AGRICULTURAL MECHANIZATION IN SOUTH EAST ASIA

1971, SPRING

FARM MACHINERY INDUSTRIAL RESEARCH CORP.

ASIA HAS LAND

Millions of square miles of potentially rich, fertile land, potentially ideal for paddy farming, for horticulture, for livestock breeding. The problem lies with that dangerous word "potentially". The land that Asia does farm could give two or three or maybe ten times the yield if only it were cultivated to its full extent. There are two fronts to work on: to cultivate virgin land, and to cultivate it better.

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ASIA HAS WATER

Sometimes too much, often too little. The problem: how to secure a stable, all-season water supply; how to protect against its destroying forces while putting to work its beneficial powers. How to control it. By building drains, reservoirs, cisterns, canals, sluice gates and ditches. By pumping it from where it hinders to where it helps.

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ASIA HAS ENERGY

Asia has rivers with—potential—billions of kilowatt hours. Asia has oil—although much of it remains to be uncovered. Asia has coal. And, best and worst of all, Asia has the sun.
Once more, a problem of control, it seems. How to protect soil and people from the relentless, eroding power of too much sun that makes the soil barren and the people age faster.
And on the other hand, how to secure useful energy where it's needed.
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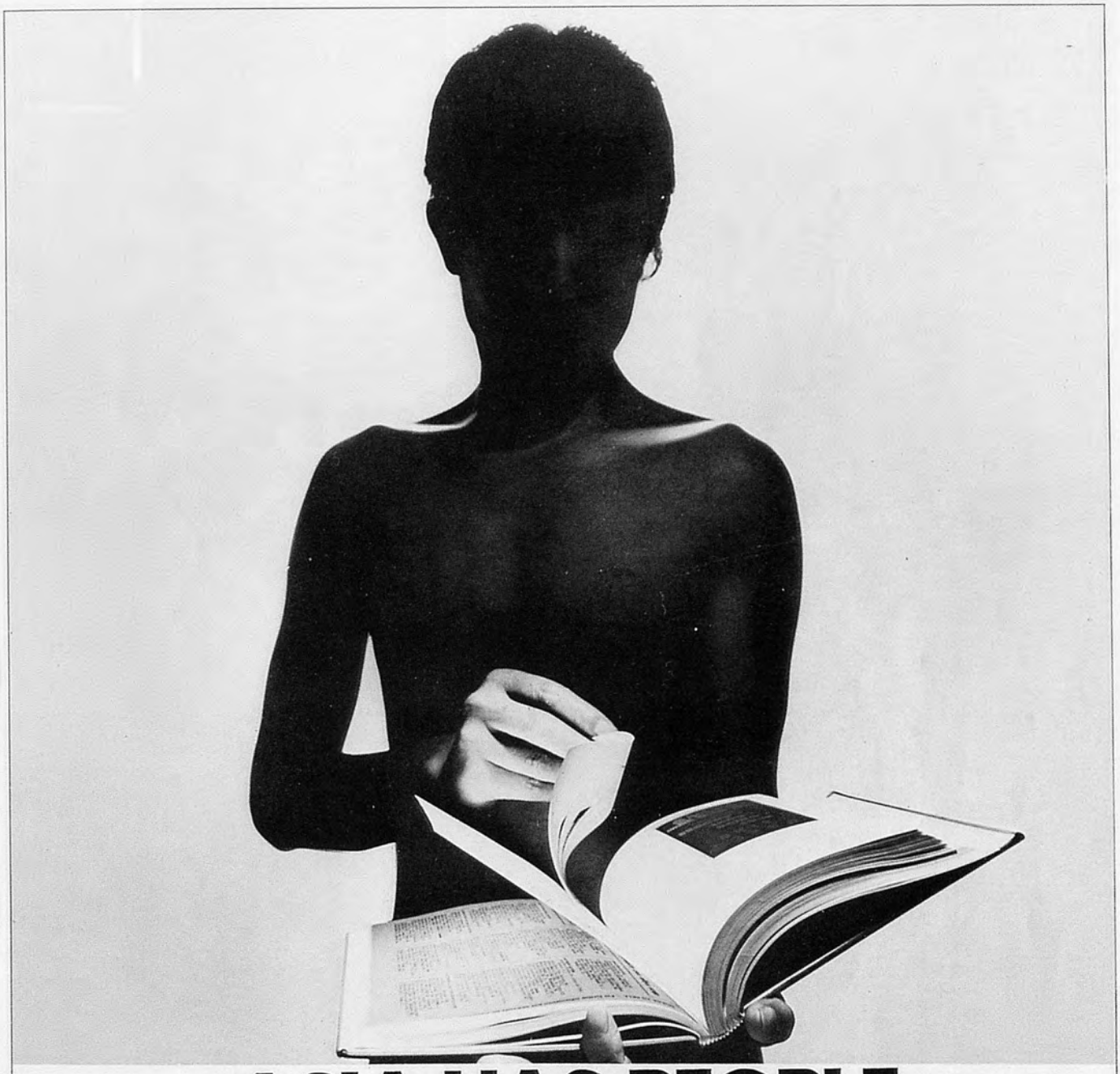

ASIA HAS PEOPLE

The understatement of the year, to be sure. Population in Asia is often a delicate subject to talk about, a dangerous subject because it is caught in the crossfire of Asian beliefs, traditions and values.

But, again, a potential source of riches. And there's one factor upon which all creeds seem to agree: the need for education. The need for people to teach and to learn how to use the land, the energy, the water, the machines, and the people.

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ASIA HAS BEAUTY

It's the finest of all Asian traditions—the quest for beauty in life, in its simple day-to-day functions as much as in its exuberant festivities. That special Asian brand of beauty that's founded upon calm and tranquility and the nearness to nature.

But this beauty can only come from, and can only be preserved in freedom—in freedom from want. And we think we can help a little. By helping to alleviate those working day burdens, by setting free the energies and interests for the pursuit of the finer things in life.

