



TOGETHER
for a sustainable future

OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.



TOGETHER
for a sustainable future

DISCLAIMER

This document has been produced without formal United Nations editing. The designations employed and the presentation of the material in this document do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations Industrial Development Organization (UNIDO) concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries, or its economic system or degree of development. Designations such as “developed”, “industrialized” and “developing” are intended for statistical convenience and do not necessarily express a judgment about the stage reached by a particular country or area in the development process. Mention of firm names or commercial products does not constitute an endorsement by UNIDO.

FAIR USE POLICY

Any part of this publication may be quoted and referenced for educational and research purposes without additional permission from UNIDO. However, those who make use of quoting and referencing this publication are requested to follow the Fair Use Policy of giving due credit to UNIDO.

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org



TOGETHER
for a sustainable future

OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.



TOGETHER
for a sustainable future

DISCLAIMER

This document has been produced without formal United Nations editing. The designations employed and the presentation of the material in this document do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations Industrial Development Organization (UNIDO) concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries, or its economic system or degree of development. Designations such as “developed”, “industrialized” and “developing” are intended for statistical convenience and do not necessarily express a judgment about the stage reached by a particular country or area in the development process. Mention of firm names or commercial products does not constitute an endorsement by UNIDO.

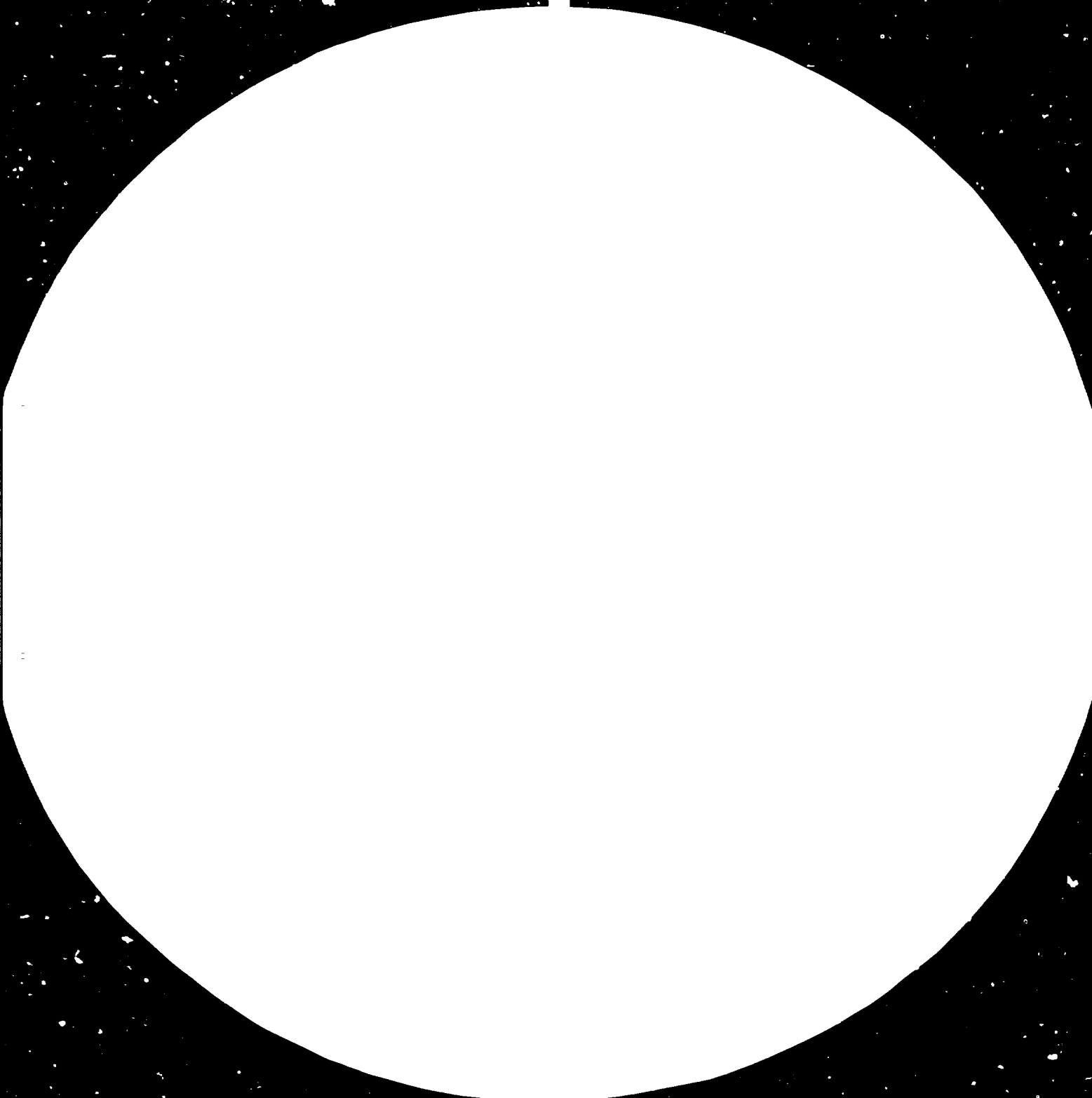
FAIR USE POLICY

Any part of this publication may be quoted and referenced for educational and research purposes without additional permission from UNIDO. However, those who make use of quoting and referencing this publication are requested to follow the Fair Use Policy of giving due credit to UNIDO.

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org





 1.25 

 1.4 

 1.6 

.....

.



2.8



2.5

3.6



2.2

5.0



2.0

1.1



1.8

10724

Distr.
LIMITED

UNIDO/PC.16
7 September 1981

English

UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

Second Expert Group Meeting to prepare for the
Second Consultation on the Agricultural Machinery
Industry

14-16 September 1981
Vienna, Austria

CHINA'S AGRICULTURAL MACHINERY INDUSTRY*

Contribution of the secretariat of UNIDO

by

Hong-fang Xiao
Sectoral Studies Branch
Division for Industrial Studies

501

*This document has been reproduced without formal editing.

V.31-29429

CONTENTS

	Page
1. Basic agricultural condition in China	
1.1 The population of China	1
1.2 The land area of China	1
1.3 The climatic condition in China	2
1.4 The organization of China's agricultural production	2
1.5 The main crop in China	3
2. Agricultural mechanization in China	4
2.1 Types of agricultural mechanization	4
2.2 Levels of agricultural mechanization	4
2.3 Problems and trends in China's agricultural mechanization	5
3. China's agricultural machinery industry	10
3.1 The population of agricultural machinery	10
3.2 The manufacturing capability of the agricultural machinery industry	12
3.3 Categories and characteristics of China's agricultural machinery	13
3.4 A characterization of China's agricultural machinery industry	18
3.5 Further development of China's agricultural machinery industry and some considerations	21
Appendix	23

The agricultural machinery industry not only serves agriculture and agricultural mechanization, but is also based on agriculture and agricultural mechanization. In order to discuss the subject of China's agricultural machinery industry, we must first clarify the agriculture and agricultural mechanization situation in China. Agriculture covers a wide area including forestry, husbandry, side occupation, and fishery, etc., but we will discuss only what concerns crops, since the production of agricultural machinery at the present time is mainly for crop production, with the rest accomodating forestry, husbandry, side occupation, and fishery, a very minor part of total agricultural machinery production.

1. Basic agricultural conditions in China

General speaking, the agricultural conditions in China is not favourable. A huge population with little arable land area per person, great geographical and climatic differences, a large variety of crops and farming technologies, a low level of agricultural production, low farmers incomes and food consumption constitute the basic condition of agriculture in China. At present, the government of China is making every endeavour to promote the modernization of socialistic agriculture.

1.1. The population of China ^{1/}

The total population of China (not including Taiwan or Chinese overseas) in 1979 was 970 million, of which the agricultural population was 810 million, and in 1980 was 982 million. The population is increasing continuously and the growth rate is about 1.2 per cent.

1.2. The land area of China ^{2/}

The total land area of China is	959,696,000 ha.
of which:	
Arable land area and permanent crop land	106,500,000 ha.
Forest and wood land	121,500,000 ha.
Permanent meadows and pastures	211,200,000 ha.

