

CROP PRODUCTION IN CHINA
WITH SPECIAL REFERENCE TO
PRODUCTION IN MANCHURIA

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CROP PRODUCTION IN CHINA
WITH SPECIAL REFERENCE TO PRODUCTION IN MANCHURIA.

By

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THESIS

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CROP PRODUCTION IN CHINA
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Chapter 1.

INTRODUCTION.

China is noted for her agriculture. The agricultural methods practiced by her people are the development of 40 centuries of recorded agricultural experience. Any crop that can be grown elsewhere on the face of the earth can be grown somewhere in China.

The Republic comprises the eighteen provinces of China Proper, three provinces of Manchuria, Mongolia, Sin-kiang province, and Tibet. It has an extreme breadth from south to north of about 2,500 miles. The southern boundaries of the Provinces of Yunnan and Kwang-si are approximately 21° north latitude, while the northern extremities of Mongolia and Heilungkiang Province, Manchuria, reach 54° north latitude. The length of the Republic from east to west is roughly 3,200 miles. The most eastern point of Kirin Province, Manchuria, touches the Meridian of 35° east longitude, while the most western extremity of Sin-kiang Province has less than 74° of east longitude. In this vast territory of the Great Republic with its wide range of soil, climatic and market conditions, a great variety in crop adaptation and methods of farming occurs. In respect to climate, soil, and facilities of internal navigation and irrigation, China Proper is, on the whole, superior to any equal area on the globe. This region is the best watered of the country. It is a land of many great rivers bordered in broad valleys

and the low mountain ranges rise on fertile plains. The Yangtze River, the Yellow River, West River, and Hwai River with numerous canals and tributaries flowing across the country, irrigating, draining, and connecting every part of it. It is in these sections that most the crops can be grown successfully under favorable climatic conditions. In general, rice, cotton, sugar, indigo, silk, and tea are chiefly produced in the south, and wheat, barley, corn, sorghum, beans, peas, millet, and other cereals in the north.

Horticulture is a favored pursuit in all sections of China Proper and south Manchuria, and fruit trees are grown in great variety. Cotton is grown all over the country, even as far north as Province of Chihli and southern part of the Province of Mukden. Tea is cultivated exclusively in the west and south, in Anhui, Hupeh, Hunan, Chekiang, Kwangsi, Fukien, Szechwan, and Kwangtung. Silk culture is one of the most successful industries in Central and South China. The silk industry depends on the mulberry plant which is used exclusively in feeding the silk worms, usually two or three crops being produced each year. Wheat, sorghum, corn, millet, soy beans and other beans are the chief crops in the north, especially in the three provinces of Manchuria. Tobacco, sugar beets, indigo, fruits, hemp, other agricultural products and live stock are raised to some extent. Silk from worms fed on oak leaves is one of the most important products of the southern part of Mukden Province. Wheat, barley, millet, and other cereals are grown in some sections of Sin-



usually of the exploitive type. Here the farming is conducted on fertile new soils which can be farmed for many years without attention to fertility. Such farming is usually quite profitable as long as the fertility of the soil lasts.

Diversified farming has been more or less practiced by the Chinese farmers. They want to grow every crop they need. Hogs and chickens are raised on the farm. Horses, mules, donkeys, and cattle are kept to do the farm work, but very few cattle for purpose of meat production.

TYPES OF FARMING

The most important types of farming which exist now in China are truck farming, fruit growing, silk farming, mixed stock and crop farming, live stock farming, and poultry farming.

Truck farming.

The production of garden vegetables is one of the most important types of farming in all sections of China. Vegetable culture has reached a high state of perfection. Every farm has a garden which produces enough vegetables as are needed for home use. In every town, city, and village, there are a number of truck farmers who can supply local markets. This type of farming is carried on to some great extent near the big cities where the markets are good and the income is usually so large that a family can make a living on a small area of land.

Fruit growing.

This farming can be found in any section of China Proper and south of Manchuria. The fruit trees are grown in great variety. However, some other crops are grown on the farm besides fruit growing, but the chief income is from fruit production.

Silk farming.

This is the important type of farming in central and south China. The worms are fed on the mulberry leaves and usually two or three crops are produced a year, but in south-eastern section of Mukden Province the silk worms are fed on oak leaves and only one crop is produced a year. Usually big profits are obtained from this type of farming though there may be some bad years.

Mixed stock and crop farming.

This type of farming is perhaps the most common type found in north China. No leguminous crops are grown in rotation for feed of live stock, save bean growing for seed production. Cattle, horses, sheep, hogs, and chickens are all raised on the farm. Wheat, sorghum, millet, beans, corn, and other cereals are grown and crop rotation is practiced. The millet straw and corn stalks are used as roughages for horses and cattle, while beans and sorghum grain are used for concentrates. Sheep pasture all year around with the only exception of a few days when the ground is covered with snow in winter, and hogs are fed in combination with bean leaves and other grain chaff, while chickens are entire-

ly fed on the grains such as corn, millet, and sorghum. This combination of farming is usually profitable and every product raised on the farm can be utilized with the result of a regular income to the farmers.

Live stock farming.

This type of farming can only be found in the mountainous sections of China Proper where it is not cultivable for other crops, but in north of Manchuria, Mongolia, Sin-kiang and Tibet big live stock farming is carried on to some extent. These sections are pastoral, cattle, horses, sheep, goats, donkeys, and others are all raised. Hog raising is carried on in every part of the Republic, in fact a few hogs are kept in nearly every country home.

Poultry farming.

Poultry raising is just a side-line farming of the common farmers and is found on any farm in China. The chickens can find their living from waste products of the farm and it is, therefore, profitable to farmers. However, there are quite a number engaged in poultry farming near the big cities and the poultry raised for the demand of meat and egg production of the market.

AGRICULTURAL CONDITIONS

It is very hard to deal with agricultural conditions in a comprehensive way because there are no reliable statistics published. In some sections with a dense population, every spot of land is being cultivated even on the hillsides, while in other sections some large areas are unfarmed. Rainfall in

some sections is uncertain on the highlands and irrigation is practised. The almost entire absence of timber or woodland in north and eastern part is noted with surprise. The highlands and the mountains are completely denuded with the usual result of alternate periods of great drouth and excessive rainfall. In general, the farms are small and the method of farming is crude. The principal implements on the farm are shallow plows, single-handed with iron point, harrows and seeders. Hoes and sickles are used for cultivation and harvesting while the flails and stone rollers are used for threshing.

There is no recognized method of financing and marketing the crops. The small farmers borrow money, but not in recognized manner, with a higher rate of interest at times. The products usually sell at local markets, but in big centers the market is in the hands of a few wholesale dealers who bring all that reaches this market from the interior of the farms and then sell to others. They dispatch agents to the places of production to arrange for the purchase, shipment, and disposal of the produce. Contracts are sometimes made on the basis of one-third of the purchase price being deposited, but usually business is transacted on a cash basis. Yet very few farmers sell the products in that way and they market the grain themselves to the local market under conditions they know best. However, the agricultural conditions in China are not as they should be, but due to certain difficulties the farmers have a hard time to produce and to market their pro-

ducts. The most important factors which affect the development of agriculture and agricultural conditions are lack of transportation facilities on one hand and the old type of implements used on the other. The transportation facilities should be improved for marketing the farm products from remote regions to the business centers, and better implements should be introduced for effective cultivation.

The conditions in central and south China, as a rule, are better than those in northern China, because a certain amount of production of crops can be depended on in normal years as the rainfall and temperature are so favorable in those sections. The transportation facilities are also good on account of many rivers being navigable and better railway lines. But in the remote regions and along boundary lines, especially in north Manchuria, Mongolia, Sin-kiang, and Tibet, the rainfall usually is uncertain and the crops often a failure due to the drouth. Products are difficult to market due to poor transportation facilities and higher freight to pay where transportation is possible. However, the three provinces of Manchuria are better off than the other boundary lines, such as Mongolia and Sin-kiang Province, because there are some big rivers which are navigable for hundreds of miles in the three provinces. Manchuria always has a surplus of food supplies for her sister provinces whether the year is good or bad. The agricultural conditions usually are good, but much can be accomplished by improving cultural methods.

AREA, POPULATION, CLIMATE, TOPOGRAPHY, AND PRINCIPAL CROPS
IN DIFFERENT PROVINCES

It is very difficult to state exactly the area and population of each province, because China has not yet carried out a proper census so only the estimation can be given for each province and the whole country. This is simply to show the climate and topography briefly in different sections to which crops have been best adapted and the principal crops of each province.

The eighteen provinces of China Proper.

Anhwi:

The Province of Anhwi, with an area of 55,000 square miles, has a population of 20,000,000, with a density of 360 per square mile. It is well watered by the Yangtze River in the south and the Hwai River in the north. In the south, there are rolling plains and mountains, but in the central sections the soil is fertile, well watered, and good for agriculture. The climate is moderate. Its temperature is about 13° to 97° and the rainfall is about 45 inches or more. Along the rivers much rain comes during the spring and summer seasons. The principal occupation of the people in this province is farming. In northern sections wheat, rye, millet, corn, rice, ground nuts, beans, and sweet potatoes are the important crops, while in the south, rice, hemp, cotton, and tea are produced. The crops of corn, kao-liang, beans, peanuts, cotton, millet, tobacco, and some truck crops are planted from March to May. Sweet potatoes and buckwheat are sown from June to August. Wheat and barley are sown during the months of September,

October, and November. The crops that are harvested at these times are beans, sweet potatoes, peanuts, cotton, rice, tobacco, sorghum, and some truck crops.

Chekiang:

The Province of Chekiang, with an area of about 37,000 square miles, has a population of 17,000,000, with a density of 460 per square mile. It is situated between 27° and 31° north latitude, and 118° and 122° east longitude. This is a province of wooded hills and fertile valleys. The west and south are mountainous, but the large fertile plains are in the east and north and rich for agriculture. The climate is warm in this region. The temperature is about 14° to 102°F. and the rainfall is about from 45 to 52 inches or more. The soil is very fertile and the latitude, together with the fact that the rainfall is plenty, evenly distributed throughout the year, permits the production of two crops a year. Rice, tea, silk, cotton, wheat, hemp, indigo, sugar, and fruits are produced. Rice, tea, and cotton are the principal crops. Silk produces two crops a year for which the province is noted.

Chihli:

The Province of Chihli is located in north China, with an area of 116,000 square miles and a population of 30,000,000, and a density of 250 per square mile. It is mountainous in the north and west, but the soil of the eastern plain is an alluvium deposited in the deltas of rivers, and is hot in summer and productive. The climate is cold in winter and warm in summer. At times the temperature rises in summer to 100°F. ,

while the daily variation may be as much as 30°F., and falls in winter to even 30° or 40° below zero. The climate is dry and the months of June and July are the rainy season. The annual rainfall, including snow, is about 30 inches. This is an agricultural region and practically the entire area of the section is developed agriculturally. Sorghum, millet, peanuts, wheat, corn, beans, cotton, and barley are the main crops. Fruits and vegetables are produced. Cattle, sheep, goats, pigs, horses, mules, donkeys, and fowls are also raised.

Fukien:

The Province of Fukien with an area of 46,000 square miles, has a population of 13,000,000, with a density of 280 per square mile. This section is broken and mountainous and the soil on the hills is poor, but fertile in the valleys. The climate is semi-tropical in the eastern portion, but in the extreme west it varies toward the temperate. The annual rainfall is about 48 inches and heavy rains come during the summer season. Rice, tea, wheat, sugar, indigo, bamboo, oranges, and other fruits are the principal crops of this province.

Honan:

The Province of Honan, with an area of 69,000 square miles, has a population of 25,000,000, with a density of 375 per square mile. The province is shaped like an irregular triangle and is hilly on the western boundary, with plains elsewhere. This area is divided into three basins, that of the Yellow River in the north, of the Hwai River on the south, and of the Han River on the southeast. The soil is very fertile and rich for agri-

culture. The climate is fairly severe in both summer and winter. The rainfall varies from 30 to 60 inches or more, and the heavy rain comes in summer. Cotton, wheat, sorghum, beans, millet, sesame seed, and corn are the main crops of the province.

Hunan:

The Province of Hunan, with an area of 83,000 square miles, has a population of 24,000,000, with a density of 280 per square mile. It, lying between 25° and 30° latitude and 109° and 114° longitude, is hilly and mountainous, especially in the west and south, and Tung Ting Lake is in the northeast with four rivers emptying into it. In the west and south the hills and mountains are well wooded, while in the plain sections the soil is rich. The climate is sub-tropical and moist. The summers are warm and winters cold, but the temperature rarely falls below freezing point. The temperature varies from 23° to 95° F. The annual rainfall is about 63 inches and the heavy rain comes in June. Rice is the principal crop. Wheat, corn, beans, sesame, barley, millet, cotton, tea, bamboo, and fruits are all produced. It is estimated that 60% of the population of this province lives by tilling the soil and in fact this is one of the richest in agricultural wealth.

Hupei:

The Province of Hupei, with an area of 71,000 square miles, has a population of 25,000,000, with a density of 350 per square mile. The Yangtze and Han Rivers intersect the province as well as numerous lakes and canals. This region is

hilly and mountainous, especially in the west, yet however the southeastern plain is considered the most fertile part of the Republic. The climate is warm, and in hot summer the nights are as warm as the days. The temperature is about 20° or 25° to 104° or 105° F. Much rain comes in summer and the annual rainfall varies from 30 to 60 inches or more. Rice, cotton, tea, and beans form the principal crops. Wheat, silk, tobacco, ramie, and sesame are also important agricultural products of this province.

Kansu:

The Province of Kansu, with an area of 125,000 square miles, has a population of 5,000,000, with a density of 40 per square mile. This province is divided into two sections by the mountains running nearly north and south, separating the Wei and Yellow river basins. In the east and northeast a large loess plateau is fertile and the Wei Basin is rich in soil fertility. The climate is dry with cold winter. Much snow falls in winter months and all the rivers are frozen over. In summer the temperature at times rises to 102° or 104° F., so that crops grow with great rapidity. Wheat, cotton, tobacco, rhubarb, licorice, and fruits are the principal crops. This province is pastoral rather than agricultural, and sheep and cattle are raised.

Kiangsi:

The Province of Kiangsi, with an area of 68,000 square miles, has a population of 15,000,000, with a density of 210 per square mile. It is made up of the beautiful basin of

Kan Kiang, including all the affluents and their minor valleys. Most parts of this region are mountainous except Poyang Lake Basin. Kan Kiang drains large parts of the province and plains of some sections are fertile. The climate is humid, generally very hot in summer and mild in winter. The temperature in summer rises to 100° or even to 105° in the extreme south but seldom falls in winter to 20° or 25°F. The heavy rain comes in summer months and the annual rainfall is about 40 to 50 inches. Rice, tea, tobacco, peanuts, fruits, indigo, and grains are the principal crops in this province. Due to the hot climate usually two crops are produced a year.

Kiangsu:

The Province of Kiangsu, with an area of 37,000 square miles, has a population of 18,000,000, with a density of 450 per square mile. This region is a fertile plain crossed by the Yangtze River from east to west and the Grand Canal from north to south. The two water courses form the basis of the series of canals and tributaries which make the province one of the best-watered sections in China. The great alluvial plain and the land of Yangtze Delta are noted for fertility. The climate is warm and its temperature is about 13° to 98°F. Much rain comes during summer months, evenly well distributed, and the annual rainfall is about 45 inches. Farming is the principal occupation in the province. Silk, cotton, rice, beans, peanuts, fruits, wheat, and bamboo are the principal crops. It is this province that produces the finest silk in the world, and cotton is produced in large quantities each year.

Kwangsi:

The Province of Kwangsi, with an area of 77,300 square miles, has a population of 6,500,000, with a density of 84 per square mile. The greater part of the region is mountainous and the mountain ranges run from southwest to northeast. The land along the West River and its tributaries is fertile. The climate is tropical in the south, but temperate in the north. The temperature is changeable and winters are cold. In the southern valleys the thermometer never falls below 37°F. and rises in summer to 100° and sometimes to 104°. The heavy rain comes during the summer months and the annual rainfall is about from 60 to 70 inches. Rice, sugar, fruits, grains, bamboo, aniseed and cassia are the principal crops. The large part of this region is mountainous and is not available for agricultural purposes so only the rich soil of the plain and valleys is cultivated.

Kwangtung:

The Province of Kwangtung, with an area of 100,000 square miles, has a population of 28,000,000, with a density of 280 per square mile. This region is for the most part a mountainous one, but it has a large plain extending over the delta of the West River. The plains, particularly the fertile sections of Canton Delta, rich and well-watered, are cultivated. The climate is tropical and very changeable. The temperature seldom rises to 100°F. in summer and falls to below 35°F. The rain comes most in summer months and the annual rainfall is about 70 to 80 inches. Silk, rice, sugar, tobacco, cassia,

fruits, bamboo, tea, cotton, ginger, indigo, ramie, camphor, and hemp are the main products. Rice is the principal crop and because of the richness of the soil and the favorable climate two or three crops a year are reaped.

Kweichow:

The Province of Kweichow, with an area of 67,000 square miles, has a population of 8,000,000, with a density of 120 per square mile. This is mountainous province and the mean altitude of the great tableland is about 4,000 feet. The soil is poor and it has the reputation of being the most unproductive in China. The climate is moist and changeable. In summer the thermometer rarely reaches 84°F. on the tableland, while in winter it falls to 18°F. Dense fogs prevail throughout the province, particularly in the deep valleys of the south. Much rain falls throughout the year. This region is poor in agriculture and the main crops are tobacco, bamboo, fruits and wheat.

Shansi:

The Province of Shansi, with an area of 82,000 square miles, has a population of 10,000,000, with a density of 122 per square mile. Practically the entire province, with the exception of Taiyuan Plateau, is covered by mountain ranges running east and west. However, several depressions, formerly lakes, form the fertile sections which are productive. The loess soil of these plains is rich and fertile. The climate is very cold in winter and hot in summer. The temperature rises in summer sometimes to 100°F., but the daily variation

is great and falls in winter to occasionally 10°F. below zero. The rain comes in late summer months and the annual rainfall is about 30 inches. This section is good in agriculture in the plains and wheat, millet, sorghum, corn, cotton, tobacco, and fruits are the principal crops of the province.

Shantung:

The Province of Shantung, with an area of 56,000 square miles has a population of 30,000,000, with a density of 525 per square mile. The southern and southwestern parts are mountainous, with a watershed bisecting that part of the province running southeast to northwest, and with many small streams flowing north and south. The western part is a great plain and the Yellow River flows in a northeasterly direction through the province with frequent floods. In central portion is a plain and comparatively low land and the soil is rich. The climate is cold and dry in the long winter, but is hot and moist in the short summer. The rainfall is about 26 inches annually and is confined mainly to the months of June, July, and August. Heavy snowfalls occur in December and January. The temperature rises in summer, occasionally to 105° or 106° , but falls in winter to 9°F. Wheat, cotton, corn, sorghum, millet, beans, tobacco, peanuts, silk, hemp, walnuts, sweet potatoes, and fruits are the principal crops.

Shensi:

The Province of Shensi, with an area of 75,300 square miles, has a population of 8,000,000, with a density of 105 per square mile. It has the fertile loess table-lands in

the north, the plain in the center, drained by Wei River and its tributaries, and the mountains in the south. The northern section has a good soil, but the crop production is uncertain due to the fact of droughts which often occur. The central section, lying in the valley of the Wei River, is rich in soil fertility and is, therefore, good for agriculture. The southern section has numerous mountain ranges which mark the boundary of the province. The climate is dry and cold in winter and warm in summer. The temperature rises to about 100° to 104° in summer and falls to 0°F. in winter. The climate is widely different in the north and south and also changeable. The rainfall is about 30 inches and is confined mainly to the summer months. The valley of Han and Wei Rivers is particularly productive. Wheat is the staple crop in the province and the best and the finest cotton is produced in the Wei Basin. Corn, beans, oats, barley, millet, silk, tobacco, peanuts, Irish potatoes, alfalfa, rapeseed, and persimmons are produced in the province.

Szechwan:

The Province of Szechwan, with an area of 220,000 square miles, has a population of 45,000,000, with a density of 200 per square mile. This is the biggest of China's provinces and lies between latitude 26° and 34° north and longitude 98° and 110° east. Three-fourths of the province is a high plateau with mountains extending to an altitude of 18,000 feet and this plateau of red sand stone slopes toward east and southeast. The principal river of this section is the

Yangtze flowing southward. The western watershed of the "River of Golden Sand" marks the western boundary of the province. There are some other rivers, the Yalung, Min, and Lu flowing west, the Chialing flowing south, and the Kung Tan flowing north. The climate is dry in the west with cold winters and warm summers while in the east it is mild and the southern part is semi-tropical. In summer the temperature rarely exceeds 100°F . and in winter it may fall to the freezing point for a short period. In the semi-tropical sections the extremes of temperature in winter and summer are about 35° to 106°F . The average annual rainfall is about 50 inches and the heavy rain comes from April to October. The province claims to produce everything raised elsewhere in China, and agriculture is the principal occupation of the people. Silk, rice, wheat, sugar, tea, tobacco, fibers, bamboo, beans, and fruits are the principal crops. The Chengtu Plain is the most fertile spot of its size in China and is irrigated by artificial system for a thousand years.

Yunnan:

The Province of Yunnan, with an area of 146,000 square miles, has a population of 9,000,000, with a density of 60 per square mile. It has high mountain ranges in the west and table-lands in the south. In the northern part the land is low, while in the eastern part it is high. The climate is tropical in the south while in the northern part it is mild and agreeable on the high table-land. The thermometer reaches 80° to 85° in summer and seldom falls below 32°F .

is about 25 inches in these sections. Manchuria contains some of the finest agricultural lands in the world, but there are some big areas of land which are not under cultivation. The principal crop now is soy beans and wheat ranks second in importance. Other cereals, such as sorghum, millet, corn, and rice are raised in large quantities. Tobacco, sugar beets, indigo, silk, hemp, and flax are also produced. Live stock raising is carried on to some great extent. (Details will be given in Chapter III.)

Mongolia:

Mongolia, with an area of 1,370,000 square miles, has a population of 2,500,000, with a density of 2 per square mile. This is a vast basin-like plateau surrounded by mountain ranges and undulating steppes and the Gobi Desert is nearly in the center. The climate is dry and winters are extremely cold. Rain comes in the summer season and snow in the winter. In certain favorable regions there are some wonderful stretches of fertile virgin lands which are capable of producing enormous crops. It is a pastoral region and the vast stretches of land are wonderfully adapted to grazing, so cattle and sheep raising is carried on exclusively.

Sin-kiang:

The Province of Sin-kiang, with an area of 550,000 square miles, has a population of 2,500,000, with a density of 4 per square mile. A large part of this region is a desert surrounded by high ranges of mountains and with fertile spots occurring only here and there. The climate is dry and cold in winter. The rain comes mostly in summer, but the moisture is not

sufficiently available to produce good crops yet, however, splendid crops can be produced only where irrigation is possible. In fertile sections crops of barley, millet, and wheat are produced.

Tibet:

Tibet, with an area of 465,000 square miles, has a population of 6,000,000, with a density of 12 per square mile. The greater part of this region is desert, but valleys in the south and west are fertile. The valley of the Chumbi River is reported to be the most fertile portion in the section, however, the region as a whole has the greatest average elevation of any similar area in the world. In the north and west there is an immense table-land and on the south there are high ranges and deep river valleys. The climate is necessarily varied but is generally very dry and healthful. It is subject to extremes of great cold and heat, and in the southern part much rain and snow fall in season. There is little agriculture in this region, but it furnishes excellent pasture lands. The raising of live stock is the principal occupation of the people. Yaks, sheep, goats, horses, and asses are reared in great numbers. However, in the fertile valleys, barley, millet, fruit, as well as corn are produced.

CROP PRODUCTION--ITS IMPORTS AND EXPORTS

In regard to the production of farm or agricultural products the writer has no definite figures to give, because there are no statistics being worked out by the government of the Republic of China. However, it is safe to say that China has

the biggest production of agricultural products of all the nations of the world. She produces sufficient food supplies for her population of about 400,000,000. In normal years she can export a certain amount of the production to foreign markets, but the exportation of grain is prohibited by the government in order to have a sufficient food supply on hand to prevent a famine. Comparatively, the production per acre in China is not lower than that in the United States or other parts of the world. The low yield of crop production is due more or less to the poor quality of seed planted and the increase of production can be greater if good seed is used. There are still many acres of land in the north, such as Manchuria, Mongolia, Sin-kiang, and Tibet, which are, in most part, good for agriculture and even in China Proper some sections of the land are uncultivated. With the regions along the valleys of the Yellow River and Hwai River reclaimed and the border provinces colonized, China's crops alone would support double her present population, so the production in the future will be not only sufficient for home consumption but for the world supply as well. China exports more agricultural products than she imports, that is, she exports raw materials and imports finished goods. The writer has not secured any available statistical reports relative to crop production, exports, and imports, so no data is very available. However, the writer wants to state just a few of the products which constitute the present exports and imports. Of course, no grain is allowed to be exported except soy beans unless there

is a big over-production or surplus of food at home. At present the principal export products are beans, bean products, silk, tea, and cotton, while the imports are very few save finished goods.

The following table shows an estimation of the principal products of exports and imports during 1913-1918. (Commercial Handbook of China, U.S.D.A., Washington, D. C.)

