

# Climate and Agriculture in China

China Meteorological Press

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## **Brief Introduction**

This book, written by a panel of Chinese experts called together by the State Meteorological Administration, is of scientific as well as practical nature with the aim of enhancement of agriculture efforts and development of farming on a scientific and technological basis. Consisting of 13 chapters, the book covers a wide range of topics and presents rather systematic information of China's climate relating to agriculture, such as agroclimate resources and agricultural distribution patterns, agroclimatic catastrophes, climate and cropping systems, food crops production, cash crops, animal husbandry, fishery, forest in relation to climate, development of agricultural regions and climate, meteorological service to agriculture, etc. Also, findings of numerous Chinese meteorologists obtained in the past forty years are described in the volume. As a reference book it is of value to the research of climate-agriculture relationship and those who are interested in the overall situation of the agriculture.

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## Foreword

The book 《CLIMATE AND AGRICULTURE IN CHINA》, written by a panel of Chinese experts called together by the State Meteorological Administration, is of scientific as well as practical nature with the aim of enhancement of agricultural efforts and development of farming on a scientific and technological basis. It is based on findings from various departments, in the past forty years, particularly in the last decade, thus providing a basis for programing socioeconomic development, planning activities of farming, forestry and animal husbandry, and their scheduling and management. On the other hand, the publication will promote international pooling of experience in agrometeorological practice so as to offer an opportunity for our foreign colleagues and scientists to gain an insight into the type of socialist agrometeorological undertakings in China.

Agricultural production as a form of biological reproduction is of twofold nature: social and natural. Various stages of life activities are intimately associated with their environmental factors, including weather and climate. Agricultural activities promote and control the biotic processes and make possible the reproduction to go on in accordance with social, economic and ecological purposes of mankind.

Climate is one of natural conditions necessary for agricultural activity and provides different amounts of energy and matter resources, such as light, heat, water and air, and thus represents one of the most fundamental natural resources for agriculture. Resources of climate, land and living beings are constantly interacting with each other. Climate, like other kinds of natural wealth, has its regionality, with striking difference in quantity, quality and pattern. On the other hand, climate resources, being linked to the atmosphere, has its own peculiarities compared to other kinds, i.e., it is marked by great variability, seasonal and interannual. Because of its geographical locality, China experiences stronger seasonality and greater interannual variability of climate than many of the other areas on the globe. With a certain climate background, interannual variation often shows considerable amplitude, thereby forming a particular pattern of climate that causes a variety of disasters of climatic origin. Thus, the frequency of these unfavorable events represents a major agriculture-limiting climatic factor.

China occupied several climatic zones, each with multiple and complicated regional climates. For agriculture, forestry, animal husbandry and fishery, all have a lot of their own biotic kinds and species to deal with, each of which differs in adaptation. It is therefore necessary to properly assess, rationally and adequately utilize our climatic conditions and resources, to work out a reasonable pattern for these different productive activities based on the knowledge of regional climates. A realistic system of techniques for high-yield, stable, quality and low-cost production with a good ecological environment can thus be achieved step by step.

In the past four decades following its foundation, New China has been attracting worldwide attention to its achievements in agriculture, with great change in its rural areas. Agriculture as the foundation of the national economy is a long-term policy of the Chinese government that is making every effort to direct and promote its development. In recent years

numerous efforts have been made in many aspects, such as: carrying on reform in rural areas; advancing agriculture on a scientific and technological basis; developing a system for providing the technical services; carrying out the program of regional comprehensive exploitation; increasing the amount of input into agriculture from the government. Scientific means serve as powerful impetus to advancing agriculture into a new stage. Great progress has been made in the stepwise comprehensive exploitation that aims at steady growth of agricultural products and utilization of resources in a scientific and planned way so as to bring the potentialities of the resources and overall benefits into play insofar as possible. In the past decade, China has made the investigation and regionalization of agricultural resources towards the modernization of our agricultural undertakings. Progress has been achieved, in many aspects of the agroclimatic resources survey and regionalization made by the departments of meteorology and agriculture, and universities. Achievements have been applied with much success in the agricultural demarcation, planning, scheduling, both on nationwide and local basis. For example, all the following activities rely on climatic study: the melioration of low- and medium-yield land and reclamation of waste-land; the selection of bases for agricultural commodities production; the utilization of vertical agroclimatic resources in mountainous areas and diffusion of suitable techniques to the poverty-stricken areas; optimized irrigation; introduction of new varieties; the extension of dry-land agricultural techniques; the monitoring and diagnosing of desertification and grassland degradation, etc. Evidently, the implementation of the development projects will advance the agroclimatology too.

