieties of upland cotton (*Gossypium hirsutum* covered 65,000 hectares and more.

In recent years, China has gained some new progress in the utilization of Crop genetic resources.

Rice: by use of wild rice to cross with cultivated rice, a large number of superior rice varieties and male-sterile lines have been developed and used in production. By use of Zhong 413, a strong salt-tolerance with broad compatibility, to make cross, an extra-high yielding combination Xieyou 413 has been produced and has been used in production. Rice variety 82-210 with strong salt-tolerance, which is selected from Indica materials introduced from abroad, has been planted in saline-alkali soil along the coast. Indica rice variety BG90-2, introduced from abroad, and its 6 derived varieties have been planted over 670,000 hectares.

Wheat: we have successfully transferred the gene with barley yellow dwarf disease resistance from Thinopyron intermedium to bread wheat. A translocation line of Thinopyron intermedium has been developed. It has provided reliable material basis for resistant breeding program of barley yellow dwarf disease. Some new winter wheat lines selected from winter varieties with cold salt tolerance can be irrigated with salt water. Winter wheat variety 442M-1 with salt resistance and good performance has been spread largely in Delta of Yellow River.

Maize: maize variety Hongyu No. 9 selected from inbred lines with strong cold resistance has been spread 26,000 hectares. Thus, the planting areas for maize have been moved to N. 51 31'. By using of maize varieties with high oil and protein contents and high lysine to make cross, a number of hybrids, of which the oil contents are 2-3 times of common maize varieties, have been developed.

Sorghum: by using of restore lines 5-26 and 5-27, which is immune to head smud (*Spacelotheca relianum*) and has resistance to aphid of sorghum respectively, to make cross, Shenza No. 6 has been developed and the planting area amounts to 65,000 hectares. Economic benefit has increased by 20 million yuan.

Millet: by introducing and using of variety Japan 60 Days, the damage, which was caused by epidemic of blast of summer millet and couldn't be controlled for several years in China, has been controlled basically. The utilization of germplasm with rust resistance has gained a good result in breeding program of rust resistance.

Soybean: by using of improved germplasm 5621, which is developed by crossing semi-wild species with cultivated varieties, as parents, a series of varieties with good performance and disease resistance have been developed.

Peanut: by using of germplasm of strong bacterial wild disease of peanut in breeding, a large number of varieties with bacterial wild resistance and good performance have been developed. They have been spread 3 million mu in the

areas with bacterial wild disease. The disease has been controlled efficiently in these areas. The income increased by 200 million yuan annually.

Fruit trees: Fuji Apple introduced from Japan has covered 270,000 hectares, with output of 5 million tons annually. The output value has reached 10 billion yuan. By using it as parent to make cross, a number of promising varieties, which are better than Fuji variety, have been developed. Sweet persimmon introduced from Japan has been planted in 14 provinces and cities. Domesticated varieties (lines) selected from wild Chinese gooseberry have covered 4,000 hectares and have got significant results. The citrus varieties Sortunella (Hindsir) and Goutoucheng (*C. aurantium* L.), which showed strong resistance to root rot (*Thytothoir* sp.) and CTV respectively in China, have received great attention in the world.

Vegetables: by using of superior local pepper growing in Hunan as parents to make cross, a series of varieties of Xiangyan Nos. 1 to 10 have been developed. They have been planted in 30 provinces and cities with accumulative areas of 65,000 hectares. By using of Yunnan pumpkin with black seeds as root stock for cucumber grafting, the yield increased by 30-50%. The varieties produced through this method have spread 14,000 hectares.