Cereal	NO. OF POUNDS EXPORTED		NO. OF POUNDS IMPORTED	
	1913	1918	1913	1918
Corn	7,414,800	9,747,567	1,103,200	5,793,986
Barley	35,434,800	4,653,722	682,267	630,398
Millet and:				
Sorghum		122,871,426		
Rye			156,800	
Oats		2,239,194	3,407,600	7,600
Rice		4,437,456		
Wheat	246,409,467	242,060,826	275,200	2,133
Other kinds	239,889,067	14,254,631	1,729,200	2,349,194
Beans:				
Black		13,481,033		
Green		21,546,879		
White	1,376,795,200	63,360,375		
Yellow		849,479,343		
Other kinds		230,250,891		
Fibers:				
Coir		2,074,395		
Hemp	10,788,400	19,817,817	2,841,600	2,083,861
Jute	14,053,866	11,293,572		
Ramie	22,816,800	36,617,108		
Bean:				
Cake	1,575,729,400	2,182,241,744		
Curd	4,846,533	3,765,591		
Oil	65,575,600	303,621,508		
Peas		34,874,713		
Potatoes	20,788,133	7,702,514		
Seeds:				
Apricot	6,136,000	2,233,194		
Cotton	24,332,533	22,040,345		
Lily-flower		929,864		
Linseed		11,744,504		
Melon	7,099,866	4,410,122		

Cereal	NO. OF POUNDS EXPORTED		NO. OF POUNDS IMPORTED	
	1913	1918	1913	1918
Seeds(cont:)				
Rape	82,236,400:	89,349,910:		
Sesame	271,286,267:	31,213,655:		
Other kinds	100,744,800:	35,465,778:		
Seed cake:				
Rape		53,072,801:		
Sesame	175,059,867:	59,333:		
Other kinds		102,982,943:		
Fruits:				
Dried	30,043,400:	7,037,849:		
Fresh	73,173,733:	22,031,278:		
Oranges (fresh)		22,031,000:		
Pears (fresh)		2,673,327:		
Cotton:				
Raw	98,505,300:	172,278,769:	17,767,337:	25,347,937
Waste	7,480,400:	4,461,189:	Finished goods.	
Tea:				
Black	73,027,733:	23,328,208:	Ind. & Ceylon:	
			19,572,667:	1,877,729
Green	36,979,066:	20,094,616:		
Brick:				
Black	57,442,533:	8,765,578:	Formosa	
			1,858,133:	1,132,397
Green	23,360,133:	1,255,730:	Java	
			4,466,800:	
			Other kinds...	3,338,392
Tobacco:				
Leaves &				
Stalks	20,268,533:	25,200,070:	215,448	24,145,406
Prepared		8,620,512:		
Silk:				
Raw				
White	13,401,600:	10,614,240:		
Yellow	2,519,930:	2,234,527:		
Wild	3,954,933:	3,811,724:		
Cocoons	22,450,399:	27,280,331:		
Other Products				
Groundnuts:			44,568,267	93,527,900
In shell	152,680,756:	70,755,690:		
Kernels	11,133,200:	15,257,295:		
Animals (According to number of animals.				
Cattle	86,565:	28,852:	7,968	2,685
Goats	10,195:	16,914:	770	3,067
Horses	1,882:	461:	1,014	532

	: 1913	: 1918	:: 1913	: 1918
Animals (cont.)	:	:	::	:
Hogs	: 277,848	: 259,512	:: 24,217	: 3,287
Poultry	: 2,779,543	: 2,875,505	:: 21,695	: 39,171
Sheep	: 44,073	: 23,714	::	: 10
Other kinds	:	:	::	:
including:	:	:	::	:
asses and:	:	:	::	:
mules	: ;62	: 2,241	:: 523	: 2,218

Chapter 2.

LEADING CROPS, PRODUCTION METHODS, AND SUGGESTIONS FOR
IMPROVEMENT, YIELD, AND QUALITY OF CROP PRODUCTION

There are many crops grown in China, but only the seven leading crops of wheat, corn, sorghum, cotton, rice, millet, soy beans, and other beans are discussed in this chapter. In the United States there are sections called the corn belt, cotton belt, wheat region, and so on. This is also true in China because the soil and climatic conditions of the central and southern provinces are so different from those of the north that different species of plants as well as different cultural methods are necessary to success in crop production. Cotton and rice are grown mostly in the central and southern provinces because in those sections they have a longer growing season with heavy rainfall, high temperature and hot sunshine. These two crops are best adapted there more or less due to the climatic conditions rather than that of soil, because they require a longer growing season and a warm and hot climate. Wheat, corn, sorghum, millet, soy beans, and others are chiefly cultivated in the north. But still there is a limitation for growing these crops because the corn crop is grown mostly in central and northern China, even far north in Manchuria though it can not be grown successfully in Mongolia and Tibet. Wheat, sorghum, soy beans, millet, and corn are all staple crops in north China, especially in Manchuria. In recent years the soy bean crop production has increased to a great extent due to the great demand of home and foreign

markets. In general, the methods of production of these crops are very similar in the north and south districts, but there is some difference between the southern and northern farmers. As a whole the southern farmers handle less acreage than those of the north, especially in the three eastern provinces. For this reason, the farmers in Manchuria cannot cultivate the crops so carefully as those in the central and the southern part. Generally 15 to 20 acres of land are the maximum number for a farmer to handle, but in central China and in the southern sections the farmers even cannot handle that much and 6 to 10 acres of rice fields are plenty of work for a farmer.

Farm methods are rather primitive. The tools used and the methods of planting and harvesting are much the same as the people have employed since ancient times. A V-shaped plow is used which does its work only superficially. The hoe is used for cultivation, while stone rollers and flails are used for threshing. The strong ridging and the close level rows are largely adopted because they have marked advantages in utilizing the rainfall, especially the portions coming early and later also if it should come in heavy showers. With steep narrow ridging, heavy rains would be shed at once to the bottom of the deep furrows without over-saturating the ridges, while the wet soil in the bottom of the furrows would favor deep percolation with lateral capillary flow taking place strongly in under the ridges from the furrows, carrying both moisture and soluble plant food where they will be most completely and quickly available. When the rain comes in heavy showers each

furrow may serve as a long reservoir which will prevent washing and at the same time permit quick penetration, the ridges never becoming flooded or puddled, permit the soil air to escape readily as the water from the furrows sinks which it cannot easily do in flat fields when the rains fall rapidly and fill all of the soil pores, thus closing them to the escape of air from below, which must take place before the water can enter. For this reason narrow rows with ridging does not waste much soil moisture as compared with large flat surface cultivation. The method of planting is by hand or by means of a one row seeder. Usually 3 persons do the planting, one man makes the furrow with a plow, one man does the sowing, and another man does the covering of the seed. In case an application of fertilizers or manures is made there should be one more man for this work.

Commercial fertilizers are not known to Chinese farmers. Animal and human manures, earth compost, ashes, garbage, and other refuse are applied to the soil. Soy bean cake and sesame cake are used in some sections. The Chinese farmers allow no weeds to take away the life of the soil from the growing crop. Careful hoeing is the best cleaning cultivation they use. The difference between western countries and China in cultural methods is that in western countries the crops are surface planted while in China they are grown on the ridge which is being formed after the first hoeing. By observing the methods of farming it seems that the Chinese farmers scientifically know little about agriculture, but practically

they have developed their own secrets to success. However, much can be accomplished by improving cultural methods. There are at least four ways of accomplishing improvement in the quality and yield of crops.

1. Better methods of culture. The method of soil culture should be the most effective in making the soil condition fit for the crops to develop the best growth. Modern farm machinery would in many cases be an advantage in fitting seed beds, planting, and cultivating. However, the western farm machines are not all suitable to Chinese farmers because the farming conditions and labor conditions are so much different. What Chinese farmers need now are the horse power tools such as the plow, cultivator, drill, and other tillage implements. It will be so much the better if a man can make a new design of a type of farm tools which are suited to Chinese farming conditions. With the new implements the method of cultivation will be effective in producing better crops and in keeping the soil in good condition. For improvement in method of cultivation practical farmers will understand the impossibility of giving specific directions regarding the best methods of planting and cultivating that would be applicable to any considerable portion of the Republic. It is the adaptation of method to conditions. Methods best adapted to many various latitudes, conditions of climate, soils, and kinds of crops should be left to the judgment of the farmers.

2. Better quality of seed planted. This is one of the most

important factors in crop production. It is the seed that largely determines the good and bad yielding ability of the crop. But Chinese farmers neglect this almost entirely and they plant the crop by taking the seed from the bulk grain and they know not whether or not it will grow. In some sections the farmers sometimes do the seed selection during the harvesting time, but that selection is done in shock and nothing is known about the plant growth in the field. So the very first step for our farmers to undertake is to select the seed of good quality with the ability to produce the highest production. This can be done at least in four ways: (1) To grow the better varieties which have been best adapted to local conditions, (2) To have the germination test of the seed made by individuals, agricultural experiment station, or institution, (3) To improve the crop through plant breeding, (4) To have a government or provincial plant improvement station.

3. Right crops for soil types. The success of crop production depends largely in choosing the crop that is best adapted to soil conditions. One crop may be adapted to light soil, while others may be adapted to heavy soil. Of course, nearly all crops can be grown on good soil, but the lands are not all the same in texture and fertility, so the soil has been classified into so many types of sandy soil, loams, silt, clay, and muck soils. Soil adaptation will be given in the following order to show which crops are adapted to the soils.

Sandy land is not well suited to crop production because it costs too much to fertilize the soil to produce a good crop.

It is, however, good for grazing and forestry. On better sandy lands, grass crops are adapted and sometimes the soy bean and peanuts can be grown well, particularly when the soil is well supplied with organic matter and the distribution of rainfall is uniform and sufficient.

Sandy loams are good for potatoes, beans, peas, melons, pickles, berries, and small fruits. Tye, peanuts, and barley are adapted, and corn may do well if the land is fertile and well supplied with organic matter. But the most profitable crops for this land are potatoes, beans, melons, pickles, and small fruits.

Loams are good for general farming. This soil is best adapted for barley, corn, rice, sorghum, millet, beans, sugar beets, sweet potatoes, potatoes, cotton, and wheat. They are also good for some truck crops.

Clay land is good for grains, such as wheat, barley, rye, oats, and rice. It is also used to grow millet, sorghum, and sometimes sweet potatoes. However, it is best adapted for small grain.

Muck land is good for truck crops, celery, onion, cabbage, radishes, and beans. For the field crops it is adapted to barley, oats, millet.

Crops adapted to special soils are:

Sandy loams: Peanuts, sesame, buckwheat, rye, oats, barley, sorghum, corn, beans, peas, pickles, melons, small fruits, and vegetables.

Loams: Corn, wheat, oats, barley, rice, cotton, sorghum,

millet, potatoes, beans, beets, peanuts, and truck crops.

Silt loams and clay loams: Corn, wheat, oats, barley, beans, beets, fibre flax, rice, cotton, kaoliang, and millet.

Clay: Corn, wheat, barley, oats, rice, beans, peas, sweet potatoes, and some truck crops.

Muck: Beans, celery, onions, cabbage, millet, barley, and oats.

4. Better systems of cropping and fertilization. A good system of cropping and fertilization is the first consideration of the good farmer. This should not be a matter of hurried planning at planting time, but should be a program laid out for a number of years. A well-planned system of crop rotation is the key note of progressive farming. It should be laid out with reference to the kind of soil, the distance from town, the available markets, and the personal preferences or abilities of the farmer himself. There is no question of the wisdom of rotation over the practice of growing one crop year after year on the same soil. The reasons for rotating are:

1. To increase nitrogen.
2. To increase organic matter--humus.
3. To improve the physical condition of the soil.
4. To use different kinds of plant food.
5. To use food in the soil at different depths.
6. To help control fungus diseases.
7. To help control insect pests.
8. To help control weed pests.
9. To enable beneficial bacteria to develop.
10. To help distribute labor throughout the year.

When any one crop is grown continuously on the same field for a number of years, the average yield is almost sure to be less than if that crop had been grown in a suitable rotation with other crops. Hence it is profitable to have several cro

grown on the farm, and the land devoted to the crops may be divided into a number of fields of equal size and the crops changed each year in regular order from one field to another. For these reasons any farm or food size may have 2, 3, or more different rotations in progress.

The first thing to consider in planning the rotation is the crop one desires to raise. The crop must be most profitable for the locality and best adapted to the soil conditions. The rotation of crops should be suitable in such a way to produce greater yield and to lessen the labor with greatest net profit. The rotation should contain at least one legume crop, a sod crop, and a cultivated crop. Deep-rooted crops should be alternated with shallow-rooted crops. The small grain does well following a cultivated crop, and especially such legumes as beans. From the standpoint of fertility a long rotation with a great variety of crops may be best, but is seldom practicable to carry out, and so four, five, or six years rotation will be suitable to work out successfully. However, rotation does not maintain fertility but the soil can be kept in good proportion of elements required for plant growth if the application of liberal amounts of farm manure and other fertilizers is made each year as to crops adapted to soil and climatic conditions.

The rotation practices depend on many local and special considerations. In the first place the crop rotation must adapt itself to the farmer's business and to soil and the fertility problem. Fertilizer applications should be made

if manures and fertilizers can be purchased cheaply. The size of the farm and the kind of soil and the climate may dictate the rotation. Rotation must be planned with reference to the species of plants that will produce the best inter-relationship result, and also must consider in what conditions one crop will leave the soil for the succeeding crop, and how one crop can be seeded with another crop. The following are suggestions for rotations:

a. Crop rotation on sandy loams:

Three years rotation: (1) Beans, (2) Peanuts, (3) Barley or oats.

Four years rotation: (1) Sesame, (2) Beans, (3) Sorghum, (4) Buckwheat, peas, or peanuts, or-
(1) Peanuts, (2) Peas, (3) Barley, (4) Beans.

b. Crop rotation on loams:

Three years rotation: (1) Corn, (2) Beans, (3) Wheat, rice, millet, or barley.

Four years rotation: (1) Corn, (2) Barley, (3) Wheat or oats, (4) Beans or peas, or-
(1) Sorghum, (2) Barley, (3) Rice or cotton, (4) Beans or peas.

Five years rotation: (1) Corn, (2) Barley, (3) Wheat, (4) Beans, (5) Beets, or -
(1) Sorghum, (2) Oats, (3) Rice, (4) Peas, (5) Millet.

c. Crop rotation on clay:

Three years rotation: (1) Corn, (2) Beans, (3) Wheat, oats, rice, and cotton, or-
Sorghum instead of Corn.

Four years rotation: (1) Corn, (2) Beans, (3) Wheat, (4) Peas, (5) Millet, or-
(1) Corn, (2) Oats, (3) Wheat, (4) Beans, (5) Millet.

d. Crop rotation on muck:

Three years rotation: (1) Beans, (2) Barley, (3) Millet.

The rotations mentioned above only give an idea for a system of cropping, but they can not be applied to all conditions of farming because many considerations depend on (1) adaptation of crops to soils, climatic and market conditions, (2) type of farming, (3) general farming and live stock, (4) special crop farming, (5) distance from market, (6) size and location of the farm land.

The system of fertilization should be worked out in such a way to produce the heaviest yield of crops and at the same time maintain the soil fertility. The farmers in Manchuria, Mongolia, and Tibet have not kept as much live stock as they ought to so the stock raising should be carried on to maintain the soil fertility. Commercial fertilizers may be used in application with farm manure to the soil if it is profitable in return. The amount of application depends on the condition of the soil and it should be sufficient to increase fertility and to give profitable returns at the same time.

The seven leading crops are to be discussed in following pages relative to methods of culture and improvement for further development.

WHEAT

Origin and general distribution.

No one can say definitely where this plant was originated, but it is believed by the Chinese people that this plant is regarded as native to the country. It is one of the oldest cultivated crops and was one of the five plants sown each year in a public ceremony by the emperor since ancient times. The wheat crop is considered as a northern crop of China, because it is well adapted to the climatic conditions of the north. It is grown extensively in central and northern China and now particularly in the three provinces of Manchuria.

Soil and climatic adaptation.

Wheat is successfully grown on a wide range of soils. It will yield the best on fertile soils, although good yields may be secured on rather poor types of soils if proper fertilization and cultural methods are employed in growing it. Wheat being sensitive to its soil conditions, requires thoroughly pulverized soil and well compacted. If manure is applied or sod is turned under, the organic matter must reach a thorough state of decomposition to produce a good effect on this crop. The best soils for wheat are of high fertility and of fine texture, such as silts, silt loams, and clay loams, usually with a large humus content. Wheat is the cereal of the moderately dry temperate climate and has a rather wide climatic adaptation. The growing season should not be less than 90 days and the annual rainfall should not be less than 9 to 10 inches, except under irrigation. The seasonal distribution

of the rainfall is as important as the yearly amount, and the best conditions for wheat growing are in the sections where they have a cool and rather wet growing season during the early life of plants, followed by rather hot, dry, sunshiny weather during the ripening period. When these conditions are prevalent, the largest yields are secured and the grain is of best quality. Varieties. There are many varieties of wheat, some being winter, sown in the fall and harvested in early summer, while others are sown in the spring and harvested usually a little later than the winter varieties. In China there are only two terms given to the different varieties of wheat, namely, spring and winter. The spring varieties grow most in north China, particularly in Manchuria, while the winter varieties grow in central and north China.

Fertilizers, manures, and rotation.

Fertilizers are most profitable when the crop is grown in a rotation that keeps the soil well supplied with decayed vegetable matter. But no commercial fertilizers have been used on farms in China, and manure and earth composts are the only means applied to the soil for production. However, manure is the most effective fertilizer used on the farm and good yields can be obtained from the land when it is applied to the soil. The manure is deficient in phosphorus and so acid phosphate should be used, because it is the most effective mineral that can be applied to this crop which demands a large amount of this element in order to develop plump grain and to yield heavily. This crop does best when following leguminous crops, such as beans and peas. So a rotation of beans, wheat, and corn or

sorghum is used to a great extent in all the sections in north China.

Methods of culture.

Preparation of seed bed: The ideal seed bed for wheat is one that is thoroughly pulverized, well compacted, with a loose mulch on the surface and a good contact with the subsoil. The land should be plowed early to a good depth and then disked and harrowed before planting, possibly also rolled, because of making the seed bed level and fine, and well packed as the small grain seed requires a firm seed bed for good germination. A loose seed bed will not allow proper root development, and also it is apt to be dry. It is also true that the plants do not winter kill to a great extent on a firm seed bed. When seed bed is well prepared, usually a clean crop can be obtained and therefore early plowing followed by disking and harrowing before planting is necessary for a firm seed bed.

Time of planting: The time of planting varies with sections and climatic conditions. In north China it is planted in October, while in the central part it is planted in November. There is no date which can be given in all sections for planting so this will leave to the farmers who know the local conditions best.

Rate of planting: The rate of seeding also varies with the conditions of the soil and time of sowing. More seed is required for late planting than for early planting and more for poor soil than for rich soil. However, the usual rate of planting is from four to six pecks to the acre.

Method of planting and cultivation: No drill has been used by the Chinese farmers to sow this crop and the method they use is by means of a seeder to seed in the furrow made by the V-shaped plow and then covered with the soil. In the spring when the plants grow about 6 to 7 inches high or more a careful hoeing is given to keep the weeds down. Sometimes two hoeings are needed for the wheat crop if the field is very weedy.

Harvesting and storing. The methods of harvesting, threshing, and storing are nearly the same for the other crops. The grain is cut by hand with sickles and made into bundles. It is threshed on the clay floor by running a stone roller over it. When it is threshed it is stored in bins or a store house. Sometimes it is sacked for market right after threshing.

Insects and diseases. A large number of insects feed on and injure growing wheat, but the most destructive insects are the chinch bug, hessian fly, and army worm.

The chinch bug goes through six different stages from the egg to the adult insect and it causes a great loss to the wheat crop. The methods for prevention and remedies are burning, over waste land, rotation, and early plowing.

The Hessian fly is one of the principal enemies of the wheat crop. It has four stages in its life cycle and does more injury to the crop at the larvae stage. The methods of controlling this insect are late planting of winter wheat, burning stubble, plowing under stubble, and rotation of crops.

The army worm also causes much loss to the wheat crop

and the best way to control this insect is to have clean cultivation and the adoption of a regular system of rotation of crops.

Rust and smut are the two diseases causing serious injury to wheat. Two kinds of rust are generally known. One occurs principally on leaves and the other affects the stems, but there is no successful treatment for these rusts. The best way to control this disease is to grow rust-resistant varieties of wheat.

The two common smuts of wheat are the loose smut and the covered smut (stinking smut or bunt).

The loose smut, having infected the seed in the field while very young, turns the entire wheat head into a black powdery mass and is distributed by wind to the next year's crop. This disease can be prevented by treating the seed with hot water. First soak the seed in cold water for four to six hours. After draining, immerse the seed in the hot water at a temperature of about 129°F. The temperature should be constant at 129°F. during the process and the seed should be immersed for ten minutes.

Covered smut produces its spores exclusively within the kernel filled with a black dust-like mass. This disease can be controlled by treating the seed with hot water, formalin, and copper sulfate.

Hot water treatment: Soak the seed for ten to fifteen minutes in water kept at a temperature from 132° to 133°F. After the treatment the seed should be drained at once.

Formalin treatment: Take one pound of formalin mixed to every forty-five gallons of water. Moisten the seed thoroughly

with the solution and the seed should be dried when it is to be sowed.

Copper sulfate treatment: Dissolve one pound of copper-sulfate in four gallons of water and then immerse the seed for one or two minutes in the solution. Then take the seed out and let it dry.

Methods of improvement for yield and quality. The main object of improving the wheat crop is to increase the production with the best quality to the acre. The most practical methods for this improvement are (1) growing best adapted varieties, (2) better culture, and (3) selection and breeding.

There are at least three ways to get varieties adapted:

1. Experiment station recommendation: This is dependable because the station has conducted tests of varieties and carried on varietal improvement for long and it has been shown by the results in the experiments those varieties which are best adapted to its section conditions so that the grower may safely adapt the best variety as a standard to increase the yield and to produce a better quality.

2. Study of farmers' experiences: This varies in locality of sections because the farmers of one locality have different methods of farming from others and the same thing is true with the variety adapted. This is the result of experience through which they know what varieties are best adapted to their local conditions as compared with the results of production they obtained from the acre. It is worth more to study the farmers' experiences of varieties adapted than to grow a variety which

has been known as a good yielder in the whole section, because the soil conditions vary greatly in localities and the farmers of this locality know the soil conditions better by their experience.

3. Run variety tests: This is a sure way to get the adaptable varieties when new varieties are introduced. The variety tests are so easily conducted that no farmer should long be in doubt as to whether or not he can increase his production by secured seed of a different variety from that which he is now growing. Frequently an increase of several bushels per acre may be secured by the growing of a better adapted variety. It is the purpose of the variety tests to determine which variety or strain is best adapted to a given soil for a series of years. The variety tests may be conducted with few or several varieties. Any farmer can conduct a test with a few of the most prominent varieties without great inconvenience. The variety test consists in growing several varieties side by side under uniform conditions of soil and culture. The farmers may find the yield and the quality of the crop at harvest time.

Better culture. With wheat, the proper treatment of the soil may be considered half the battle. In wheat growing a great deal depends upon local conditions of soil and climate, and as these conditions in any particular locality can be thoroughly understood by long residence in that locality the farmers know best the adaptability of wheat to any particular section. The early and deep plowing is best. This especially is true in arid regions where conservation of moisture is a very important matter. For spring sowing plowing should be done in

the fall, and for fall sowing plowing should be done soon after harvest. The seed bed should be made very fine and mellow before planting. The proper time for seeding varies, of course, with the latitude, while depending also occasionally on the locality and on the variety used. But whatever the conditions otherwise, it is a safe rule to sow at a period which is considered early in the locality where the sowing is done.

Selection and breeding. The most important thing for improvement of seed grain on the farm is the quality and purity of the seed. For quality of the seed, (1)it should be adapted from a variety known to be a good yielder in the region in which it is to be grown, (2)it should be adapted seed of the variety chosen, produced under conditions similar to those under which it is to be grown, (3)it should be practically free from impurities, including weed seed, seed of other grain and seed of other varieties, (4)it should be free from seed borne diseases. For purity the seed planted should be free from mixture of other grain and seed of other varieties. The field should be kept clean from weeds so that a pure grain will be obtained.

Selection of varieties is a matter of much importance. Well known varieties that are best adapted to local conditions should be planted. One of the first things to bear in mind is the utter uselessness of giving any attention to announcements made by certain farmers of new varieties that make such an astonishing yield as 50 to 70 bushels per acre where the farmers' best average before had been only 25 bushels. This occasionally may be true or a fraud and in fact no one

variety can succeed in all sections of the country. Therefore, it is best to grow home grown seed for its best adaptation. Improvement by head selection is the most reliable way to improve the seed grain. This is the practice of selecting enough of the best heads in the field to plant a seed plat of one-half an acre or more in size. This seed plat is carefully prepared and planted, and after further head selections for another year's planting are made, it is harvested separately and the seed used to plant a general field the following year. To obtain the best results the farmers must get seed of the best varieties and then keep the seed up to a high standard of purity and quality. The matter of seed selection is of such vital importance that probably nothing would be of more benefit to the farmers than the establishment of special seed plats of a few acres from which to select seed each year.

The improvement by breeding is a rather slow process and the farmers can hardly work out this problem on account of much work on the farm so this must be left to the plant breeders.

RICE

History, origin, and distribution of rice. Rice is one of the oldest of cultivated cereals and has held an important place in the agriculture of China. For thousands of years before the dawn of the Christian Era and continuing down to the present day, rice has been the staple article of food for the people of China. It is probable that China is its original home and then it was introduced to Japan and India and later to southern Europe. In 1647 it was introduced into the United States and from that time on it has been grown to some extent. Rice is considered as a crop of southern China, because it is well adapted to the climatic conditions in south and central China. It is grown extensively in the Yangtze basin and south to Kwangtung. However, it has been grown to some extent in the northern provinces and at present even far in the three eastern provinces of Manchuria. But it is only grown in south Manchuria because of the limitation of climate.