The average area of arable land per capita is about 0.1 ha, much less than the world average of 0.35 ha. per capita.

^{1/} Bulletin of State Statistics Bureau of China.

^{2/} FAO Production Yearbook 197c.

1.3. The climatic conditions in China

There are great climatic differences due to the huge land area. These could be divided into four parts such as:

The North-West area: this occupies about one fourth of the total land area of the country and has a low temperature and sometimes low precipitation. A certain part of this land is semi-desert and desert. There are few arable land regions with a lower crop yield.

The South-West area: this mainly a mountainous district. It is of hilly terrain with a few arable areas scattered in plots, but warm weather and rich precipitation.

The North-East area: part of this region has not yet been exploited due to cold weather conditions and a sparse population.

The South-East area: this is the best farming area as its weather is warm and humid, but the average arable land area is very small due to the dense population.

As a result of great difference of climatic and natural conditions and the backwardness in science and technology, China's agriculture is handicapped in the fight against natural disasters. Floods in the south and drought in the north are a common occurrence, and are the cause of frequent bad harvests. Taking the country as a whole, the average amount of suffering area for every year come to about one quarter of the total arable land area. Counting the years from 1949 liberation of China to 1979, a total of 30 per cent produced bad harvests as a result of serious disasters, 40 per cent produced average harvests and 30 per cent had bumper harvests. The average quantity of food grains per capita was as low as about 342 kg. in 1979.

1.4. The organization of China's agricultural production^{3/}

The basic unit of agricultural production, product distribution and accounting is the production team. In China, there are a total of 5.15 million production teams with an average of 34 holdings and 157 people per team.

^{3/} Reference material of Agricultural Machinery Ministry of China.

There are a total of about 53,000 people's communes and about 700 thousand production brigades. They are two organization units above the production team, but almost all of them are not accounting units.

Besides the above production units of agriculture, there are about 2000 state farms which are owned by the people as a whole, as are a total of about 4 per cent of the total arable land area of the country.

1.5. The main crops in China^{4/}

The staple crops in China are rice, wheat, corn, sorghum, beans and many kinds of potatoes. The main cash crops are cotton, oil crops, sugar cane, sugar beet, and tea.

Statistics for the above crops are shown as follows:

	Yield in 1979	Yield in 1980
a. Total food-grain	332,115,000t	318,220,000t
of which: paddy		139,255,000t
wheat		54,155,000t
various potatoes		27,845,000t
beans		7,880,000t
b. Cash crops		
of which: cotton	2,207,000t	2,707,000t
peanut	2,822,000t	3,600,000t
oil seeds	2,402,000t	2,384,000t
sesame seeds	417,000t	259,000t
sugar cane	21,508,000t	22,807,000t
sugar beet	3,106,000t	6,305,000t
tea	277,000t	304,000t

^{4/} Bulletin of State Statistics Bureau of China.

2. Agricultural mechanization in China

General speaking, China will have to follow the principle of using a combination of machinery, draught animals and manual labour for a fairly long time, which means that agricultural mechanization will be limited to selected areas, farming operations and crops depending upon different levels of production.

2.1. Types of agricultural mechanization

There are three types of agricultural mechanization:

- a. Basic full mechanization: most state farms, but fewer communes or production brigades have been basically fully mechanized. They use machines in ploughing, harrowing, drilling, cultivating, fertilizing and harvesting etc., but this represents only a small percentage of the total arable area of the whole country.
- b. Partial mechanization: a large number of communes and production brigades has been mechanized in some labour intensive farming operations, such as: pumping and draining with pumps, ploughing with tractors, food grain threshing and food processing with threshing machines and processing machines, and transport with tractors and trailers. The remaining farming operations continue to use hand labour and some animal drawn implements. However, this kind of commune and production brigade represents nearly half of all those in China.
- c. Farming based on animal drawn power: with the exception of the above mentioned units, the remaining communes and production brigades are still in the stage of farming employ animal drawn implements and hand tools. They use animals for ploughing, harrowing, irrigating, and hand tools or animal drawn implements for drilling, cultivating, fertilizing, harvesting and threshing.

2.2. Levels of agricultural mechanization^{5/}

Based on the number of hectares planted in 1980, the levels of mechanized farming operations can be shown as follows:

^{5/} Reference material of Agricultural Machinery Ministry of China.

Operation	Covered land areas 1000 ha. (mechanized)	% of the whole planted area
a. Ploughing	40,991	41.3 %
b. Drilling	15,300	10.9 %
Transplanting	200	0.58 %
c. Irrigation	26,470.	56 %
d. Harvesting	4,350	
e. Threshing	Almost all mechanized	

2.3. Problems and trends in China's agricultural mechanization

a. Most farmers are unable to purchase agricultural machinery.

Due to the limited arable land area per person, the low food-grain selling price and low productivity, Chinese farmer earns about 100 US\$ per capita per year in average. Although the prices of Chinese agricultural machinery are not too expensive, but they can't afford to purchase agricultural machinery, especially such sophisticated machines as harvesters, which is used for only one month each year, with such poor incomes.

China is making an endeavour to develop simple low-cost agricultural machines and to expand the uses of agricultural machines. In recent years, the rapid development of walking tractors has been a marked example of this case. The walking tractor is low-cost and has multiple uses. It is suitable for the wet-farming of small plots and it can be used for ploughing, harrowing, drilling, transplanting, fertilizing, pumping and draining, harvesting, threshing, transport and many other operations when it is coupled with appropriate implements. Then the utility of the machine is enhanced.

In the meantime, the Chinese government is lowering the selling price of agricultural machinery and limiting profit both in the manufacturing process and in the distributing process. Some factories, especially those involved in the trial production of new machinery, are given subsidies to cover losses resulting from lower selling price. Farmers are also given credit by the government for the purchase of agricultural machinery.

In some areas, the Chinese government has established many tractor stations and pumping stations which hire machines to farmers for ploughing, harvesting and irrigation.

The high mechanization of agriculture combined with the wider use of chemical fertilizers has stimulated an increase in productivity and yield. But in some cases the cost of the product has also increased to a larger extent than that of lower mechanized process, due to the high depreciation of machines and the high cost of fuel and fertilizers.

The inevitable result was that the farmers' incomes in such communes or brigades has stagnated, and in some instances decreased.

What level of agricultural mechanization should be kept and what kinds of agricultural machinery should be used?

Obviously, this is to be determined first of all from the economic results. It depends upon whether the output, income and specially the proportion of marketable farm produce to the total output can be rapidly increased and whether the living standard of the peasants can be rapidly improved. At present, if many communes or brigades using animal drawn implements get better economic results, they will have to retain these implements and not change to power machinery. They will mechanize these farming operations, however, if good economic results are achieved in using power machinery. Of course, it is nonsensical to carry out agricultural mechanization if there is to be no economic effect.

b. Agricultural mechanization and way out of labour force

Except in a busy farming season, the surplus labour is a regular phenomenon in the rural areas, because 80 per cent of the population is agricultural in China. Generally speaking, there will be certain surplus labour after agricultural mechanization is carried out, and part of the labour is transferred to positions such as machine operators, personnel for machine maintenance and other services required for agricultural mechanization. But it is presently impossible to recruit all this labour for industry, as the industrial development is slow and population increase is sharp. Therefore, it is necessary to divert attention to the placement of surplus labour while carrying out agricultural mechanization. Otherwise, an increase of surplus labour and decrease of the farmer's income will occur.

Currently, China has made great effort in family planning to reduce the growth rate of the population. However, a main trend is to develop a diversified economy in the rural areas. Through the development of a diversified economy, the farmers will get greater incomes and gradually become rich, while the surplus labour force will be introduced into the same rural area.