Crop germplasm resources have been provided for use in three ways: 1) The germplasm resources with good characteristics are used as parents in breeding program. 2) Through ecological evaluation, the germplasm resources with comprehensive characteristics are provided for use in production directly. 3) The germplasm resources will be provided for the use in biotechnology research and other research concerned in agriculture. Meanwhile, these materials will be provided for germplasm exchanges with foreign countries. About 350,000 accessions of crop germplasm resources have been collected and preserved in China, including 50,000 accessions which were introduced from abroad and identified with the worth to be preserved. By rough statistics the germplasm resources used now only account for 3-5% of total collections preserved. In past 45 years, about 5,000 new crop varieties have been developed in China. It is estimated that more than 10,000 accessions of genetic resources have been used. For instance, about 1,000 wheat varieties were used in production in 1970's. But about 30,000 accessions of wheat germplasin resources were preserved at that time. From 1986 to 1990, 200,000 accessions of crop germplasm were evaluated primarily through state major research projects. Nearly 20,000 germplasm resources were found with single or multiple superior characteristics. But only about 1900 were used in breeding programs and in production. They only accounted for 1% of total materials provided for evaluation, and 9.5 % of materials with superior characteristics. In recent years, China, through germplasm resource exploration, has collected 10,000 accessions and more of crop genetic

resources. But most of them haven't been studied and used. In grain crops, some minor crops, legumes, cash crops and horticultural crops and their wild species have rich genetic resources for development and utilization. So we can say that the utilization of crop genetic resources in China has great potentials and bright future.

In China, the crop genetic resources collected already which are often listed in the state research projects are as follows: rice, wheat, maize, barley, millet, sorghum, sweet potato, potato, cotton, soybean, rape, peanuts sugarcane, sugar beet, vegetables, fruit trees, and rubber trees. These crops are closely related to national economy and people's livelihood. Most of landraces are used in crop germplasm resource research. Some wild relatives have been drawn attention in the research. All breeders both at home and abroad have attached great importance to the introduction of germplasm.

Farmers are eager to obtain new varieties with good quality and high yielding. As the spread of new varieties with good quality and high yielding, farmers can get more and more benefits. So their initiatives to obtain new varieties are much higher. Therefore, the native varieties have become less. Monoculture of cultivated varieties has become more serious. For instance, before 1949, nearly 10,000 wheat varieties were used in production in China. But by statistics in 50's, local varieties accounted for 81 %, varieties we developed accounted for 14.9%, and varieties introduced from abroad accounted for 4.1%. By 70's, only about 1,000 wheat varieties were used in production. The varieties we developed accounted for 91 %, the varieties introduced from abroad accounted for 4.1, local varieties only accounted for 5%. In the past, the varieties the farmers cultivated mainly depended on the exchanges among themselves or obtained from research organizations. In recent years, as the development of economy and the spread of superior varieties, farmers can buy the seeds they need from seed production departments (seed companies, seed extension stations).

4.2 BENEFITS OBTAINED THROUGH USING OF PLANT GENETIC RESOURCES IN CHINA

Utilization of crop genetic resource in China has brought significant economic and social benefits to agriculture. Since the founding of New China in 1949, The seeds used in production have changed for 3-5 times on large scale in China. Coverage rate of improved varieties has reached over 85 %. By statistics from 1949 to 1992, the yield ofgrain crops increased from 1,050 kg/ha. to 3,900 kg/ha . The total production increased from 132.1 billion kg.

to 456.4 billion kg. The yield increased by 3.7 times and 3.45 times respectively. All these results were realized mainly by regeneration of varieties, among which, the yield of rice increased front 1,890 kg/ha to about 6,000 kg/ha through 4 renovations of rice varieties. The yield of wheat increased from 630 kg/ha to about 3,000 kg/ha through 4 renovations of wheat varieties. The planting area of hybrid maize accounted for 70-80% of total planting areas of maize. The yield increased from 1,335 kg/ha to 4,500 kg/ha. Through 6 renovations of cotton varieties, the yield increased from 375 kg/ha to 750 kg/ha. China now has become the biggest country in cotton production in the world.