Varieties. There are an immense number of varieties of rice, differing in length of the season required for maturing and in character, yield, and quality. Their divergence not only extends to size, shape, and color of the grain, but to the relative proportion of food properties and the consequent flavor. Owing to the great antiquity of rice and the varied conditions of soil, climate, and culture under which it has been produced, many varieties have come into existence. Some varieties known in the United States are Carolina Gold Seed, Honduras, Blue Rose, etc., but in China we do not have those

names. We call them "water-rice" which is grown in water, and "dry-land-rice" which is grown on dry land. Of course there are many different varieties but no particular names are given and sometimes a variety name is given by the local growers which is not known to the whole country.

Lowland and highland rice. While rice is chiefly grown on lands that are low, level, and easily irrigated, there are varieties which can be grown on fertile uplands without irrigation. In north China the upland rice has been grown to a considerable extent, but the quality and flavor is not so good as water-rice. The water-rice can sell for a higher price on the market than the dry-land rice, so the farmers will grow it in water wherever possible.

Adaptation to soil and climatic conditions. The best soil for rice is a medium loam, containing about 50 percent. of clay. This allows the presence of sufficient humus for the highest fertility without decreasing too much the compact nature of the soil. The alluvial lands along the rivers where they can be drained are well adapted to rice cultivation. It has a wide range of adaptation but the best lands are underlaid by an impervious sub-soil. Gravelly or sandy soils are not adapted to rice cultivation because they do not possess the mechanical condition for the retention of water. In general it may be said that rice can be grown on any soil adapted to wheat provided climatic conditions are favorable.

Rice is a tropical or semi-tropical plant, and requires a long, hot growing season, with a moist, humid climate. It is grown therefore only in low-lying regions with a plentiful

supply of moisture and a long growing season.

Irrigation and drainage.

Irrigation is an important feature in the culture of rice. Water must be applied continuously and at uniform depth for days. For this reason in the first place we have to consider the sources of irrigation water. In China the water needed for rice production is obtained mostly from streams and wells. From the streams it is lifted by pumps or other means and distributed by canals. It is also important to consider the size of the field. However, in rice culture the size of the fields depends on circumstances chief among which are the slope of the land and the character of the soil as regards drainage. Fields may range in size from 50 to 100 acres, but in China very few fields are more than 10 acres in size. This does not mean that there is not a field of that size but that the fields are usually divided into smaller fields to have better irrigation with even depth of water and to give greater convenience in pulling weeds. The entire surface of each field should be nearly at the same level so that the irrigation water will stand at about the same depth. Hence, where the slope of the surface is considerable, the field must be made small. Fields must be also laid off in such a manner as to allow effective drainage. The next important thing we have to consider is the method of applying irrigation water. A rice field must be enclosed by strong levees in order to hold the water that may be put upon it. The most important thing is to locate the levees especially those that separate the subfields. These levees should be

permanent and constructed on contour lines at distances which will hold the water at a desirable depth or a depth of about 5 inches. They should be at least 10 feet at the base and built up with sloping sides to a height that is just sufficient to prevent the water from overflowing into the subfields below. Those levees can be made in winter time. The water is admitted to subfields through openings in the levees. These openings should be controlled by the wooden gates and not made with a shovel each time water is needed. The gates should consist of a floor and end pieces to hold a sliding shutter in a vertical position across the opening. The flow of water may be regulated by the shutter, which consists of a narrow piece of wood that may be increased in number or removed as the water is raised or lowered.

Drainage.

Perfect drainage is one of the most important considerations in rice farming, because upon it depends the proper conditions of the soil for planting. Complete and rapid drainage at harvest time always insures the saving of the crop under the best conditions and reduces the expense of the harvesting. Thorough drainage is more essential for rice than for other crops because irrigation brings the alkali to the surface to an extent that finally becomes detrimental to the rice plant. Alkali sometimes accumulates in the soil just below the depth of the usual furrow to such an extent that any plowing is dangerous to the crop. But the effective way of disposing of these salts is by thorough drainage and deep plowing. The ditches

should be deeper than the furrow so that water drains away and the excess of soluble salts is carried off.

General directions for flooding.

Flooding is the most destructive feature of rice culture as compared with the culture of other crops in general. Except where water is necessary for germinating the seeds, flooding is not practiced until the rice is 6 to 8 inches high. If showers are abundant enough to keep the soil moist, it is better to delay flooding until the rice is 8 inches high, as there is considerable danger of scalding the rice when very young. The depth of water that should be maintained from the first flooding until it is withdrawn for the harvest depends upon other conditions. If the growing crop thoroughly shades the land, just water enough to keep the soil saturated will answer. To be safe, however, for all portions of the land or fields, it should stand 3 to 6 inches deep, and, to avoid stagnation, it should be renewed by a continuous inflow and outflow. The water should stand at uniform depth all over the field or it will cause the crop to ripen at different times.

Fertilizers and rotation.

Rice is not a great impoverisher of the soil, especially if the straw and chaff are regularly returned to it. It has been claimed that the flooding of rice fields restores to the soil as much nutritive material as the rice crop removes. This may be true in central China along the Yangtze River which carries a large amount of silt, but it is not the case where flooding is done with pure water from the wells. In China

applications of manures and earth compost are made to the soil every year to grow this crop. It is a question whether commercial fertilizers will pay for their application and I think this should be left to the farmers to decide according to the conditions presented. Crop rotation has been practiced to a small extent in the rice fields in central and south China. In many places there is no rotation for rice fields because the fields are the low land and easy to irrigate. If the farmers make a considerable application of manures and bean cakes they may make more money on rice than by growing other crops. For water-rice no rotation is used whatever.

Method of culture.

Time of plowing: The time of plowing differs somewhat with soil. It may be plowed in the fall, winter, or spring. Fall or winter plowing will permit the free circulation of air in the soil if the land is well drained at that time. Spring plowing land should be disked and harrowed immediately after plowing because the soil dries out very rapidly under the action of the winds which usually prevail at this season, and if allowed to dry out, a satisfactory seed bed can not be obtained.

Depth of plowing: Some farmers do shallow plowing for this crop because it appears to thrive best in compact and firm ground. However, deeper plowing gives better results because the better the soil and the more thoroughly it is pulverized the better the crop. The plants do not feed much below the plow line, so that it is evident that deep cultivation places more food within the reach of the plants. It should be plowed in the fall to the depth of 5 to 7 inches. If pulverizing or

or plowing the soil or ground deeply is a disadvantage by reason of the great porosity of the soil at seeding time, it can be easily remedied by the use of a heavy roller subsequently. If the soil is well-drained, deep plowing will be found profitable. A firm and even seed bed is required for this crop.

Sowing and time of planting.

Preparing seed before planting is of utmost importance. The seed should be free from red rice, grass, and weed seeds. Uniformity of kernels is most essential and seed should be good in quality and free from sun cracks.

The best time to sow rice differs in sections and varies somewhat with varying conditions in the same section. In south China it is sown early in the spring while in the north it is sown as late as May. However, sowing should take place as soon as possible after the spring plowing. Care must be taken to plant the fields at different periods so that cultivation and harvesting will not be too crowded.

Amount to sow.

The rate of rice sown per acre varies with soil conditions and methods of seeding. It varies from 1 to 2½ bushels, but 2 bushels of seed is plenty to the acre.

Methods of seeding.

For germination, some farmers let on just enough water to saturate the ground immediately after sowing and harrowing and at once draw off any surplus water. This is to insure the germination of the seed. Other farmers sow and trust to there being sufficient moisture in the ground to germinate the seed. This is sometimes uncertain and rarely produces the best results.

A few others sprout the seed before planting by placing bags of rice in water. This is sure to result in failure if the soil is very dry when the seed is sown. In Japan the farmers practice the last method to some extent, but their seeding is different from the method mentioned above. They sprout the seed and have the land covered with water and then do the planting. This assures the germination of the seed and the seedlings have a rapid growth. Drilling has been practiced some in China, but we do not have the drills the farmers have in the United States. The drilling method is more effective than other methods because the seed will be more equally distributed and the quantity of seed used to the acre will be exact. The seeds will be planted at a uniform depth and the earth packed over them by the drill roller. Broadcast sowing of rice is the method which has been used in some localities and this is used for transplanting when an even stand cannot be obtained. This method is not the best for the seed is never scattered with uniformity. Some grains remain on the surface and others are buried too deep. Broadcasted seed does not germinate with any uniformity, the stand varies greatly, maturity is not uniform, and quality of rice in poor condition. After sowing, the next thing to consider is the applying of water for irrigation. In most sections the water stands in the fields just after the planting, but great care must be taken in applying water, for if water is left on the land too long, it is likely to cause the seed to rot. The irrigation water should be applied when the young plants have

reached a height of 6 to 8 inches.

The common practice in rice growing in central and south China is to have the soil carefully prepared and highly fertilized. A special seed bed should be prepared. Before sowing the plat must have one to two inches of water, sowint the seed in the water. The method is usually by broadcasting. If a farmer wants to raise ten acres of rice, he must have on acre of land for the special seed bed and sow at a rate of from 7 to 10 bushels. After one month of growth the seedling grows out of the water to about the height of a foot, the seedlings are pulled out carefully without breaking the roots and then set out in the general fields.

Harvesting and thrashing.

Rice should be harvested when it ripens and it can be cut with grain binder and handled in the same way as other grain crops. But in China it is cut with a knife entirely by hand labor. The threshing method consists of a roller drawn by horses or mules tramping over it. The yield is about 30 to 40 bushels to the acre though rice sometimes yields as high as 50 or more.

Uses and importance.

For centuries rice has been the "staff of life" to the people of Asia and it is one of the most important starchy foods of the world. In China, rice is the chief food of the people and is supplemented with seed grains of millet, sorghum, soy beans, and wheat. The by-products of rice are hulls which are of little value and the bran which is considered to be of some value as stock food. The straw is not palatable and is

of very little value to stock, but it is good bedding.

Insects and diseases.

Only a few insects attack the rice plant. The one causing greatest injury is the water weevil. While in the larval stage it destroys the roots and later the adults feed on the leaves. The most practical means of controlling the rice weevil is to cause the temporary withdrawal of water and the drying out of the land. Stink bug, fall army-worm, stalk borer, etc., are all the most destructive insects of the rice crop. The best means of controlling these insects are as follows: (1) Plow fields in the fall previous to planting time to kill pests in the soil. (2) Drain fields and dry out the land to prevent damage by root maggots. (3) Flood the fields immediately in case of caterpillar or worm attacks upon leaves. (4) Keep weeds down around the fields.

Blast, blight, and rotten neck are common diseases. Blast attacks the node in which the rice head is forming, causing the head to fail to fill or to break off. But there are no specific means of control being recommended yet. Rice smut sometimes does damage. It can be controlled by the following means:

Hot water treatment: Soak the seed for 10 to 15 minutes in water kept at a temperature of from 132° F. to 133° F. The seed should be dried at once after the treatment.

Formalin treatment: Thoroughly moisten the seed with a solution made by mixing 1 pound of formalin to every 45 gallons of water. The grain may be soaked. The most important is to get every kernel wet with the solution and then dry out for

planting.

Copper-sulfate treatment: Immerse the seed for one or two minutes in the solution by dissolving one pound of copper sulfate in 4 gallons of water. Dry the grain and then sow.

Improvement of rice crop.

Stand and yield can be greatly improved by using large, well-developed seed. Such seed can be mechanically selected by using fanning mill or some other methods for cleaning and grading. It is a very important factor to give careful seed selection before sowing. The adaptability of a variety of rice to the region in which it is to be grown should always be considered. Quality and productiveness cannot be obtained from a variety when it is grown under conditions that are not favorable to its best development. It is best to grow the home-grown seed which is best adapted to local conditions. A large sowing of new varieties should not be made until those characters are known. The new variety should be tested out in a seed plot and if it is found to be better variety showing good quality and productiveness it will then be sown in the general field. Home-grown seed, however, if carefully selected and well graded, generally yields better than the seed of the same variety from a distant locality. The selection should be made at the time of ripening and from the plants that are grown under ordinary field conditions. The earliest and best heads should be selected and threshed by themselves. The seed obtained from them should be sown apart from the main crop and the seed bed should be well prepared. The seed from this

plat may use for the next planting. The best heads should be selected from this plat and used for next year seed plat so that a permanent improvement of the rice crop can be obtained by this practice year after year. A better method for improving the quality and yield of rice crop would be to test and select strains which have been developed from individual heads. This is too much work for individual farmers. Breeding is also an important factor for improving the rice crop, but this should be left to the agricultural experiment station. The method of breeding, of course, is important for the improvement of this crop, but for the present time seed selection is the most important thing for the Chinese farmers to do. It is not necessary to introduce new varieties from foreign countries, but to improve the home-grown variety by head selection.

COTTON

General distribution and production.

Cotton is grown in all sections in central and south China, at present even as far as the north provinces of Chihli and the southern part of Mukden. However, the chief area of production is in central China, especially in the Yangtze Valley. Some of the leading cotton producing provinces are Anhwei, Chekiang, Honan, Hupeh, Shansi, Shensi, and Szechwen. This is rather the climatic limitation, because in these sections the climate is hot and the growing season is longer and we also find some provinces of Kwangtung and Yunnan producing considerable cotton too. In the north, the provinces of Shantung, Chihli, and the southern part of Mukden, though a considerable amount of cotton has been produced the quality is not so good as that is produced in the cotton belt of central China. China has produced a large amount of cotton and it was reported in 1918 that cotton production was at least 2,500,000 bales of 500 pounds. China ranks next to India and the United States and is already the third largest cotton producer in the world. The acreage of cotton growing is increasing enormously every year in China, due to the fact of the great demand of home mills and foreign market. In recent years some new varieties have been introduced to China and they have shown greater production and better quality than those grown in China. For this reason I may say that the cotton crop might be doubled on the same acreage as now grown by proper attention to the use of good seed and careful methods of culture, but China is still

increasing her acreage of cotton growing, so in the near future she may be the largest cotton producer in the world.

Varieties.

No special name being given to different varieties of the cotton in China, "China" is the universal term used by the farmers for different varieties of the cotton crop. However, some varieties have been named as Chinese Cotton, Foreign Cotton, and American Cotton. The term "Chinese Cotton" means that this variety has been grown in China for centuries and has been known as Chinese cotton. The plants known as Chinese cotton grew small, much branched, bearing small bolls, and the branches being rather slender. It is also less productive and the lint is short. The term "foreign" cotton refers to the cotton varieties which have been introduced into China from foreign countries and they are much different from varieties of Chinese cotton. "American" cotton means varieties of cotton introduced from America. They are now growing in various sections in China. These are the three groups of varieties of cotton grown in China now, but the American cotton varieties have been shown to be more productive than the home varieties and the farmers are growing more American cotton than the Chinese because the American cotton gives greater production and therefore the farmers make more profit. There are many varieties of Chinese cotton but there is no classification as in the United States. However, there is no one best variety of cotton for all conditions because production is modified by

factors such as length of growing season, soil type, and moisture supply, which has resulted in the development of varieties particularly adapted to more or less local conditions. Some varieties are especially fitted to certain conditions of soil and climate and usually are not profitable when grown in new localities.

Adaptation of soil and climate.

The best soil for cotton is a medium grade of loam because heavy soil produces large vegetative growth but a small amount of lint, while the light soil produces small yield. The best cotton produced in China is in the Yangtze Valley where the soils are composed mostly of alluvial deposits washed from upland and deposited by overflow waters. In fact, cotton may be grown on any type of soil well supplied with organic matter, but not with equal success.

Climate is the most important factor in cotton growing. The length of growing season, temperature, sunshine, and the amount and distribution of rainfall are all important factors to the normal growth and fruiting of cotton. It takes about 190 to 200 days from planting to harvesting for the full development of cotton. It has been claimed that the longer the growing season the better the production will be because good yields are usually produced in sections where the growing season is more than 200 days. High temperature and hot sunshine during the period of plant growth are most desirable, but they should be decreased when the plants are fruiting. A well prepared seed bed with equable distribution of

rainfall in spring is the most important for cotton growing because this will insure the germination. Just after planting frequent showers are desirable, and heavier rainfall should come in July and August evenly distributed.

Fertilizers, manures, and rotation.

No commercial fertilizers have been used so far because there are none on sale on the market. Sometimes bean cake has been used as a fertilizer, but not to a great extent. The maintenance of fertility of the soil is accomplished by applying earth composts. This not only adds the elements for plant food, but also organic matter to the soil. The farmers collect vegetable wastes and other organic matter which may be used to maintain the soil fertility. This is why Chinese farmers have cultivated for forty centuries land which is still productive under cultivation. Rotation has been practiced too, because they found out that continuous cropping results in poor production. But in cotton sections, they do not employ a proper crop rotation because in these sections the land value is high and the farmers try in every way to produce a crop which will bring them more **profit**. So they grow rice one year and cotton the next year. In this case they apply more manures and earth composts to the soil to grow these crops. However, the rotation of legumes should be used because the cotton crop needs more nitrogen and, therefore, the leguminous crops should be used in rotation as a cash crop or a cover crop of legume should be grown after the cotton is harvested, if possible.

Method of culture.

Time of plowing: The preparation of the seed bed is the most important factor in cotton growing. The land may be plowed in the fall or spring, but fall plowing is desirable because it enables the soil to absorb and hold a large quantity of water during winter time and gives the organic matter being plowed under sufficient time to be transformed into humus. Fall plowing also can make the plant food available in the soil and the soil conditions can be made good through chemical and biological process. It is preferable to plow light soil in spring and disk before planting.

Depth of plowing: The depth of plowing depends on the character of soil and time of plowing. In general, heavy or clay soil may be plowed deeper than the light and sandy soil and also fall plowing should be plowed deeper than the spring plowing. The land should be plowed at least 8 inches because of the deep root system of this crop. Disking and harrowing is necessary for a firm seed bed.

Time of planting: The time of planting varies in sections of the country. In southern provinces it is planted early, while in the northern provinces it is planted late in spring. However, the best time to plant is just as soon as the soil becomes warm.

Rate of planting: This varies with the size of the seed and varieties. About one bushel to the acre is plenty. The seed should be good in quality and heavy because it will germinate better and gives good yield. In order to get a good

stand a little more seed should be used and then it can be thinned out for desirable growth.

Method of planting: In China the method of planting is dropping the seed in furrow by hand in hills. The process of planting requires at least three men, one making the furrow, one dropping the seed, and the other doing the covering. This is rather slow and modern machines should be used in the future for handling a big acreage,. The distance between rows varies with fertility of soil and varieties of cotton and soil. In general, the richer the soil the greater the distance. On rich soils, well supplied with moisture, the plants grow large and require more space than on poor soil because of outward growth of long branches. Chinese cotton is usually planted a little thicker than in the case of American varieties. This is because the Chinese cotton varieties grow small plants and do not require so much space as American varieties. If the fertility of soil is increased, the distance between plants in rows should be also increased because this will give the plants better growth and good production will be obtained.

Cultivation: When the young plants appear, the first hoeing should be done so as to check the weed growth. Frequent cultivation is necessary for this crop and when the plants grow about one foot high from the ground a ridge is formed, the crop hoed frequently, to keep weeds down.

Harvesting.

Harvesting is done by picking by hand, no machinery being

used whatever. However, our labor is cheap and the cost of production of this crop is no greater than in the case of other cultivated crops. After harvesting the ginning and baling will take place and the cotton is then ready for market.

Insects and diseases.

The most destructive insect enemies of cotton are boll-weevil, boll-worm, and leaf-worm. There are some other insects such as leaf-louse, red spider, cut-worm, etc., but they are not so important.

Cotton Boll-weevil: This insect has four stages in its life history. It is in the larva stage that boll-weevil does its greatest damage. The means of control is to destroy cotton stalks early in the fall by up-rooting, and burning, by cutting and plowing under, and by pasturing. This is done to cut off the food supply of the weevils and starve them. It is also important to destroy weevils in hibernating places such as fence corners, etc., and the best way is to get all the rubbish and trash around the fields and burned. Planting early varieties, planting early, and frequent and shallow cultivation are all good means of control.

Boll-worm: The boll-worm also has four stages in its life cycle. When hatched, the young caterpillars or larvae feed on leaves and later attach bolls or bore into buds. They do great damage and sometimes eat all the contents of a boll before leaving it. The best means to control the boll-worm are through early planting in spring, planting early maturing varieties, early, frequent, and thorough cultivation.

Cotton leaf-worm: This insect feeds on cotton entirely and has done a lot of damage to this crop. In the caterpillar stage it eats the leaves and destroys the plants. However, this insect is not so hard to control and the best way is to dust arsenical poison over the top of the cotton plants when there is any sign of damage showing.

Diseases.

There has been a great loss to cotton production by the diseases of cotton every year. There are many diseases of cotton crop, but the most destructive and injurious diseases are Root-rot, Root-knot, Anthracnose, and Mosaic diseases. Of course, there are some more diseases doing more or less damage to the cotton, but they are not so important as these four mentioned above and so only these four diseases are going to be discussed.

Root-rot: This is most injurious in heavy soils and is caused by fungus which lives and spreads in soils. The best way to control this disease is to plow deep in the fall and to have the air circulate freely through the soils during that period.

Root-knot: This is a pest in light soils. The "knot" is produced by the worms and destroys the plants. The best means to control this is to have land prepared by early fall plowing and also to have a proper crop rotation.

Anthracnose: This disease is known as boll-rot and is caused by a mold-like parasitic fungus. It is spread by insects and sometimes it may be spread by wind. To control

this disease the safe way is to plant seed free from disease. Fall plowing and proper rotation are effective in preventing this disease.

Mosaic disease: This disease is often known as yellow leaf-blight and black-rust. It does great damage on soil, especially on land that lacks organic matter. The poorer the land the more damage will be caused by this disease. The safest way to control this disease is to have the soil in good condition well supplied with organic matter, with good drainage, and a better cropping system in use.

Improvement.

The problem of prime importance in the cotton industry at the present time is to increase the production of cotton per acre. In the past the production of cotton per acre in China is far less than at present. This is due more or less to better varieties of cotton rather than the methods of cultivation. Since the American varieties of cotton were introduced to China, the production is increasing every year. It is the general opinion that the cotton crop might be doubled on the same acreage as now grown by proper attention to the use of good seed and careful method of cultivation. For the improvement and development of cotton production, China should introduce the best varieties from other lands and increase the varieties which have already been proven their adaptability to the different sections of the country and also should practice improvement of the varieties by seed selection and breeding. Better cropping system and systems of fertilization should also be employed.

The character of soil and method of culture is of the greatest importance for the success in cotton production, but still there is great opportunity of improving this industry on all lands, both good and poor. This is probably the importance of good seed to be planted. It is too commonly a practice for farmers to take any seed they can secure regardless of whether it is adapted to their soil or climatic conditions, or whether it has been bred up to a high standard of productiveness. The Chinese farmers use seed taken at random from public gins, about which they know nothing other than that it was produced somewhere in that locality. The use of good seed and its production by a regular system of selection are just as important factors in the production of the crop as proper cultivation. Only seed of known variety, selected because of its desirable qualities, and adaptability to local conditions, should be planted. The selection of good seed has long been neglected by the farmers in China. It is not because they think that the work of selection is too much trouble, but because of lack of knowledge. The custom is for farmers to select seed after harvest. They do not practice field selection and for this reason do not know the character and habit of growth of the plant. The very first thing the Chinese farmers should understand is to practice the field selection of seed. This method is simple in application and inexpensive. Every farmer has a method of cultivation which he pursues with little variation each year and, therefore, every farmer should use in the same way a definite method of seed selection, carefully

followed each year. The farmer should follow a definite principle of selection. Some plants mature early, some later, some branch low and some high, some have large bolls, and others have small bolls, some have long lint, and others have short lint, etc. These variations furnish the means of improvement by selection.

After selecting, only the seed from those plants which possess the desirable features in the greatest degree should be increased. It is safe to say that the seed selected from the most prolific individual will in almost every case give progeny having a tendency to produce more. But it is not so easy to improve a variety to desirable perfection in every feature because it will complicate the process so it is usually desirable to select mainly for one object at a time. If attempting to increase the length of its quality much attention should be given to these points and continuous selection should be made until it is up to the standard of variety and to the ideal character in the mind of the grower.

In selection, the transmitting power of the individual is also a factor of importance in improvement of the plants. It is important to test individuals that have been selected to make certain that they possess in the highest degree the desired qualities of yield and length of lint, etc. It is also important to determine whether the plants possess the faculty of transmitting this quality to progeny. Selecting should be tested in seed plats to find out whether the qualities and characters for which the parent plants were

selected are transmitted because some strains are prepotent and have the power of transmitting the qualities to all, while others lack in prepotency and fail. The test should be isolated for the cotton plants are normally cross-fertilized. Insects carry the pollen from one plant to another and cross-fertilization may destroy some of the desirable characters sought.

Care and method of selection should be taken into consideration if good results are to be obtained. It has been shown that seed produced by plants grown on good soil under best conditions produces in its turn the best and most vigorous seed. For this reason, the selection field should be planted on good soil, but it would be wrong policy to select seed from rich and heavy soil for all soil types. This means the selection ought to be made in a field of the same kind of soil on which the crop is to be generally cultivated. The main object of selection is to secure the best plants which are most productive, early in maturing, with good length of lint, and having the largest, best formed, and most numerous bolls. Productiveness is the most important factor of improvement by seed selection. The varieties of cotton are not adaptable to all conditions so planting the adapted varieties is of the most importance in cotton growing. The new varieties should not be planted in general fields unless they are well known to be adapted to local conditions. Home-grown seed is best adapted to local conditions, but the varieties of Chinese cotton are less productive, so it would be a good policy to increase the varieties of American cotton which have been

grown in sections where they have been more or less adapted. It is from these varieties that the selection should be made. The first selection can be made in the general field. The fields must have good cultivation, and good soil so that the plants can make their best growth for selection. Selection should be made before the first picking. Uniformly maturing plants, with long fiber, are selected for productiveness.