For decades China's meteorological department has followed the policy with focus of the provision of service for farmers, and hence scientific and technological efforts are directed towards many ways: submitting information for government strategy decision-making; public and specialized weather services; disaster prevention; agroclimatic resources; artificial rainfall and hail suppression experiments.

The book covers a wide range of topics and presents rather systematic information of China's climate relating to agriculture. Chapter I is devoted to the main features of our agriculture and climate with the importance of the latter to the former. Climatic resources, disposition of agriculture and disasters over the vast territory are contained in Chapters II and III. Chapter IV elucidates the climatic basis and problems of our practice of great importance: multiple croppings. Climatic dependence of the main grain and cash crops with the regionalization and problems is presented in Chapters V and VI. Given in the next two chapters is the relation of climate to other branches of macro-agriculture (forestry, animal husbandry and fishery). Chapters IX to XI summarize the researches on the development of the promising subtropical mountainous region, the dry-land farming and the engineering or protective farming. Chapter XII based on the previous chapters presents, in a comprehensive manner, a number of suggestions regarding the development of the eight subregions from the perspective of resources utilization. And shown in the last chapter is the necessity of regular agroclimatic and weather services for better production and against major disasters. Also, included in this chapter is the successful application of weather satellite information to agriculture, which is the result of the considerable advances in the past decade in the modernization of our meteorological undertakings that favor many forms of agrometeorological services, forest fire and flood abating and many other needs. So this book is of value to the leading cadres at all levels, researchers, technicians and people in production branches concerned in our country. Further, it is hoped that the presentations here

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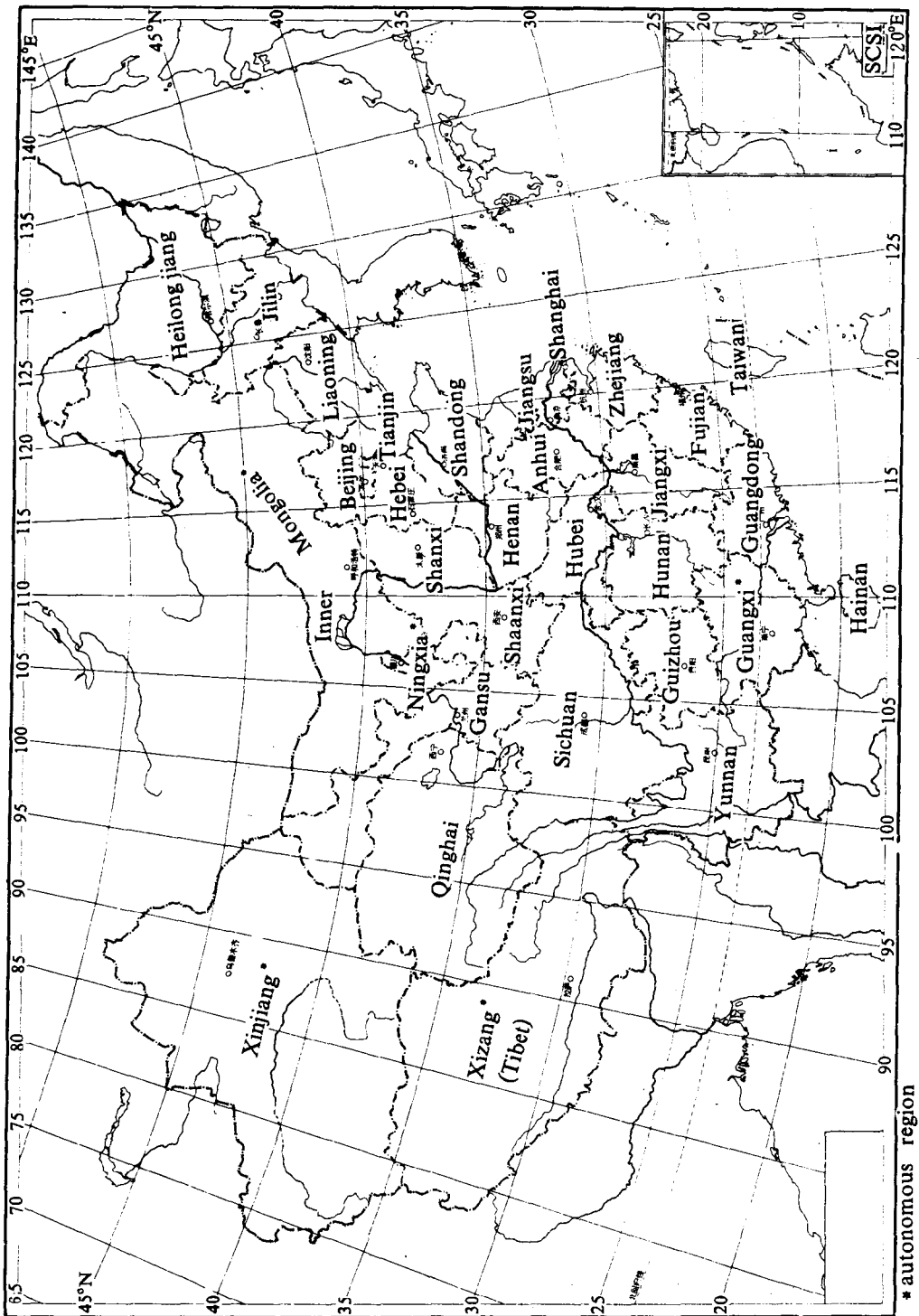
could serve as reference by the developing nations making up 75% of the world's population in performing their agricultural work.