At present, China has established germplasm exchange relations with more than 90 countries and regions. About 3,000-5,000 accessions of germplasm will be introduced from abroad annually. About 3,000 accessions will be provided for germplasm exchanges with foreign countries. The utilization of germplasm introduced from abroad has played an important role in agricultural research and production in China. Since the founding of New China in 1949, there are 19 rice varieties introduced from abroad with the planting areas over 67,000 hectares for each. By using of rice germplasm introduced from abroad to make cross, more than 300 new rice varieties have been developed. More than 80 wheat varieties introduced from abroad have been used directly In production, 6 of them with the planting areas of 670,000 hectares for each. Hundreds of wheat varieties have been developed by using of wheat germplasm introduced from abroad. By statistics more than 80% wheat varieties developed in China are with foreign blood relationships. Through introduction of inbreed line Mu No. 17, single-cross maize varieties Zhongdan No.2 and Danyu No. 13 have been developed. The planting areas have covered 2.1 million hectares and 3.2 million hectares respectively. By using of Dalta, Stoneville and varieties with low phenol contents introduced from abroad, the cotton production in China has made a great leap forward. The varieties of rape and other oil crops and sugar crops introduced from abroad have not only increased the yield, but also improved the quality. New fruits and vegetables introduced from abroad have significantly increased the varieties on the market and regulated the supplies of market. Additionally, the germplasm resources provided by China have also played an important role in the countries around the world. For instance, the United States has found out of genes with water-logging and root rot resistance from soybean germplasm resources provided by China in recent years. These genes have been used with good results.

4.3 ACTIVITIES OF CROP BREEDING IN CHINA

Crop breeding in China has developed quickly in recent years. In the course of increasing productivity of agriculture, the function of new crop varieties account for 30% and more. The main objective of crop breeding in China is, through improving local varieties. To resolve the problems on the requirement of quality and quantity of agricultural commodities caused by population increasing continuously (at present, the population is 1.2 billion, with 10 million people increasing annually) and cultivated land reduced constantly (about 40,000-470,000 hectares of cultivated land are reduced annually). The emphasis is given on improvement of quantity and quality of grain, cotton and oil crops and vegetable.

At present, the activities of crop breeding in China are conducted mainly by agricultural research institutions establish by national and local governments. The funds are granted by central and local governments. But since the funds granted by governments are very limited in quantity, it is far from the normal requirements for crop breeding. Many breeding projects are difficult to conduct their research activities. At present, apart from the support for crop breeding, from the departments of national government, it is difficult to get assistance from private companies or foreign companies.

The varieties developed in our country must participate in zone testing for three years. After that they must be examined and approved for release by provincial and national governments. Farmers and seed departments can spread and multiplicate the seeds they obtained from research institutions, which have been examined and approved by the departments concerned. Farmers prefer to plant the varieties of high yielding, good quality, with diseases and pests resistance, drought, cold and saline-alkali tolerance, and suitable for growing, in different kind of ecological conditions. For the new varieties planted by farmers, apart from meeting the needs for themselves, most of them are sold in the market. Thus it can increase the incomes for farmers and expand the production. The farmers always plant and preserve the varieties with special purpose and the varieties they used to plant. Thus, it can play an important role in preserving some superior germplasm resources in natural conditions. Whether the variety is good or bad is determined by farmers on the benefit they, obtained by planting it, and then to determine the planting area.

At present, the main problems existed in crop breeding are short of varieties with breakthrough in yield, although a large number of varieties have been developed. The yield of a new variety generally increased by 8-10% than that of major varieties. The main causes are as follows: 1) The genetic resources

used at present are narrow; the germplasm resources collected haven't been studied thoroughly; some superior germplasm resources haven't been used and developed sufficiently, and it is poor in artificial improving and creating new germplasm. All these have limited the utilization of genetic diversity widely and led the results of less superior materials available for crop breeding. 2) It is slow in the use of high and new techniques. New technique can't be closely linked with conventional breeding. Basic research is poor. The research on some important characteristics and genetic regulations is not enough. 3) There are no protection of intellectual property right on breeding. So the initiative of breeders can't be brought up. 4) Financial inputs is seriously insufficient in the research of genetic resources and breeding. Facilities and research conditions are poor and backward. Research system is not suitable for the development of agricultural research. Therefore, we must reform the existed system on breeding and management, increase breeding efficiency, strengthen the applied basic research on breeding, make and promulgate seed law, protect the benefit for both farmers and breeders, and increase inputs on germplasm research and crop breeding.