This should be done every year and then a better yield and quality of cotton will be obtained. The varieties of cotton grown in China are small, of poor quality, too short lint, and low in yield. During recent years, American cotton varieties have been introduced to some extent in China. The result is higher production, better quality, good length of lint. There are new varieties which are new to local conditions of sections in China, but they make good growth according to climatic conditions. The climate of the cotton belt in China is nearly the same as that in the United States and so there is no reason why the American cotton varieties cannot be grown successfully in China. It would be better to test new varieties before planting the general fields. Variety tests have been carried out by the agricultural experiment stations of cotton growing provinces and seeds have been distributed to the farmers with information and suggestions in regard to culture. Attention to this work has been given by every station, especially the agricultural experiment station in Peking. From this station seeds are distributed free. To make suggestions for increasing production of cotton, China should introduce varieties of worth

and adaptation, adapted to local conditions. These should be improved by selection.

Breeding is an important factor in improving cotton production, but this can hardly be done by the Chinese farmers because they have no knowledge of such work. This work must be done by the people of the agricultural experiment station. Breeding and selection must go together in accomplishing the improvement of cotton in China.

Cropping and fertilization systems have not been worked effectively by Chinese farmers. They continue to grow the same crop on the land every year with only a small amount of manure. Chinese farmers have been known for their clean cultivation of any crop they grow, but they know very little about cropping systems and the use of mineral fertilizers. For the best production of the crop and the benefit to the soil, better systems of cropping and fertilization must be practiced. In conclusion, seed selection, breeding, growing early maturing varieties, and practising proper systems of cropping and fertilization must be utilized if China is to be the largest producer of cotton in the world.

CORN

General distribution.

Corn is grown extensively in all sections in China, particularly in central and north China. It is one of the staple crops in the three provinces of Manchuria. This crop is best adapted to central and north China. In Manchuria it is best adapted in the province of Mukden and southern part of Kirin and does not do well north of those sections on account of climatic conditions. Corn is grown in all sections of the republic because it produces not only grain for human food, but stalks for the feeding of live stock.

Adaptation to climate and soil.

Corn is a temperate zone plant and has a wide range of growth. During the growing season it requires a high temperature, bright, but not too intense sunshine, and a heavy rainfall. It not only requires warm days, but comparatively warm nights as well. One effect of cool nights even when the days are warm is to delay ripening. The best soils for corn are well-drained, fertile loams which contain a large amount of vegetable matter. Corn is a heavy feeder, likewise a heavy producer, and to produce large yields it is necessary to keep the soil in a high state of fertility by the frequent addition of barnyard or green manures and the use of legumes in crop rotation. It is known that the climate favorable to corn is determined not so much by the amount as by the distribution of sunshine, rainfall, etc. Great fluctuations retard growth. For this reason the average temperature, rainfall, and sunshine

are not safe guides unless the fluctuations of these factors during the growing season are known.

Length of growing season.

Corn differs from most crops in being able to adjust itself to the growing season. In some northern regions the varieties will mature in 80 to 90 days while varieties in the south may take 200 days. There are some large corn growing regions with a growing season of more than 200 days, but it does not appear that corn has been able in any region to utilize to advantage a longer growing period. In order to avoid killing by frost in regions of relatively short seasons it is preferable to grow varieties which require a short period for maturing. All other factors being equal and favorable, it may be safe to say that the ability of corn to yield will increase with the length of growing season up to somewhat near 200 days. The most important point in considering high producing varieties for a particular locality is that the growing season nearly coincides with the last probable frost of spring and the first probable frost of fall. It is advisable to grow a variety maturing 3 or 4 weeks earlier than the growing season given between the average date of the last killing frost in spring and the average date of the first killing frost in fall.

Sunshine and warm nights.

The function of sunlight is to furnish the necessary energy for the various activities of plant growth. No plant life is perfected except through the influence of radiation from the sun. Corn not only requires warm days, but compara-

tively warm nights as well. It is believed that corn makes no growth at night especially if it is cold, and also that one effect of cool night, even when the days are warm, is to delay ripening.

Rainfall.

It is important that plenty of rainfall during the growing season of June, July and August occurs. The rainfall should be well distributed from May to September with about 12 inches in the first and 20 inches in the second season. With sufficient rainfall, properly distributed, it is probable that the yield of corn would be increased 50 to 100 percent. However, the climatic conditions, such as rainfall and its distribution, are beyond human control, therefore farm practice must make the best use of rainfall as it comes.

Varieties.

Yellow corn is the only important variety grown in all sections in China. There is no special name given to different varieties in China as in the United States. All are called "corn". White corn is not grown very extensively. Flint and sweet corn are not known to Chinese farmers. There are many types of yellow corn varying in size, shape, length, and color.

Cropping systems, manures, and fertilizers.

In China, no definite system of cropping is practiced by the farmers. In some sections the farmers have followed a system of rotation, but on small farms usually definite rotation is practiced. The common cropping system used in China is corn, followed by beans and then wheat or millet, but sometimes corn and beans are grown on the same land with alteration of these

two crops in hills. However, the cropping system varies with sections of the country. In wheat regions, it is used in rotation with wheat, beans, millet, and sorghum. In the cotton belt it is in rotation with cotton, beans, and other crops, and in rice sections it is a crop in rotation with rice, beans, and other cereals. Farm manure is the only fertilizer applied to the corn field in China. Soy bean cake is sometimes used as fertilizer to grow this crop, but the chief source of fertility is barnyard manure and earth composts.

Methods of culture.

Preparation of seed bed: Fall plowing or early spring plowing to a depth of 7 inches or more is the best beginning for a good seed bed for corn. Frequently the gain in crop yields resulting from early and deep plowing in the fall or early spring, as compared to late spring plowing, is sufficient to more than offset the entire cost of plowing. Moisture is retained, the seed bed settles firmly, and insects are largely controlled when land is plowed in the fall. Fall plowed land should be allowed to go through the winter in the rough, that is, as turned. In this shape it catches and holds snow and absorbs rain. As soon as in condition to be worked, fitting with disc, harrow, or spring tooth should begin in the spring. Early spring plowing should be followed by roller and harrow. It is usual to plant corn after sod, applying manure before plowing. The early plowing gives time for the thorough incorporation of sod and manure with the soil. Corn

planted on land prepared late in the spring is much more liable to injury from drought, insects, and weeds. A good seed bed for corn should be well settled at the bottom of the furrow slice with surface freely worked.

Depth of plowing.

For a deep, rich, soil deep plowing is best, provided it is done in the fall and hence does not render the soil too loose and dry. The plowing should not be at the same depth from year to year, as by such a practice the soil is not mixed well and a hard surface is left at the bottom of the furrow where the horses walk and the plow drags. A little subsoil turned to the surface occasionally allows the elements to act upon it, liberating plant food, and as it becomes mingled with surface soil and vegetable growth, the soil depth will be increased. To accomplish these desired results, it is well to plow a little deeper each year for several successive plowings and then for one season give a plowing at about half the depth of the deepest plowing.

Time of planting.

The time of planting varies with sections of the country, but it has been shown by experience that corn planted early most often gives the best result and best yield. Occasionally later plantings yield best, but they are exceptions. Corn must be planted in most regions as soon as the ground is sufficiently warm in order that it may mature before early fall frost. The most favorable time to plant corn varies with the latitude, altitude, soil, and drainage conditions and lo-

cation of the land. In south and central China planting is earlier than that in north China. In southern Szechuen the average range of the best period for planting is from the last week of April to the first part of May, while in northern sections the corn planting is about from two to four weeks later. The planting in Kirin and Heilungkiang is from middle of May to the end of that month and some sections even later than that. However, the planting time is left to the farmers who know the local conditions best.

Method of planting.

The method of corn planting is much the same as kaoliang. The seed is dropped by hand in hills with four or five kernels in a hill. It takes at least three men to plant one row of corn at a time and that is too slow a process. In order to do a better and quicker job the modern planter should be used.

Depth of planting.

Corn may be planted from 1 to 3 inches deep. In a stiff, heavy soil, or in clay soil containing plenty of moisture at planting time, 1 inch is sufficiently deep, but if it is light, open, dry soil, 2 or 3 inches is a satisfactory depth.

Rate of planting.

The proper rate of planting corn will depend largely upon the fertility of the soil and the purpose for which it is grown. In China, it is grown for seed corn only, and the distance between two hills is about 15 inches and from 28 to 32 inches apart in rows. For grain from 4 to 5 quarts per acre is sufficient.

Cultivation.

The principal reasons for cultivating the corn during the early stages of growth are to kill the weeds and conserve moisture. Corn growing requires a large amount of water and the amount of rain fall during the growing season is closely correlated with the yield. While it is not possible to control the amount of rainfall during the growing season, it is possible to save a large part of that which falls early in the season for the use of the plants when their needs for water are greatest. To do this, it is necessary to keep the surface soil broken up into fine particles, to form a mulch which will prevent the water that is in the lower soil from reaching the surface and being lost by evaporation. Weeds are undesirable in a corn field because they not only use up the water that should be left for the use of corn, but they also use up the plant food. Therefore, one operation may serve to kill the weeds, and also to re-establish the earth mulch to prevent evaporation of water. There are about 2 or 3 cultivations or hoeings for this crop in China. The first hoeing is when the plants are 3 or 4 inches high or more and at the same time the thinning process takes place as there will be only one plant left to grow in a hill. The second hoeing takes place two weeks later. Then a V-shaped plow is used to form the ridge with the soil around the plants. There may be one more hoeing if too many weeds grow in the field. However, the number of cultivation necessary will depend upon the season and the condition of the land. The cultivation should be often enough to keep the weeds down and maintain con-

stantly a loose soil mulch till the corn has attained its growth. The frequency of cultivation will largely depend upon the nature of the soil, a number of weeds present, and the amount of rainfall. Cultivation should be shallow so as not to prune the feeding roots.

Harvesting and storing.

The harvesting takes place as soon as the corn reaches its maturity. It is cut with sickle by hand and then bound into bundles. It is husked by hand. For storage the grain is spread on the clay floor to dry and then stored in the grain room.

Insects and diseases.

The most destructive insects of corn are cut-worms, wire-worms, ear-worm, chinch bugs, etc. The first two kinds of insects can be controlled by early fall or winter plowing, late planting in spring, early and frequent cultivation, and rotation. The worst insects of this crop are the corn borers. The corn borer has caused a great deal of trouble to the farmers, especially in Europe, although it has recently appeared in the United States. Diseases of the roots, stalks, and ears of corn cause great losses each year. The best method for the control of these diseases is to select disease-free seed ears. This selection should be made in the field before the first killing frost. Select normally matured ears from normal stalks. The seed ears, after being selected in the field, should be so handled and stored that they will dry uniformly and thoroughly. Later in the winter times these ears should be selected again.

Discard those ears that show disease or other undesirable characters. The germination should be tested before planting. Corn smut often causes some loss to the farmers. The spores of the diseases are carried over in the soil so that when land becomes infected with smut it is likely to injure the crop each year. No treatment of the seed is effective. The best way to fight this disease is to cut out and burn all infected plants before the smut-balls reach that stage of development at which the skin breaks and frees the spores.

Uses.

Corn is used chiefly as human food in China. This is one of the staple foods of the poor people. Sometimes it is used to feed live stock, particularly hogs, but not so extensively as in the United States.

The stalks of the corn provide an important roughage for cattle in China. They are chopped into small pieces as feed for the cattle. Sometimes the stalk is used as fuel when there is plenty on the farm and therefore the stalk of this crop is just as valuable as its grain.

Methods of improvement for yield and quality.

This crop has produced poor quality and low yield in China and therefore it must be improved to produce the best and biggest yield. There are at least three ways to increase the corn production, (1) By improving soil conditions, (2) Better culture, and (3) Better seed.

Improvement in condition of soil.

The naturally productive soils contain all the mineral elements and organic matter necessary, and are supplied with sufficient natural rainfall. Of course some sections produce a high yield of corn when they have a favorable climatic condition, but most of the sections though they have an ideal soil, do not produce so much as they ought to due to the fact that rainfall is not properly distributed. Corn needs a large supply of nitrogen and is able to make use of fertility furnished through the decaying of coarse organic matter such as manure or sod land. The ideal corn soil is well-drained, well supplied with organic matter, and rich in available nitrogen, phosphates, and potash salts. The principal cause of the low production is lack of available fertility in the soil which should be treated properly with manure and commercial fertilizers. It is true that proper attention to seed selection and method of cultivation of corn will greatly increase the average production per acre for all lands now devoted to corn growing. The plowing and cultivating of poor land is as expensive as the plowing and cultivating of fertile soil. Corn growing should not be attempted on poor land until it is brought into a fertile condition by growing leguminous crops, the application of manure and fertilizers. The farmers must know field conditions and make a study of the soil in determining whether or not it is profitable to grow this crop. Soil washing, hilly land, too hard soil, subsoil too loose, and lack of organic matter are factors which decrease profits in corn growing.

It is a question whether or not it is profitable to make an application of commercial fertilizers to the soil in China. A soil lacking in fertility can, of course, be made to produce a good crop if the requisite amount of nitrogen, potassium, and phosphorus and organic matter be added and the soil be kept in good condition, but the growing of corn on a land is usually attended with very little or no profit, and, unless continued, the application of commercial fertilizers does not permanently improve the soil. However, an application of commercial fertilizers may cause the soil to produce one good crop of legumes and the roots and foliage of this crop will usually benefit the physical condition and the fertility of the soil sufficiently to make other good crops possible without additional application of fertilizers. Of the ten elements necessary to plant growth, nitrogen, potassium, and phosphorus are the ones whose application to soils produce the greatest increase in productivity. Soils composed almost wholly of sand are often deficient in all of these three elements. Soils containing much vegetable matter are not deficient in nitrogen and usually contain sufficient phosphorus but usually lack in potassium. Clay soils may contain sufficient potassium and phosphorus and be deficient in nitrogen. Such soils are made more highly productive by growing leguminous crops. Nitrogen can be added to the soils by applying sodium nitrate, dried blood, tankage, etc., but this element can be more cheaply obtained from the air by growing and plowing under legumes. Potassium can be supplied in the form of potassium chloride or potassium sulphate. Phosphorus can be supplied by an

application of ground rock phosphate or ground bone. If soil is acid phosphate or of such a nature that the application of one or a few elements at a small cost will cause it to produce good corn crops, these elements should be applied, but if the application is too great, corn growing should be suspended until the soil is permanently enriched by applying large quantities of barnyard manure or by continued growing and plowing under of leguminous crops.

Improvement in method of cultivation.

Practical corn growers or farmers will understand the impossibility of giving specific directions regarding the best method of planting and cultivation which would be applicable to any considerable portion of the country. Methods that produce the best results in some sections have failed to produce good results in others. This is because the soil and climatic conditions are so different in the different provinces. In general, proper seed bed preparation and frequent shallow cultivation to control weeds may be advised.

Improvement in quality of seed planted.

This is the most important factor of increasing corn production. It proves that the varieties of corn have a great difference in maturity, in amount of production, and in form of stalks, ears, and kernels of the different varieties. In some sections the yield of corn is about 30 bushels per acre while in others frequently from 75 or more bushels are obtained. The secret of good yields consists in causing each stalk in the field to produce a good ear. Every stalk grown from a

well-developed kernel from a good ear has its requisite amount of space in the row. Just as there is the possibility of a very great increase in the quantity of corn produced per acre, so there is the possibility of a very great improvement in the quality. When the selection of seed corn is made the most important characters of stalk, ear, and kernel must be considered first, so that a good crop of corn will be obtained.

Stalks.

A stalk great in circumference near the ground and tapering gradually to the tassel, with sufficient foliage of vigorous appearance, free from disease and bearing a good ear or ears at a convenient height is a desirable stalk from which to select seed. The height at which the ear is borne is a point of considerable importance, and the seed selection with reference to this point is governed by the locality. The desirable height of ear is just below from the middle of the stalk.

Ear.

While in the field selecting ears one must also have in mind the type of ear toward which he is striving. It is good plan to reserve for comparison an ear that comes nearest the ideal ear, but it must be remembered that the ideal ear will not be found because no ear is in all respects perfect. The leading qualities that will recommend the ear of a variety suitable to most general purposes are high percentage of shelled corn to cob, soundness of ears and kernels, high nutritive value of the kernel, uniformity in size and shape of ears, purity in color of grain and cob.

The percentage of shelled corn of good quality is the most important character the ear can possess, because after the productiveness of the stalk it must influence the feeding value of a crop. The proportion of grain to cob is influenced by the length and solidity of kernels in proportion to size and composition of cob filling out at butts and tips, space between the rows of kernels, uniformity in shape and arrangement of kernels. The great weight of grain in proportion to weight of cob is highly desirable. This does not mean an ear with too small cob has more yielding quality, but a large cob with proportionally larger kernels and less space between the rows of kernels would be a great improvement to the corn and would not reduce its high percentage of grain. Neither can ears with crooked or irregular rows, which produce ill-shaped kernels, have as high a percentage of grain as straight rowed ears having the kernels uniform in size, shape, and arrangement. It is desirable that a variety should have some distinctive character of ears and kernels that have the possibility to produce a good type of high producing variety. So it is not advisable for a breeder to select for character that is subject to some objection. It is necessary that the variety should have cylindrical ears, because this is the type that best permits of a high percentage of grain and uniform size and shape of the kernels.

Kernels.

The selection of seed ears having very long kernels is the best means of producing a corn with a high percentage of grain, but in selecting for long kernels quality must not be over-

looked because frequently the quality of kernels is poor on ears having longest kernels. The best shaped kernels are those of good length, which gradually broaden from the base or point of the attachment on the cob to the cap, thus leaving the least space unoccupied. The variety selected to grow depends upon the conditions of the locality. If the growing season is short, early maturing varieties should be planted. So it is safe to grow local varieties that are best adapted to the soil and climatic conditions.

Selection of seed corn.

The great advantage of selecting seed corn in the field before the crop is harvested lies in the fact that mature corn is secured and that a study of the plant on which the ear grew and of its environment can be made. Field selection and proper storing usually increase the yield of corn. The importance of field selection is to make a possible selection of ears from the earliest maturing and best developed stalks. When carried on through a number of years of this selection, this will result in getting a strain especially adapted to the locality. Because of the varied climatic conditions existing in different parts of the country this selection is very important. The best plan to follow this field selection is to walk through the field with a sack tied over the shoulders, or carrying a basket, plucking those ears which are considered desirable. Mature ears borne on vigorous plants growing under average conditions, which are carried at the right height about the center of the stalk or just below, and with tips slightly drooping, should be selected, then properly stored. Further selection

for uniformity and composition can be made through the winter.
Ear-to-row-test.

Ears of corn vary greatly in size, shape, weight, and other ear characters. They also vary in productiveness. It would be a great convenience to the farmers if they could by the appearance of an ear estimate with some degree of accuracy its ability to yield. This, however, has not been found possible with the present knowledge of the relation of ear characters to yield. The ear to row test is the only method of picking out the high yielding ears. This test consists in comparing the relative productiveness of a number of ears of corn when planted side by side, an ear or a part of an ear to row. Ears for such tests may be well selected while ripening in the field in order that the conditions of growth may be noted, and only such ears chosen as give some reasons for believing that their excellence may be due to something other than favorable environment. This test may be carried out in the corner of the field. The soil should be uniform in fertility, and the rows should run at right angles in order that all the rows will be same. The rows for convenience may be made 50 hills long. Plant row No. 1 with corn from ear No. 1, row No. 2 from ear No. 2, until a row 50 hills long is planted from each ear that is to be tested. This method consists in planting 50 hills or more in marked rows properly checked from each of 100 or more carefully selected ears, the ears being shelled lengthwise, and half of the ears reserved. The adaptation and yielding ability of the ears are found in this test. The remnant ears from several of the highest yielders are planted the second year in an increase

plat and multiplied for general distribution.

Germination and method of testing.

Though the seed corn has been selected from the field and stored properly yet no one knows that it will grow. So it is very important to have the germination test of each ear of corn to be planted. There is a saying "Test, don't guess" because experience has shown that it is impossible to surely distinguish, by outward appearance, between ears of good germination and ears of low vitality. The only accurate method is testing in the germinator.

There are two common and simple methods of making separate ear tests. These are by means of the Saw-dust Box and Rag Doll.

The Saw-dust Box tester: Construct a square box 2 ft. by 2 ft., 3 inches deep. Cut piece of white cloth to fit and mark off in center with heavy lead pencil a square 20" by 20", divide into 100 squares 2" by 2". Number upper square 1, 2, 3, 4, 5, 6, 7, 8, 9, and 10 at the top and left side row 1, 11, 21, 31, 41, 51, 61, 71, 81, 91. Place one inch of sawdust moistened in warm water in bottom of the box, pack firmly and smooth evenly. Moisten marked cloth and spread over saw-dust on box.

Number ears to be tested and place where they will be undisturbed. Take six kernels from ear beginning near butt and turning ear slightly as each ear taking last near tip. Place kernels in square numbered to correspond with ear, germ face up, tips toward the bottom of box. When all squares are filled, cover with moistened cloth 22" by 22". A third cloth should be

spread over the box and 1½" of moist saw-dust spread over top evenly. Inspect after 7 days and moisten if necessary. When the test is ready to read, roll back upper cloth, remove saw-dust and carefully remove cloth over kernels. Kernels from good ears should show vigorous sprout and root development. Kernels which fail to grow or which produce weak sprouts or moldy sprouts, come from the ears unfit for seed and the ears corresponding to their numbers should be discarded.

The Egg Doll Tester.

Cut cloth into strips five feet long and ten inches in width. Bisect lengthwise with heavy pencil line. Beginning about 15 inches from end draw 11 cross lines at right angles to center line, 3 inches apart. Number spaces from one to ten on upper side of line and 11 to 20 on lower side. Select and number ears to be tested. Dampen cloth and lay out smoothly on table. Remove 6 kernels from different parts of the ear No. 1 and place germ side up in space No. 1, tip pointing in same direction. Proceed with each ear in like manner. When spaces are filled, roll carefully so as not to displace kernels and tie roll around center with string. Place each roll as finished in bucket, cover with lukewarm water for several hours. Drain and cover top with damp cloth, and then place in warm room. After several days moisten with warm water. On the 7th day test is usually ready to read. To read the test, unroll cloth carefully on table and study kernels in each square. Discard all ears corresponding to squares showing dead kernels which produce weak or moldy sprouts. Save for planting ears

with kernels showing strong sprouts and roots.

Conclusion.

There are five pretest controllable factors in corn production:

1. Well bred seed--best adapted to locality.
2. Fertile soil.
 - A. Drainage.
 - B. Lime.
 - C. Manures.
 - D. Legumes in rotation.
 - E. Available phosphate.
3. Proper seed selection.
 - A. Select mature corn in field from healthy stalks
 - B. Store on racks in well ventilated place.
 - C. Avoid selecting ears showing high degree of starchiness.
4. Proper testing.
 - A. Test six kernels from each ear.
 - B. Discard diseased and weak germinating ears.
 - C. Plant only strong healthy ear as shown by test.
5. Proper planting and cultivation.
 - A. Prepare good seed bed.
 - B. Plant grade seed.
 - C. Plant early.
 - D. Prevent weed growth.
 - E. Cultivate shallow.

THE SOY BEAN

Origin and general distribution.

The soy bean is a plant of ancient cultivation in China and has been one of the staple crops in central and north China, particularly in the three eastern provinces of Manchuria. It is generally believed that this crop was originated in China and then it was introduced to India, Japan, and some other countries in the east. The soy bean has been well distributed over all sections in the Republic of China. It is a crop grown with corn together in alternate hills and sometimes it is grown alone in the field. This is the most important crop in Manchuria and it is grown only for seed production.

Soil and climatic adaptations.

The soy bean will grow on all classes of ordinary well-drained soils. They succeed on sand, silt, and clay, but the best results are obtained on loams. On account of their resistance to the drought and heat, soy beans may be grown on sandy soils and the soils that are somewhat acid, but they do best on soils well supplied with lime and are well adapted corn soils.

Soy beans are adapted to a wide range of the climate, doing well from central China and far north in Manchuria. This crop is particularly adapted in north China, especially in the three eastern provinces. They will withstand a great deal of moisture in the soil, but will not thrive where water stands on the land for a considerable time. On the other hand, the soy bean is decidedly drouth resistant.

Varieties.

There are a great number of varieties of soy beans grown in China, but they are divided only into three classes according to color, yellow, green, and black. The yellow is further subdivided into the Chinguan or Round Golden Bean, the Paimoi or White-eyebean, so named from the whiteness of the hilum or scar marking the point of attachment to the pod, and the Heichi or Black Havel, so called from the dark brown hilum. The green bean, which is the same as the yellow one in shape and size but different in color, has two sub-varieties, the one having a green skin and yellow interior, and the other being green both inside and out. The black bean or Heitou has three sub-varieties, the Tawutou or large black bean, having black skin and green interior, the Pisao-Tutou or small black bean, the inside of which is yellow, and Hien-Tutou or flat black bean with yellow inside. There is also a great number of sub-species differentiated from each other by some minute peculiarity. These varieties are all best adapted in the three provinces of Manchuria, as well as other parts of China.

Fertilizers, manures, and rotation.

The soy bean is an important factor in the production of profitable crops because it can grow on any soil, help to solve the problem of protein feed of people and live stock, and also serve to maintain and even increase the nitrogen supply on the farm. The best results of crops can be secured on following soy bean rotation. So by growing soy beans, not only is it possible to grow a valuable leguminous crop to be used as feed

for stock, but, in direct contrast to non-leguminous crops of small grain as wheat, oats, and barley, the growing of them is a direct benefit to the soils. In China only manures and earth composts are used and applied to soils when they are needed. The application of fertilizer to the soy bean crop on either fertile or highly fertile land is usually not very profitable. But on poor land, good returns will nearly always follow a light application of 100 to 150 pounds per acre of acid phosphate, or a light dressing of 5 or 6 loads per acre of stable manure. When soy beans follow corn, as is frequently the case, they seldom require direct application of fertilizers. Land in condition to produce good corn will usually give good yields of soy beans. The application of the nitrogenous fertilizer is not necessary as soy beans like other legumes assimilate the free nitrogen of the air, but phosphorus and potassium are required in abundance. In case the potash cannot be obtained, the acid phosphate may be used alone to good advantage. It is advisable to work commercial fertilizer well into the soils before planting and good results are usually obtained by applying quite sufficient lime to the soils to increase the yield of soy beans.