Nowadays, the changing global climate and the vital effects have been the main concern of vast numbers of scientists, public and officials of various nations of the world. China is among the developing countries and has 7% of the global total cultivated land in support of its 22% of the world's population. The Chinese people is being heavily challenged by such major issues as population pressure, resources shortage and environmental deterioration in its development. We are now confronted with development of economy, protection of environment and improvement of the living standard, and the accomplishment of the three tasks requires the enhancement of climate awareness and efforts into the science of climate. The China National Climate Committee was founded in 1987 and national programme set up, to join the long-term worldwide activity. Chinese scholars have made much contributions to palaeoclimatology, studies on historical and modern climate variations and have to make great further efforts to address the task of understanding the climate system and its applications.

Zou Jingmeng

Administrator, State Meteorological Administration

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# Contents

<b>1</b>	<b>Introduction .....</b>	<b>(1)</b>
1.1	Development of Chinese Agriculture.....	(1)
1.2	Outline of China's Climate.....	(5)
1.3	Climate and Agricultural Development .....	(21)
	References .....	(29)
<b>2</b>	<b>Agroclimatic Resources and Agricultural Distribution Patterns .....</b>	<b>(30)</b>
2.1	Outline of Agroclimatic Resources .....	(30)
2.2	Agroclimatic Regionalization and Agricultural Distribution Patterns .....	(42)
2.3	Agroclimatic Productivity.....	(60)
	References .....	(68)
<b>3</b>	<b>Agroclimatic Catastrophes .....</b>	<b>(70)</b>
3.1	Effects of Agroclimatic Catastrophes on Agriculture .....	(70)
3.2	The Temporal and Spatial Distribution of Agroclimatic Calamities .....	(73)
3.3	The Precautions against Agroclimatic Catastrophes .....	(94)
	References .....	(98)
<b>4</b>	<b>Climate and Cropping Systems .....</b>	<b>(100)</b>
4.1	Cropping Systems in China.....	(100)
4.2	Climate and Cropping Systems .....	(102)
4.3	Intercropping and Relay-Cropping in Relation to Climate .....	(110)
4.4	Problems of Cropping Systems in the Developing Agriculture .....	(125)
	References .....	(130)
<b>5</b>	<b>Climate and Food Crops Production .....</b>	<b>(132)</b>
5.1	Rice .....	(132)
5.2	Wheat .....	(153)
5.3	Corn .....	(165)
5.4	Soybean.....	(179)
5.5	Ipomoea Batatas .....	(187)
5.6	Sorghum and Millet.....	(189)
	References .....	(193)