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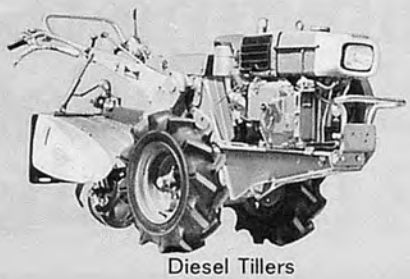
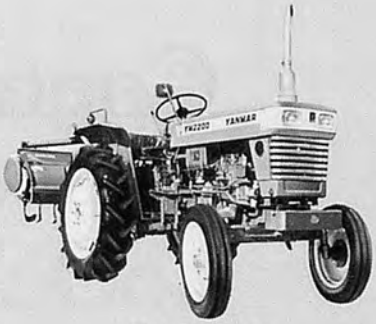
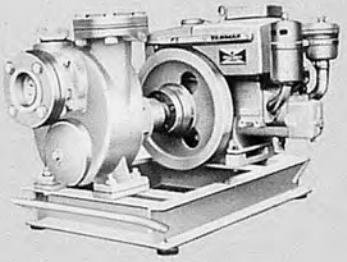


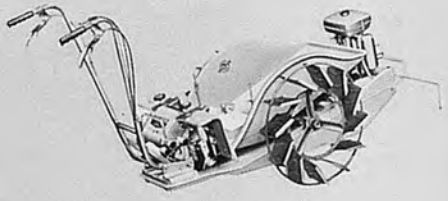
Diesel Tillers



Diesel Tractors

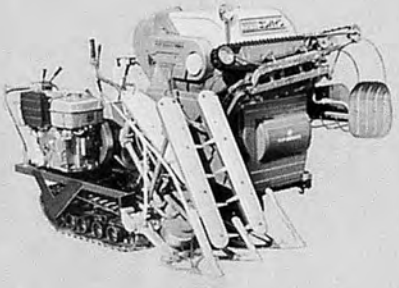


Irrigation Pumps

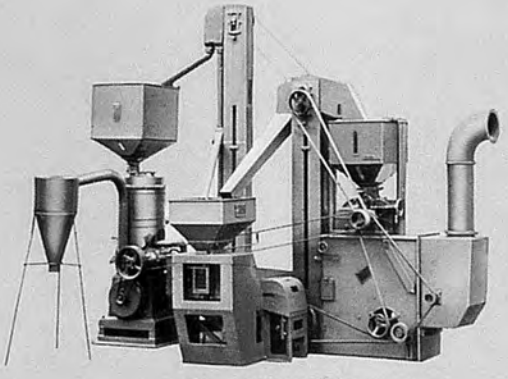


Rice Planters

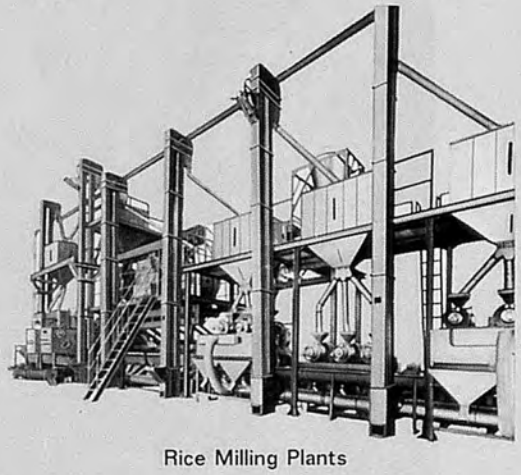
Power Sprayers



Combines



Rice Milling Units



Rice Milling Plants

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AGRICULTURAL MECHANIZATION IN SOUTH EAST ASIA

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Published by

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THE INTERNATIONAL FARM MECHANIZATION RESEARCH SERVICE

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PREFACE

Agricultural mechanization is urgently needed not only for farmers but also for every people in this world. But it seems not to be clear as an general consensus still. Those who stand one step outside from agricultural mechanization think it only as some problems of machinery.

Why do we need the agricultural mechanization, especially in developing countries and how can we promote it effectively ?

We planned to publish this book for those who are going to engage in the problems of agricultural development and its mechanization especially in Southeast Asian countries. In this book, many writers show the essence of their long experiences, new results from their current researches and their progressive ideas for the future.

To establish the better understanding of agricultural mechanization is our responsibility and the purpose of this book.

"Time is Life.", I believe that this is the essence of agricultural mechanization in our history towards the space age. We, human-beings, need more new time and talents freed from the activities only for foods to develop new culture.

The discoveries of agriculture, hand tools and use of animals produced new spare time for human-beings in each age and made an each epoch in its long history. At last, only in last fifty years the use of machines, "Agricultural Mechanization", has developed completely new age of civilizati on especially in advanced countries.

The population on our planet is increasing rapidly. Everyday we need to get more foods with smaller time resources. I believe that agricultural mechanization is the basic power to solve it, because we always want to extend our life and history, while foods basically keep our time of life.

We should know what creates time and what eats it up in this complicated world.

I will be very glad if this book will be helpful to promote the agricultural mechanization in Southeast Asia by all means.

At last I would like to express my sincere thanks to every writer who kindly devoted his precious time to write his fine article and also to Japanese companies who gladly supported to publish this book titled "Agricultural Mechanization in South East Asia".

Let's create ideas, transmit them and form a public opinion to promote better agricultural mechanization also in future !

Yoshisuke Kishida


B. Ahmad


N. Ahmed


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R. Bradfield


W. J. Chancellor


M. L. Esmay


K. H. Friedrich


W. J. van Gilst


T. D. Huan


L. Johnson


H. Kaburaki


A. U. K n

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Born in 1932. Graduated from College of Agriculture, Kasetsart Univ. Bangkok in 1957. Employment: 1957–1958, Instructor in Farm Machinery "Operation and Maintenance" Kasetsart Univ. 1959–Present, Superviser of Engineering Workship Agriculture Engineering Division, Rice Department Ministry of Agriculture.