What aspects of a diversified economy should be covered? Of course, it depends on the local natural conditions, that is to say, forestry and husbandry could develop in mountainous areas, fishery and aquatic breeding could develop where rivers and lakes are present, sericulture and beekeeping could develop in plains areas. Small industry and handicrafts could develop in the vicinity of populated areas or where raw materials are available, etc. As in the case of the Chang-fa production brigade of Jilin province, which has now carried out basic agricultural mechanization, they own 900 ha. of arable land and a labour force of 1200, of which about one half concentrate on farming. The remainder of the labour force, a total of 649, is to be organized into ten specialized teams of the following sort:

Manure collecting team	121 labourers
Tree planting team	39 "
Poultry and livestock raising team	60 "
Brigade's industry (including brick-making, metal working, wood working, oil extracting and clothes-making)	117 "
Cash crop planting team (including tobacco, jute, and crude drugs)	19 "
House construction team	80 "
Agricultural research team	11 "
Machinery repair and maintenance	69 "
Team for education and public health	41 "
Members working in Commune-run enterprise	92 "

In the first production brigade of the Yueqi Commune, Wuxian County, Jiangsu province, the amount of farm land averaged less than 0.1 hectare per capita. The mechanization of agriculture has been in process since 1970. There are 314 holdings and 1597 people of which 758 constitute the labour force of this brigade. They have run 3

crops every year and the ploughing, harrowing, irrigating, and draining are mechanized, and 70-80 per cent of the transplanting and harvesting is mechanized. In 1979, they had 360 people in sideline occupations and in the brigade's industry. They are running a rice mill, a food processing mill, an agricultural machinery repairing workshop and an electronic parts manufacturing workshop. Moreover, they have run a pig farm, a chicken farm, a tailor's workshop, a workshop for embroidery and have done some work in tree planting. The annual output value of industry and sideline occupations reached 640,000 Yuan (~430,000 US\$) comprising 55 per cent of the total production value of this brigade in 1978. The per capita labour productivity has reached 1356 Yuan (~900 US\$). Nevertheless, the two above mentioned production brigades have enhanced food-grain production in a large part due to mechanization.

In incorporating modes of production for diversified agriculture, and promoting the development of side line occupations, and developing small industries and handicrafts among commune members, a large labour force has been introduced into China's rural area.

Up to now, there is no data about the labour force introduced in diversified agriculture and side line occupation due to statistical difficulties. According to the statistics in 1980 for handicrafts and small industries alone there were a total of 1.43 million enterprises owned by communes and brigades. These enterprises employed a total of 30.5 million labourers, fully about 10 per cent of the total labour force in China's rural area, and earned about 41 billion US\$ in 1980. While increasing the farmers' income and creating jobs, they have also laid the foundations for the further development of agricultural mechanization.

c. Energy resources for agricultural machinery

The fuel oil consumption of agricultural machinery is considerable in China. The total power of China's agricultural machines is about 200 million hp. and those of 130 million hp. use diesel oil. The diesel oil consumption of agricultural machinery is about 8 million tons and occupies 40 per cent of the total diesel oil consumption for the whole country. Moreover, greater fuel oil consumption causes an increase in

the cost of agricultural products. At the present time, there is no need for imported oil and no crisis in increasing prices in China, but it is significant to save the fuel oil to ease the situation of its shortage, to reduce the cost of farm produce and to aid in the further development of agricultural mechanization.

The present trend for energy is seen in diversified energy.

i. Developing minor hydropower stations in rural areas to supply electricity for stationary farm machinery. Most stationary farm machinery is electrically powered, and the government gives about 70 per cent price rate for electricity, where an electricity supply is available. In some rural areas, especially in the south of China where an electricity supply is not available, but where the hydropower resource is rich, the development of small hydropower stations with capacities from several kilowatts up to a hundred kilowatts is highly favoured. Using hydroturbogenerators, the power stations supply more cheap electricity either to drive pumps and other agricultural machinery, or to serve small rural industries and as house lighting. In many cases, the farmers use the hydro pump directly for irrigation or drainage. Such kinds of hydroturbo pump and small hydroturbogenerators are simple in construction, cheap in price, easy in operation and maintenance and easily manufactured by medium or small factories at a price affordable to farmers. According to the statistics, the total installed capacity of minor hydropower stations is 6,300 megawatts, and its electricity supply 11.9 billion kilowatt hours, which satisfied 37 per cent of the rural demand for electricity in 1979. It has made a great contribution towards the development of agricultural mechanization.

ii. Biogas^{6/}

The small-scale production of biogas using straw and cattle dung as raw materials, generated in a simply constructed generating pit has been rapidly developed of late in China. There is a total of 7 million of built generating pits with volume

^{6/} Documents of Technical Consultations among Developing Countries on Large Scale Biogas Technology, in China, 1980.

capacities of 3-10 m³, and about 30 million people are using the biogas. But most of these small biogas generating pits supply biogas for farmers' house lighting and cooking only. However, about 36,000 biogas generating pits with greater capacities have been built by communes, brigades, state farms, distilleries and food processing factories. These generating pits supply biogas for running internal combustion engines with dual fuel for water pumping, rice and flour milling, processing feed, drying agricultural products and generating electricity. According to incomplete statistics, there are about 715 biogas engine stations with a total installed capacity of 9234 Hp. and about 617 small biogas electro-power stations with a total installed capacity of 5069 kw.

iii. Other energy sources

There are many kinds of energy resources for agricultural machinery, such as solar energy for drying crops, wind energy for pumping water or generating electricity, tidal energy for generating electricity, and generating gas from coal as a substitute for fuel oil, etc., but this has just begun to be developed recently in certain areas of China.

Some energy resources, such as the production of alcohol from food-grain and edible vegetable oil as a substitute for fuel oil are developing in some industrial countries. Considering the unsatisfied demand for food-grain and vegetable oil in China in the recent past, energy substitutes using food-grain and edible oil are not presently suitable.

3. China's agricultural machinery industry

3.1. The population of agricultural machinery ^L

China has attached great importance to the development of agricultural machinery since 1949, and especially the engine powered agricultural machinery has been developed very quickly after China has begun to make tractors locally in 1958. Nearly all of the machines including in the inventory listed below, were built by China's agricultural machinery industry.

^L Bulletin of State Statistics Bureau of China Reference material of Agricultural Machinery Ministry of China.

No.	Items	Population in 1979	Population in 1980
1	Large, medium size tractors Walking tractors Total power of all tractors	670,000 units 1,670,000 units 4,6 million Hp.	745,000 units 1,674,000 units
2	Tractor drawn implements of which: Seeders Trailed rice transplanters	1,300,000 units 180,000 units 90,000 units	
3	Harvesting machinery of which: Combines Swathers	20,000 units 70,000 units	
4.	Irrigation and drainage equipment Total power	5 million units 71 million Hp.	 .74.64 million Hp.
5.	Crop protection equipment of which: Power Sprayers and power blowers Hand sprayers	230,000 units 20 million units	
6.	Threshers, hullers and winnowers Total power	2 million units 10 million Hp.	
7.	Crop processing machinery (for cotton, food-grain, oil bearing crops and fodders Total power	3.4 million units 30 million Hp.	
8.	Transport equipment of which: Trucks Tractor-trailers Trailers drawn by walking tractors Animal-drawn rubber tired carts Wheel barrows	100,000 units 460,000 units 1,290,000 units 2,470,000 units 28 million units	135,000 units

3.2. The manufacturing capability of the agricultural machinery industry^{8/}

China's agricultural machinery industry has maintained:

- a. manufacturing plants 2327 units and more
- b. manufacturing and repairing plants at county level 2396 units and more

Up to now, basically, in every province there is a set of manufacturing factories for tractors and other agricultural machinery and there is at least one manufacturing and repairing factory in every county. Every commune and sometimes production brigade owns a repairing station for agricultural machinery and implements.

Unless some new models of agricultural machinery are to develop in the near future, China's industry can now provide all models of agricultural machinery and implements which are needed for agricultural production within the entire country. Moreover it can also satisfy the need for repair and maintenance of agricultural machinery.

The manufacturing capacity of this industry in 1979 and 1980 was as follows:

No.	Items	Annual productivity	Output in 1979	Output in 1980
1.	Large and medium-size tractors	120,000 units	126,000 units	98,000 units
2.	Walking tractors	300,000 units	318,000 units	218,000 units
3.	Internal combustion engines	30,000,000 Hp.	28,080,000 Hp.	25,390,000 Hp.
4.	Large and medium tractor-drawn implements	300,000 units	259,000 units	122,800 units
5.	Pumps for agricultural use	800,000 units	937,000 units	533,000 units
6.	Agricultural trailers	110,000 units	117,000 units	73,300 units

^{8/} Bulletin of State Statistics Bureau of China. Transactions of the Chinese Society of Agricultural Machinery, 1980. Reference material of Agricultural Machinery Ministry of China.