<b>6</b>	<b>Climate and Cash Crops .....</b>	<b>(195)</b>
6.1	Cotton .....	(195)
6.2	Oil-Bearing Crops .....	(207)
6.3	Bast Fiber Crops .....	(217)
6.4	Sugar Crops .....	(223)
6.5	Tea and Tobacco .....	(228)
6.6	Citrus.....	(238)
6.7	Rubber Trees .....	(244)
	References .....	(255)
<b>7</b>	<b>Animal Husbandry and Fishery in Relation to Climate .....</b>	<b>(257)</b>
7.1	Grasslands and Fodder Grass in Relation to Climate .....	(257)
7.2	Distribution, Pasturing and Products of Domestic Animals in Relation to Climatic Conditions .....	(268)
7.3	Relationship between Climate and Fisheries .....	(284)
7.4	Climatic Problems with the Development of Graziery and Aquatic Product Industry and Their Countermeasures .....	(295)
	References .....	(300)
<b>8</b>	<b>Forest and Climate .....</b>	<b>(302)</b>
8.1	Distribution of Forest Resources in Relation to Climate .....	(302)
8.2	Climate in Relation to Forest Productivity .....	(309)
8.3	Climatic Disasters of Forestry .....	(318)
8.4	Afforestation and Climate .....	(321)
8.5	The Effect of Forests on Climate .....	(326)
	References .....	(331)
<b>9</b>	<b>Mountain Climate and Agricultural Development in Subtropical Latitudes .....</b>	<b>(332)</b>
9.1	Climatic Features of the Subtropical Mountain Area .....	(332)
9.2	Acclimatization of Agricultural and Forestial Crops in Mountains.....	(348)
9.3	Rational Utilization of Mountain Agroclimatic Resources .....	(356)
	References .....	(364)
<b>10</b>	<b>Climate and the Northern China Dry-Land Agriculture .....</b>	<b>(367)</b>
10.1	A Survey of the Climate in Northern China Dry-Land Agricultural Zone .....	(367)
10.2	The Crop Potential Productivity in the Dry-Land Agricultural Zone of Northern China .....	(374)
10.3	Dry-Land Agricultural Techniques .....	(375)
10.4	The Soil Reservoir of Dry Farmland.....	(376)

10.5	The Dry-Land Agroecosystem and Its Control .....	(387)
	References .....	(389)
<b>11</b>	<b>Climate and Facility Agriculture .....</b>	<b>(391)</b>
11.1	Facility Agriculture with Its Applications.....	(391)
11.2	Control of Microclimate in a Structure of Facility Agriculture .....	(394)
11.3	Facility Agriculture under Different Climatic Conditions .....	(408)
11.4	Problems and Solutions in the Development of Facility Agriculture.....	(412)
	References .....	(416)
<b>12</b>	<b>Climate and Development of Agricultural Regions .....</b>	<b>(417)</b>
12.1	Northeast China .....	(417)
12.2	The Loess Plateau Agricultural Zone .....	(423)
12.3	The Huanghe-Huaihe-Haihe Region .....	(429)
12.4	The Region of the Middle-Lower Reaches of the Changjiang River .....	(439)
12.5	Southwest China .....	(447)
12.6	South China .....	(455)
12.7	The Inner Mongolia-Gansu-Xinjiang Region .....	(463)
12.8	Qinghai-Xizang Plateau .....	(471)
	References .....	(476)
<b>13</b>	<b>Meteorological Service to Agriculture in China .....</b>	<b>(478)</b>
13.1	Meteorological Service to Agriculture .....	(478)
13.2	Service of Agrometeorological Information .....	(483)
13.3	Service to Crop Yield Prediction .....	(487)
13.4	Prediction of Soil Moisture and Irrigating Amount.....	(493)
13.5	Meteorological Prediction of Agricultural Plant Diseases and Insect Pests .....	(500)
13.6	Prediction of Forest Fire Danger .....	(507)
13.7	Application of Satellite Remote Sensing (SRS) in Agriculture .....	(512)
	References .....	(517)

# 1 Introduction

Climate is intimately related to the development of agriculture. The distinctive climate of China is an important factor affecting its agricultural production.