Richard Bradfield

Born in 1896, Ohio, USA. In 1937 he was appointed Head of the Department of the Agronomy and Professor of Soil Technology at Cornell Univ. In 1962 he became a Special Consultant in Agriculture to the Rockefeller Foundation. Since 1964 he has been located at the IRRI where he is engaged in research on methods for increasing food production in the rice belt of the humid tropics of Asia by intensive multiple cropping techniques.

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Born in 1931. Graduate study, Cornell Univ. (1954–57). Employment : Univ. of California, 1957 to present. (presently professor of Agr. Engr.), Teaching duties mainly in the area of farm power, but also in farm machinery and soil mechanics. Research duties mainly in the area of agricultural soil mechanics, but also in the areas of forage processing and handling, grain drying and environmental measurement.

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Born 1920. Professor of Agricultural Engineering, Michigan State Univ. Teaching, Research, and Extension work in South Dakota, Iowa, Missouri and Michigan in Agricultural Structures for Livestock and Stored Products. Authored a book (1965) entitled "Principles of Animal Environment" AVI Publishing Co. Involved in international work Asia since 1962, with particular emphasis on drying, storage and handling of paddy rice and other food grains.

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1959–1962 : Univ. of Munich. 1964–1966 : JFO Institute for Economic Research, agro-economic survey of African small holders in Bukoba, Tanzania (published report). 1966–1969 : Agricultural Production Economist, FAO/UNDP project Land and Water Resources Survey, Mauritius ; various farm surveys (report in print). 1969 – present Agricultural Production Economist, Production Economics and Farm Management Service, FAO, Rome, Italy.

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Professor Emeritus, Agricultural Engineering Department, Michigan State Univ. Over five years has been spent in Asia; three years in China as Research Agricultural Engineer, two years in Taiwan as Chief of Party, and short periods of time in recent years.

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B. A., Princeton Univ. , 1950 ; M. S., 1955, Ph. D., 1959, Cornell Univ. Associate Professor, Department of Agricultural Economics, Michigan State Univ. Research Interests, Economics of Agricultural Development, Agricultural Planning, Primarily in Asia.

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Distinguished Professor, Department of Agricultural Engineering, Texas A & M Univ. President, American Society of Agricultural Engineers. From 1964 to 1968 Director of Ford Foundation--Ohio State Univ. Educational Project in Punjab State, India.

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He is Industrial Development Officer, the United Nations Industrial Development Organization (UNIDO), Vienna, Austria, since April 1969. He holds a Master of Science (Agricultural Engineering) Degree of the Univ. of Illinois. Prior to his joining UNIDO, he was the Member - Secretary of the ECAFE/UNIDO Fast Finding Team on Industries Manufacturing Agricultural

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Y. Kishida


R. M. Lantin


H. F. McColly


T. Nakata


C. Ozaki


T. S. Peng


R. D. Stevens


R. E. Stewart


A. A. Swamy-Rao


Wikram anayake


M.-Wu Wu

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CHAPTER Ⅱ

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SUPPLEMENT

MESSAGE

Takekazu Ogura

Chairman, Agriculture, Forestry & Fisheries Research Council

The dawn of a new era is here in Asia. The regions are about to launch upon an epochal take-off from their traditional economic society. And the force behind it is the development of agriculture. The so-called Green Revolution, however, invited an illusion to some people that the problems of agricultural production will be solved in no time by the introduction of 'miracle seeds'. There is a danger of looking upon the 'miracle seeds' as the solutions for agricultural advance. The new hybrid strains are but a single ingredient in a total technology. There are so many essential components such as water management, land reform and improvement, fertilizer, insecticides, transportation, storage, marketing facilities, credit sources and agricultural mechaniztion, if the hopes for the Green Revolution are to remain green.

As one direction of agricultural development in Asia highly-intensive-land-utilization farming method can be conceived by intensive-fertilizer-input and multi-cropping methods under the introduction of new strains. However, it can not be achieved without the rationalization of farming operations—using the right kind of machinery at the right time and at the right place. In that respect agricultural mechanization is the most important and indispensable component among various essentials stated above.

And agricultural mechanization is necessary not only in the pursuit of the Green Revolution but to manifest the economic benefit and the expansion of management scale. Of course, in the introduction of machinery there are important matters to bear in mind.

Heretofore, various agricultural machineries manufactured in developed countries have been introduced and used in many Asian countries. However, in many cases those machineries could not fully display their efficiency and they have not fully contributed to the improvement of agricultural productivity. There are some reasons where agricultural machineries made in developed countries can not be fully effective. One is a great difference between Asian and developed Western countries in natural environmental conditions such as soil and water and in socio-economic conditions such as management scale and industries related to agricultural machinery.

Another reason is that in most Asian countries the investment on infrastructures such as land improvement has not been so active. For instance, Japan carried out an extensive land improvement project throughout the country under a very large Government investment program for the past two decades thus paving the way for the introduction of agricultural machineries.

The very first step to promote agricultural mechanization is the improvement and consolidation of land. But the program calls for a large investment and requires so many years. So the realization of such a program can not be expected in full scale in most of the Asian countries. Accordingly, a realistic approach is to develop agricultural machinery which can fully display its efficiency under the existing conditions in Asian countries. Of course, such a development of agricultural machinery should be in accord with production technique which can be improved in the very near future and to be compatible with socio-economic conditions such as management scale, etc.

In the light of these factors a key to promote agricultural mechanization in Asia is to develop the machineries suited to the natural and socio-economic conditions of Asia. And to do so Asian countries must direct their attention to innovative research to develop their own machineries to be suitable to their own various conditions as well as to the system of efficient utilization of machineries.

The Ministry of Agriculture and Forestry of Japan has launched upon a research on tropical agricultural technique since 1966 to contribute to the development of agriculture in tropical and sub-tropical regions, mainly in Asia, and in order to further promote this program the Tropical Agricultural Research Center has been instituted in June, 1970, an entirely new research institution for this very purpose.

The Center held the symposium on Agricultural Mechanization in October, 1970 as an integral program of tropical agricultural technique improvement of the Center, by inviting 10 researchers from the South and Southeast Asia.