Although there are some improvements on seed multiplication and extension, seed processing, storage and business, however, with the establishment of market economy, existed system and operation mechanism are not suitable for the need of development. The work on breeding, seed production and extension are separated each other. Seed business is confusion, and seed quality is poor. All these have been drawn attention by our government. The reform and construction of seed system has been listed in the state key programs.

4.4 PROBLEMS AND PROPOSALS ON THE UTILIZATION OF PLANT GENETIC RESOURCES IN CHINA

For the plant genetic resources collected in China at present, apart from few resources which showed their value clearly in their utilization and could obtain the benefit in short time, most of them need to be studied further so that they can play their role in the utilization. The long benefits of plant genetic resources in the long run is much more important and more valuable. So we never evaluate the investments on plant genetic resources only with the benefits gained in short run. In recent ten years, the Chinese government has attached great importance to the work on plant genetic resources and has increased the inputs on that. So we have gained great achievements on the collection, conservation and research of plant genetic resources which have been attracted worldwide attention. But needless to say, compared with the

international advanced standards on the research, utilization and management of plant genetic resources, we still have a long way to go. The main problems are as follows: 1) A large number of plant genetic resources we collected are short of further research. The classification and evaluation of plant genetic resources are still on phenotypes. We are short of advanced techniques and equipment to explore and utilize efficiently the superior germplasm. 2) Exploration and utilization of wild resources of some major crops and minor crops haven't received sufficiently attention. 3) The research of genetic resources hasn't closely linked with breeding program. 4) Funds and management have limited the introduction and utilization of superior germplasm from abroad. 5) The laws and regulations of plant genetic resources are imperfect. 6) It is difficult to draw attention and get support from local governments on the research of plant genetic resources. Although our government has attached great importance to this work, the funds and inputs are still insufficient seriously.

In order to obtain more benefits from the rich plant genetic resources we collected and maintained, we think that: 1) The research of crop genetic resources must be listed continuously in the state major research projects, Africa the Inputs from the Government must be increased, and the basic research on genetic resources should be strengthened. 2) We should develop relevant policies and regulations and perfect the working system on genetic resources, put in order the relations of research on crop genetic resources with breeding work. Bring up the initiative of scientists on plant genetic resources research and breeding. 3) We should train a number of over-century scientists who love and devoted to the cause of crop genetic resources and give them a guarantee on research funds, research conditions and lives. 4) We should strengthen the international cooperation on the exchanges of germplasm, and conduct jointly the research, development and utilization of existing genetic resources.

CHAPTER 5
National Target, Policy, Projects and Legislation

The short term targets of plant genetic resources in China are:

- To protect in all-round way the cultivated lands, forestry, grass lands, wet land, water sources, species of animals and plants, wild relatives of animals and plants and wild species in agricultural regions.
- To strengthen the construction of protection system; to revise and supplement some necessary laws, regulations and standards. The laws and system of agricultural resources will be established gradually before 2000.
- To protect in priority agricultural ecosystem and crop species, to set up a number of *in situ* conservation sites for wild relatives of crops, to strive to establish a batch of protective regions and protective grounds for agriculture which have local significance.
- To establish and perfect the protective network for rare and endangered animals and plants in whole country to protect the genetic resources. To strengthen the farming domestication and utilization of rare and endangered animals and plants.
- To strengthen the survey, collection, maintain and multiplication of genetic resources of crop plants.
- To establish in priority other 23 local gene bank for medium term conservation, and 10 germplasm nurseries for perennial crops.

During the period of consideration for establishing national board of plant genetic resources, the work on plant genetic resources may be coordinated by State Planning Commission and State Science and Technology Commission, and conducted by relevant departments of the Government separately. In order to strengthen the work on crop genetic resources, The Chinese Government established a National Institute of crop genetic resources, which is under the Chinese Academy of Agricultural Sciences. The Institute is entrusted to organize and coordinate the work on crop germplasm resources in the country and conduct the germplasm exchanges with and introduction from abroad. The Ministry of Agriculture and the State Science and Technology Commission have clearly defined that the principles on the work of crop germplasm resources in China are: to assemble widely the genetic resources (including all crops, wild relatives of plants), make proper conservation, do in deep research, make actively the enhancement, use them

sufficiently, serve the crop breeding and speed up the construction of agricultural modernization.