Agricultural production is a complex of organisms (as the object of the activity), natural environment (as the place) and human socioeconomic activities. Through man's manipulation organisms are made to better adapt himself to, utilize his environmental conditions and absorb matter and energy so as to provide mankind with things for manufacture and life. This means that man gets his products in such a way that he makes himself adapted to and changes natural resources, e.g., climate (water, heat, light and air) and land (soil and nutrients) offered by the natural environment to promote and control organisms and their life activity. China has complicated climate, rich resources in different forms, which are favorable for breeding a wide range of plants and animals, with the main grain and cash crops found in other parts of the world grown also in China, together with aquatic resources and domestic fowl / herd resources in abundance, too. These resources are so rich that many other countries can not bear comparison with our nation. However, a lot of regions in China has light, heat, water and other resources often in an unstable and inharmonic state which causes a variety of agroclimatic disasters and do damages to agricultural production that at worst even result in nothing. Therefore farmers should rationally utilize climatic resource and have a good grasp of laws of these catastrophes along with effective measures against them so as to obtain an optimal pattern of crops that will produce maximum fine-quality yields. In short, we have to follow agroclimatic laws in practice <sup>[1,2]</sup>.

It is no doubt of vital practical importance to the implementation of the policy of agriculture as the foundation of our national economy and the agriculture development resting on science and technology to explore the advances in this branch from the perspective of fully exploiting climatic resources and overcoming adverse agroclimatic conditions, based on the characteristics of our national conditions, agricultural production and agroclimate.

## 1.1 Development of Chinese Agriculture

### 1.1.1 *Agriculture as the Foundation of China's National Economy*

China is among the nations first to develop agriculture in the world. Our ancestors began their crop growing in the land mass seven or eight thousand years ago. The ideas of "agriculture being the foundation of China" and "food being the first necessity" indicate the important role of agriculture in socioeconomic, political and cultural activities. The development of agriculture in China maintained the Chinese nation and advanced its ancient civilization. The laboring people have accumulated in their long period of farming practice vast wealth of valuable knowledge of agroclimate, intensive cultivation, dry-land growing in the north, paddy-field in the south, and silkworm raising -- in doing all these, stress is on the season (agroclimate) and land conditions



(soil and topography). As far back as the Qing Dynasty (221—207 B.C.), the premier Lu Buwei et al. indicated in the chapter of “Seasoning” of their famous book 《Lushichunqiu》<sup>①</sup> that ‘Climate is the major factor for agriculture’ and ‘Cultivation is made by man, supported by land and grown by climate’. Also, in the chapter of “Cultivation” of 《The Book of Fan Shengzhi》<sup>②</sup> in the Western Han Dynasty (206 B.C.—24 A.D.) mention is made that ‘Season is of vital importance to agriculture’, and the book 《Qi Min Yao Shu》<sup>③</sup> of Northern Wei (386—534 A.D.) says in its chapter of “Grain Cropping” that ‘Ampler harvest can be achieved by less effort if the climate and land conditions are taken into account, v.v.’ Prior to the advent of modern agriculture, China took the lead in this field. However, our agriculture was heavily impeded and became backward in its development because of the long-period feudalism, followed by the oppression and exploitation by feudalism, imperialism and bureaucrat-capitalism, which weighed lime mountains on Old China more than one century.

After the foundation of New China, we have been carrying out the policy of agriculture being the basis, and have attained a great success in this field. Through the 40-year painstaking efforts, especially by taking the rural reform policy since 1949, depending on the superiority of our socialist system and with our own strength China has solved the problem of supporting its population of more than 1.1 billion (22% of the world’s total) and providing materials for its industries, with 7% of the total world’s cultivated land. The following table shows the rapid advances of China’s agriculture:

Type	Output(×10 <sup>4</sup> kg)		Ratio
	1949	1990	1990 / 1949 (%)
grain	11 318	42 500	376
cotton	44.4	425	957
oil crops	256.4	1 600	624
sugar	283.4	6 800	2400
aquatic production	45	1 200	2667
meat	335	2 740	818

Cash crops, including tobacco, tea, fruits, silkworm, hemp, etc., have been increased by a factor of more than one to ten. The 1989 statistics shows that outputs of main agricultural products, e.g., grain, cotton, eggs, meat, of China are very close per capita to the world’s averages, with 26 kg of grain, 0.1 kg of cotton and 3.0 kg of meat below, and 0.3 kg of eggs above, the world’s mean value. After the 3rd Session of the 11th National Congress of the Communist Party of China put its agriculture into a new stage of development to lead the farmers into a relatively wealthy condition from the state of lower living standard. In particular, the 5th Session of the 13th Congress of the Party asserted that the steady development of agriculture is the basis of the stabilization of the nation politically, economically and socially, a problem that concerns

① 《Lushi Chunqiu》 is a book written by many writers around 200 B. C., part of which is devoted to agricultural techniques at that time.