The symposium has achieved a large success in that very fruitful discussions were carried out to promote agricultural mechanization in the regions. And the Center is planning to send Japanese researchers in agricultural mechanization to Southeast Asian regions to jointly study agricultural mechanization with local researchers.

Japan's agriculture, influenced by Asian monsoon and characterized by its small scaledness and paddy rice culture, has many common features with that of her Asian neighbors. So it is reasonably safe to assume that it would be very profitable to have the Asians develop their own machineries to suit their particular conditions by making use of machineries developed for Japanese agriculture and its accumulated techniques.

All of us concerned shall be more than gratified if this book contributes even in a small measure to our Asian colleagues in agricultural mechanization who are dedicated to a noble task to insure that those who till the soil of Asia may equally or fairly share in the nations' prosperity.

CHAPTER I

HOW TO PROMOTE AGRICULTURAL MECHANIZATION IN SOUTH EAST ASIA

A PROPOSAL FOR AGRICULTURAL MECHANIZATION IN THE DEVELOPING COUNTRIES OF SOUTHEAST ASIA

Howard F. McColly

Farming is the arduous task in East Asia of millions of human beings. Land holdings are small, incomes are low, and hunger and want stalk these people all of their lives.

In countries where primitive tools and limited power sources are applied in agricultural production, four agricultural workers are required to produce enough for themselves and one other person. When a high percentage of the workers is engaged in food production, there is little surplus to exchange for other necessities, and unfortunately, the exchange goods are the food products directly needed domestically.

Increased Agricultural Productivity Needed

Agricultural mechanization is one of the predominate means of achieving agricultural productivity. The increases in agricultural productivity which have been due to technological innovations have primarily benefited the United States, Canada, Japan and some parts of Europe. The developing nations have made only limited use of the newest agricultural technology, and thus, remain in need of positive economic development.

In the developing countries, agriculture contributes 30 to 50 percent of the national income, provides employment for 50 to 90 percent of the workers, and furnishes over one-half of the export income; yet, impressive as these facts are, there exists serious food shortages and there has been but little increase in productivity per unit area or per man hour for some important food products.

Better Use of Labor

Agriculture in the developing countries has a labor-intensive situation, and there is a resistance to labor displacement which is often linked to labor-saving devices. A social reason for adopting labor-saving devices would be to relieve agricultural labor of severe toil and drudgery.

In most of the developing countries where agricultural mechanization is progressing, the number of farm workers initially did not decrease. Instead, working hours were shortened, thus reducing the drudgery in farming. This is a sound manner in which agricultural mechanization may be initiated but the extent will have limitations. As mechanization expands, the overall agricultural labor demand will decrease and labor seeks or develops other gainful employment.

New goods and services are required to support agricultural mechanization. Some of the replaced farm labor will find opportunities in agriculturally related occupations as dealers, distributors, salesmen, demonstrators, or trainers; or in service shops, parts and supplies depots, manufacturing, education programs, construction, contracting, trucking, delivery and transportation.

Parallel to this development, industry increasingly fills its labor requirements from agriculture, the largest population segment, and the farmer is forced to mechanize in order to remain in business. The expansion of agricultural mechanization is intertwined with industrial and commercial development and the draft of farm labor by industries creates a sound economic development which increases agricultural productivity, and in the end more gross national product.

Mechanization Objectives

Even though agricultural mechanization may appear that it can naturally and methodically develop, extreme care must be exercised in the various programs, plans, aids and devices proposed for growth. All facets of the agricultural mechanization proposals and develoments must be recognized, evaluated, and satisfactorily answered.

At this point, the really fundamental objectives of agricultural mechanization should be established. The status of each in every country or in every area may differ, but all objectives should be fully considered. A partial list of objectives may be as follows:

1. To reduce drudgery for agricultural labor.
2. To increase the agricultural output per man hour.
3. To improve timeliness of operations.
4. To reduce spoilage, waste and other losses of products.
5. To preserve ane properly process farm products and food supplies.
6. To maximize yields by improved agricultural operations.
7. To enable the production of more or additional food products.
8. To convert animal power feed production areas to human food production purposes.
9. To improve water supplies and water control systems.
10. To reclaim land abandoned because of primitve operations or inadequate power.
11. To develop new land for agriculture by clearing of obstructions or by draining, leveling or other reclamation operations.
12. To create a greater measure of well-being for farm families.

Progress in agricultural mechanization is often imbeded by one or several reasons. The lack of success may be due to only small problems plaguing the program.

Some of the factors which impede agricultural mechanization may be summarized as follows:

1. Small fragmented and scattered farm parcels.
2. Surplus labor during part of the crop production seasons.
3. High population density in agricultural regions.
4. Low per capita income especially in agriculture.
5. Lack of mechanical ability of farm workers.
6. Intensive crop production methods.
7. Great attachment to tradition in

A Japanese is directing cucumber growing in the suburbs of Dacca, Pakistan (A farm of Agriculture Development Corporation)

agriculture.

8. Conservatism of rural people in their operations.
9. Need for teaching and demonstrating proven practices.
10. Shortage of or lack of agricultural extension workers.
11. High import prices on machinery and parts.
12. Shortage of spare parts.
13. High credit rates.
14. Shortage of servicemen and mechanics.
15. Lack of training centers and facilities for mechanization specialists.
16. Inadequate industrial raw materials and industries.
17. Higt cost of indigenous machinery manufacture.
18. Deficiency of suitable of designs of machines.
19. High price fossil fuels often without agricultural production allowances.
20. Unstable government policies related to agricultural mechanization programs.

In certain situations, there may be additional impedements. In some countries, many of the impedments listed above have been solved or corrective measures are occurring.

Aids to Progress

Agricultural mechanization is aided in its progress by many factors, although some of them may require adjustment considerations. A few of the major aids are:

1. A growing desire by farmers for better machinery and tools.
2. A government sympathetic to mechanization developments.
3. Education, research, and extension programs.
4. Establishment of agricultural mechanization training centers.
5. Adequate transportation facilities from farm to market.
6. Development of food storages, processing facilities, and distribution organizations.
7. Advancement of industrial production.
8. Favorable fossil fuel prices.
9. Development of suitable machines for small farms.
10. Labor shortages during transplanting and harvesting.
11. Shortage of work animals.
12. Work animals too slow and inadequate to perform timely operations.