The soy bean may be combined advantageously in many systems of crops rotation. It is especially adapted to short rotation taking either an entire season or a part of a season following some grain crops. Since soy beans can give more yield of seed production and the cash value of the seed is great so it is sufficient to encourage growing the beans as one of the main

crops. When the whole season is thus devoted to soy beans, they may take any in a rotation system where corn and other grain can be used. The small grains may follow soy beans and the soil requires but little preparation after a crop of soy beans. Soy bean crop generally is grown between two small grain crops, such as wheat and rice. A rotation of corn, soy beans, wheat, and millet is practiced in some sections. Sometimes it is used in rotation with rice, cotton, millet, sorghum, and some other cereals. However, soy beans used in short rotation with small grain usually gives the best results.

Inoculation.

The process of inoculation is not known to Chinese farmers because they can grow this crop any field of their farm in any section of the country. This is because the soil has already been naturally inoculated. For the new country soy beans should be thoroughly inoculated with their proper nitrogen fixing bacteria. Whenever the crop is grown in the field for the first time, artificial inoculation of some kind usually is necessary. Soy beans will make an indifferent growth in most soils unless the bacteria are present in the soil. The lack of inoculation is generally indicated by a pale or greenish yellow color of plants. The soy beans will give good results, however, on rich soils, even though the bacteria are not present, but in such case the nitrogen is taken directly from the soil. Fortunately natural inoculation occurs throughout the sections of China where the soy beans grow extensively. For a new country it is advisable to inoculate the soil for growing this

new crop. There are three methods of inoculation. One of the simplest being by the pure culture method. This is because of ease of application, ready availability of the reliable cultures, eliminating of chance of introducing seed and plant diseases, and the proved effectiveness, the pure culture is the more practicable way of artificially inoculating a field. The pure culture preparations at present are in 3 forms; on agar, a jelly-like substance in liquid or in soil or muck. The treatment of seed with the pure culture is so simple that no one should hesitate to use it for fear of difficulties or waste of time. First the jelly-like mass is broken up in the bottle by striking the bottle against the palm of the hand. Shake the contents into an appropriate quantity of water and mix thoroughly, rinsing out the bottle with the water. The bacteria are on the surface of the jelly-like substance and be sure to mix it thoroughly with water. The amount of water used should be enough to moisten the seed, varying of course with the nature and size of the seed. Generally nearly a pint of water is enough. Sprinkle the culture over the seed on a smooth floor of some kind and mix the seed well. If it is too moist, allow to dry in a shady place. Points necessary to observe in using the culture are: Do not keep too long, Keep in a cool, moist place, Do not heat the material, Have a good suspension before adding the seed, Mix seed thoroughly, Do not try to sow when too moist and do not expose to sunlight.

Soil method.

The inoculated soil should be secured from a well inoculated field, and preferably from among the roots of crops of soy beans of previous years. The soil should be passed through a sand screen before using, to remove roots and stones. This soil may be applied through the fertilizer attachment or sown broadcast over the field and harrowed in. The application of 300 pounds of soil is sufficient to inoculate one acre. The soil should be protected from the sun all the time since bright sunlight injures the bacteria. The soil method has been successful if the inoculated soil can be secured.

Glue method.

This method may be used when it is not convenient to secure large quantities of soil. From one to one and a half ounces of carpenter's glue is dissolved in a quart of water and then sprinkled over a bushel of seed which has been spread out on a smooth floor. The seed is shoveled over so that the glue solution will come in contact with each seed. About a quart of fine soil that has been secured from a soy bean field where the roots had an abundance of nodules is sprinkled over the seed. This method also has been very successful. However, the pure culture method is being largely used due to the ease of securing the culture and simplicity of application. Without inoculation, the soy beans cannot secure nitrogen from the air and cannot make their best development. Neither can it produce its proper beneficial effect in improving the fertility of the soil. Therefore, inoculation of soy bean crop

is very important if it is new to the soil.

Method of culture.

Preparation of seed bed: The preparation of soil for the soy bean is similar to that for corn or other cultivated crops. The land should be plowed early, deep, fitted, and then harrowed at frequent intervals until planting time. Clay soil should be plowed in the fall and in the early spring disked, and made smooth by the drag and the packer while on light sandy soil or extremely heavy soils spring plowing is preferable. On well-drained clay loams and sandy loams, fall and spring plowings are equally satisfactory, so well prepared seed beds keep weeds down otherwise they are likely to choke out the young plants.

Time of planting: Soy beans may be sown during a period extending from early spring until mid-summer, depending largely on the latitude and the use to be made of the crop. They are easily injured by the frost in the spring. They come through the ground slowly and grow slowly in cool weather. Nothing is gained and frequently much is lost by planting too early. It is common practice to plant soy beans after corn planting is completed. It is believed that earlier planting than is commonly practiced would be better, provided the soil is reasonably warm. However, time of planting will vary for different localities and different seasons, depending on the conditions of the soil and length of growing season. For grain the best time is about that corn planting when the ground has become thoroughly warm. The plants will then start quickly

and make a rapid growth. Since the plants grow slowly in cool weather, there is ordinarily no advantage in planting earlier than corn. In Manchuria planting from May to the end of June is usually satisfactory for seed production. Do not plant too early and too late to be injured by frost.

Depth of planting: Planting soy beans in drills so as to allow the cultivation is the most successful method. In seasons of abundant rainfall, planting in solid drills has produced good results. The distance and method of planting will depend upon the use which is to be made of the crop. However, in China there is no drill being used for planting this crop and the only methods are by means of a seeder and dropping by hand. When soy beans grow with corn in alternate hills, it is planted by hand and when growing alone in the field it is planted with a seeder. Soybeans are grown only for seed production in China and the distance in rows from 28 to 32 inches apart and with plants every 2 or 3 inches apart is best.

This crop has been made in good use as hay crop in the United States and therefore it may be worth while to mention what the soy bean is grown for and the method of planting.

If intended for hay and green manure, the soy bean may be planted by drilling in rows of 28 inches apart, using ordinary grain drill with the cup open the second, sixth, and tenth, so that they can receive occasional cultivation. But if the land is quite free from weeds and there is sufficient moisture to carry a crop which is to be used for hay, a large yield and finer quality can be secured by broadcasting or by

drilling with the grain drill all holes open and drill rows seven inches apart.

For ensilage and hogging off: A special soy bean attachment should be used or secured for corn planter if soy bean is to be grown for ensilage and hogging off. This is because to sow corn and soy bean with even stand and to make a better crop for hogging off. The attachment should consist of a separate drill and grain box so that it is not necessary to mix corn and soy beans. For ensilage the best way is to sow corn and soy beans separately and mix the two as they are put in the silo.

Rate of seeding.

The quantity of seed to be sown to the acre will necessarily vary somewhat according to the size of the seed and the purpose for which the crop is grown. When soy beans are planted in rows 28 inches apart for seed, it will require from 2 to 3 pecks of seed per acre. When sown for hay by drill it will require from 5 to 7 pecks of seed per acre. If planted by broadcasting, at least 2 bushels of seed should be used.

Cultivation.

Under favorable conditions the soy beans germinate in a few days and cultivation should be begun as soon as the seedling plants appear. One deep cultivation may be given, but afterwards the cultivation should be shallow. The soy bean readily responds to the good cultivation and requires about the same number of cultivations as corn until the plants begin to blossom when they are grown for grain. Usually 2 or

3 hoeings are being made by the farmers in China and generally a ridge is formed for this crop as for others.

Harvesting.

Soy bean for seed: When the soy bean plant is nearly matured, the leaf begins to turn yellow and drops, and before all the pods are mature, the leaves, except in a few varieties, have all fallen off. In general, the best time to harvest is when about three-fourths of the leaves have fallen and most of the pods have turned color. The plants should not be allowed to become too ripe because the pods will shatter and much seed will be lost. The method of harvesting this crop is cut by hand with sickles and this process usually is done in the morning, but if large acreage of soy beans is to be harvested, the modern mowing machine and grain binder should be used. The soy bean has been grown so extensively in Manchuria and the new machine for harvesting should be used in order to handle this crop in good shape.

The soy bean for silage and hay.

It should be cut when well podded several days later than when cut for hay. One load of soy beans and two loads of corn will make a good silage when they run through the ensilage cutter at the same time. For hay, the soy bean should be harvested between pod formation and full development of the seed and before the leaves have turned yellow and dropped off because at this stage of growth the large yield and the best quality of hay will be obtained. The hay is cured in much the same way as a heavy crop of clover or alfalfa.

Threshing.

The ordinary grain separator can be adjusted to thrash any bean successfully, but as equipped for small grains a large percentage of cracked beans will result. The chief cause of split beans is the high speed of the cylinder, which can be reduced at least one half, but the speed of the fans and the other parts of the separator should not be changed. The beans may be threshed with little split if proper adjustment could be made to the ordinary grain separator. Special bean separators of different sizes are now on the market and these machines can do clean hulling and split practically none of the beans. Wherever a considerable acreage of soy beans or other beans is grown, such separators are satisfactory. The method of threshing in China is by means of a stone roller and no matter how many acres of soy beans are to be threshed this old method is still in use.

Storage of seed.

As soy bean seed spoils rather easily if not properly handled, care should be exercised in curing and storing. After the beans are threshed, they should be spread out on a floor to dry and then they may be stored in bins. The storeroom should be dry and have a free circulation of air, but most of the soy bean crop in Manchuria, after threshing, is put in bags and ready for market, so the farmers do not store this grain as for the others.

Enemies.

In general it may be said that very few insects do quite

a bit of damage to this crop. Rabbits are most troublesome, as they are fond of soy bean plants and have been known to destroy considerable areas. Caterpillars and black blister beetle also do a little damage, but in conclusion insects are not serious to the culture of this crop.

Uses and importance.

The soy bean seed has been used for feeding live stock in China. It contains from 30 to 46 per cent. protein so its feeding value is very high. In feeding hogs and sheep, it may be fed whole, but in general it is preferable to grind the seeds. Soy bean seed mixed with corn or kao-liang and then ground together into mash gives best results in feeding live stock. Soy beans also have been used as a food product in China. In the United States this crop has been grown more for animal feed than anything else. Of course it is a new crop in the United States and the people do not commonly know the value of this crop especially for human food. The oil of the soy bean is valuable and it can be pressed and used for other purposes, but the feeding value of the by-products such as soy bean meal or cake will be nearly the same so far as the percentage of protein is concerned.

Soy bean meal.

Soy bean meal, from which the oil has been removed by pressure or extraction with solvents, has become a product of considerable importance. The oil finds a ready market for a variety of uses, and the meal or cake left after removal of oil is sold to stockmen for feed and to farmers for fertilizer.

In Manchuria there are large numbers of soy bean oil manufacturing companies. Aside from large quantities of oil and bean cakes being used at home, the oil is used as a lard substitute for human consumption and other manufacturing purposes. The cakes are used for either feeding animals or as fertilizers. They are all exported to Europe and America. There are two methods used for obtaining the oil, the one by hydraulic pressure, used chiefly or entirely in China, the other by means of solvents. By the first method the beans are crushed into meal, treated with steam and then subjected to pressure. This method leaves four to nine per cent. of oil in the cake. In the second method the beans are crushed and then treated directly with a solvent, such as benzine, which removes the oil. The solvent is separated from the oil by distillation and used again. The odor of the solvent can be entirely removed from the meal, leaving a light colored product with only one per cent. of oil and forty-three to forty-five percent. of protein.

Soy bean oil.

The oil is being used extensively by paint manufacturers. There has been a large quantity of this oil exported from China to Europe and the United States. It is used in the manufacture of paints, varnishes, linoleum, and soap, and is also being refined for use as a salad oil and lard substitute. In China it is used for cooking vegetables for food by the common people. A large quantity of this oil has been exported from China every year, but the people do not know much of its use in the western countries. The only thing they know is that there is a great demand in the foreign markets. The

greater the demand, the more oil mills will be opened, and the more the mills, the more demand of soy bean seed. In this way soy beans will become an important crop in China, especially in Manchuria.

Uses for human food.

For many centuries soy beans have been used as human food by the people of China and some other countries in the east. The soy bean forms the chief source of protein in diet, supplementing rice, which is so extensively used and contains a great excess of carbohydrates. The people keep little live stock and eat but little meat. They believe it is the part of economy to eat vegetables rather than to feed them to live stock or animals and then eat the animals. Of course the living is far different between the east and west. It does not mean that the people do not eat meat nor that they cannot afford to pay for meat for their daily food. This may be true among the poor, but even the rich still eat more vegetables with or without meat in cooking because they believe that the vegetable is a more desirable and valuable food for human beings. The whole bean is not used to a great extent in China and the people do not eat the beans in the way the people do in the United States, for example, baked beans, etc., but what the Chinese people eat are the food products which are manufactured from them.

The principal products are Soy Sauce (Kiang-yu), Bean Milk (To-chih), and Bean Curd (To-fu).

Soy Sauce: Soy Sauce is a dark brown very salty liquid

with an odor and taste suggestive of beef extract. It is used for a flavoring in cooking. That is why the people in the United States are so fond of Chinese restaurant dishes because the characteristic flavor of "Chop Suey" is more or less due to Soy Sauce, which is an essential part of that dish. Many people think that Soy Sauce is indispensable to an oriental kitchen and it may be true in a certain point, but not exactly so, because many people in China do not use much Soy Sauce at all. It is not used at every meal every day. Though it is common and is used in large quantities, the food value of this sauce is only very slight. The people use it for flavor and taste only when good dishes are to be cooked. There are two kinds of sauce. One is commercial and the other is home made. There are different grades of Soy Sauce. The way of making is the same, but the quality is much different. Two parts of soy beans and one of wheat are used in the commercial manufacture, but the home made usually uses soy beans only. The soy beans are cracked and then soaked in the water with a sufficient amount of salt. The soaked beans mixed with salt are put into a big can with its opening covered and allowed to ferment. The process is from one to two years long. The home process is about one year. The liquid or salty water is boiled. It is first yellowish brown in color and after it has been boiled a couple hours or more, some onions and a bag of pepper and flavorings are added, boiling until it becomes dark brown in color and of a desirable quality.

Soy bean milk: This has not been used to a great extent but

it has been used as a drink instead of milk in the morning. There are some manufacturing companies in some of the big cities making this milk for drink. The way of making this milk is to mix finely ground soy beans with about ten parts of water and heat near the boiling point for fifteen to thirty minutes. An emulsion is obtained which is remarkably similar in appearance and properties to cow's milk. Upon standing for a while the particles of the meal will settle and the liquid can be poured off. The liquid remaining in the residue can be separated by pouring the mass into a cloth bag and shaking until the liquid has run out. If allowed to stand quietly the filtration is extremely slow. The liquid thus obtained has a yellowish white color. It is a permanent solution with fat, protein, and other material. It does not "settle out" on standing if fermentation is prevented. The composition of this liquid is about as follows: Protein 3.7%; Fat 2.0%, Carbohydrates 1.8%, Salt 0.5%.

Bean Curd: This product has been consumed to a large extent in China. In the cities and towns it is sold every day. The soy beans are being roughly ground and then soaked in water for about ten to twelve hours and crushed between millstones. The ground material is then boiled with about three times its bulk of water for about an hour and filtered through cloth. The filtrate is white and opaque, having somewhat the appearance of milk. This filtrate is then boiled to a high boiling

point and add the mother liquor obtained in the manufacture of salt from sea water, which contains considerable magnesium chloride. The quality of the curd is dependent on the amount of mother liquor. If too much is added, the curd will be too hard and if too little the curd cannot be pressed in a form which can be handled by hand. The amount of mother liquor used is determined by the appearance of precipitation. When the curd is formed it then can be drained and pressed. It is palatable when salted and fried. Sometimes it is eaten frozen. These are the two kinds of bean curd commonly consumed by the people. There are so many ways of cooking it either with vegetables, sea food, fresh or salted, or with meat.

The composition of the products is as follows:

	Water	Protein	Fat	N. Free Extract	Ash
Fresh To-fu:	89%	5%	3.4%	2.1%	0.5%
Frozen To-fu:	18.7%	48.5%	28.5%	2.6%	1.7%

Soy bean straw.

The straw obtained from threshing the soy bean for seed is a valuable feed for all kinds of live stock. But in China it is used mostly for fuel and very little is used for feed of animals. Of course, this straw cannot be so good as clover or alfalfa hay, but it is better feed than corn stalks which are used extensively in China for cattle.

Methods of improvement and the future development of soy bean production.

Soy beans have been grown in all sections in China, particularly in Manchuria. The three eastern provinces are noted for their soy beans which are the chief products and main crops

grown there. It is a good cash crop because the demand is so great in the market. Soy beans are grown more in the three provinces because of their best adaptation to soil and climatic conditions. Market is also an important factor which encourages the farmers in those sections to grow more of this crop because there are many soy bean oil manufacturing companies there. The demand for soy bean seed is so great and no matter how big production is harvested, the market is always good and the farmers can make a big profit. The farmers do not know anything about what becomes of the soy bean so far as western market is concerned. They only know the market in China, so the greater the market demands, the more soy beans they grow. The future development of soy bean production depends largely on the lands in Manchuria because there are so many acres of lands in those provinces which are still uncultivated. The three provinces of Mukden, Kirin, and Heilung-kiang have an area of about 365,000 square miles, equal to that of both Dakotas, Minnesota, Nebraska, and Iowa combined. The soil is fertile and the cultivated acreage possibly is not more than two-thirds of the total area. Up to this point it is believed that the possibility of the future soy bean crop in these sections will be great if it is properly developed and the cultural methods improved. There are about 18,000,000 people in these sections and the population is not so great as compared with any part of China Proper, but the population is going to be greater and greater as so many people in central and southern China are moving there every year. This means that soy bean production will be greater

because as more people move there, more lands will be cultivated. The bigger the acreage under cultivation, the bigger the production will be. In Manchuria some big farms are found of from one hundred to several thousand acres, but the lands of some big farms are not all under cultivation. If a farmer owns one to five hundred acres of land and he is expert in farming with some help, he certainly can make a profit every year under the normal conditions. All the farm work is done by hand and more crops will be obtained per acre where the farms are smaller. All the big farms mostly belong to the rich people and they know nothing about farming and have a hard time to hire any man to farm successfully, and the result is a failure and the lands are no more cultivated. What these big farms need now are scientific farmers who know how to manage and to cultivate those fertile soils to be productive lands. Of course the labor is cheap, but to cultivate big acreage of farms such as in Manchuria it certainly will pay to buy modern farm machinery which is effective and economical. The tools, such as plows, cultivators, drills, planters, binders, and some other tillage implements are adaptable to the conditions of those sections. The gas engine and machines such as tractors and threshing machines are not suitable to the present conditions because the gas costs too much and does not pay for its return. However, the threshing machines will be profitable to the farmers in Manchuria if they grow big acreages of soy beans and wheat. Horse-power farm implements will be adaptable with the cheap labor to the conditions in China. Wealthy land owners, of course, may have capital to run a big farm by buying modern farm

machines, but they lack knowledge of agriculture and even the men they hire may not know about farming. They may be good workers, but not good managers. It is the trained men in agriculture who will be successful. To cultivate that big area of land in those three provinces it is a matter of all the farmers who go there to farm and make their home there. Most of the farmers are not rich and they can hardly afford to buy any modern farm machine which costs too much. So the best way to do is to have men trained, knowing the conditions in China, who will design types of farm implements similar to western plows, drills, planters, cultivators, etc., and sell them as cheaply as possible. This is one way to help farmers to do better work and to cultivate more land. The aim of farming is to raise necessary food products for human consumption and the future development of Manchurian agriculture is to cultivate more land for big production of soy bean and other crops and to help farmers to make better profits. It is not the matter of few people to buy farm machinery from foreign countries, but to improve the farm tools and manufacture them in desirable and workable types suited to our conditions. In this way the poor farmers can buy the farm implements cheap and do the work quickly and effectively. So the big area of land in Manchuria will be all cultivated and more production of soy beans and other crops will be obtained as a consequence and every man will have work and food. Since soy beans have so great a demand in the market, the production in the future will increase with the increase of acreage of land cultivated,

and the methods of improvement. The soy bean has many varieties grown in China. One variety in one section yields more bushels to the acre while another variety yields less in another section. This, of course, has more to do with varieties as well as soil and climatic adaptation, but the main trouble is that farmers lack knowledge in varieties. They are too careless in seed planting and sometimes several varieties grow mixed in one field and thus cause an uneven maturity of this crop. Therefore, on farm practice the methods of improvement should grow the best adapted variety to local conditions, have seed selection, grow pure strains, and have better culture in preparation of seed beds and clean cultivation. The methods of breeding of different varieties should be worked out by the government or provincial improvement station, and this station should have variety tests and inform the farmers to grow the different varieties best adapted to their local conditions. The standardization of soy bean crop is very important, especially for export. In conclusion, the improvement of culture and seed is to get the right man to work out the problem of agriculture in China.

SORGHUM OR KAO-LIANG

Origin and general distribution.

The Chinese name for sorghum is Kao-liang. The origin of this term no one can say definitely, but literally it means "tall millet". The term "Kao" means tall and "Liang" means millet or grain. These two words combined form the term or rather the name which is a leading variety of sorghum in the United States.

It is a question whether or not the Kaoliang crop plant was originated in China. It is the belief of the agriculturalists in the United States that this crop was originally brought into China from India. However, it was originated in the east and is a new crop in the United States introduced from China. It is an old crop in China and it received the first cultivation and was planted along the Tsung Ming Island, near the mouth of Young-Tze River when the early Chinese settlers settled there. It is an easily cultivated crop, but it was not grown very extensively. Later as the people moved north and they found out it is good for the climatic adaptation as the growing season is short and it is therefore a profitable crop in the north. It is most abundantly grown and becomes highly important as a staple crop on the farms in north China, especially in the three provinces of Manchuria. This section is level or a great plain area and the soil is fertile. The crop grows more in north China because of climatic adaptation, length of growing season, soil condition, and moisture of the soil.

In general, the topography of the Republic is a series of elevated mountain ranges and plateaus in the central and western parts, declining gradually eastward to a broad and fertile alluvial plain of low elevation. This plain has such a gentle gradient as to make part of it subject at times to disastrous overflow and consequent famine. The Kao-liang is grown more or less extensively over most of the eastern half of the Republic.

In China Proper, they are found from Yunnan, which is the most southern province and adjoins Tibet on the south east to Chili in the north and thence south to Shantung and Cheking. They appear to be found only rarely or not at all in the southeastern alluvial provinces from Fukien and Kiangsi on the east to Kwangtung Kwangsi on the southwest. These provinces comprise part of the great rice growing area of China. In general, the Kao-liangs are becoming increasingly important westward in the piedmont areas up to the prohibitive elevations and northward with increased latitude and shorter seasons.

Kao-liang is cultivated generally throughout central and western China, but not so extensively as in other parts of China, notably the three eastern provinces of Manchuria. It does not mean this crop cannot grow and yield well in central and southern China, it is too expensive to grow this crop there where other valuable crops, such as rice can bring more profit to the farmers, that is, the success of farming depends on the crops grown with their best adaptation. In north

China the growing season is short, rainfall is less, and usually the drought occurs during growing season. Hence this crop is better adapted there.

Adaptation to soil and climate.

Sorghum or kao-liang may be successfully grown on soils of almost any character provided they are reasonably fertile and well drained. On account of its deep roots, a permeable subsoil is desirable. These crops are strong feeders and excellent drought sisters, which qualities often cause them to be grown on the poorest land of the farm. Yet it is true of sorghum, as of corn, that the return in crop will usually be proportionate to the richness of the land. Sorghum or kaoliang feeds more deeply than corn and, moreover, it has greater power to gather food in the soil and subsoil. Good crops of kaoliang may be grown on land too low in fertility to produce crops of corn. The best soils for sorghum are free-working, moist, sandy loams, under-laid with a porous clay subsoil, rich in the elements of phosphoric acid and potash. Humus soils are good, but not so good relatively as for corn. Hard clays lying on harder subsoils are quite unfit for growing sorghum.

Kao-liang or sorghums are adapted to regions having a warm summer climate. The earliest known varieties will mature with three months' warm weather. No degree of summer heat seems too intense for the sorghums, but they are easily susceptible to injury both in spring and fall by even light frosts. So the regions of long, cool summers are of little value for sorghum. In general or with a few exceptions,

the climatic adaptations of sorghum are nearly identical with those of corn. Lao-liang, however, suffers less than corn from intense heat, insufficient soil moisture, often remaining fresh and green when corn is completely destroyed or remaining semi-dormant during short periods of extreme drought and again growing with the advent of favorable weather. On these accounts, this crop is especially well adapted to agriculture in semi-arid regions.

Varieties.

There are three common well known varieties, white, red, and brown. Of course there are some other varieties, such as pink and so on. The farmers call them white if they look white and red or brown if they show more red or brown color. The yields of the different varieties vary a great deal. This has to do with the climate and fertility of soil conditions. However, the white and brown varieties generally have grown bigger and stronger stalks than the red ones. The general belief of the farmers is that the red varieties are more adapted to drought resistance and in fact they have smaller stalks and have lower requirement of moisture. The farmers like to grow white and brown varieties under favorable conditions because they yield better and are better for human food.

Fertilizers, manures, and rotation.

It is customary to grow kao-liang without fertilizers for it is surface feeder and will respond to judicious fertilization as readily as corn. The character, amount, and method of application of fertilizers are the same as for corn.