② 《The Book of Fan Shengzhi》 is a book based on the farming experience of the Guangzhong Plain, Shaanxi, written about 50 B. C.

③ 《Qi Min Yao Shu》 is a book of agronomy based on the experience of farmers in the mid and lower reaches of the Huanghe River, written by Jia Sixie in 533—544.

the existence, and hence calls for all its members and all the people to advance agriculture in combined efforts. The Party's Committee and State Council have set down a set of policies and worked out corresponding measures to advance agriculture.

### *1.1.2 Resources and Features of China's Agriculture*

#### *1.1.2.1 Rich resources and smaller amount per capita*

China is famous for its tremendous population, vast territory and ample resources, with the absolute amount of agricultural resources among the countries of the richest natural wealth. China occupies 9 600 000 km<sup>2</sup>, covering about 49° of latitude and 62° of longitude, with diversified terrains, climates, soils, which result in a wide range of biological resources. Statistics shows that there live more than 32 000 species of higher plants, 414 of wild animals, 1166 of birds and many rare plants and animals in China. In this country there are as many as over 2 000 species of edible plants, 390 of domestic fowl and herd and vast quantities of aquatic resources -- these serve as the basis of species for the development of agriculture, forestry, animal husbandry and fishery. On the other hand, the amount of resources per capita is smaller because of the population explosion. For instance, per capita cultivated area is about 1 / 3 the world's average and 1 / 8 of the average of the former Soviet Union and the United States. What is more, the it is still decreasing. As for water resources, China takes the 6th place in the world, but with its per-capita mean reaching only 1 / 4 of the world's value and the per-mu<sup>①</sup> water consumption average of 2 / 3 the world's. The forested area in China is 12% of the land mass, equivalent to 68% of the average of other countries. We are confronted with such serious problems as an annual increase of over 17 000 000 babies and loss of soil and water, expansion of the desertized area, and grassland degradation, implying that our ecological environment is getting worse and worse. Besides, there remains only 100 to 200 million mu reclaimed. Evidently, the way out of the difficulties is to utilize the agricultural resources available highly effectively by intensive farming with the aid of scientific and technological advances.

#### *1.1.2.2 Intensive farming, land use in conjunction with its soil fertility maintenance, and multiple cropping*

The largest problem of China's agriculture is to support its tremendous population with its lesser farming area. For the traditional agriculture of the country the most distinctive feature is intensive farming with a complete set of techniques, focus on the land use in conjunction with soil fertility maintenance and multiple cropping practice for fully utilizing its cultivated land and climatic resources, all aiming at the increase in land utilization. At present, the multiple cropping index has attained 155% in China, with its area exceeding 700 million mu, which plays a major role in raising the yield both per unit area and total. Leading to a good space-time arrangement of farming operation are intercropping, interplanting, and increased area and duration for photosynthesis due to the expanded multiple crop area. Starting from our national

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① 1 mu = 1 / 15 ha, or about 666.6m<sup>2</sup>.

conditions, we shall make reform of the traditional agricultural techniques with the effective of them to be retained and developed, and assimilated with good experience of other countries to establish our modernized social agriculture in Chinese style.

### *1.1.3 Agricultural Development in This New Stage*

Nowadays, China's agriculture is in a historical turn from its traditional to modern stage and from the half self-supporting and self-supporting to commodity economy. There exist great potentialities in the persistent, steady and harmonic development and exploitation of agriculture, which is, however, accompanied by serious problems in such respects as modern science / technology, technical manpower, basic facilities, labor productivity, structure of production, incomplete system for services of agricultural techniques and the highly imbalanced development among different regions. Agriculture, to great extent, depends upon weather / climate conditions and the ability of resisting natural disasters. For this reason, the Party's Committee and State Council have put emphasis over and over again on the enhancement of the agricultural development and will continue in the 1990s the policy of the overall promotion with focus on grain crops and cotton. As is planned, annual grain yield total will reach 450 million and then 500 million tons; the productions of cotton, sugar and other cash crops will be increased; afforestation and the related industry are to be intensified; animal husbandry and aquatic production to be further advanced, in order to produce more meat, eggs, milk, fish, fruits, etc. In this period, our rural industries will be made to further grow in a proper manner to promote the rural economy in all aspects.