3.3. Categories and characteristics of China's agricultural machinery

a. Tractors

The common models of tractors are as follows

- i) Tractor tractors: 3 main models 100, 80, 75 Hp.
- ii) Wheeled tractors: 6 main models 55, 45, 40, 35, 28, 25 Hp.
- iii) Walking tractors: many models with 10, 12 Hp.

The basic construction of Chinese crawler and wheeled tractors is not too much different with the world's conventional tractors, but there are some small parts modified only. However, the multiple uses with the appropriate implements is the specific character of walking tractors, (see appendix fig. 1). The walking tractors are designed according to local condition and could be used for ploughing, harrowing, irrigation and etc.

Heavy tractors are also manufactured in China but these tractors are often used for farm land capital construction, reforestation and logging, and transportation in the forest. The common models are 120 Hp., 160 Hp., 180 Hp. up to 320 Hp., (crawler type).

b. Ploughing machinery

Furrow ploughs, disc ploughs, tillers and other special ploughing implements are the main ploughing machinery in China.

There are many models of ploughs being produced in China, with ploughing width from 0.6^m - 1.8^m, and drawn by walking tractors or other tractors. There are specialized factories for the production of tiller's cutters and ploughs discs.

The combined plough (see appendix fig. 2) and the ditching plough are two special models now being developed in China. The combined plough, which has the furrows in front and the tilling device at the rear, can plough and harrow the land simultaneously. It is helpful for farm work in the right season in areas where there are two or three crops per year.

The ditching plough (see appendix fig. 3) can make ditches with a depth of up to 0.8 and a width of about 200 mm for control of the ground water level and for drainage. This is very useful for the transformation of saline-alkali land.

The frame size of ploughs has been standardized, so that it is possible to fix many different models of furrows or discs with the same frame.

c. Harrowing machinery

China produces many models of harrows with harrowing width of up to 3^m, and drawn power from 20 to 80 Hp. for wet farming as well as many models of harrows for dry farming. There are many forms of harrow discs, such as the knife disc, cut out disc, and dished disc. and many rollers for harrowing such as the spited roller and the corrugated surface roller, sometimes several are combined in use. Moreover, there are many models of harrow for dry farming with the conventional construction being produced.

The boat-type harrow (see appendix fig. 4) for wet farming is a special model in harrowing machinery. Inside the boat is an operator and engine, and on the exterior at the rearside are the tilling implements or harrowing rollers, which are sometimes combined. When harrowing, the rotating tiller cutters or harrowing rollers cut the soil and level it, and simultaneously the boat driving with wheels slips above the soil and moves forward. It is simple in construction and functions well.

d. Planting machinery

There are many models of planters, seeders and drillers produced in China, which are similar to common models in the rest of the world.

Rice is higher yield crop and occupies 40 per cent of the total food-grain production in China. But the transplanting of the rice seedling is a labour intensive operation.

The government and farmers have long wanted to improve it, so the rice transplanter has developed quickly. There are two types of rice seedling planters catered to the type of agronomy.

- i Transplanters of seedlings from which soil has been removed (see appendix fig. 5). The most common type of transplanters are the semi-boat type which glide above the field soil in wet farming, pick up the seedlings using a seedling picker, and insert it into the soil. The transplanter is generally

powered with a 3 - 4 Hp. small engine unit and can transplant 0.1 - 0.15 Ha. per hr. Two or three persons are necessary to operate the transplanter, mainly to put the seedlings in good order for the seedling picker to pick up easily.

ii Soil-stuck seedling transplanters

Using the seedling picker, the transplanter cuts the block, cut before from the seedling field (measuring 120 x 350^{mm}, with a soil thickness of 15-20^{mm}) to small pieces (measuring 20 x 25^{mm}) of soil-stuck seedlings and then puts it on the field soil. Soil-stuck seedling transplanters are not as popular as the transplanter of seedlings from which soil has been removed.

With the exception of the power-driving rice seedling transplanters, hand operated seedling transplanters (see appendix fig. 6) have been widely developed in China. They are acceptable to farmers, because the hand-operated seedling transplanter is simple in construction with a weight of 23-24 kg. and can transplant about 0.3 Ha. per day, which means an increase in efficiency of up to 4-5 times for hand transplanting.

e. Plant protection machinery

The most popular machinery for plant protection are dusters and sprayers. Among the sprayers the automatic hand sprayer (see appendix fig. 7) is the most popular. The automatic hand sprayer, with a volume of 10-16 l., under pressured a solution of insecticide pumping with a hand pump. The automatic power sprayers use a 3.5 Hp. engine as their power source, or the power of a walking tractor, with a solution output of from about 36 l/Mun to 70 l/Mun. These are used in communes, state farms and gardens.

As for dusters, the most popular models are the front-carried dusters (see appendix fig. 8) and crank dusters with a 5-10 l volume of powder. Power driven dusters with a 1.6 Hp. engine contain a powder volume of 11-15 l.

Recently, knapsack airblast sprayers with an engine drive have been developing in China, which spray solution as well as powder.

f. Harvesting machinery

There are mainly three types of harvesting machines in China.

i Combine harvester

These combines are self-propelled or trailer-type and are similar to most of the world's common types. They are popular for use

in wheat and legume harvesting in large-scale farming but not yet popular in rice sorghum or corn harvesting.

ii Tractors with harvesting systems (see appendix fig. 9)

These harvesters are used for both rice and wheat in wet farming and dry farming, and are composed of the tractor and the additional harvesting, threshing and winnowing attachment which function together as combine. The cutting width of these harvesters is 1200-2200^{mm} and the power of the tractor is 10-45 Hp.

iii Swathers

The swather (see appendix fig. 10) is powered by walking tractors or small engines. These swathers are used for wheat or rice cutting in wet farming, dry farming or in hilly areas. They are not highly efficient because the swathers only cut down crops and require manual collecting and binding.

The productivity of the swather powered with a 10-12 Hp. engine is about 0.2 - 0.3 ha per hr, with a cutting width of about 1 meter.

Both swathers and tractors with harvesting systems have flexibility in that the tractor or walking tractor could be used for other agricultural operations after harvesting, and these kinds of harvesters could be used in very small plots say, 0.2 - 0.3 Ha. and more. Harvesting machinery is developing now in China, although mechanized harvesting does not yet figure in a large percentage of the whole cropping area. However, in some areas suffering bad weather during the harvesting season, farmers prefer the mechanized harvester, in order to harvest more food-grain which in turn would repay the expense of the machines. Now, there are some models of cash crop harvesters such as sugar beet toppers, sugar beet harvesters, sugar cane, leaf-removing machines, sugar cane harvesters, and tea-leaf harvesters etc., which are produced in prototype or small scale.

g. Threshing machinery

In China, all threshers are of the drum type. Simple threshers with manual crop feeds are the most popular type, and they have different

threshing elements (rasp bar, peg or other type). The thresher has a drum diameter of about 400^{mm}, and a drum width of about 900-1800^{mm}. It is powered by 1. to 2.3 Kw. Some pedal threshers (see Appendix fig.11) which weight about 100 kg. and affords a productivity of 100-500 kg./hr. are acceptable to the farmers.

Moreover, there are some threshers with cone-drums enabling the threshing of rice and wheat as well as legumes, sorghum and corn, with less broken grains.

Based upon the above models, there are some kinds of automatic threshers being developed with automatic feeding, threshing and air drafting systems, which are a bit more productive than the pedal-thresher and reduce labour intensity, but which increase energy consumption.

h. Food processing machinery

The following three categories are popular in China:

i Feed mills (see appendix fig. 12). There are many models of mills possessing on the same principle, that is to say, rotating elements impact the feed and cause the feed to become pulverized. The mills are powered by 7-10 Kw., with a maximum of up to 40 Kw., composed of milling, screening and air drafting, the productivity of which some hundred kg. per hour, depending upon the kinds of crops.