The solving of impedements to mechanization changes them to aids for progress, and ultimately the objectives are met. Fundamentally, the major concern favoring agricultural mechanization in a country should be to economically increase the food resources, reduce drudgery in farmimg and assist in creating a greater gross national product.

Table 1 —Total Area, Percent of Area Arable, Potentially Productive Unused Area, Percent of Economic Active Population Engaged in Agriculture, and Agricultural Labor Population.

	Total Area (1,000Ha)	Percent of Area Arable	Potentially Prod. Unused* (1,000Ha)	Econ. Active Pop. in Agr. (Percent)	Agri. Labor (1,000)
Burma	67,800	13	6,088	62	
Cambodia	18,100	17	1,168	80	
Ceylon	6,560	28	1,348	50	2,250
China, Taiwan	3,590	25	470	47	1,775
India	326,810	49	88,420	70	145,365
Indonesia	190,440	12	10,258	66	25,005
Japan	36,976	16	4,786	24	12,955
Laos	23,680	6	8,080	81	
Malaysia	33,260	10	2,430	55	
Nepal	14,080	16	5,282	92	4,555
Pakistan	94,670	30		74	28,455
Philippines	30,000	28	6,006	53	6,105
Thailand	51,400	22		78	12,405
Vietnam, S.	17,090	16	6,074	85	10,700
Total/Ave.	914,456	23	140,360	61	249,570

Sources : (a) Food and Agriculture Organization of the United Nations, Production Yearbook, Vol. 23. 1969.
(b) Asian Productivity Organization, Expert Group Meeting on Agricultural Mechanization, APO Project SYP/III/67. Vol. II, 1968.

*Unused but potentially productive in some cases including in some instances built-on area, wasteland, grassland and scrub, rough grazing, cultivable land requiring minor improvements, shifting cultivation (fallow), and forests.

Table 2 —Arable Land Holdings, Power Available, and Agricultural Workers Data.+

Country	Arable Land per Holding, Ha	Human Power HP/Ha	Animal Power HP/Ha	Mech'l. Power, HP/Ha	Total Hp Avail. Per Ha	Agrl. Workers Per Ha	HP Per Agrl. Worker
Ceylon	1.59	0.120	0.148	0.110	0.378	1.20	0.315
China, Rep. of	1.11	0.195	0.164	0.146	0.505	2.00	0.253
India	2.62	0.090	0.204	0.008	0.302	0.90	0.335
Indonesia	1.88	0.110	0.062	0.001*	0.173	1.10	0.157
Japan	1.06	0.216	0.120	2.664	3.000	2.16	1.388
Nepal	1.22	0.249	0.480	0.004	0.733	2.49	0.294
Pakistan	2.37	0.109	0.288	0.013	0.410	1.09	0.376
Philippines	3.66	0.071	0.104	0.023	0.198	0.77	0.258
Thailand	3.64	0.110	0.184	0.054	0.348	1.10	0.316
Vietnam, S.	1.57	0.210	0.244	0.023	0.477	2.10	0.227
Total/Average	2.07	0.148	0.200	0.305	0.652	1.49	0.392

*Estimated +Sources: See Table 1

Agricultural Productivity

Farms in East Asia range in size from one to three hectares, and in most cases are composed of small fragmented scattered parcels. However, in most countries there are areas of larger holdings where modern machines may be utilized, but these areas average roughly about 10 percent of the total area. Table 1 indicates about 23 percent of the total area is arable, and approximately 15 percent of the potentially productive land is unused. Even though some of the potentially productive area is built-on and includes forests, etc., a significant portion of the area can be rendered into producing land by the use of mechanization means. The clearing, leveling, draining, conquering the jungle, developing irrigation and other land improvements are operations awaiting mechanization.

Agricultural productivity can result in increased food resources by saving the products already produced. Ravages of the elements, and prey by bird, beast and theft are sorely needed protection measures. Adequate drying, storing, and preservation facilities can effectively save the over 25 percent loss of the year's harvest. A gain of several percent in agricultural production can be realized by saving the products through improved and adequate drying and storage facilities.

Table 2 contains data regarding the arable land holdings, the power available per unit area, agricultural workers per hectare, and horsepower per agricultural worker including human power. The average is about 0.4 hp per agricultural worker. Research indicates that at least one half hp per ha of main crops area

should be available if some productivity increase is expected. This amount of power will shorten the work day, reduce human muscle use and thus reduce drudgery. The net effect on labor would be to establish it at about 50 percent of the working population employed in agriculture.

In the farming areas where monsoon seasons occur, the soil becomes so dry and hard in the non-monsoon season that it cannot be plowed by the primitive plows and the slow plodding beasts. After the periodic rains commence and the soil can be tilled, the optimum planting season is short, because the rains increase in amount and frequency until farming operations have to cease. In demonstration areas under monsoon conditions, the use of mechanical power enabled farmers to double their yields due to their ability to prepare optimum seed beds and to plant their crops under timely operation conditions. Tractors in these areas in two or three days completed operations which formerly occupied farmers for a month using indigenous implements and animal power.

As an average, it is estimated that 1,000 man hours per hectare are expended in paddy production, with the use of animal power. In Taiwan and Japan the total is about 1,300, while in countries where broadcasting, less intercultivation, and less tillage are practiced the total is near 700. A tabulation of the percentage distribution of the average production operations for rice is as follows :

Operations	Man Hours Expended Percent
Tillage and seed bed preparation	18
Transplanting	15
Fertilizing and protection	10
Weeding	18
Water control	6
Harvesting	10
Threshing and cleaning	10
Drying paddy and husked, transporting and storage	13
TOTAL	100

Three large and almost equal areas of production activities transpire in rice production,viz. (1) seed bed and planting --33%, (2) nurture and protection--34%, and (3)harvesting, threshing, drying, transportation and storage--33%. The two labor peaks occur during planting, and during harvesting and threshing. These are labor shortage periods and both are critical timely operations. Fertilizing, weed control, and water control are spread over a major portion of the growing season and usually do not encounter critical labor shortage periods.