In recent 30 years, with the financial support from our government, we have organized some key national projects. The survey and collection of crop germplasm resources began in 1950s. The Ministry of Agriculture has issued two notices to whole country on collection of various seeds of major crops, asked to take county as a unit to make collection and documentation on various crops in all-round way. On the basis of that Conservation and Supply of Crop Germplasm Resources Assembled both from Domestic and Foreign Sources (Draft) has drawn up. In 1979, the Ministry and the State Science and Technology Commission jointly issued a Supplementary Notice on Collection of Crop Germplasm Resources. Additionally, from 1979, according to the documents issued by the Ministry of Agriculture, we have organized scientists to Yunnan and some important areas more than 20 times to survey and collect key crops, including wild soybean, the activities including comprehensive and single survey and collecting. In recent ten years, the major projects are germplasm conservation and research. During the period of two Five-year Plans (1980-1995), the State Planning Commission and the State Science and Technology Commission have listed the Research of Crop Germplasm Resources as the first item in state major projects, and have organized more than 2,500 scientists and technicians from 400 organizations all over the country to make joint efforts on the germplasm research. By implementing the projects mentioned above, we have made considerable progress in the research of crop germplasm resources. The Regulations of Seed Management in the People's Republic of China was issued by the State Council in 1989. The Detailed Rules of Crop Seeds on the Regulation of Seed Management in the People's Republic of China was Issued by the Ministry of Agriculture in 1991. The Quarantine Law for Export and Import of Animals and Plants in the People's Republic of China and Quarantine Regulation of Plants were issued in 1991 and 1992 respectively. In 1994, the Ministry of Agriculture and the Ministry of Forestry jointly drew the Protective Regulations of Wild Plants in the People's Republic of China and Protective lists of Wild Plants in China. In addition, Seed Law will be promulgated. The law of Wild Plant Protection is in consideration. In short, China has attached the importance to legislation and to perfect it gradually. All these have played a motive and guarantee role in the research work of crop germplasm resources.

CHAPTER 6
International Coordination

No one nation or region can be self-sufficiency in plant genetic resources. Meanwhile, if plant genetic resources in any country or region were damaged or destroyed, they would directly and indirectly influence the existence and the development of mankind. The plant genetic resources are distributed in different countries and regions. We should recognize that each country and region has its own right to possess plant genetic resources. Since farmers have made great contribution to protect local plant genetic resources in a long period of production, these resources could be survived so far. We therefore should also recognize the farmers' contribution. When we use and exchange these plant genetic resources, we should give proper compensations to farmers for their loss. In view of the facts mentioned above, China realizes that, through international coordination, to comprehensively and carefully protect and use the plant genetic resources will benefit each country. To conduct fare and equal exchanges of plant genetic resources is also in keeping the interests of each country. So we propose to do following work:

- We are willing to expand the exchanges of genetic resources, including the germplasm of forestry, Chinese medicine, pasture, etc. By cooperation with IBPGR in 1987, we compiled a catalogue for 4,300 accessions of crop genetic resources for exchange with foreign countries. In 1994, we compiled a catalogue for 2,500 accessions of crop genetic resources for exchange through the cooperation with FAO. The major constraints limited the expansion of germplasm exchanges are short of funds for seed reproduction. If the funds for seed reproduction could be compensated through germplasm exchanges, the scales of germplasm exchanges would be expanded.

  At present, the work of germplasm exchange is still at initial stage in contact with the work of international exchanges of genetic resources.

- Expansion of cooperative research in plant genetic resources.

  In order to make deep study on plant genetic resources in China, on a mutually beneficial basis, we have made bilateral or multilateral cooperation with some countries. In recent years, we have conducted the cooperative research with the United States on the germplasm resources of wheat race and soybean. The research goes on smoothly. The cooperative form is that a certain amount of research funds and the equipments needed in the laboratory will be provided by the United States, China will provide a certain amount of germplasm materials. The research will be conducted by two sides. The results and benefits will be shared each other.