In order to develop the livestock and poultry raising in large scale, China has been producing feed processing set with annual feed output 3000 - 10000 tons per year, in recent year.

ii Rice mills

With the exception of using different machines for rice husking and rice milling in large processing plants, the commune's small processing plants always use the same rice mill for both operations. The common model is a corrugated roller type, powered by 2.6-7Kw., with a productivity of less than 1 t/hr.

iii Flour mills

One kind of mill contains two rotating ribbed iron casting discs which pulverize the grains between the discs. Another model consists of two rotating rollers which crush the grain between the rollers. This is used mainly for wheat flour. Both machines are made up of milling, screening and air draft devices.

i. Irrigation equipment

The manufacturing of pumps belongs to the general machinery manufacturing department. Common models are centrifugal pumps, deep well pumps and axial flow pumps (diameter up to 4 meters). After the liberation in 1949, China developed chain pumps, and after 1960, the development of pumps was gradually focused on.

Some other models of irrigation equipment such as sprinklers, etc. are being developed now.

j. Other machinery

The farmers used to use river silt as fertilizer in the southern areas of China. In the past, they used manual tool clamps, and now have changed to silt suction machinery.

This machinery (see appendix fig. 13) is fitted into a boat, and is actually a diaphragm pump with a rubber pipe touching the river bottom to suction up the silt and unload it in the boat. The slurry pumps used in agriculture which are single stage vertical centrifugal pumps with a waterhead of about 3 meters and a capacity of 50 - 150 t/hr, and powered by 1.7 - 4.5 Kw. are another model of silt suction machinery.

The common transport machines used in China's agriculture are trailers, animal-drawn carts and manual labour carts and small number of trucks. The trailer drawn by walking tractor can be easily connected with the walking tractor or tractor for transportation and can easily separated when walking tractor or tractor is used for other purposes. This dumping trailers capacities 1-4 ton, with simple construction and cheap price, are acceptable for the farmers.

In China only few models of cultivators and tractor-drawn implements for cultivating are being produced in small quantity. So most of cultivation are based on manual operation. It will be not illustrated in this paper.

Drying Machinery: Drying food-grain in the sun is the main drying process in China, but it often suffers some losses of food-grain due to bad weather. The crop drying machinery is just being developed.

3.4. Characterization of China's agricultural machinery industry

a. A variety of agricultural machinery must be developed in line with local conditions.

The priority of agriculture lies on intensive and meticulous farming due to the limited amount of arable land area per capita in most parts of China.

The uneven distribution of precipitation is China's basic climatic factor, that is to say, it is often flooded in the south and there are often drought condition in the northern area. Rice is the main crop, the production of which constitutes about 40 per cent of China's entire food grain cultivation and wet farming is the main method. There is a large area with saline-alkali soil which can be cultivated by diluting it with water or by lowering the ground water level to reduce the saline-alkali. Based upon the above-mentioned conditions, China's agriculture has put the priority on the development of irrigation and drainage equipment since 1960. Up to now, this equipment has constituted the largest in quantity, with a total of 5 million units out of China's agricultural machinery, and it has been the most rapid in developing.

Three crops are produced every year, and the multiple crop index is up to 230 per cent in many provinces of Southern China. The demand for harvesters, transport machines and post-harvesting machinery is imperative. China is now attaching importance to develop special varieties of this machinery, adapting them to local conditions, such as medium and small tractors, rice transplanters, boat type harrows, swathers and threshing machines.

In the rural area, a certain part of the labour force is occupied in food processing, and the transfer of these labour forces to small industries or sideline occupation will be significant. The need for food processing machinery is also imperative, and has been developing at a rapid pace in recent years.

b. The development of agricultural machinery must be proceeded from the raising of farmer's income and their economic capabilities.

The key point governing the farmers' purchase of agricultural machinery is whether or not its use would mean an increase in income. This machinery should be simple in design, low price, durable in use, easy in operation and maintenance, adaptable for multiple uses and high utility. In the meantime, the development of semi-mechanized implements such as animal-drawn tools, manually operated machines and hand tools is still significant in most areas of China. The rapid

development of walking tractors and threshers would serve as a good example. As for sophisticated agricultural machinery, it is also needed for certain areas of China, but the quantity of this machinery will be limited.

c. The integration of large, medium and small-scale agricultural machinery factories is another factor in China's industry.

China has many large-scale factories producing sophisticated machinery. There is also mass production of general machinery as well as a great quantity of medium, and small factories producing simple products and specialized parts for agricultural machinery. The small-scale factories are scattered in rural areas and not only manufacture but also repair agricultural machinery. During the busy farming season, these factories aid farmers in the repair and maintenance of farm machines, thus supporting agriculture. During the ordinary season, they help farmers to adapt the machines to local conditions.

d. The development of agricultural machinery is based on widespread rural research units and the research and design units of factories.

With the exception of the central and provincial organizations for the research of agricultural machinery, not only does every farm machinery factory have its own design and research units, but every commune, and brigade, has an agricultural research team, including research into their own farm machinery. Many special agricultural machines such as transplanters are originally produced by brigades, and gradually become standard models. Basing much in agriculture on practice and attaching great importance to self design, China has established an indigenous research, design and manufacturing capacity, for agricultural machinery. They can manufacture most kinds of machines and implements without a license. This is very important and difficult achievement for the developing countries.

e. Besides ordinary working machines, there are many specialized working machines which have been designed on the basis of China's own experience in agricultural machinery factories. These specialized working machines are simple in construction and highly efficiency for manufacturing certain parts of farm machines. For example, in the manufacturing production line of the walking tractors, most of the working machines are specialized working machines.

3.5. Further development of China's agricultural machinery industry and some considerations

China's agricultural machinery industry now has more than 4000 manufacturing and repairing plants and over 320,000 machines for metal-cutting, forging, casting and stamping. The capabilities for manufacturing and repairing are basically suited to the needs of agricultural mechanization. But basic problems now exist, such as the following: the factories are too scattered; part of their technology is backward; product quality is not satisfactory; and management needs to be strengthened. This industry is now under going readjustment following the readjustment of the whole Chinese economy to serve the modernization of agriculture more favourably.

Because the purchasing ability of the farmer in agricultural machinery will not be quickly increased due to the small land area per capita and the low price of food-grain (about $\frac{1}{2}$ of the food grain price of other countries) and since the same holds true for state farms as a result of the decrease in funds accumulation in agriculture, there has been a decrease in investment. Both of the above reasons affect the selling of a agricultural machinery. In the near future, agricultural machinery production in China will be at a saturated point in quantity and will continue to develop in quality and number of varieties. Heavy agricultural machinery and implement production will stagnate and decrease in quantity, and medium size agricultural machines will not increase quickly, but the small, semi-mechanized, manual-power machines and then animal drawn implements and tools will develop quickly.

New factories producing agricultural machinery will not be established in the near future, the whole industry will focus, rather on readjusting already existing enterprises, tapping their potential and promoting industrial innovation.

Breaking away from the rigid structured system, that is, from the divisions between different administrative areas and different government departments, and from ownership by the state and ownership by the collective, these agricultural factories will be gradually organized to a level of high efficiency, manufacturing of specialized products which will differ from the original situation in which every factory had to be complete, to manufacture every part and perform all operations.

During the industry's readjustment period, attention will be focused on technical transformation and innovation. As for machine products, emphasis will be placed on the improvement of design and machine construction, improvement of machine quality aiming toward a more simple, more flexible machines, better quality, cheaper in selling price and more economical in fuel consumption. As for working equipment in agricultural machinery factories it will emphasize new technology, specialized production, more productivity and the creation of new products suited to China's conditions.

With due regard to the efforts of Chinese research, design and operating personnel to improve design and construction of agricultural machinery, it is important none the less to consider importing requisite advanced technology. However, in the import of technology, focus should be placed on technology which brings quick results, high profits and absorbs more of the labour force. It should also emphasize technology in important basic parts and individual units of machinery, and not in whole machine assembly.