There has been considerable success in mechanizing or efficiently performing the operation listed in the tabulation. The most difficult operation to mechanize is transplanting, but vigorous research and development programs are being pursued in some countries, principally in Japan, Taiwan, and Thailand. Economical farm size crop dryers are needed and research and development needs expansion; and more than anything, the creation of new technology in drying grain crops must be encouraged.

The Agricultural Machinery Situation

The total arable land listed in Table1 is almost one million hectares which averages a little over 2 ha per land holding, and an average of about 1.5 agricultural workers per ha.

Human power※ expenditures average 0.148 hp per ha, the intensive agricultural operations by human power applications being in Nepal, Japan, South Vietnam and the Republic of China.

Animal power averages 0.200 with Nepal having the greatest application and Indonesia the least. Several countries are below the average.

The use of mechanical power averages 0.305 ranging from 2.664 in Japan down to 0.001 in Indonesia and 0.004 in Nepal. The total hp per ha averages 0.652. If Japan which indicates 3.000 is deducted, the average drops to 0.392 hp per ha. Three countries ; Japan, Nepal and the Republic of China are above the onehalf hp per ha suggested as desirable. The data clearly reflect the shortage of power in Southeast Asian countries.

Most of the Southeast Asian countries are well supplied with indigenous implements, some of which have changed little in several centuries. However, research and development is progressing in some of the countries to improve the implements. Metal pieces on plows and tillage tools to care for wear and adjustments have been noted as improvements added by local artisans. The greatest advancement these people could make would be to standardize their models, so repair parts could be utilized. As it is in many pla ces, the farmer must have two implements in order to have one in the field while the other awaits repair at the overburdened shop.

Some of the machinery improvements have resulted in increased cost which has retarded their adoption. Unless the new model results in more income, its adoption will be resisted. Farmers with about one hectare of land cannot take chances or support uneconomical applications. Demonstrations, guaranteed returns, adequate financing, and many other factors need consideration for farmers to initially embark on new ventures.

※Note: The unit conversion is 1.0 hp for mechanical power, 0.4 hp for draft animals, and 0.1hp for human sources. These units are considered average for Asia due to nutrition levels, climate, animal size and harness, and individual factors.

Table 3 —Typical Ranges of Power Requirements, Operating Speeds, Field Efficiencies, and Field Capacities of Farm Machinery in Asia.*

Machine or Operation	Power Requirements	Speed, km/hr	Field Efficiency, %	Ha/Hr Per Meter Width	Hrs/Ha per Meter Width, Ave.
Plow :					
Indigenous	0.14-0.70kg/cm²	1.6-3.5	30-60	0.05-0.21	7.7
Moldboard	0.21-1/12 〃	2.4-5.0	30-80	0.07-0.40	4.3
Disk	0.21-1.00 〃	2.5-5.0	30-80	0.08-0.40	4.3
Disk Harrow :					
Single Action	0.45-1.50kg/cm	1.6-4.2	65-85	0.10-0.36	4.4
Double Action	1.20-2.70 〃	1.5-4.0	60-80	0.09-0.32	4.9
Rotary Tiller	0.70-3.50kg/cm	0.8-2.8	60-80	0.05-0.22	7.4
Harrow :					
Spike/Peg	1.80-2.70kg/peg	1.6-6.0	70-90	0.11-0.54	4.5
Spring Tine	10.0-25.0kg/tine	1.6-5.0	70-90	0.11-0.45	3.6
Rolling or Leveling	0.15-0.90kg/cm	0.8-5.0	60-80	0.05-0.40	4.5
Cultivating	6.00-20.0kg/shnk	1.6-4.0	60-85	0.10-0.34	4.6
Row Planter	30.0-70.0kg/row	1.6-5.0	50-65	0.08-0.33	4.9
Transplanter	10.0-20.0kg/row	0.8-2.5	30-60	0.02-0.15	11.8
Grain Drill	6.0-22.0kg/row	1.6-5.0	60-75	0.10-0.38	4.2
Reaping or Binding	1.0-2.0 kg/row	1.6-3.5	60-80	0.10-0.28	5.3
Combining	2.0-4.0 kg/row	1.6-4.8	50-75	0.08-0.36	4.5
Mowing	0.5-0.8 hp/ft	1.6-4.8	50-80	0.08-0.38	4.4
Raking	0.2-0.6 hp/ft	2.4-5.0	60-85	0.14-0.43	2.1
Baling	1.0-3.0 hp/ton	2.4-5.0	50-75	0.12-0.38	4.0
Field Chopping	1.0-3.0 hp/ton	3.0-5.0	40-70	0.12-0.35	5.4

* APO Project SYP/III/67, Vol. 1. 1967.

Table 4 —Percentage Values for Estimating Machinery Annual Costs.+

Machine	Estimated Life, yrs.	Depreciation, %	Ownership Cost as Percent of New Cost			
			Int.*	TIH	Repairs	Total
Tractor	12	8.3	4.0	4.0	10.0	26.3
Plow	15	6.7	4.0	4.0	10.0	24.7
Disk harrow	12	8.3	4.0	4.0	10.0	26.3
Rotary tiller	12	8.3	4.0	4.0	10.0	26.3
Harrow	15	6.7	4.0	4.0	8.0	22.7
Leveler	15	6.7	4.0	4.0	8.0	22.7
Planters	20	5.0	4.0	4.0	5.0	18.0
Drills	20	5.0	4.0	4.0	5.0	18.0
Sprayer	10	10.0	4.0	4.0	8.0	26.0
Mower	10	10.0	4.0	4.0	10.0	28.0
Combine	10	10.0	4.0	4.0	10.0	28.0
Rice huller	15	6.7	4.0	4.0	5.0	19.7
Seed cleaner	20	5.0	4.0	4.0	3.0	16.0
Wagon	15	6.7	4.0	4.0	5.0	19.7
Pumps	15	6.7	4.0	4.0	4.0	18.7

*Based on average one-half value throughout life, 8% annual rate.
+APO Project SYP/III/67, Vol. 1

Selection and Management of Agricultural Machinery

The many problems in selecting machinery for farming enterprises always confronts farmers and their advisors. Each production enterprise needs complete analysis, and the operating plan of the farmer must be thoroughly interwoven into the procedure. The farm operator is the performer in the plan and it will succeed or fail according to his performance, therefore he needs to be involved in planning, agree to it, and believe in it.