In addition, we have made contact with Japan, Korea, Australia, etc. on the projects with common interest for cooperation.

- Expanding the approaches of international coordination.

  The protection and sustainable use of plant genetic resources is a giant systematic engineering. Since China is sufficient in labor forces and with low costs of land, we can provide seed production bases to foreign research organizations and seed companies for multiplicating superior seeds used directly in production. The spare space and land of gene bank and germplasm nurseries may be rented by international societies.

  We want to establish a center of plant genetic resources in China. We warmly welcome the scientists from different countries to China for conducting cooperative research.

- Cooperation with international organizations.

  On the research of plant genetic resources, especially on the crop germplasm resources, we have kept good relations with the centers in CGIAR system, including IBPGR/IPGRI, IRRI, CIMMYT, CIP, ICARDA, ICRISAT, AVRDC, etc. We have made broad cooperation and germplasm exchanges. At present, international standards and methods used in the world are applied in germplasm collection, reproduction, evaluation and being put in the bank, and data processing. Thus it is convenient to the exchanges and utilization of genetic resources in the world. For example, apart from the conservation of genetic resources of our country, China National Gene Bank has undertaken the tasks of preservation of rape, Chinese cabbage, radish for the globe and wheat and barley for Asian Region in long term. We have conducted the cooperation with IPGRI on the collection and conservation of Chinese bullwheat and multiplication and regeneration of seeds stored in the gene bank. We have conducted the cooperation with ICRISAT on regional trials of legume and the collection of sorghum in China. The cooperation with AVRDC on introduction and extension of mung bean has got good results. The practice shows that these international and regional centers have made great contributions to the research of parent genetic resources in China. We are willing to make better cooperation with international organizations, especially with neighboring countries and regions on the collection, international exchanges, research and utilization of germplasm resources, and personal training.

CHAPTER 7
The Needs of the Country and the Opportunity

The overall targets for next decade on plant genetic germplasm resources in China are:

- To obtain a general understanding on the species, distribution, quantity of population and the status of changes of plant genetic resources in China.
- To make the crop germplasm resources to increase 10,000 accessions annually.
- To study the formative factors of centers where are rich in diversity of plant genetic resources and put forward the overall plan on *in situ* conservation of the germplasm.
- To establish national key laboratories for the evaluation and enhancement of crop germplasm resources.
- To establish control center and monitoring system for genetic diversity of germplasm and information systems.
- To make detailed identification, utilization and evaluation of stress resistance for crop germplasm resources.
- To conduct actively the enhancement of germplasm, strive to develop crop germplasm resources which have not been used sufficiently, and bring plant genetic resources into full play in the development of sustainable agriculture.

The major projects for next ten years are as follows:

- Fundamental investigation of diversity of plant genetic resources in China.

  The purpose of the project is to find out basically the species, distribution, quantity of population and the status of changes of plant genetic resources, traits of ecology and biology. The exploration and collection of germplasm resources are focused on major areas (such as Three Gorges reservoir areas, Wulin Maintain areas, Maintain areas in Fujian, Zhejiang and Jiangxi Provinces, Wuzhishan areas, Changbaishan areas, etc.), major crops (which are originated in China and haven't. been used sufficiently) and border areas with neighboring countries. Meanwhile, we have strengthened the germplasm introduction from and exchanges with

foreign countries, and we will gradually establish and perfect 6 major ecological areas for germplasm isolation, introduction and trail, and a germplasm resources center for multiplication, regeneration and exhibition of superior germplasm.

- The study on formative factors of centers where are rich in plant genetic resources in China and protective measures in all-round way.