The application of farm manures is the only means to add to the fertility of the soil in China because commercial fertilizers are not very commonly used by the farmers.

This crop is not very good for rotation with other crops because crops like wheat or oats, which make much of their growth during the fall or early spring, are most likely to suffer when grown after kao-liang. But late planted crops like corn, cow-peas, soy beans, millet, and sweet clover, which make their greatest growth during the latter part of the growing season, should follow this crop. Kao-liang, however, has been used in rotation with the crops of soy beans, millet, corn, and other beans in north China.

Drought resistance and effect on soil.

The peculiar adaptation of the kao-liang to agriculture in semi-arid regions is well-known. But the qualities that enable this crop to successfully resist dry, hot weather are not well known. People know that the root systems of sorghum are less extensive than those of corn, a crop not particularly adapted to dry regions also the agriculturalists have observed that as much water is required to produce a pound of dry matter in sorghum as in corn. Thus it would seem that the dry climate is impossible for the growth of sorghum. The most probable explanation of the peculiar adaptability of this crop to dry, hot regions is to be found in the high degree of resistance of the sorghum plants to injury from dry, hot weather and the ability of the plants to cease growing and become practically dormant during periods of severe drought, growth being renewed

without any apparent injury with the coming of rain.

The sorghum or kao-liang is generally considered to be hard on the land. The reasons for this are not very clear. Possibly this is due to the fact that the kao-liang seems to concentrate its feeding roots in the upper layers of the soil to a greater degree than most other crops, which peculiarity probably results in exhausting the surface soil of its available fertility. Its stubble often breaks up cloddy on account of the fact that the soil is held together by the matted roots and the slowness with which kao-liang stubble decays renders its immediate effects less apparent than that produced by other forms of vegetable matter. In fact kao-liang is not more exhaustive of fertility than other crops. Pound for pound, it removes no more plant food, but it does leave the ground in poor condition. It grows so late in the fall that little, if any, available water and plant food is left at the end of the growing season. The effect is apparent in the next crop, owing to the fact that low yields of other crops are often obtained from the ground the following year, but by the second and third year it has disappeared. The soil is not permanently injured any more than would result from growing an equal crop of any other grain.

It is now clear that the successful adaptation of kao-liang in Manchuria is due to its drought resistance and shorter growing season. It is also becoming a staple crop for food and the stalks for fuel. This crop is easily handled and cheaply cultivated and produces more profit than other crops on the

same soil.

Methods of culture.

No doubt there is a big difference in sorghum culture between America and China so far as their methods in cultivation is concerned. However, the crop culture differs somewhat in sections of China, as is the case in the United States to some extent, except with regard to the amount of labor engaged. The acreage of land a farmer can handle varies. The farmers in central and southern parts usually handle less acreage than those in the north, because southern farmers have smaller acreage of land and therefore pay more attention to the cultivation. The northern farmers have more acres and more work to do so the cultivation of this crop cannot be done so carefully as in the south and central parts. However, Chinese farmers do more clean cultivation of any crop than the Americans so far as their labor is concerned.

Preparation of seed bed.

The work necessary to prepare a good seed bed depends largely upon the kind and condition of the soil. Light soil usually requires less work than heavy soil. The seed bed should be uniform and firm and free from weeds if a good crop is to be produced.

Time of plowing.

The soil on which the grain is going to be planted should be plowed in the fall, lay rough and unbroken during the winter, and manured and plowed in the spring. Fall plowing generally gives better results on the average than spring plowing. This depends on the amount of moisture in the soil and on the winter

precipitation. If plowing is done early in the fall before the weeds have used the available moisture in the soil, and the winter precipitation is normal, then fall plowing has a decided advantage over spring plowing. For best results fall plowing on old land should be at a depth of 6 to 7 inches. Late in the spring shallow plowing is sometimes best if moisture in the surface soil is lacking and the crop is to be sown immediately after plowing is done.

Time of planting.

The time to plant varies with the season, the locality, and the variety. The grain sorghums are of subtropical origin and therefore grow best where temperatures are high. The seeds will not germinate well nor will the plants make normal growth in cold soils. When planted too early, the plants make a slow growth and weeds are likely to outgrow them, making it difficult or impossible to keep the crop clean. For the best results seeding must not be done too early in the spring. A good time to plant in any given locality is from 10 days to 2 weeks later than the average date for planting corn there.

Depth of planting.

Sorghum seedlings are not as vigorous as the other cereal crops. The seeds, therefore, usually should not be planted so deep. They should be placed in moist soil and covered deep enough to prevent drying out. As a rule, one or two inches is about the right depth. On wet heavy soils, one inch is usually sufficient while on light sandy soils, two inches and possibly more are necessary for the best results.

Methods of planting.

The seed is sown by hand or by means of a kind of seeder and is then covered with the soil. It is planted in rows in hills and the distance between rows and hills varies with the fertility and condition of the soil. Usually the rows are the same distance apart as with corn, but the space between the hills is closer. However, the methods of planting are the same as with other cultivated crops.

Rate of seeding.

No one stand or rate will produce the highest yield under all season conditions. Thick stands yield higher than thin ones in favorable seasons, but in dry seasons thin stands are best. To get the stand desired, it is necessary to sow a heavier rate because all the seed will not germinate under field conditions though it may have 100 percent. germination in test. In China there is a common saying that "money can buy seed, but not stands". The general tendency is to plant much too thick, with the hope that enough will survive to furnish a satisfactory stand. However it is recommended that the rate of planting should be greater on rich, fertile soils than on poor soils and where the rainfall is heavy than where the annual precipitation is light. For grain it should be seeded at the rate of 6 to 8 and 4 to 5 pounds per acre. This varies with the seasonal and soil conditions. In Manchuria, the rate of planting is about 10 to 12 pounds to an acre. This is to insure a good stand and is then thinned by the first hoeing.

Cultivation.

Cultivation should be begun early and repeated frequently enough to destroy weeds and keep the surface soil loose. The cultivation is usually done a few days after the young plants appear above the ground. The fields are regularly hoed and cultivated, even if the plants do not make much growth during that period. In the first hoeing when the shoots are about 2 or 3 inches high and they are thinned to about 13 inches apart where it is planted in drills, while where planted in hills they are thinned when the plants are about one foot high and generally one plant is left. The farmers usually give one or two hoeings and then a ridge is formed by a V-shaped plow with the plant growing on the ridge and then cultivation is complete.

Harvesting.

Time and methods of harvesting: The sorghum or kao-liang should be harvested when it becomes thoroughly ripe. When headed in the field, it should be allowed to stand until the stem at the base of the head is dry. If headed while the stems contain moisture, heating will occur if the heads are stored in piles. Kao-liang is often headed in the field. The heads are cut from the standing stalks after the grain becomes thoroughly ripe and stored in ricks until they are thrashed. In China it is harvested with sickles by hand and topped with a knife. The best way to harvest this crop is to use a corn binder when both grain and fodder are saved. In Manchuria this crop is harvested during the month of September when the stalks have reached a height of from 8 to 10 feet and the heads have

turned purple caused by the small, dark purple cases which contain the grain. They are cut down near the roots. After they are cut down and made into bundles they are shocked up if they are not hauled home at once. They may be headed in the shock in the field or headed after the whole plants are hauled home. These heads are spread out every day in the sun until dry.

Threshing, yields, and storing.

The process of threshing consists of cutting off the heads of the stalks, spreading them on the solid clay floor, and threshing them with a stone roller drawn by some domestic animal. This is completed in about four hours. The grain is then passed through a winnowing machine or tossed up in the air and thus **separated** from the empty heads which are used for fuel or in the manufacture of brooms.

The now cleaned **but unhusked** grain is put in sacks and is ready for the market to be sold for fodder. To be fit for human consumption it must still pass through the process of husking, which process consists of placing the grain on a circular stone floor and passing a circular stone roller over it which crushes the husks and separates the grain from the husks.

In some sections it yields as high as 50 bushels, but the average yield is from 30 to 40 bushels to the acre.

The grain may be stored in bins. It should be free from foreign material and cracked kernels and should be dry when stored in large quantities or it will heat and spoil. The storage room should have good ventilation of air to keep grain in good condition.

Uses and importance of Kao-liang or sorghum.

The primary use of the kao-liang crop throughout most of the regions where it is grown is for human food and the feed of the farm animals. This is one of the chief products and no doubt is the most valuable crop of Manchuria. It is the most important staple crop to Manchurian farmers. The people live in that part or section where it is grown and therefore use it as a staple food, also feeding it to the stock. However, the chief use of the grain or seed is to manufacture liquor or is used in distilling spirits or wine. China is not so dry a country as the United States and so nearly all of the fiery spirits or wines are used throughout the sections of the Republic. A large quantity of this distilled wine has been used and so the demand for this grain on the market is great.

Most of the white varieties of grain are used for human consumption. It is ground into flour, out of which cakes are made or they are simply boiled or cooked in water and served in the form of a gruel to the common people.

This is the chief grain feed for the horses, mules, and some other live stock. The kao-liang seed for feed takes the same place that oats do in the United States. For feeding cattle it is better to grind the seed and feed with alfalfa or some other feeds containing a considerable percentage of protein, such as cotton seed meal, cakes, or soy bean cakes. The seed of sorghum is very rich in carbohydrates or fat forming materials, but is low in protein, so it will be profitable to feed kao-liang seed with additional protein feed for fatten-

ing cattle. To feed hogs this grain is nearly equal to feeding corn meal. This will make a most economical grain by feeding a ration containing a small proportion of some feed rich in protein. For sheep it is practically the same to feed kao-liang as shelled corn when alfalfa is used as roughage. It will make better feed for horses during hot weather or when they are doing hard work because it is considered rather less heating than corn and is excellent feed to combine with alfalfa or other leguminous hay. However, it is not advisable to feed this grain alone all the time. This grain ranks high as poultry food. For fattening fowls it is about equal to corn and is much superior for feeding to laying hens. In feeding value it is only slightly less than shelled corn, but is somewhat less digestible on account of its hard flinty character. The stalks of kao-liang are almost as valuable as grain itself to the people in north China. They are the chief supply of fuel. They are used to cook food, to heat the brick bedstead in winter time, to boil the water for tea, in fact, are used whenever heat is needed in those sections of north China where this crop is grown so extensively. They are not used as silage or any other feed purposes in China as they are in the United States. Another important role they play is in the fine fencing material they furnish. Sometimes they are used to build pens for pigs and chickens. They constitute the frame of the roof, upon which the clay is smeared. These stalks are also used as supports for plants in the vegetable gardens. They serve as poles for beans, cucumbers, and yams. They also lend themselves to basket and matting making. In making the finer quality of baskets

the outer skin only is used, being split off by hand and woven into the various articles desired by skilled makers. For large coarse baskets, however, the whole stems are taken while they are still fresh, for when once dry they cannot be manipulated very well. There are still several minor uses for the stems such as frames of kites, paper animals, play things for children, and so on. Even the roots are not allowed to stay in the ground, but are grubbed out and dried for fuel among the poor people.

The kao-liang has been an important crop in north China, especially in the three provinces of Manchuria. The land in Manchuria is fertile and a great and level plain. Since the growing season is short and the farmers have to grow some crop which will be well adapted to that condition, kao-liang is becoming the staple crop. It will give good production of seed and at the same time the stalks serve as the chief supply of fuel. According to the uses mentioned above, it will be impossible for the natives to get along without this crop. It is one of the chief farm products in north China and is grown to supply all of China. The farmers grow it more because the market demand is great. This is the chief source of grain to feed live stock and good results will be obtained when other crops grown in the same section fail. From this point it is safe to say that the development of the kao-liang crop in the future will be great. This is because this crop is more adapted in Manchuria where there are so many acres of fertile land not being cultivated. So in the near future the more land being cultivated the greater the production will be.

The smuts of Kao-liang.

The smuts are among the most destructive enemies of sorghums. There are two well known smuts of the sorghum, the grain or kernel smut, and the head smut. The grain or kernel smut is easily distinguished by the fact that only the individual kernels or grains are affected, while the head retains its usual form and nearly its usual appearance. Most, if not all of the kernels in a smutted head, are destroyed. The head smut is very different in appearance. The whole head is converted into a single large smut mass, covered by a whitish membrane, which soon bursts and sets the spores free. In this smut, therefore, all trace of the individual grains are then lost. It is found that almost universally where sorghum crops are grown the kernel smut is widely distributed. This results in great losses of this crop every year. The head smut is good to eat. It tastes good when cooked, but usually the children eat it raw. It is taken from the stalk in the field before the spores open. However, it is eaten only by children.

Treatment.

Formalin: Mix 1 pound of formalin with 30 gallons of water. Put seed in sacks and immerse the sacks in this solution for one hour, stirring occasionally. Then take the sacks out and set them out to dry.

Hot water treatment: Heat 2 large tubs of water to about 133°F. Place the seed to be treated in a clean sack and bring it to about 133°F. by plunging it into the first tub of water heated to this temperature. Then transfer the sacks to the

second tub and keep the seed submerged for 10 to 15 minutes. Keep the temperature of the water in the second tub between 130° and 137°F. It should not be allowed to go above 138° or below 130°F. The seed should be frequently stirred in order to keep the temperature constant. After it is treated take it out and dry for sowing.

The head smut does not occur in abundance, but the farmers should be careful to keep the smut away. Some suggestions for keeping this smut away are (1) Get seed free from smut, (2) Keep farm free from smut by using own seed, (3) Treat seed with formalin or hot-water if not sure that it is free from smut. Methods of improvement.

Though kao-liang has been grown in China for many years still it requires the improvement of its variety because it lacks uniformity of maturity, purity, and quality. So for its future development and improvement it requires much rigid selection for its adaptation.

The main purpose of improving kao-liang is to get more bushels to the acre. This can be done by improving seed selection and better quality of seed planted, also by better cultivation. In the improvement of grain kao-liang the principal considerations should be (1) Increased drought resistance,

(2) Increased earliness, (3) Dwarfness, (4) Greater productiveness, (5) Adaptability to machine handling.

Drought resistance: The kao-liang finds its greatest usefulness in regions where moisture is often the controlling factor in crop production. Much good would therefore be accomplished by increasing its drought resistance especially in the areas of lighter rainfall. The most important factors are probably (1) Increased ability to prevent the loss of water by transpiration, (2) Increased development of the root system, and (3) A possible increase in power to extract water from a dry soil. How to control the transpiration is well known to all, the best way being to keep the soil in good condition to prevent it. The size and character of root systems are probably strong factors in drought resistance. The larger the root system is in proportion to the plant, the larger the area of soil from which it draws moisture in time of drought. A deeply rooting plant may be able to secure water when shallow root systems lie wholly in dry soil. To extract water from dry soil is now only a theory and may be in the future a variety having this quality will be found and grown. It is through selection that the drought resistance and adaptations for drought evasion will be obtained. Deeper rooting plants will stand more drought resistance, while dwarfness, earliness, and thin stand are adaptations and conditions for drought evasion. When selected for actual drought resistance it is important to have the idea in mind to select those plants which give the best results under dry conditions when they are neither dwarf nor earlier nor more thinly

planted than their neighbors. The best selection should be made in the field because field conditions can be seen and maturity and form of plants be known clearly.

Earliness: The earliness of kao-liang is the most important factor in the regions where it grows. Because of shorter growing season in the north the earliness of kao-liang is an important quality. A variety must be obtained that will mature before the possible early fall frost. It is also important because early varieties make better use of seasonal rainfall which comes largely during the early part of the summer months. Earliness is a means of drought evasion, not of resistance. Improvement in earliness has to do with seed selection of varieties on dry farming regions and selection should be made in the fields selecting the earliest heads for improvement. Keep up this selection for years until a desirable earliness of a variety is obtained which variety is then adapted to the local conditions. The effect of earliness in permitting drought evasion is very important. The earlier plant having a shorter growing period, not only uses less water, but uses it earlier in the season. So it is important to use the seasonal rainfall during its early growth.

Dwarf stature: The dwarf stature is usually desirable in the kao-liang because it decreases the water requirement of the crop to a unit of grain produced. We know the larger the plant the more water it requires and the more it is likely to lose by transpiration. A small plant which can produce as much grain as a large plant will thus have real advantage in

the dry season. This is not true drought resistance, but merely a lower water requirement which permits drought evasion. It will be possible to select the dwarf stature plant of kao-liang but the selection should not reduce the ability of yielding power.

Productiveness: The two most important factors of increasing the kao-liang grain yield are better varieties and better methods of growing them. Better varieties means to grow the varieties well adapted to the local conditions so the best and heaviest yield will be obtained. This has to do with the selection from year to year. Selecting stalks of desirable size and habit, bearing large and well-shaped heads, well loaded with plump grain. The heads should be well-filled, fully exerted, large in proportion of size of stalk, and good weight. When selecting not the largest head alone, but the largest possible head on the smallest stalk is most desirable. Select the early and desirable varieties and heavy yielders, well adapted to the local conditions. Better methods relate to proper and even spacing of stalks in rows and to thorough cultivation of the growing crop. Rotation and general tillage to conserve moisture influence crop improvement. Till the soil so as to absorb the rainfall and to prevent evaporation. In the fall the land should be plowed and lain rough and unbroken in the winter. The seed bed should be so prepared in the spring. The first step in planting kao-liang is to have a proper stand or row space. Kao-liang yields best with a stand of 1 stalk in each 5 or 6 inches, rows of 2 feet apart. The

rate will vary with varieties. In favorable climate and with soil conditions a thicker stand is preferable, while in dry regions a thinner stand should be planted.

Adaptability to machine handling.

The farm work in China is entirely hand labor. Planting, cultivating, and harvesting are all done by hand. This is because we do not have the modern farm machines as the farmers do in this country. However, the farmers can do good work and clean cultivation just the same. This is because our labor is cheap. This is effective and can only apply to small acreage of farms. It is my opinion that in order to grow kao-liang on a large scale it would be much better to introduce the modern farm machines such as planters, cultivators, and binders which are workable to the conditions of north China. With these machines and our cheap labor we can handle more land and produce the grain profitably. As to the header and harvesting machines, I do not believe they are economical to our conditions.

Conclusion.

With the future development of more fertile land in Manchuria the production of kao-liang grain will be increased to a great extent because it is a staple crop well adapted to that section. It is an important crop to grow for food and feed and at the same time the stalks will furnish the chief supply of fuel for the poor people. But the crop growing there lacks purity and quality, so it should be improved for better seed production. For the present, it seems to me that we do not have to talk about the breeding work because it is rather

slow work, so the first thing for our farmers is to do the work of selection with the local varieties being already well adapted. This is to select the pure strains and better quality of seed and plant them to increase the production. The next step is to introduce some of the workable farm machines which will do effective work but the cost of the machines should be as low as possible. In this way our farmers not only can do better work, but also can handle a larger acreage of land of this crop.

MILLET

General distribution and origin.

Millet is grown extensively in all sections of China, particularly in the northern provinces. It is one of the staple crops in Manchuria, because it is better adapted to the climatic and soil conditions to raise the crop for the food stuff of the native population and also for the great demand of it as an export. This is one of the five plants sown each year in a public ceremony by the high officials 2700 B. C. Nobody can say definitely where it originated, but it is generally believed that these plants are all regarded by the people as natives of the country.

Varieties.

There are many varieties of millet known in the United States such as Foxtail, Common, German, Italian, Hungarian, Siberian, and many others. Broom-corn or Proso, Japanese barnyard, and Pear millet are also known varieties in this country. But in China, we do not have those names given to the millet as they have been classified into varieties by the western agriculturalists. There are three varieties of millet according to size and character, known to the people as Large, Small, and Glutinous. They are all grown for seed production and other purposes.

Adaptation to soil and climate.

Millet delights in rich, warm, loamy soils and will not thrive in soils that are poor and thin. So for this crop a fertile, mellow soil is preferable. Loams with but little

clay and not too much sand give the best results. Heavy clay soils require considerable working in order to get them into proper condition. It requires a shorter period of growing season than the other crops, but the growing period must be hot. These plants not only endure excessive heat and sunlight, but make very rapid growth if the supply of moisture is not too limited. However, they are very susceptible to cold, particularly when the plants are young. It does grow well at high altitude or in other localities where cool weather prevails during the summer months. Notwithstanding, this preference for warm weather, millet is grown successfully in north China where summers, though short, are hot. Millet, as it matures quickly, can be planted and harvested during the summer months. The long days prevailing in the latitude provide plenty of sunshine and thus a shorter period of time is required for maturing this crop. Millet does best in the localities which have a fairly abundant rainfall. Some have referred to the millet as a drought resistant crop and it does have a low water requirement, but it lacks the ability to recover after being injured by drought. The millet succeeds in localities subject to drought almost entirely through its ability to escape the period of acute drought on account of their short growing season, but it is usually one of the first crops to show the effect of a drought, mainly because of its shallow root system.

Place of millet in the cropping system.

Where the season is too short to grow other crops, millet is admirably suited to such use because of its short season of

growth and the ease and certainty of obtaining a stand. This is done in northern Manchuria. The plant is also adapted to a wide range both of soil and of climate. Large yields are not obtained either on poor soils or in dry climate, but millet has been found to make a heavier yield under such conditions than most crops.

Rotations and fertilizers.

There is no rotation whatever practiced on very small farms in China, but they do on the large farms. The reason is that the small farm can supply enough manures to produce a good crop and because the farmers need the crop production for their family consumption, so they have to grow a certain amount for their own use, but the big farms grow the different crops which will be profitable for market and at the same time they find out that when a proper rotation is used a better production can be obtained with a certain amount of manure applied. The commercial fertilizers are not known very well to the farmers. What they apply to the soil is manure and earth compost, and sometimes soy bean cakes are used as fertilizers in some sections. Millet draws its nourishment largely from the surface soil so the supply of plant food should be concentrated on the upper layers of the soil and should be in forms readily available to the plants. If the surface soil does not already contain sufficient available plant food this should be supplied in the form of barnyard manure or commercial fertilizers. Those containing large percentages of nitrogen, phosphate, and potash in readily available forms are most valuable. The amount of application depends on the nature of the soil and

the judgment of the farmers.

Method of culture.

The land is plowed either in fall or in the spring. In spring the land should be well prepared, because it is of prime importance that the seed bed should be in condition to insure prompt germination and an even development of the plants. Spring plowed land is preferable to fall plowed, because the operation of plowing usually destroys one crop of weeds. About two weeks before the time for seeding, the plowing and discing will keep the ground clean. When fall plowing is used for the seed bed, it should always be disced before sowing the crop. A fine and firm seed bed is very necessary for millet because of its small size of seed.

Time of seeding.

The time of planting varies in sections and localities. The length of time required to reach maturity varies a great deal, according to the varieties and the soil and climatic conditions. However, millet should not be sown until the ground is warm. This means ordinarily about 2 or 3 weeks after corn planting.

Method of seeding.

There is no grain drill or special modern machine for sowing this crop in China. It is sown by a kind of seeder. It is grown in rows and the seeder can sow one row at a time. This process consists of three operations and requires the services of three persons, one making the furrow, one doing the seeding, and the other covering the seeds.

Rate of seeding.

The rate of seeding depends on the varieties of the millet and the condition of the soil, but the common practice is to sow $1/3$ to $1/2$ bushel which is plenty of seed to the acre.

Time of harvesting and threshing.

This crop is grown entirely for the seed production in China, so probably the best time for harvesting is when the seed is in the stiff dough. It is cut by hand with a knife and then bound up and shocked. When threshing it is to be done, it is hauled to the place where a solid clay floor is ready. It is threshed on this floor by rollers drawn by horses over the millet. This takes about 3 hours after which the grain is ready for the market.

Uses.

The seed is used for human food in sections where it is grown so extensively. However, the three varieties, large, small, and glutinous, have been used for different purposes. The large variety of millet is used for food and makes a delicious porridge, being used as the principal food for a large population in the north, the small variety is used for both human and animal food, and the third, or glutinous variety, is used for making flour and cakes and for distilling purposes. The straw of millet is used entirely for the feed of horses and is the only hay for animals. It is not grown and cut for hay, but is grown for seed and after the seed has been threshed the straw is used for feed.

Diseases.

The millet is less subject to destructive plant diseases than most other crops. There is a little tendency to smut, but it can be controlled by treating the seed with hot water or formalin. If hot water treatment is used, the smutted seed should first be floated off by throwing it loose into cold water. The seed should then be placed in a porous bag and dipped in water at a temperature of 110° to 120°F. to warm the seed, after which it is immersed for 10 minutes in water at a temperature of 132° or 133°F. The temperature of the water should be retained during the 10 minutes at not less than 130°F. After the treatment the seed is dried quickly to prevent its sprouting.

The formalin treatment is much simpler and is gradually superseding the hot water treatment for smuts. It consists in dipping the seed in a solution containing 1 pint of formalin to 30 gallons of water. The seed may be put in sacks containing $\frac{1}{2}$ to 1 bushel each and immersed in a barrel of the formalin solution for about 10 minutes. When taken out, the sacks of wet seed are suspended so that they will drain or the seed is placed in piles and covered for 2 hours, after which it is dried as rapidly as possible to prevent sprouting. Shoveling the seed over frequently will accelerate the drying process.

Insects.

The chinch bug and army worm are the most destructive insect of the millet. Great damage will be done if they are abundant in a locality. A successful way of protecting fields

of millet from chinch bug invasion is by means of a deep furrow plowed around the edges of the fields to be protected, running the land side of the plow toward the fields. In dry weather the sides of the furrow thus made can be rendered so steep and the earth so evenly pulverized that the chinch bugs cannot crawl out of it. In showery weather the bottom of the furrow can be smoothed with a shovel, thus making it easier for the bugs to follow along the bottom than to climb the sides of the ditches. If holes with perpendicular sides are then dug across the bottom of the ditch at intervals of 30 to 40 feet, the chinch bugs will fall into them and can be disposed of easily by the application of kerosene oil.