In selecting farm machinery to efficiently and economically perform the operations in the time available, basic principles must be considered. Timeliness involves the optimum season to accomplish the operations, the working days available considering rainy days, the ability to operate additional hours per day if necessary, and allowances for unplanned delays. Costs are always in the forefront of planning, but are more meaningful when applied to a unit of time like the man hour, or to the unit of production such as the kilogram.

Table 3 includes data for farm machinery applications under Asian conditions. Soil characteristics, climate, crop conditions, power and machinery abilities, operator performance, and other factors present the necessity for a rather wide range of values. The data indicate ranges which will fit most situations.

Basic relationships relating to computing data such as included in Table 3 are :

(1) $dPs = \frac{\text{(draft, in kilograms)} \times \text{(speed, in meters per sec.)}}{75}$

where d = drawbar horsepower
Ps = Pferdestärke = 0.9859hp

(2) $\text{Ha per hr} = \frac{\text{(W, in m)} \times \text{(S, in km per hr)} \times E}{1000}$

where W = rated width of machine action in meters
S = speed of travel of the operation
E = field efficiency in percent

Table 4 contains data which can be used as a guide to establish the estimated life of the machine, the rate of depreciation, interest charges, taxes, insurance, and housing, repairs, and the total cost as a percentage of the new cost. Basic relationships are :

(1) $\text{Annual cost} = \frac{\text{Fixed Costs}}{\text{Annual Costs}}$

(2) $\text{Depreciation} = \frac{\text{First cost} - \text{Salvage value}}{\text{Years of life}}$

(3) $\text{Interest} = \frac{\text{First cost} + \text{Salvage value}}{2} \times \text{Rate of interest}$

where Fixed costs include depreciation, interest, taxes, housing, and insurance. Variable costs include fuel, lubricants, repairs and maintenance.

Taxes, insurance and housing charges (TIH) may in some cases be known or calculated, but if not, they are often estimated at 4 percent annually.

Rapair costs are usually low during the early years of machine life, then increase in amount as use increases. However, a uniform repair charge is usually levied each year, with accumulated experience indicating the adequacy of the estimation.

Fuel and lubricant charges can often be estimated based upon experience, or from data supplied with the machine. Fuel, oil and lubricants consumption of engines is obtainable, but they may be estimated on the basis of about 2.5 hp per liter of fuel (gasoline), and 3.0 or more hp per liter of diesel fuel. Thus, a 10 hp diesel engine operated at an average load of 7 hp will consume about 2 liters of fuel per hr. Oil and lubricants can be estimated as 10 percent of the fuel costs.

The total ownership costs listed in Table 4 do not include labor costs for maintenance or operation, and petroleum products costs.

The units of costs listed in Table 4 can be applied to the exact cost of the machine, or if preferred on cost units of 100's or 1,000's monetary units. For example, if a plow costs 125 units of money, its annual ownership cost would be:

$125 \times 24.7\% = 30.875$ units of cost

Conclusions

Agricultural mechanization is progressing in Asia, fortunately with organized sound programs. Some failures have been noted in former attempts, because too extensive programs were attempted, and involvement of farmers themselves in the plans was lacking.

Since individual farm ownership is favored, farm operators will exert maximum effort to apply production techniques which result in high returns. There is a strong farmer desire in every Asian country for some degree of agricultural mechanization, and these people should be assisted in adopting sound progressive methods.

(*Continued from page* 53)
A net increase of NT $579.07 is obtained by reallocation of the inputs.

Conclusion

From the above analysis, we have found, that the reliability of the MVP and the regression coefficient, plus the fact that the highest ratio of the MVP of machine use to its MFC, indicate a high feasibility of farm mechanization in the area. Therefore, a reorganization in the input combination toward high profit by means of adding more machine use in the production process is essential. In other words, any change to be made in input combination for higher profits, as indicated by the production function, increased use of power tillers should be given first consideration.

* Helpful suggestions and assistance of Professors Karl T. Wright and David L. Armstrong, Department of Agricultural Economics, Michigan State University, are gratefully acknowledged.

** The marginal value productivities were computed from the general formula, i. e.,

$$MVPXi = \frac{bi \cdot \overline{V}}{\overline{Xi}}$$

SOME PROBLEMS ON POLICY FOR AGRICULTURAL MECHANIZATION

Chujiro Ozaki

1. Background

In most of the countries in Asia and the Far East, agriculture is influenced by the monsoon. The climate is divided into dry and wet seasons and the rain comes, in most cases, in June, with monsoon. The rain, however, does not come regularly. If rain comes, a farmer must do agricultural practices fast because their quick operation is needed after rain. Another factor is the hard soil, particularly in dry season. Without rain it is too hard to till, he must wait for rain for tillage. In this case, plows drawn by a pair of bullocks do not work sufficiently and efficiently, because the animal power is too weak for the soil. Deep plowing and quick operation require some kinds of mechanical power because of such natural conditions.

In actuality, mechanical power is not widely used in this region, except in the arid zone where such crops as wheat and cotton are grown in large farms. Rice is the most popular crop in this region, and the size of holding of most of farm households is small which is fragmented into small patches. It makes mechanization technically difficult.

As a social factor, the land tenure system in those countries, particularly in the rice growing area, is traditional, namely tenancy rent, in many cases, exceeds 50 per cent or more of the yield. Such conditions naturally made farmers poor. The land reform has had a strong influence on the modernization of agriculture, thus influencing the mechanization. We witnessed this, particularly in the Republic of China and Japan. However, once mechanization is introduced, the machinery they use tends to become larger and the scale of farming limits the efficiency of using this machinery. The problem of small scale farming still remains where land reform has been carried out.