  On the basis of investigation of germplasm, we will determine the protection targets, grade, the endangered levels, compile the catalogue for endangered plants in China, and publish red book of plants. When we determine the targets, apart from the endangered levels, we should also consider to give priority to the special and rare species with high academic and economic values, single family and single genus of crops, flowers, forestry, medicinal plants, and their wild relatives. We will investigate the distribution of 50 crops (originated in China) and study the agro-ecological areas where are rich in species. According to the materials on history, geography, ecology, geology, etc. We will study the formative factors of centers where are rich in germplasm resources, and regulations of their evolution (including distribution regulations of some important properties), establish geographical information system for crop genetic resources, investigate the distribution of rare germplasm of crops and wild relatives of plants and centers where are rich in germplasm resources, and put forward the catalogue of rare and endangered species and protective measures. When we build the reservations, natural parks and botanic gardens, and arboretum, we should also give the priority to protect agro-ecosystem, establish 24 protective sites, protective areas and protective grounds for wild relatives of crops, build another 10 gene banks for medium term conservation and 8 germplasm nurseries for perennial crops. Thus, we will form a well-established plan for *in situ*, *ex situ* and *in vitro* conservation of crop genetic resources. By establishing the information network of protective areas, sides, gene banks and germplasm nurseries, we may keep Beijing as the center to establish control center and monitoring system for genetic diversity of crop germplasm resources and information.

- Research oil plant genetic resources.

  To establish national key laboratories for evaluation and enhancement of diversity of crop genetic resources. Through the research on biochemical markers and molecular markers, including clone and probe which are used for the evaluation of idiosyncrasy of species and genus of crops. We have isolated the biochemical markers and molecular markers for the evaluation of genetic diversity of major crops (including rice, wheat, cotton, maize, and soybean) and their wild relatives, including the genetic markers used for evaluating different kinds of interspecies and intergenecies, and the gene markers for the identification of resistance to diseases, pests and other environmental stress factors. We have establish the methods which can be

used for rapid and accurate identifying crop genetic diversity, and put forward the use prosperous for these markers in collection, protection, research and sustainable use of germplasm resources.

Since the classification for the genetic resources under the species is quite important and since there are no well-established classification system for genetic resources under the species to be followed, so we should combine the traditional methods with modern biotechnology to study and develop a classification system, which is reasonable, and suitable and can be accepted by scientists both at home and abroad, for 100 crops originated in China, and to conduct the study on the origin and evolution of some major crops (including rice, wheat, soybean, millet, rape, fruit trees, vegetables, etc.).

According to a large number of basic information, characters of botany, agronomy and biology, and by using of materials on cytology, genetics, taxology, ecology and material geography, and on the materials of biochemical markers and molecular markers, we have conducted the research on nucleus germplasm of some major crops (including rice, wheat, cotton, maize, soybean), and drawn the finger print illustration for major crops (about 200 illustrations for each crop).

- Evaluation and Utilization of Plant Genetic Resources.

  One hundred thousand genetic resources of various crops which are collected and introduced in recent years, will be catalogued, multiplicated and put in storage. Meanwhile, they will be identified on major characterists of agronomy, resistance to stresses, diseases and pests, and quality.

  The research is focused on some major grain crops and cash crops which are related to the national economy and the people's livelihood, e.g. rice, wheat, maize, soybean, cotton, rape, major fruit trees and vegetables. Some pilot materials obtained from wild and special germplasm resources which have the value to be used, through conventional hybridization, radiation, biotechnology, gene transfer and recombination, will be used in crop breeding and biotechnological programs.

  Through deepening the utilization and evaluation of about 20,000 superior germplasm identified in existing crop genetic resources, we have provided to the departments of production, breeding and biotechnology with the germplasm resources of dwarf, early maturity, good performance, high combining ability, strong resistance to stresses, diseases and pests, high protein and oil contents, and good quality.

- Personal Training on Plant Genetic Resources.

  Each year, about 4-5 young scientists will be sent abroad to pursue master and doctor degrees, 10-20 visiting scientists will be sent abroad for

cooperative research. On the other hand, about 100 scientists will pursue their degrees in the country or receive in-service training. Only thus, can we meet the minimum requirements on the work of plant germplasm resources in China.

Due to following reasons, we need to get international assistance and to conduct cooperation with foreign countries in order to realize the programme.

Diversity of plant genetic resources is an important part of biodiversity, and has an international nature.
Developed countries have fifty years experience in protection, utilization and development of genetic diversity.

Abundant economic forces are needed to realize the programme.