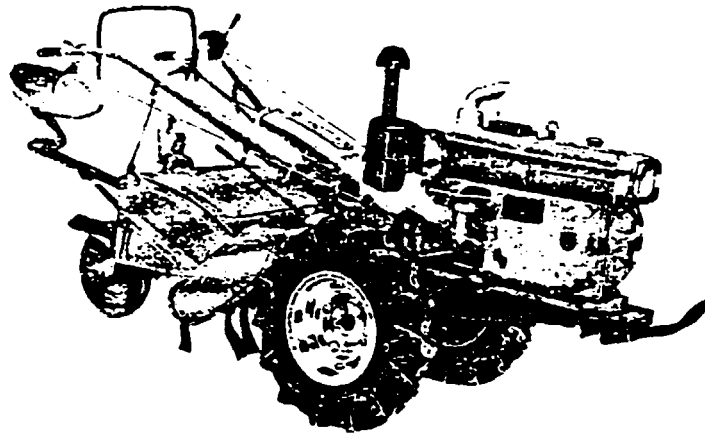
Generally speaking, the development of agricultural machinery has been uneven in the past 30 years in China, that is to say, the agricultural machinery for food-grain and cash crop production has developed more quickly than the machinery for husbandry, fishery, forestry and sideline occupations in rural areas. The total arable land area in China is limited to about one hundred million ha. now and will not quickly expand.

However, not only does China have about 121 million ha. forest and about 211 millions ha. meadow and a huge amount of rivers and lakes under further development, but also a huge potential for food processing and sideline occupations in rural areas, the demand for agricultural machinery in many varieties will be very great.

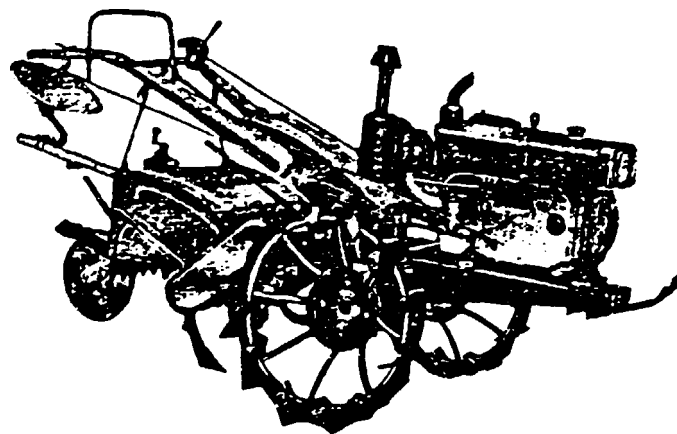
China's agricultural machinery industry has broad prospects and will develop further to serve either food production, cash crop production or other forms of production.

Appendix

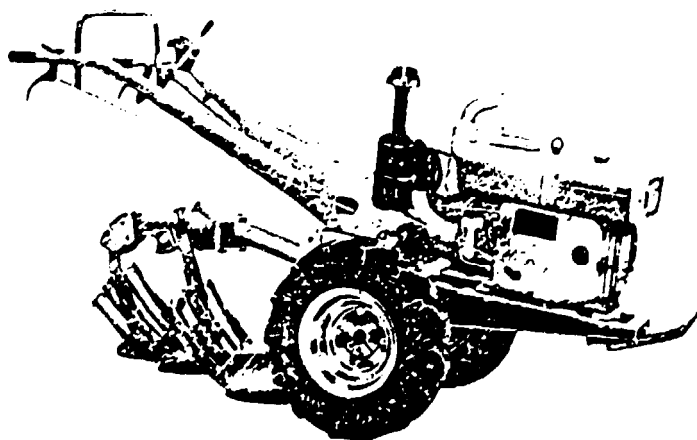
Fig. 1 Tractor with main implements and accessories attached



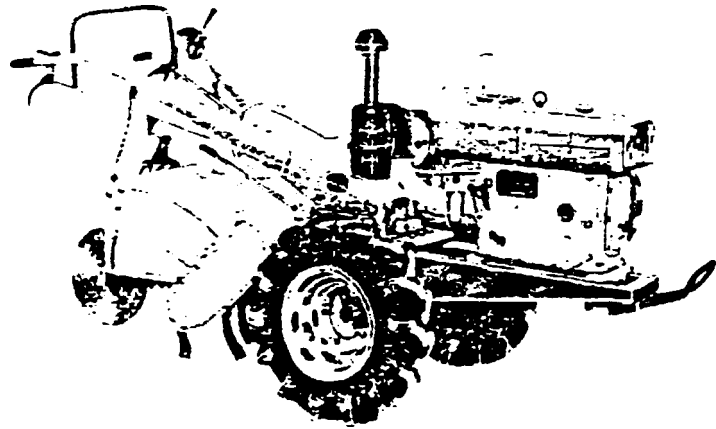
Rotary cultivating in dry field with riding installation



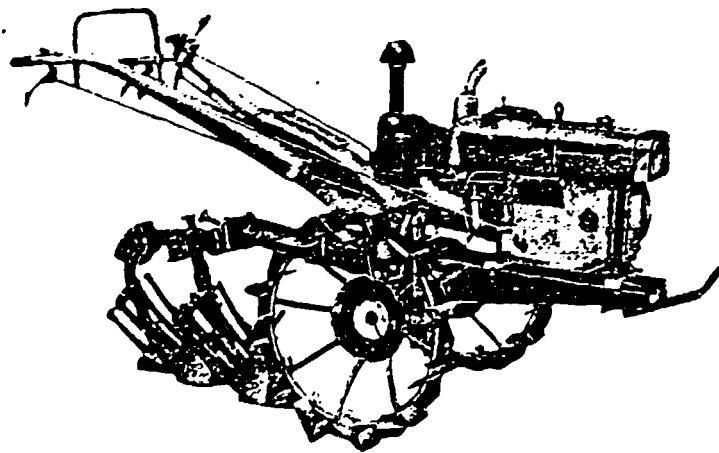
Rotary tilling in paddy field with riding installation