The army worm also may be prevented. This is done by the use of similar furrows in which the caterpillars may be crushed by dragging a log back and forth in the furrow. When a large brood of grasshoppers hatches in a locality, they are likely to do considerable damage before they arrive at maturity. The most effective way of destroying them is by scattering poisoned bran about the edges of the fields. The grasshopper poison is made up of the following ingredients:

Bran	25 lbs.	
Paris green or white arsenic	1 lb.	
Low grade molasses	2 qts.	
Oranges or lemons	3	
Water	3 $\frac{1}{2}$ gal.	

Mix the bran and white arsenic thoroughly in a tub while dry. Squeeze the juice of the orange or lemon into the water, chop the remaining pulp and the peel to fine bits, and add them to the water. Dissolve the molasses in the water and wet the bran

and poison with the mixture, stirring at the same time, so as to dampen the mash thoroughly. This bait when flavored with orange or lemon is found to be much more attractive to the grasshoppers than that prepared without fruit of any kind. The poisoned bran should be scattered at intervals of several days about the fields in open places where the insects are most abundant, so there will be fresh bran for grasshoppers to feed upon until their numbers are reduced.

Some other insects such as flea beetles, wireworms, corn root-worm, etc., are known to attack the millet but they are not important.

Method for improvement.

There are two important points for the improvement of this crop, one is to improve the method of culture and the other is to improve the seed quality by selection. The Chinese farmers have done good work in culture so far as preparing the land in good condition and keeping it clean from weeds are concerned, but what I mean here is to improve the method of culture by doing the work in a scientific way. The farmers are too slow at their work because they do not have the up-to-date tools to do the farming. So for the future better tools should be well equipped and then better culture will be obtained. Now the very important step that the Chinese farmers should undertake is to improve the varieties for yield and quality. First get a better variety which will be well adapted to the local conditions and then improve it by head selection. Study the conditions and select the best variety and best head to run a seed plat. By this method a better yield and quality of

seed production will be obtained. It is my impression that very few farmers in China do the selection of seed. They just plant the seed taken from general grain. They use more seed for planting to the acre so that they can get the stand for the crop. In conclusion, I would suggest for the improvement of yield and quality of this crop a better culture with proper rotation. Grow the home grown seed best adapted to the local conditions and select seed before harvesting for the next year's planting. These are all the important points to be considered.

Chapter 3.

AGRICULTURAL AND CROP CONDITIONS IN MANCHURIA, AREA, SOIL, CLIMATE, CROPS ADAPTED, POSSIBLE ADDITION TO CHINESE FOOD SUPPLY BY PROPER DEVELOPMENT OF MANCHURIA, OUTLINES OF ORIGINAL AND REVISED FIELDS REPRESENTING MANCHURIAN FARM PLAN AS SHOWN BY MAP, ROTATION CHARTS SUPPLEMENTED WITH NOTES ON TYPE OF FARMING, CROPS, KINDS OF LIVE STOCK, DISTANCE FROM MARKET, MARKET CONDITIONS AND FACILITIES, PREVAILING SOIL TYPES, CONDITION OF SOIL FERTILITY, PRESENT SYSTEM OF FERTILIZATION, REVISION OF PLAN OF CROPPING AND FERTILIZATION SYSTEMS, POSSIBILITIES FOR PROFITABLE RETURNS.

Manchuria is part of the Republic of China. The soil is rich and land is level. The agricultural and crop conditions are generally considered good in normal years. It is in this section that big farms are found, but the crop growing is different from those sections in China Proper where cotton and rice form the principal crops, while in Manchuria soy beans, sorghum, millet, and wheat are the staple crops, though rice, corn, cotton, and other cereals are raised. This part of China we call "Tungshanhsing", or the three eastern provinces of Mukden, Kirin, and Heilungkiang. Lying between latitude $38^{\circ}43'$ and $53^{\circ}30'$ north and longitude $117^{\circ}50'$ and $135^{\circ}2'$ east, is bound on the north by Siberia, on the east by Siberia and Korea, on the west by Mongolia and China Proper, and on the south by Korea, the Yellow Sea, and the Gulf of Chili.

Manchuria is traversed from south to north by two moun-

tain ranges, Khingan and Changpai, the one close to the north-western frontier, and the other near the southeastern boundary. These ranges have peaks which are as a rule from 3000 to 6000 feet above the sea level, while a few of them are as high as 8000 feet. These ranges send off spurs toward each other which come close together in the central regions, so that Manchuria is composed of high mountain ranges on the northwest and south east, with an extensive plain lying between them opening out towards the southwest, embracing the most fertile lands of Manchuria. The mountainous regions are rich in timber and minerals, while through the valleys flow many rivers which, besides irrigating the regions they pass through, serve as routes for traffic. The largest of these rivers in the north are the Amur, the Sungari, and the Ussuri, while those in the south are the Tumen, the Yalu, and the Liao. The Amur has the largest course of 2,500 miles of which 2,000 are navigable along the frontier line between Manchuria and Siberia. The most important rivers draining the interior of Manchuria are the Sungari, the Nonni, and the Liao. Sungari and Nonni form one system as they mingle their waters near Petuna, the latter coming from the northern part of the Khingan range in the northwest and the frontier from the mountains in the neighborhood of Kirin. The Sungari after receiving the water of the Nonni flows on through north Manchuria until it empties itself into the Amur. The river with main and important tributaries is navigable for 1060 miles. The Liao, which drains the plains of south Manchuria, has its source in the steppes

of Mongolia, and empties itself into the Gulf of Chili. This river system is navigable for about 400 miles. These two river systems naturally divide the Manchurian plains into two sections, the northern or the Sungari Plains, and the southern or the Liao Plains.

The area and population are not exactly known because China has not carried out a proper census, so these can be given only in estimation. The statistics are also different from the various authorities. The estimation of area and population for this region given in the "Commercial Handbook of China" is about 365,000 square miles with a population of 15,000,000, while according to the statistics given by the Manchurian Railway Company in 1916 the whole of Manchuria has an area of 382,632 square miles with a population of 20,000,000. The acreage of the land under cultivation in Manchuria is estimated by the Manchurian Railway Company at 22,580,250 acres, consisting of 11,233,800 acres in Mukden, 7,594,650 acres in Kirin, and 3,751,800 acres in Amur or Heilungkiang.

The following table shows the cultivated and uncultivated area and the cultivated area per head.

Province	Area under cultivation.	Area not under cultivation.	Cultivated area per head.
Mukden	11,233,800 A.	3,134,700 A.	.938 A.
Kirin	7,594,650 "	3,910,050 "	1.347 "
Heilungkiang	3,751,800 "	4,575,600 "	1.503 "
Total	22,580,250 A.	11,620,350 A.	1.122 A. (Av.)

These uncultivated areas given in the above can be turned into farm lands readily. According to the above table about two-thirds of the land of Manchuria is already under cultiva-

tion. The average cultivated area per head is 0.938 acres in Mukden, 1.347 acres in Kirin, and 1.503 acres in Heilungkiang, and that the whole of Manchuria in average is 1.22 acres. It constantly enlarges as one goes north, thus showing the respective agricultural development of the three provinces of Manchuria.

Manchuria, taken as a whole, is one of the most sparsely inhabited parts in China, being about 50 people to the square mile. But when the individual provinces are taken for consideration, there is some difference between the density of the population of each province. Mukden has a density of 139 to one square mile, Kirin has 59 to one square mile, and Heilungkiang has only 10 to one square mile. This shows the development in the past and the development for the future.

The following table shows the area, population, and density of population in each province:

Province	Area in sq. mi.	Population	Population per sq. mi.
Mukden	84,841	11,782,100	139
Kirin	95,733	5,625,895	59
Heilungkiang	204,715	1,997,622	10
Total	385,289	19,405,617	50 (Av.)

The following table shows the increase in population from the year 1906 to 1916:

Province	Population 1906	Population 1916	Increase	Av. Yearly increase	% of Av. Yearly increase
Mukden	8,763,148	11,804,241	3,041,930	304,193	3.47
Kirin	3,047,077	5,736,611	2,689,534	268,953	8.82
Heilung- kiang	1,455,657,	2,098,819	643,162	64,316	4.41
Total	13,265,882	19,639,671	6,347,626	637,462	4.8

In this table it shows that there are more than six million people added to the population of Manchuria during the

ten-year period, with an average yearly increase of 4.8 percent. The increase of population in Manchuria is so fast because of its rich soil and the new development of agriculture in Manchuria.

Soil.

The soil is not general so rich in every section of this region because in some sections the soil has been exhausted by continuous cropping without fertilization. But with the exception of southeastern portions and other mountainous districts, the soil is generally rich, and especially it is so in the great valley of Sungari and the Liao Plains. The soil in the southwest where agriculture has been carried on for many years, becomes poor in fertility due to the fact of continual raking away of the stubble for fuel, thus depriving the soil of organic matter. The wonderful loaminess of soil in the new regions further north are most productive.

The southeastern portion comprises the whole basin of the Yalu and Liao-tung Peninsula, being mountainous and generally sandy and sterile soil with its mixture of gravel. This is the most densely populated portion of Manchuria, every inch of arable land, even the hill sides and the river bed is under cultivation. Really there is no room for further development of agriculture in this section save some districts along the upper reaches of Yalu where there is still left some land to be cultivated. The southwestern portion of the entire basin of the Liao is level, and is generally well suited for agriculture. The whole section is well cultivated, and there is



still some land left for further exploitation along the upper reaches of the river and those adjacent to Mongolia. There are some rich soils in this section, but there are also some poor sandy soils, especially along the sea coast and low lands. The central or middle part of Manchuria watered by the River Hurka (Hu-Dan-Kiang) and the upper and middle reaches of the Sungari is the best agricultural section in Manchuria. The lands around Changchun, Kirin, and Harbin are exceedingly rich and moreover there is still plenty of room for further development. The northern section watered by lower Sungari, the Nonni, and the Amur, is rich in soil, but it is the most sparsely populated portion in Manchuria and therefore the possibilities of agricultural development are great.

Climate.

The climate is continental and is greatly affected by the proximity of the great Mongolian Desert. The climate is much different in the various sections of this part of China on account of its big area. In the middle portion of the Mukden Province the temperature sometimes rises in summer to 96°F., and falls in winter to 25°F. below zero. The rainfall, including snow, is 33", and is spread over 70 days. The changes of temperature are great and sudden when spring comes, the atmosphere in summer is very dry and the heat is greatest toward the end of July. During the day the temperature generally ranges from 91°F. to 96°F., but during the night rarely above 75°F. The heavy rains usually begin the latter part of July or early in August.

The average annual temperature in the eastern section of Mukden is just under 45°F., and the average rainfall is 42.27 inches annually. The average lowest temperature for January is about 6.66° and the average highest for July is 89.66°. There is about 21.15 inches of rainfall in the months of July and August.

The following table shows the temperature and rainfall at different seasons in the eastern section of Mukden Province.

Months	Rainfall and melted snow. (inches)	Mean Temp. (Degree F.)	Average highest F.	Average lowest F.
January	0.35	16.66	40.00	-6.66
February	0.09	22.80	47.00	6.00
March	1.65	33.88	54.00	16.00
April	1.33	46.03	71.66	28.33
May	2.66	56.81	82.33	37.66
June	5.35	55.98	89.33	53.33
July	11.48	66.53	89.66	61.66
August	9.67	67.75	89.66	61.66
September	5.50	62.73	87.00	46.00
October	2.73	49.33	78.66	28.00
November	.94	33.22	60.00	9.66
December	.52	17.55	39.33	-6.33
Annual	42.27	44.35		

The southern section or southwestern section of Mukden has nearly the same climatic conditions as the eastern, but there is still some difference in the two sections.

The following table will show the temperature and rainfall at different seasons with monthly average for five years from 1910 to 1914.

Months	Rainfall (Inches)	Temperature (Degrees F.)
January	0.52	24.1
February	0.31	28.0
March	0.96	34.9
April	0.92	47.7
May	1.25	59.4
June	1.96	67.8
July	6.50	73.6
August	5.60	75.4
September	5.03	67.5
October	1.36	56.1
November	1.54	40.8
December	0.33	27.3
Annual	26.38	50.2

The above table gives an average temperature for the whole year of 50.2° and seasonal temperatures of spring 47.3°, summer 72.3°, fall 54.8°, and winter 26.4°.

The climate in north Manchuria or in the provinces of Kirin and Heilungkiang is much colder than that in Mukden. It has long, dry, exceedingly severe winters and short, hot and rather showery summers. Ice closes the rivers to navigation from the beginning of November to the end of April. The coldest regions are along the upper course of the Amur in the Greater Khingan Mountains, where the temperature in winter sometimes falls to 70°F. below zero. At Harbin or the central portion of Manchuria in ordinary winters the thermometer rarely falls lower than 40°F. below zero, but in an ordinary year from the first of December to the end of March the maximum daily temperature averages about 30°F. In summer the thermometer at Harbin seldom reaches 100°, and as the atmosphere is very dry the heat is not very oppressive.

In general the climatic conditions of Manchuria are such as to confine agricultural operations to seven months of the

year. With the exception of the very south of Liao-tung Peninsula, or the extreme eastern and southern sections of Mukden Province, where a little winter wheat is grown, the farmers do not touch their lands till the frost begins to relax its grasp of the soil toward the middle of March, and they must take care that crops of all kinds are harvested before the end of October or early in November, for in the latter month the icy hand of winter again tightens its hold of the ground. As a matter of fact, the surface is still slightly frozen in March, when the land is broken up and drilled by plow for the reception of wheat and barley, which are harvested in June. But in further north the plowing cannot be done until the end of April.

The crops that are best adapted to Manchurian soils are soy beans, kao-liang, millet, corn, wheat, rice, and other beans and also some minor crops of flax, tobacco, and cotton.

Beans.

Large varieties of beans are grown in Manchuria, and, together with their resultants, bean cake, and bean oil, they constitute by far the most valuable item in the export trade of the three provinces of Manchuria. The methods of culture of these beans are nearly the same. In the month of April they are sown by hand in drills, and the crop is harvested in September. The small green bean known as Lu-tou matures early and is harvested in August.

Lu-tou is the smallest but one of the most important of the beans of commerce cultivated in Manchuria. The epidermis is of a dark green color, while the inside is whitish yellow,

shading to green. It is somewhat blunted at the ends and has a white scar on the saddle. It is much harder than the soy bean and contains very little oil or fat. This bean when soaked in water, produces excellent sprouts which are used in the Chinese restaurant in the United States, but is mainly and universally used for the manufacture of vermicelli. The process of the manufacture is to have the beans first steeped for a night in a jar of warm water. The next morning they are then ground up between two millstones and the liquid mixture passed through fine sieves to separate the flour from the crushed skins, which are discarded. The filtrate is poured into jars of water, the flour sinks to the bottom, and all floating impurities are removed. The water is poured off, and the flour packed in fine hempen bags which are hung up to dry. When this has been accomplished the bags are removed and the contents remain hard masses of white flour, which it requires a considerable pressure of the hand to break up. When the vermicelli is being manufactured a little of the bean flour is placed in a vessel and mixed thoroughly with water. The boiling water is then poured in and makes it into a sticky mass and then more flour is added to it until the dough no longer sticks to the hands and arms of the man. A wooden vessel with a number of round holes in the bottom is filled with a piece of the dough. Then a man holds the handle of the vessel in his left hand and beats with his right hand the dough, which escapes in strings through the holes in the bottom and falls into boiling water, whence it is immediately drawn into a tub of cold water by another man armed with a

pair of sticks. When sufficient length of strings has been obtained the latter severs them with his teeth. The vessel is constantly being refilled with dough and the men relieve each other at the beating process. When the strings are taken they are then hung over a framework to dry and are afterwards made up into bundles for market. It enters largely into the native diet throughout the whole of China and will be found in every market.

The soy bean is grown entirely in all sections of Manchuria. It is only in the last decade that soy beans have figured in the world trade, and their rapid rise in importance has been one of the most remarkable commercial events of the recent times. It was the soy bean that introduced Manchuria into the trade of the world, and it is still the soy bean that makes Manchuria famous. The soy beans and their products are very predominant in the Manchurian trade and now they constitute nearly one-half of the value of the entire exports of the three provinces. Though the soy bean is such an important crop in Manchuria, the culture has no change in manner of cultivation or in the method by which they are prepared for the market. The soy bean is sown in April, cultivated by hoeing when the plants are about 8 or 9 inches high and harvested in September. There are three big varieties of soy beans grown in this region, yellow, green, and black. They are so called because of their colors. Though the soy bean is grown in all sections of Manchuria the best and biggest bean fields are found in the north of Mukden, and this is because the farms are generally bigger

than those in southern sections of Mukden and also the soil is richer in fertility. This has been proved by the fact that of 974,000 tons of soy bean shipped down to Dairen during 1917, 863,000 tons came from north of Mukden. It is estimated about 108,783,316 bushels of soy beans produced in Manchuria and about three fourths of the total production exported, and of the total export, about 30 percent. is in the form of beans, and the rest in the form of bean cake and oil.

The amount of soy bean production by districts of each province is shown in the following table:

Provinces	Principal districts.	Amount of production (Bushels)
Mukden	Shenyang, Liaoyang, Faku, Hailung, Tungfeng, Hsifeng, Hsian, Huaita, Lishu, Tiehling.	52,477,445
Kirin	Ningan, Changchun, Panshih, Yushu, Linhsien, Kirin.	33,809,060
Heilungkiang	Hailun, Suihua, Fayan, Hulan.	16,415,487
Total production in bushels		102,701,992

Kaoliang.

Kaoliang may be considered even more important than soy bean because it is used as the staple food of the native population and the principal grain for farm animals. Before soy beans attained their present importance, half the total area of the cultivated land in Manchuria was devoted to the kaoliang crop, but now the acreage is reduced to about 20 to 30 percent., while the soy bean is cultivated to 50 percent. of the whole cultivated area. The annual production of this crop is estimated at about 183,000,000 bushels. This grain is not only used as food for native consumption and also is used

to make spirits with a production of about 1,965,000 gallons or more, valued at \$10,000,000 gold. It is exported to the southern provinces and Japan. During the year of 1917 the total export of kaoliang grain amounted to \$5,655,000.

Millet.

This is next important to Kaoliang and is used as food for the native people. It is cultivated throughout Manchuria, but more largely in north than in south Manchuria. It is sown in spring in the early part of April, cultivated by hoeing, and harvested in July, or early August for the late varieties. It is exported to the southern provinces of China and Korea, where it is used as food. The total production of this grain is about 31,000,000 bushels, and the export of it in 1917 valued at about \$2,000,000.

Corn.

Corn is grown in Manchuria in the same manner or way as kaoliang. It is grown extensively in the southern part of Mukden and the grain is used for food by the people. It is sown in April and harvested in September. The estimation of this crop production is about 37,400,000 bushels. This grain besides consumed by the native people, is exported to southern provinces for food supply, and the value of export in 1917 was about \$1,500,000.

Wheat.

Manchuria is an ideal wheat country and both barley and wheat are grown in considerable quantities. South Manchuria does not produce so much wheat as north Manchuria, so the best wheat fields are found around Kingan, Petuna, and Harbin,

along the banks of the Sungari River. The wheat is sown in spring and harvested in July. Most of the wheat is spring wheat and because of the severe winter there is only very little winter wheat grown in the south of Mukden. The acreage of wheat growing is increasing every year and the possibilities of development are great. The production of wheat is about 60,000,000 bushels per year. The best and heaviest wheat grows in the valleys of the Sungari and along the Kutan River, in Kirin. This wheat averages over 71 pounds to the bushel, whereas wheat from the other districts sometimes weighs 3 to 5 pounds less. There are quite a number of flour mills in Manchuria, particularly in the north such as Harbin and Changchun. This grain is exported either to the south provinces of China or to foreign market. In 1917 the value of export of wheat in North Manchuria was about \$3,275,992.

Barley.

This crop is also cultivated in considerable quantities in central and northern Manchuria, and is used mostly for the feeding of animals. It is grown in the same way as wheat with but very little care to the cultivation. The annual production is about 30,000,000 bushel.

Rice.

Rice growing is not so extensive as the soy bean crop, but in recent years it has been very successful wherever the land is level and water can be obtained for irrigation. Rice growing has been developed to a great extent in these few years and the total production is now estimated at 1,500,000

bushels. The cultivation of rice in this section is nearly the same as in China Proper and the yield is about from 40 to 45 bushels to the acre.

Hemp, jute, and flax.

These fibers have been grown as the important crops in Manchuria. Hemp is grown in all the three provinces, while jute is cultivated only in Mukden and Kirin and flax only in Heilungkiang Province. In Heilungkiang, hemp plants are for the most part cultivated for seed, from which oil is extracted. The production of their fiber and seed for 1915 was as follows:

Province	Hemp (pounds)	Jute (pounds)	Flax (pounds)	Seed (pounds)
Mukden	31,281,813	12,360,673		11,534,116
Kirin	6,046,654	2,290,010		20,461,762
Heilungkiang	45,257,016		10,710,468	17,410,054

Tobacco.

This is one of the important products of Manchuria and the best crop is raised around Kirin with excellent quality.

Cotton.

Because of the limitation of climatic adaptation, cotton is grown only in the southern part of Mukden. The principal districts of cotton growing are Kaiping, Haicheng, Liaoyang, Shenyang, Tiehling, Penhsi, Faku, Heishan, Peichen, I-Hsien, Chinghsien, Kwangning, Chinghsi, and Chaoyang.

Owing to the absence of reliable statistics it is very hard to give the amount of production of the agricultural products. But the following table will just show the cereals produced for 1915 by the reports.

Kinds	Mukden (No. Bu.)	Kirin (No. Bu.)	Heilungkiang (No. Bu.)	Total (No. Bu.)
Kaoliang	162,052,691	13,264,633	8,174,492	183,491,816
Corn	22,511,696	8,992,419	5,925,211	37,429,326
Millet	12,312,303	6,730,855	11,462,635	30,505,793
Beans	39,217,693	17,663,030	17,164,111	74,004,834
Small beans	7,015,543	2,119,188	1,492,544	10,627,275
Other beans	1,315,886	609,925	251,140	2,176,951
Barley	3,276,847	7,118,797	17,642,844	28,038,488
Wheat	4,702,600	11,334,736	9,263,998	25,301,334
Oats	995,432	928,350	3,545,612	5,469,394
Rice	6,057,613	1,350,239		7,407,853
Total	259,458,304	70,112,173	74,922,587	404,493,064

The following statistics for the same year 1915 have been worked out by the South Manchuria Railway Company, for which the export of these products as given in the customs returns is made the basis of the calculation:

Kinds	South Manchuria (Bushels)	North Manchuria (Bushels)	Total (Bushels)
Beans	79,109,647	29,672,569	108,782,216
Cereals	226,570,587	97,707,098	324,277,685
Total	305,680,234	127,379,667	433,059,901

In the above it will be seen there is a great difference between these two tables. Since there are no reliable statistics it is very difficult to say how much reliance can be placed on these figures. The amount of figures in the latter is larger than that former table by about 29 million bushels, but it is stated that millet, kaoliang, buckwheat, and other cereals are not all included in the first table and, therefore the two tables in totals may agree with each other. The production of beans is much different in the figures of these two tables but in this case it is more reasonable to take South Manchurian Railway Company's figure than the other because beans and their

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products are mostly exported, and, since that company's figures are based on the export returns it will be correct in these figures. In conclusion it is safe to say that the total amount of cereals and pulse produced in Manchuria must be somewhere between 404,000,000 and 433,000,000 bushels.

Wild silk.

The wild silk fed on oak leaves, is one of the most important industries of south Manchuria. It has been developed to a great extent in the south section of Manchuria and it has now become one of the important industries in that region. The most prominent districts for wild silk raising are Kaiping

Haicheng, Suiyen, and Kwantien, while Antung and Kaiping are known as the largest centers of Manchurian silk. Large quantities of silk are exported from Antung to Shantung, other parts of China and Japan. There are big numbers of this type of farming in Mukden and really it is only in this section that wild silk produced.

The following table shows the approximate number of farms in the principal districts of Mukden:

Districts.	Number of farms.
Liaoyang	170
Fu-Hsien	1143
Antung	1575
Haicheng	561
Suiyen	770
Kwantien	2527
Kaiping	5357
Feng-Hwang	663
Huan-Jen	51
Total	13,817

Since there are no reliable statistics worked out by the

government it is impossible to ascertain the quantity of wild silk cocoons produced in Manchuria. It can therefore only be given by estimation on the basis of the amount of export and of home consumption. The production of the cocoons for recent years must be between 6 to 7,000,000,000. The estimated total production of cocoons for 1910 to 1915 is as follows:

Years	Number of thousand
1910	5,042,737
1911	6,356,506
1912	7,059,103
1913	6,259,624
1914	5,030,286
1915	8,528,171

Stock farming.

In general, the Manchurian farmers keep large numbers of horses, mules, cattle, and donkeys, and this can be seen in their farming assisted by those animals. However, the big pastoral grounds are found far north where the population is not dense. Before the immigration of the Chinese farmers from the south, the chief occupation of the people was the raising of live stock and in consequence stock farming was greatly developed in those days. With the entry of the farmers from the south, the rich pastoral country was converted gradually into grain fields. So at present there is not much pastoral grounds left in south Manchuria because the population is big with a density of 133 per square mile, but in the far north in the western part of Heilungkiang Province and on the Mongolian frontier the people are as yet devoted to the breeding of live stock. Every farm keeps some pigs and a number of chickens

and on the big farms sheep and cattle are raised. Very few stock farms are found in south Manchuria and the type of farming in Manchuria in general, we may say, is mixed of grain and live stock. As to the amount of stock raised in Manchuria no statistics are available so the figures given in the following are only an estimate:

Kinds of stock	Number of heads
Horses	2,200,000
Mules	560,000
Cattle	1,837,000
Sheep	2,620,000
Donkeys	510,000
Hogs	5,300,000

Forestry.