International assistance and cooperation for projects of the programme are needed as follows:

1. Assistance for Capacity Building: training scientists, establishing information control centers and monitoring system, and establishing key laboratories for the evaluation and enhancement of genetic resources.
2. Technical cooperation: to conduct jointly the evaluation and testing on the diversity of plant genetic resources in China, and conduct jointly the research, development and utilization of genetic resources in China.
3. Facilities and engineering construction: to establish information control center and equip the soft and hard facilities for the laboratories of diversity of plant genetic resources, and to build the centers of germplasm resources according to different kinds of ecological areas.

CHAPTER 8
Proposals on Globe Action Plan

Since the World Conference on Environment and Development held in Brazil, the protection and sustainable use of biodiversity have received wide attention by international society. It has become one of the key topics on human environment and development today, and have been attached great inportance by each government and relevant organizations. A pressing matter of the moment is to take action immediately. So we propose as follows:

- Taking action immediately. We should intensify the protection of plant genetic resources for original centres of major crops in the world. The distribution of genetic resources on the globe are quite difficult. Some areas are very rice. So N.I. Valiov calls these places as origin center of crops. The most of origin centers of crops in the world are located in the developing countries, such as China, India, and the countries in Southwest Asia and Latin American. These countries have done a lot of work on germplasm resources, including exploration, collection, establishment of long-term gene banks and germplasm nurseries. However, since these countries are limited in financial resources, it is different for them to protect these important human heritages by their own efforts. By taking China, the biggest origin center of crops in the world, as an example, China has made several explorations and collections on genetic resources, it has 300,000 accessions of crop genetic resources both from its own country and abroad. With the portion of financial assistance from Rockefeller Foundation and IBPGR, we have build a national crop gene bank. In recent ten years, the Chinese Government has made efforts for multiplication and regeneration of 280,000 accessions of crop genetic resources. All seeds have been put in national crop gene bank for long term conservation. In addition, we have established 25 national crop germplasm nurseries for the conservation of perennial fruit trees, vegetative crops and water vegetables. At present, the cooling facilities of national crop gene bank has been operated for 9 years continuously, they need to be overhauled urgently. Additionally, to keep the cooling storage at the temperature of 18°C, we need funds to keep the machine in operation. Since we are short in funds to manage the germplasm nurseries, some of them are overgrown with weeds, some are with serious diseases and pests, it is difficult for Chinese Government to provide funds to overcome the problem mentioned above. Some countries are faced with the same situations like China. So we propose that great support should be given in priority to the countries where the origin centers of major crops are located, and help them to do well the following work and to make the

contribution to mankind: to continuously collect the genetic resources, give the priority to save the threatened germplasm in the places where the ecological environments will be changed for the nation's construction, such as the genetic resources in the areas of Three Gorges of Yangtse River in China, give financial assistance to the countries without long-termed gene banks, for gene bank construction, to the countries where the national crop gene banks and germplasm nurseries have been built, for keeping the operation of the banks and nurseries and regenerating the seeds when it is necessary, make systematic investigations of wild genetic resources, arrange *in situ* conservation for endangered and rare genetic resources, and multiplicate the seeds for research and utilization both at home and abroad.

- To coordinate well the exchanges and compensation of genetic resources in the world, and make sufficient use of existed genetic resources. When we recognize the sovereignty of genetic resources for each country, we should encourage them to provide the materials for the use on globe. International compensation will be paid according to the accessions (times) they provide with. In the process of germplasm exchanges, the compensation should be doubled for rare species and the species originated in their countries. Thus, the countries around the world may share each other and use the sufficiently.

- To establish globe information network of crop genetic resources. In order to expand the exchanges and sufficiently utilize the crop genetic resources in the world, first of all, the scientists in each country of the world should be aware of what materials have been maintained in each country or each international research center. Therefore, we should give the priority to develop globe information system and rapid retrieve system for germplasm conservation.

- Extremely urgent problem is to set up specialized funds for globe crop genetic resources. The funds will be donored by foundations, charitable institutions, private enterprises and governmental sectors. The expenditures of funds should be limited strictly in the collection, conservation, exchanges and utilization of crop germplasm resources in the world.