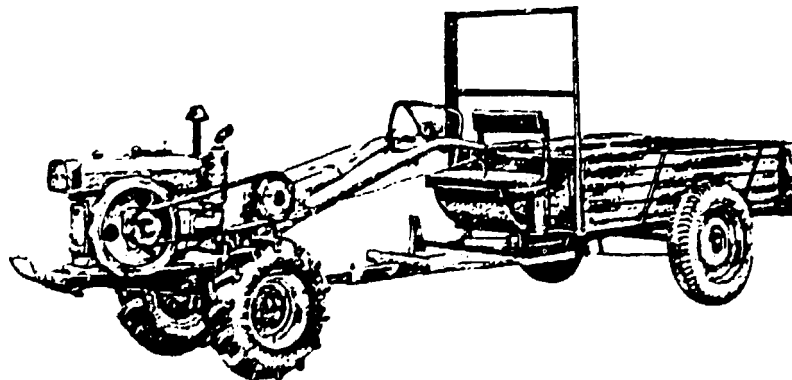
Tractor with ploughs for dry field



Rotary cultivating in dry field without riding installation



Tractor with ploughs for wet field



Tractor with trailer

Fig. 2 Combined Plough

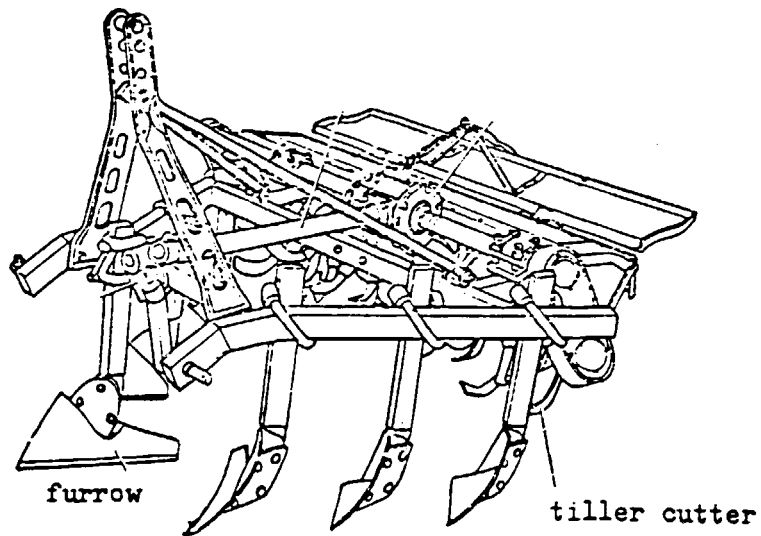
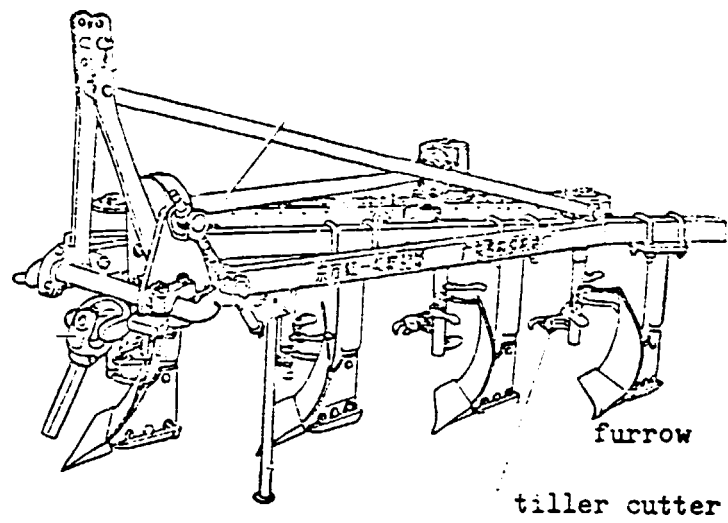