The advance in our agriculture depends upon the efficient policy, scientific / technological efforts and financial input. At present, the major tasks are to further deepen rural reform, to keep carrying out and improving the policy of the contract responsibility system based mainly on family management, to strive for the development of socialized services, to enhance collective economy, and to stabilize other rural policies in order to further arouse the peasants' enthusiasm; to improve basic facilities by scientific and technological progress and the increases in finances and materials inputs; to implement agricultural integrated exploitation and the construction of bases for agricultural commodity, with focus on the increase in productions of grain, cotton, oil and sugar, and finally to strengthen the ability of integrative production so as to ensure the subsequent development of agriculture.

### *1.1.4 Agricultural Development by Way of Science, Technology and Education and Its Integrative Exploitation*

As stated before, China has smaller area for farming as compared to its tremendous population so that our agricultural development depends mainly on the increase of yield per unit area. And this is, in turn, parasitic, to great extent, upon the improved scientific and cultural quality of peasants, the extension of advanced agricultural techniques and equipments and further amplification of the width and depth of resources utilization. According to the statistics from some developed countries, the percentage of the dependence of agricultural advances on scientific and technological progress has been increased from roughly 20% at the beginning of this century to



60—80 % of today versus 30—40% now in our nation. Thus, agricultural development by way of science, technology and education is the key link of the issue. For this reason, the State Council has adopted the “Resolution of agricultural development by virtue of scientific and technological progress, and enhanced extension of agricultural scientific and technological results”. The scientific development of agriculture includes a big army of technologists and researchers for enhanced study of new techniques, establishment of a complete system for popularizing applicable scientific and technological results, full and rational utilization of natural resources, mitigation and prevention of natural disasters, reinforced cultivation of good varieties over an increased area, diffusion of efficient cropping systems, cultivation methods and techniques for increased productions of agriculture, forestry, animal husbandry, sideline production and fishery integrated into a system for high yield, good quality, considerable efficiency and low consumption, effectively putting efforts into key projects and making demonstration regarding regional development, and continued implementation of the “Spark Program”, “Blazing Prairie Fire Program” and “Harvest Program”.

At present, a large-scale complex development project is being carried out with focus on reforming medium- and lower-yield land in a planned way and stepwise reclaiming wasteland suitable for agriculture. This is a strategy for rural prosperity with advanced agriculture. The key regions under consideration include the North-China Plains, the Huanghe-Huaihe-Haihe Plains, the Changjiang reaches in Central and East China, which are further divided into 13 subregions. In other parts of the country there are other 21 small-sized areas that will be exploited in a general sense. The State Council has allocated huge funds for this purpose and is enhancing directions as to what projects to put the agricultural investment into in different regions. The undertakings in the current period include the scheduled melioration of medium- and lower-yield land, reclamation of wasteland suitable for farming, diffusion of good varieties and scientific and technological results of agriculture, forestry, water usage and atmospheric research, and complex harnessing of mountain areas, water bodies, crop fields, forest conservation and roads according to the conditions of a given area and season. The comprehensive exploitation will bring into full play regional resources superiority and overall benefits, economic, social and ecological, to raise resources utilization, land productivity, output-input ratio, and labor efficiency so as to further develop and enhance the agricultural productivity. An encouraging situation is coming for the overall integrated development of agriculture, forestry, animal husbandry, sideline production and fishery of our country<sup>[3]</sup>.

## 1.2 Outline of China's Climate

China has a vast territory, complicated terrain, distinctive distribution of temperature and precipitation (Figs.1.1 and 1.2), and abundant climate resources marked by strong seasonality, which falls into a continental monsoon climate.

### 1.2.1 Fundamental Characteristics of the Climate

The northwestern part of China is located in the hinterland of the Eurasian continent (the largest in the world), its southeastern part facing the Pacific (the biggest on the globe) with the