Most of the big forests are found in the far north of Manchuria especially along the ranges of Khingan and Changpai Mountains, so the most valuable forests are on the north and east. In south Manchuria afforestation is needed in many places. Hills and mountains now bare and barren are capable of being converted into fine forests to the benefit of the people. The trees in the forests of the far north are mostly of the pinus, quercus, and salix family. These large pines, often with a circumference of 12 to 14 feet, have a height of about 100 feet. The following table shows the distribution of forests and estimated numbers of trees in Manchuria:

Province	Location of large forests.		No. of trees in thousand
	Located by Mt. ranges	Located by rivers	
Mukden	Sungling		Suichung, Chihhsi, 1,000
	Tailing)		Ningyuan, I-Hsieh
	Fenshuiling)		Kaiyuan, Fushun 28,800
	Hamaling)		Hailung, Hsingking
	Laoling	Right bank of upper valu	etc. Linkiang, Liu-Ho 14,400 Tinghua

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Province	Location of forests. Located by Mt. ranges	Located by rivers.	Located by districts	No. of trees in thousand
Total forward (Mukden)				44,200
	Lungkang Shamuling	Right bank of mid. Yalu	Hwai-Jen	16,200
Kirin	Changpai- branches	Upper Sungari	Mengkang Hua-tien, etc.	21,400
	Heishan	Upper Hurka	Yenki, Tunhua, etc.	5,400
	Changkwan- tsailing		Kirin, Tunhua, etc.	21,600
	Hsiao-Chang- pai	Lalin Ho	Wuchang, Chang- show, Pin-Hsien, etc.	30,600
	Mukotchen-shan	Upper Sui- fenho and Tumen	Huichun, Min- gan, Tungning, etc.	21,600
Heilung- Kiang	Small Khing- an	Hulan-Ho	Suihua, Heilun, Yuking, etc.	720,000
	Great Khing- an		Aigun, Hulun, Munkiang, Lungkiang, etc.	5,400,000
Grand total for the three provinces				6,299,000

Labor.

Probably not more than two-thirds of the whole arable land of Manchuria is at present under cultivation. Particularly the sections of north Manchuria, the provinces of Kirin and Heilungkiang are still waiting for development. The present colonists are of themselves unable to cope with the land they have taken up, and labor is yearly imported from the northern provinces of China, especially Shantung and Chihli to till, sow, and reap. From Chefoo, Shantung, alone more than twenty-five thousand agricultural laborers come to Manchuria every year and go back at the end of the

year. The provinces of Chihli also send a large number of laborers but they enter and leave by land so there is no means at hand to know how many laborers come into Manchuria. It is estimated that no fewer than 300,000 laborers enter Manchuria every year, but even this amount of labor does not seem to be much account when scattered over Manchuria. The farm work has to be done by hand, no farm machinery being used even at the present time. Horses and cattle are used as the means of power to plow, sow, and harvest.

Method of farming.

The method of farming in Manchuria is nearly the same as in other parts of China. In Mukden province the farming is carried on on a small scale, but big farms are found in the north and a certain rotation is followed. The fields of millet, kaoling, and wheat will be seen in miles and the corn planted alternately with soy beans or other beans but not over 28 inches apart, one stalk of corn in a place every 16 to 18 inches, all carefully hoed. The sharp ridge cultivation is generally practised all over this part of China. Animal and human manure and earth composts are used as fertilizers applied to soil. The large soy bean fields are seen in the central portion and northern sections of Manchuria. Fields in this part of China are larger than in China Proper, and the cultivation is done with cattle and horses and a large number of men work in gangs of ten, twenty, and sometimes as high as thirty to fifty or sixty, hoeing kaoling, corn, millet, and soy beans. The three year rotation is practiced on the big farms generally

A rotation of millet, beans, small grain is used. On small farms the soy bean and corn are planted in the same field with alteration of hills in a row and followed by millet and then sorghum or some small grain.

Manchuria exports large quantities of agricultural products every year to the southern provinces and foreign markets. The soy bean products are famous in the world trade and because of rich soil and favorable conditions of the large uncultivated area in Manchuria, there is great possibility for development as a field of agricultural enterprise. With three big ports of Newchwang, Dairen, and Antung in Manchuria, the farm products can be shipped out to any section of China and any part of the world and so the farmers can get a better price on their products.

The principal articles exported through the maritime customs at Newchwang during the years 1904, 1913, 1915, and 1918 were as follows:

Article	1904 (Tons)	1913 (Tons)	1915 (Tons)	1918 (Tons)
Beans	121,825	90,823	134,135	36,677
Bean cake	132,411	281,927	272,401	117,248
Bean oil	4,784	7,531	4,018	480
Castor oil	157	914	405	162
Seed	1,317	1,575	1,061	423
Cereals		40,544	15,749	15,614
Silk, wild and refuse	825	725	1,067	383
Tobacco	41	96	38	131
Wool			75	
Hides	43	251	17	
Bristles	14	123	210	167
Kaoliang spirit	457	1,455	1,803	1,611
Skins (furs) pcs.	3,584	89,806	74,253	

The principal articles exported from Dairen during the years 1908, 1913, and 1918 are as follows:

Article	1908 (Tons)	1913 (Tons)	1918 (Tons)
Bean cake	210,472	536,966	977,539
Bean oil	3,906	38,714	137,521
Beans	220,377	165,216	371,561
Hemp seed		16,822	3,860
Kaoliang		26,615	58,507
Millet		48,276	7,797
Sesame	2,026	2,236	494
Tobacco Leaf	139	837	84
Silk: Cocoons, wild, Lbs.			
Raw, wild	1,538,800 1,360,933	5,872,667 1,106,400	12,191,733 1,147,333

The principal articles exported through the Maritime Customs at Antung in 1908, 1915, 1917, and 1918 are as follows:

Article	1908 (Lbs.)	1913	1915	1917	1918
Bean cake	30,478,800	72,644,400	100,509,200	226,336,133	194,100,933
Beans	3,051,600	15,233,200	45,132,400	77,361,066	71,219,600
Bean oil	4,000	384,133	1,044,400	6,230,000	4,329,066
Kaoliang		3,959,733	1,677,200	454,800	
Corn	1,158,266	2,983,466	5,781,333	12,068,667	15,162,933
Millet		46,880,200	29,356,800	42,809,200	
Kaoling wine		1,413,066	561,466	269,867	240,133
Wild raw silk	1,066		1,194,266	371,333	296,533
Cocoons, wild	12,856,800	16,024,400	22,487,600	6,240,267	12,851,866
Waste silk	432,800	612,166	974,533	252,000	527,200
Cocoons, refuse	33,066	96,933	132,933	400	28,400
Pongees	666	11,866	22,666	5,867	27,066
Tea			799		
Tobacco	76,400	39,200	41,200	37,867	27,867
Vermicelli			42,400	46,533	55,200
Mushrooms	69,600	25,600	13,200	6,400	23,600

Modern farm machinery in Manchuria.

Modern agricultural machinery is being introduced, but the farmers are slow to accept it. Western plows, harrows, cultivators, planters, grain drills, and others are practically unknown. The farmer in Manchuria usually has a large family and believes in the efficacy of hand labor. In the prosperous districts of

1. The first part of the document discusses the importance of maintaining accurate records of all transactions. It emphasizes that proper record-keeping is essential for the transparency and accountability of the organization. This section also outlines the various methods used to collect and analyze data, ensuring that the information is reliable and up-to-date.

2. The second part of the document focuses on the implementation of the proposed changes. It details the steps involved in the process, from initial planning to final execution. This section highlights the challenges faced during the implementation phase and provides strategies to overcome them. It also discusses the role of different departments in ensuring a smooth transition.

3. The third part of the document addresses the future outlook of the organization. It discusses the long-term goals and the strategies to achieve them. This section also mentions the importance of continuous improvement and the need to stay updated with the latest trends in the industry. It concludes by expressing confidence in the organization's ability to meet its future challenges.

4. The fourth part of the document provides a detailed analysis of the financial performance of the organization. It includes a comparison of the current year's performance with the previous year's, highlighting the areas of improvement and the challenges faced. This section also discusses the impact of the proposed changes on the financial health of the organization and provides a forecast for the future.

5. The fifth part of the document discusses the human resources aspect of the organization. It mentions the current state of the workforce, the skills and qualifications of the employees, and the plans for recruitment and training. This section also highlights the importance of maintaining a motivated and skilled workforce to achieve the organization's goals.

6. The sixth part of the document discusses the legal and regulatory aspects of the organization. It mentions the various laws and regulations that the organization is subject to and the steps taken to ensure compliance. This section also discusses the importance of maintaining accurate records of all legal and regulatory activities.

7. The seventh part of the document discusses the environmental and social aspects of the organization. It mentions the organization's commitment to sustainability and the steps taken to reduce its carbon footprint. This section also discusses the organization's efforts to support the local community and improve the quality of life for its employees.

big farms usually a number of 20 or 40 laborers are hired to do the work. Tractors and plows have been used by an American company in north Manchuria where there are many acres of land under cultivation, but it has been found that the cost is too great. This is because the hand labor with horse power is cheaper in production than with traction machinery. So long as the horse and hand labor are so comparatively cheap, the market for modern agricultural machinery will not be great.

Agricultural education in Manchuria.

There are only few agricultural schools in Manchuria at present. Very few courses are given and as a whole the agricultural education is very poor in the three provinces. During the last decade the Mukden provincial government expended a considerable amount of money in establishing institutions to foster agriculture and forestry in south Manchuria. Agricultural experiment station, agricultural schools, forest-tree nurseries, and experiment farms were organized. Owing to various causes, these are now either closed or suspended. A large experiment station and agricultural school were established at Mukden. It possesses about 250 acres, was well equipped with buildings for farm work, and has class rooms and dormitories for quite a number of students. It was also well stocked with foreign cattle, sheep, and swine. It suffered much from having no unified plan of management. The Mukden Forestry Department has about 700 acres and a number of young trees growing there. There is also a government live stock farm at Chenan, near Jaoyangho, on the Peking Mukden Railway, possessing 15,000

acres, which was well stocked with foreign horses, cattle, and sheep. There is a fruit nursery at Kwangning where apples, pears, peaches, cherries, plums, grapes, raspberries, and blackberries are all successfully grown.

The future development of agriculture in Manchuria.

Manchuria is primarily an agricultural section of China and owes recent economic development chiefly to agricultural products. It is rich in great level, fertile plains, adapted for agriculture on an extensive system. The total area of arable land is roughly estimated at 385,289 square miles, of which not more than two-thirds are under cultivation. About 90 percent. of the cultivated land is taken up by soy beans, wheat, millet, and kaoliang, these four being cropped in rotation. Manchuria always has a surplus of food products whether the year is good or bad. This is because she has more land in proportion to the population in that section and the soil is rich, and fertile. It produces not only sufficient food supplies for that section alone, but furnishes a large quantity of food products to her sister provinces, as well as to the world.

The following tables will show the surplus food products of Manchuria in cereals and beans, exported from the ports of Newchwang and Dairen (Antung is not included on account of no available statistics in 1918 and 1919.

Exports through port of Newchwang in 1918 and 1919:

Article	1918 (Metric tons)	1919 (Metric tons)
Bean cake	106,366	200,234
Bean oil	960,800 lbs.	14,206,400 lbs.
Beans: Black	6,206 tons	9,933 tons
Green	5,638	5,634
Red	371	252
White	1,180	2,395
Yellow	19,877	51,905
Cereals: Barley		1,568
Kaoliang	6,363	679
Corn	2,960	16,854
Millet	1,928	5,459
Wheat	2,881	12,342

Exports through port of Dairen in 1918 and 1919.

Bean cake: To Foreign countries	791,207	933,287
To Chinese ports	81,596	3,009,084
Bean meal	29,937	30,176
Beans--in bushels of 60 lbs.		
To foreign countries	11,220,442	20,900,118
To Chinese ports	1,166,029	969,796
Barley--in bushels of 40 lbs.	31,114	399,039
Corn--in bushels of 58 lbs.		
To foreign countries	89,117	962,746
To Chinese ports	326,476	88,550
Wheat flour--bbls. of 196 lbs.		
To foreign countries	19,418	11,897
To Chinese ports	13,744	5,709
Kaoliang--in tons		
To foreign countries	4,564	30,001
To Chinese ports	67,671	6,883
Millet--in tons		
To foreign countries	6,404	37,641
To Chinese ports	558	271
Wheat--in bushels of 60 lbs.	972,260	1,651,924
Bean oil--in tons		
To foreign countries	122,604	108,816
To Chinese ports	183	5,369

Manchuria needs labor and the proper development of farming. More than one-third of the uncultivated land can be turned into farm land, all the conditions required for that purpose being taken into consideration. With all the lands cultivated in Manchuria it will not only give the possible addition of food supplies to China, but to the world as well,

because its soy beans and their products have already become important items in the world use. This means that the more land cultivated in Manchuria the more soy beans and their products are exported to meet the world demand.

The future development of Manchurian agriculture depends largely on the following considerations which should be carried out properly:

1. Transportation facilities: This is the first important factor in the development of agriculture in Manchuria because it is found that the most prosperous agricultural regions are the sections where the transportation is convenient. In the northern sections in Manchuria more lands are uncultivated and that shows the respective development in the three provinces with the extent of transportation facilities. So the improvement of canals and rivers for water transportation is very important as a means of cheaply moving the bulky freight of grain, and railways and roads should be built for the convenience of transportation. Building of good roads must be pushed forward for hauling products to shipping points and enable farmers to market products which they could not market with roads over which they could not easily transport them. Good roads increase the value of farmers' marketable products and increase the value of the land. They also make life more pleasant on the farm if the means of communication and transportation with others and outside world are made better. Therefore the transportation facilities must be made easy for the future development of agriculture in the far remote regions of Manchuria.

2. Technical education in agriculture: This is the most important consideration for the future development of agriculture in the three provinces. Trained men are needed to carry out the policy of agricultural development and better methods of farming for the future improvement. So the agricultural institutions should be well established to meet this demand.

3. Immigration: The development of Manchurian agriculture since the early times has been due to the immigration from the south to open the future development in Manchuria. Manchuria is now lacking in labor and a policy of immigration to colonize the remote regions should be worked out by the government by granting the lands to farmers with 3 or 5 year term payments of the land value. At the same time, the government should give good protection to farmers where they are farming. In this case the more immigrants enter and settle in Manchuria the more lands will be cultivated with the consequence of a large production of crops.

4. Agricultural organizations: This is essential to promote the interest of farming and to encourage the farmers to improve the methods of cultivation. This kind of organization has been established for a number of years in China, but under the management of non-agricultural trained men the work has not been very successful. In the near future this organization should cooperate with the agricultural institutions to work out the better development of agriculture in Manchuria.

5. Irrigation: Irrigation is necessary in Manchuria because the rainfall is not well distributed throughout the months in which crops make their greatest growth and also the drouth usually occurs with a result of failure in crop production. Irrigation is practicable in Manchuria because there are so many rivers, especially the Sungari, the Liao, and others can irrigate most the area of the fertile plains along those sections. The farmers and the government should work in cooperation in the construction of systems of irrigation. Since in most cases the water can be taken from rivers and streams, canals should be built. In some cases dams are necessary to raise the level of the water in the streams from which the water is drawn. In other cases dams should be made to create great storage reservoirs in which supplies of water are accumulated to be used when the crops most need them. However, this should be worked by the construction men whatever the system of irrigation should be.

There are of course many points to be considered for the future development of agriculture in Manchuria and suggestions mentioned above only emphasize the immediate steps which should be taken to cultivate all the Manchurian lands to produce a great production of food supply.

Farm plan in Manchuria.

The land around Mukden is divided into small fields, in which farming is carried on in the intensive manner practiced in the southern provinces, but the typical Manchurian farm is one of from 200 to 300 acres. Practically there is no definite field plan in field divisions for a system of crop rotation.

Though kaoliang, soy beans, millet, corn, and wheat are grown in rotation, the farmers have not laid out a plan for growing the crops. The farmers grow all these crops on their farms, but usually kaoliang and soy beans occupy a large portion of the land with a few acres of corn, millet, wheat and some other crops. The lands or farms are usually about 100 acres square and this is because the government divides the lands in such a unit to sell to the people. Therefore, if a farm has 300 acres farm and bought the lands at different times the farms will be 100 acres in one piece and 200 acres in another. Of course there are some big farms, such as 1000, 8000, 5000, or even more than ten thousand acre farms, but as a typical Manchurian farm we will take 200, 300, or 500 acre farms. There is no pasture on the farm and all the lands are planted with cereal crops. The farmers live in the villages or towns and go to the fields in the morning and return to their homes in the evening so no farm house can be seen on the farm.

An original and revised farm plan is given on the next page. It represents a general type of farming. Pigs and poultry are raised on the farm and horses and cattle are kept to do the farm work. In general the farm is entirely devoted to cereal crops and live stock is only a side line. The soil varies from loams to silt and clay and good crop production can be obtained under normal conditions. Sorghum, millet, corn, soy bean and wheat are the main crops in these sections but sometimes these are a failure due to drought during the growing season, so irrigation is profitable if the water can be drawn

from rivers. The big markets are in the south, such as Mukden, Newchang, Antung, and Dairen, and in the north such as Chengchun, Harbin, etc. Since the railways were built and the rivers are navigable for hundreds of miles the facilities of marketing farm products are good, but in the far remote regions far from shipping points the transportation facilities should be improved for future development. The distance from various markets varies with different directions. However, the farmers can sell their products in local markets to the grain dealers and then it is shipped to the big markets. The lands are now in high fertility, especially the new lands where no manure or fertilizer has been applied.

The new plan to revise the farm is shown in the next page by map in which the fields have been divided and system of rotation planned. The farm is divided into three divisions for which a three year rotation has been planned. According to the rotation every year a certain number of acres of wheat, soy beans, corn, millet, and sorghum are grown. No legumes such as alfalfa or clover being planned in the rotation because it is going to be used as a cereal crop farm, and sorghum and the millet straw and corn stalks will be used for roughage, and corn sorghum and soy beans for grain feed for horses and cattle. The soy bean is the only legume used in the rotation and it may be sown after harvesting the spring wheat the idea being to grow two crops in the same year. If the soy bean can mature for seed production, then it will be cut for seed, if not, it will be plowed under in the fall to benefit the soil and next crop.

However, this system of rotation is not very efficient in maintaining the fertility of the land, so the manures or commercial fertilizers should be used and applied according to the conditions of soils. Most the lands have plenty of lime and if legumes, such as beans and peas, are used in rotation not much nitrogen is used, but phosphate is the only fertilizer necessary. The rotation has to do with the cropping system there so there is no definite formula for fertilizers. In conclusion, for revision of plan of the farm and fertilization system, the farmers must consider financial returns, possible as the result of revision of the cropping system.

The original farm of 200 acres.

100 A.	100 A.
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The following is a revised farm plan of 200 acres with three field division of 3-year rotation.

66 A.	66 A.	66 A.
1. Wheat followed by soy beans.	1. Soy beans.	1. Millet, corn and sorghum.
2. Millet, corn and sorghum.	2. Wheat followed by soy beans.	2. Soy beans.
3. Soy beans.	3. Millet, corn and sorghum.	3. Wheat followed by soy beans.

----- Field division.

----- Field lanes.

===== Roads.

The original farm of 500 acres.

	100 A.	100 A.
100 A.	100 A.	100 A.

Revised plan of 500 acre farm with 5 fields with 5 year rotation.

	96 A. Field I. 1. Soy beans. 2. Wheat. 3. Sorghum. 4. Beans. 5. Corn and millet. Homestead.	100 A. Field II. 1. Wheat. 2. Sorghum. 3. Beans. 4. Corn and millet. 5. Soy beans.
100 A. Field III. 1. Sorghum. 2. Beans. 3. Corn and millet. 4. Soy beans. 5. Wheat.	96 A. Field IV. 1. Beans. 2. Corn and millet. 3. Soy beans. 4. Wheat. 5. Sorghum.	100 A. Field V. 1. Corn and millet. 2. Soy beans. 3. Wheat. 4. Sorghum. 5. Beans.

----- Field division lines.

==== Road.

Chapter 4

GENERAL DISCUSSION FOR THE FUTURE DEVELOPMENT AND IMPROVEMENT OF CHINESE AGRICULTURE, WITH POSSIBLE ADOPTION OF WESTERN SCIENTIFIC METHODS BY INTRODUCING MODERN FARM MACHINERY.

China is essentially an agricultural country. She has a big area of land and large population. With favorable climate and plenty of labor, she produces the biggest production of agricultural products of all the nations of the world.

There are still many acres of land in northern China, especially in Manchuria, Mongolia, Sin-kiang, and Tibet, which are in most part good for agriculture and even in China Proper some sections of the lands are uncultivated. With the regions along the valleys of Yellow River, Hwai River, and some other big rivers in the southern provinces reclaimed and the border provinces colonized, China's crops alone would support double her present population of 400,000,000, so the production in the future will be not only sufficient for her own consumption, but for world supply as well. There is great possibility of development as a field of agricultural enterprises in those sections, especially the provinces of Manchuria, Mongolia, Sin-kiang, and Tibet. Due to the lack of proper transportation facilities and the uneducated farmers there has been a great drawback in Chinese agriculture. The big area of land, the favorable climate, and the large population have been the same since ancient times, but now the agriculture of other nations is much in advance, while China is far behind. Therefore, the future development and improvement of Chinese agriculture must be worked properly.

Education in agriculture is the first important thing in the development and improvement of agriculture because the drawback of the present Chinese agriculture is due to the fact that the farmers do not have education and the educated men do not study agriculture. That China needs how is trained men who are interested in the work of agriculture to carry out the policy of agricultural development and better methods of farming for future improvement. In order to have men well-trained on these lines, agricultural schools should be established by the provincial government.

The transportation facilities are big factors which affect the present agricultural development and conditions in China. Very little land is cultivated in the far remote regions where the facilities of transportation are poor. This is so in border provinces and some sections in southern provinces. Most of the lands in the border provinces are rich and fertile and produce good crops, but the inadequate transportation facilities for marketing agricultural products cause very little land being farmed. So the railways and roads should be built and waterways should be improved for transportation. In this way the farmers can move their grain to the market and the value of agricultural products will be increased and the people in the city can buy a cheaper food stuff. It is usually found that the price of the agricultural products is very high in the cities or in sections where the population is dense, while the products on the farm of the remote regions far from market sell very low. Therefore, the improvement of transportation facilities

ties would not only help the farmers to sell their products at a better price, but the people could buy a cheaper food.

A policy of colonization of border provinces should be worked by the government. The lands should be granted to the immigrants for a number of 3 or 5 years terms in payment of the land value from the time they have taken it up, and as the result more lands would be cultivated and more production of food products obtained. Open boundary regions for farming would mean a decrease in the density of population of the southern provinces and increase the production of crops and the value of lands. Granting lands to the disbanded soldiers is another step the government should take up to farm those lands in the north. If the soldiers are converted into farmers, and greater efforts directed to the production of goods than to their distribution, the dawn of a new China might be safely predicted. Moreover, the people colonized in boundary regions would not only farm the lands for production of crops, but protect it from invasion from outside as well.

In order to make every acre of land yield its right quota of produce, farming methods should be modernized. The present methods of agriculture in most sections deprive the soil of humus. There is no system of crop rotation. This condition is aggravated by the continual raking away of the stubble for fuel, thus depriving the soil of organic matter. The scarcity of animals makes the price of manure prohibitive. The use of night soil, procured in the cities, and farm manure and earth composts are the only methods adapted for keeping the soil pro-

ductive. The necessary changes for improvement might be:

1. Rotation of crops should be in system, so that nitrogen consuming crops may be succeeded by nitrogen-producing crops, and deep and shall crops should alternate.

2. Animal husbandry should exist, hogs, sheep, cattle, and horses should be bred, in order that they may consume the grass crops of the farm and the by-products of the crops.

3. There should be improved methods of tillage, this involves the supersession of the inadequate implements by modern ones.

4. Afforestation policy is imperative, in order to check soil erosion and driftage, and the silting up of the navigable rivers.

These are some of the points which should be adopted for improvement, but these can come only with the complete education of the people. Government or provincial crop improvement stations should be established to distribute the seed to farmers for its best adaptation.

With the development of agricultural industries, a demand for the improvement of different classes of live stock in China is necessary. Three methods of improvement can be adopted:

1. Improvement within the breed. A few generations of intelligent selection of individuals for breeding purposes would greatly improve the stock.

2. The second method of improvement would be to introduce males of improved breeds for mating with native stock.

3. The third method for improvement of native stock is to secure pure bred animals of desirable breed and continue to

breed them pure. The first method of selection within native breed is safest, but slow in bringing results. Introducing modern improved breeds will bring better results, provided only that good, healthy animals are secured and intelligent breeding is practiced. However, the most important thing is that men well trained in animal breeding and feeding are much needed in China to improve the quality of live stock raising as well as for the crop production are great in the border provinces where the lands are good for grazing. The mixed farm of live stock and cereal crops is important in these regions because of maintenance of soil fertility.

It is now questionable whether or not the modern farm machinery would be adopted to our conditions. Because on the average the farmers have a small acreage, except Manchuria, Mongolia, Sin-kiang, and Tibet, and the lands are all divided into small fields, in which farming is carried on in an intensive manner. However, in these border provinces the modern farm machinery would be adaptable to operate on the greater farms but these implements should be used with horse power because gas costs too much. The farm implements manufactured in the western countries are used and adapted to their own conditions in the extensive way so those tools may not be adapted to the conditions in China and also the cost is rather high for our farmers to buy them. So the best way to do is to have men trained, knowing the conditions in China, who will design types of farm implements similar to the western plows, drills, planters, cultivators, and other tillage im-

plements and sell to the farmers as cheap as possible.

In conclusion, the future development and improvement of Chinese agriculture depends largely upon (1) Education, (2) Immigration to colonize the border regions, (3) Transportation, (4) Improved farming methods, and (5) Improved farm implements.

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