Fig. 3 Ditching Plough

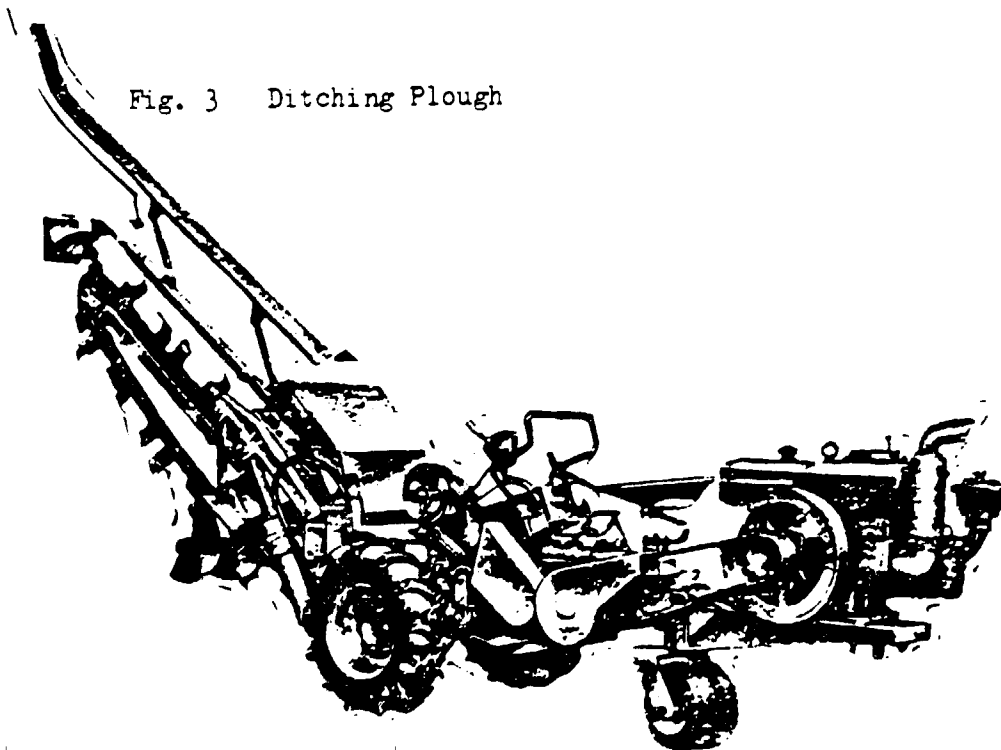


Fig. 4 Boat Harrow

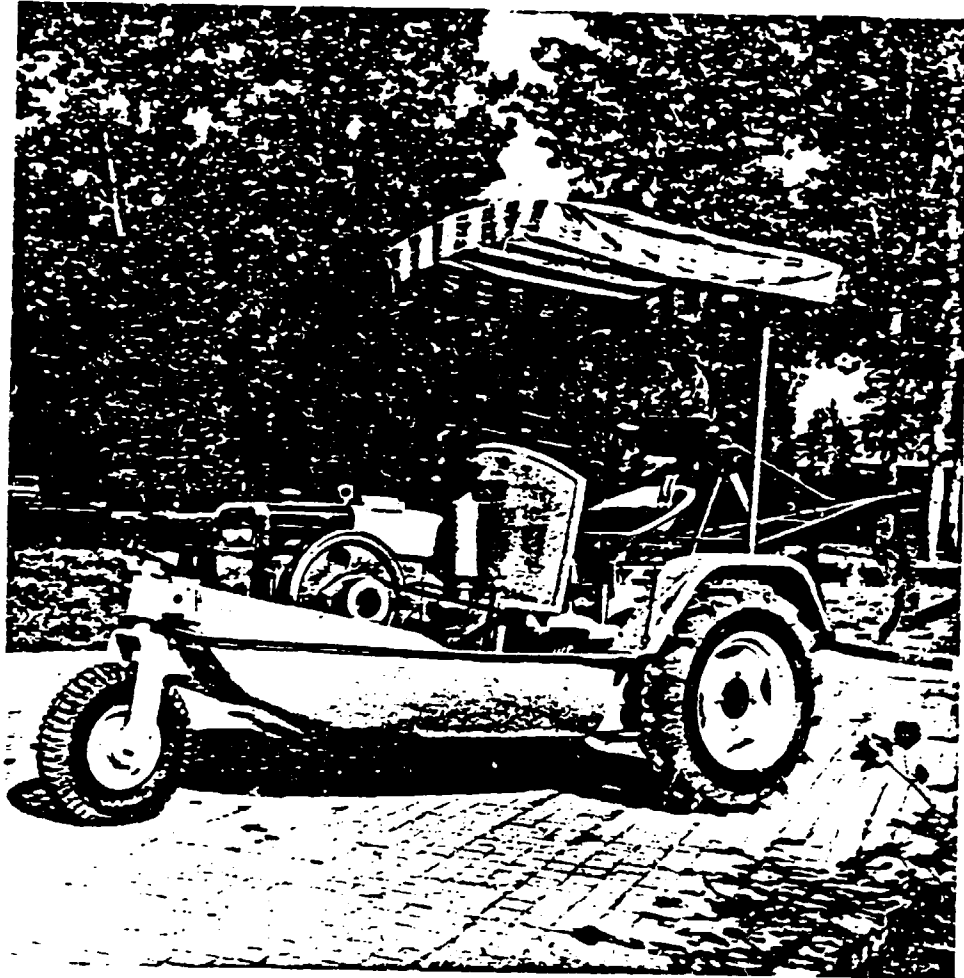


Fig. 5 Rice Transplanter

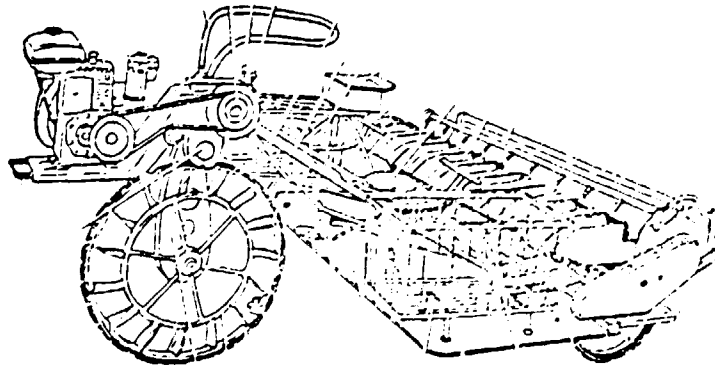


Fig. 6 Hand-operated seedling transplanter

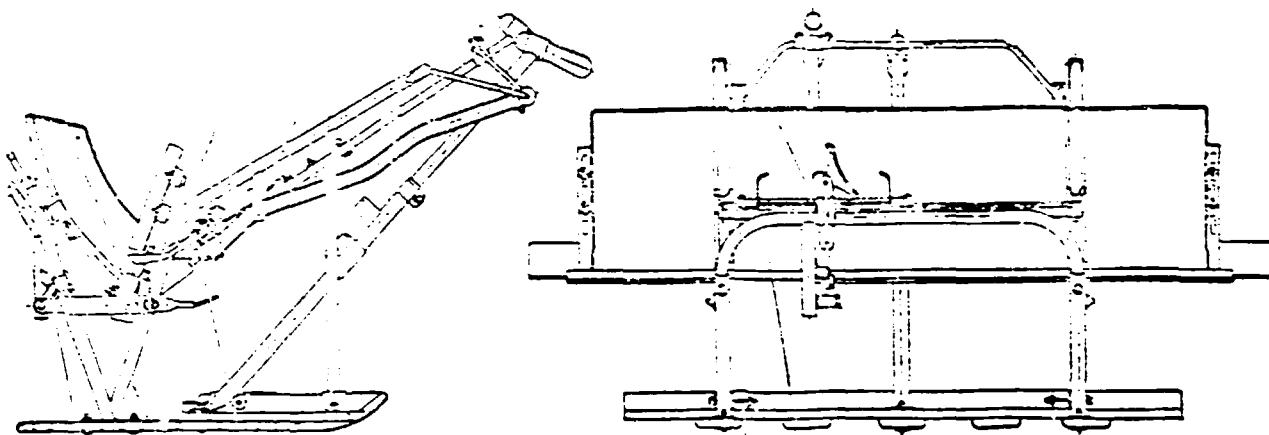


Fig. 7 Automatic Hand Sprayer

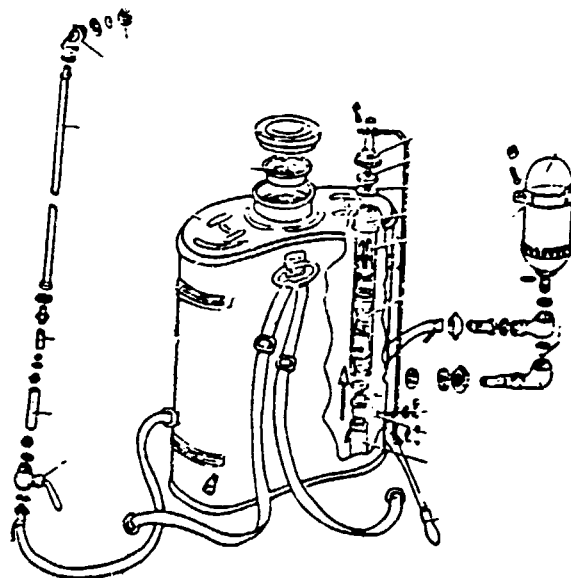


Fig. 8 Front-Carried Duster

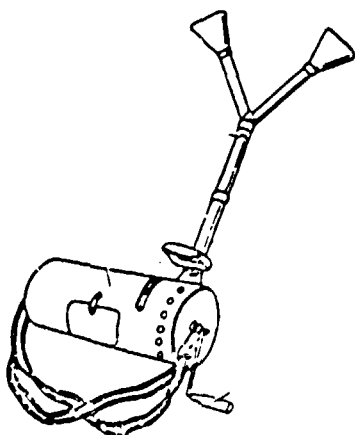


Fig. 9 Walking Tractor with Harvesting System

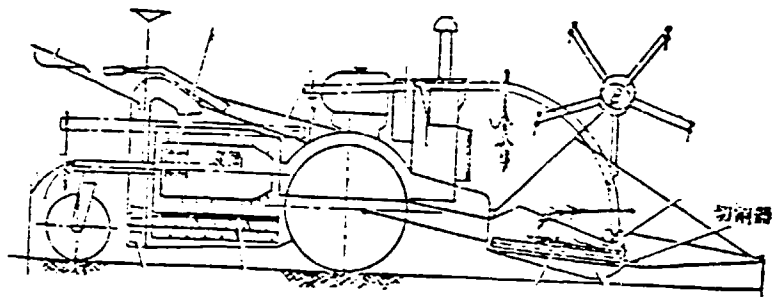


Fig. 10 Swather

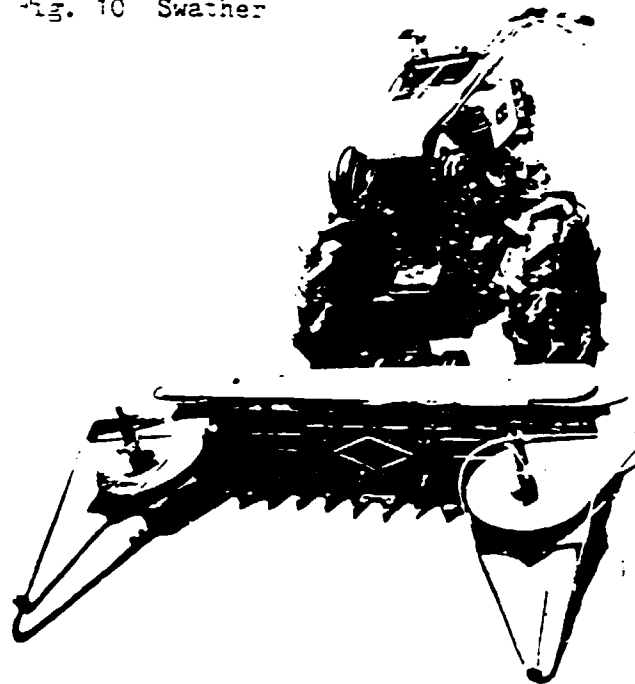


Fig. 11 Pedal Thresher

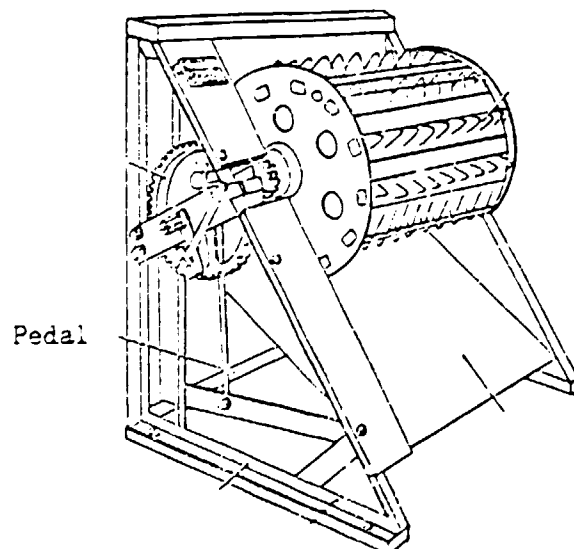


Fig. 12 Feed Mill

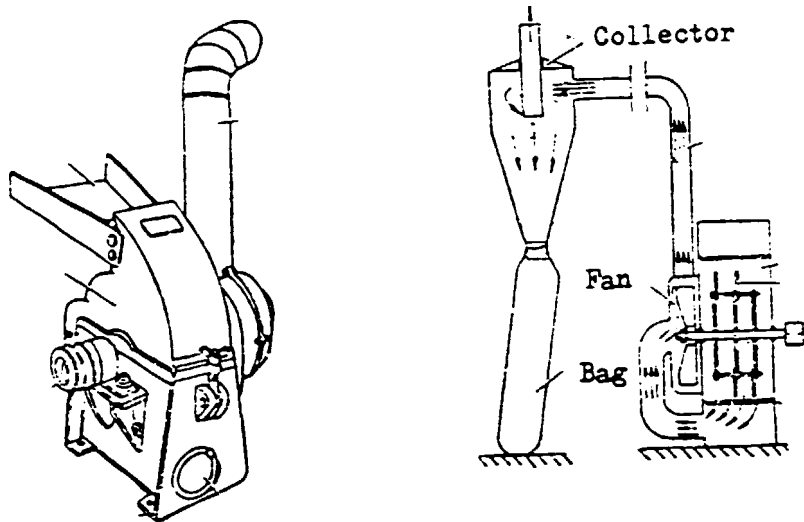


Fig. 13 Silt Suction Machine