The labour is abundant in rural areas in most of countreis in this region. In absolute number, it is still increasing, though in relative terms, it is decreasing in most cases. Under such a condition, mechanization is still required for increasing total food production through mainly higher utilization of land and high yields. Under abundant labour condition, labour is short because the peak of labour exists in the transplanting and harvest seasons. The machinery evens up the peak of labour which enables them to introduce double or more croppings. It means that in some cases, the mechanization invites intensification of labour of small farms. With quicker operations by mechanical power, agricultural practices could be done timely and efficiently which also leads to the increased yield per hectare, even if it is small type machinery.

In some countries as mentioned earlier, larger tractors were introduced where dry farming is practiced in large farms. In such cases, some farmers enlarge their size of holding beyond the ceiling of land area regulated by the Land Reform Law, as exemptions for mechanized farms or orchards. This measure tends to induce farm mechanization in such areas. However, if such expansion is carried out by ejecting peasants from the tenanted land, another problem would be arisen because they become landless labourers.

The use of farm machinery to develop unused land is also important, particularly modern machines are profitable for reclaiming land and also for developing drainage or irrigation works, because modern machinery develops land more rapidly and economically.

Another economic condition for the dissemination of fram machinery is the credit given to farmers and distribution of the farm machinery and implements. Cooperative associations play important role for this purpose. They are not yet highly developed in APO member countries. Some cooperatives are giving credit to farmers for purchasing machinery and implements. There are, however, a few cooperatives which distribute them at reasonable prices, giving credit to the farmers. The Republic of China and Japan have well-developed channel of cooperative associations in this respect.

2. Technical conditions

Changes in crop varieties influence the mechanization and in some cases mechanization requires changes in variety. Any change of agricultural technique influences the mechanization and mechanization also requires changes in other agricultural techniques. They are always inter-related. It should be noticed that changes or modernization of agricultural inputs, such as seeds, fertilizers and insecticides are technically feasible for any farmer in the developing countries irrespective of the size of his holding, since such modern inputs are divisible. If, however, we envisage mechanical power, particularly the tractor, this is more closely related to the size of holding because tractors are indivisible. New high yielding varieties developed and distributed by International Rice Research Institute also have influenced farm mechanization. Though they are now on the way of popularization, the method of farming in those countries would have to be changed if they have widely been introduced. Particularly, in some countries, the new varieties are being introduced in dry season because of their insensitiveness for photo-period, with the construction of irrigation facilities. It would require at least the use of power tillers for the double croppings. Also it requires power threshers because grains of the varieties stick tightly to the stem and the conventional animal and mannual threshing does not work well for the grains. Driers are also needed for keeping better quality of grains after harvesting and also for prevention of wastage and losses of the grains because they are harvested in the wet season.

In this connection, we found that the multi-purpose use of power-tillers or small tractors is helpful for smaller farmers which includes tilling, harrowing thresh-

ing, pumping water and transportation.

Any use of agricultural inputs is related to industrialization, i. e. the use of chemical fertilizers, agricultural chemicals and farm machinery requires, if these are manufactured domestically, the establishment of industries to manufacture these input. It modernizes agriculture while at the same time industrialize economy of the country. Absorption of population by these industries decreases agricultural population and in turn it influences farm mechanization. Industrialization also improves technical level of the people and farm mechanization would be promoted by it. It also influences to the lowering of prices of inputs and improves their timely distribution, if the factories are managed efficiently. No one denies these facts but economic and social conditions so far have hampered the progress of such industrialization.

Technical training is very important for the dissemination of modern machinery and implements. Lack of facilities and technicians is the problem. There are three types of the training ; training for the farmers which includes simple operation and repair ; that for trainers of the farmers and ; that for trainers of the trainers. In many countries the shortage of trainers of the last training mentioned above who have knowledge on mechanics is most serious. In many cases, the training for farmers is organized by dealers or makers of the machinery.

Training of artisans or blacksmiths and carpenters of the village would also be needed. In India extension workers are conducting training courses for the artisans. This is useful not only for improving locally made implements and tools but also for repairing farm machinery.

3. Economic appraisal of farm machinery

According to the Survey, made by APO in 1967, if we draw cross-section linear trend curve of the correlation between land productivity and labour productivity for countries such as Nepal, Viet-Nam, China (Taiwan), Korea and Japan, we can find that the land productivity is highly correlated with the labour productivity among those countries (correlation coefficient = +0.997). In these countries, persons engaged in agriculture are nearly or more than two persons per hectare, or the pressure of labour to land is more serious than other countries in this region. Consequently, the land is intensively cultivated largely by human labour and the land itself is utilized more than other countries, so that their land productivity is higher than labour productivity in these countries. Among them, some countries, particularly in China and Japan, use small-type power machinery in most cases in paddy fields, in order to intensify their farming. In this case, the land productivity as well as the labour productivity is raised by introducing machinery (mainly small type machinery) ; because by doing so the land is more intensively cultivated. It is also found that order of the countries mentioned above show stages of development of agricultural productivity in densely populated countries. Starting from Nepal the surve tends to go upwards to the right side in order of Nepal, Viet-Nam, Korea, China and Japan.

In other countries, such as Thailand, India, Iran, the Philippines and Pakistan, persons engaged in agriculture per hectare of arable land area are less than 1.1. Iran has only 0.37 person of working population per hectare of arble land area, or the smallest agicultural population per unit area, and the labour productivity is the highest in this region, with the exception of Japan. Including Iran, the latter five countries show relatively higher labour productivity than land productivity, compared to the former five countries; though the labour productivity is not very high. However, there is little correlation between land and labour productivity. Some of the latter countries are using some large tractors, particularly large farms in dry zone, while a few tillers are used in paddy field where the size of holding is small.

APO survey reveals that an increase in land productivity influences the labour productivity as mentioned above and also an increase in the use of mechanized power as well as total powers including human and animal powers influence at first the land productivity and then the labour productivity, where labour/land ratio is serious. Mechanization, however, seems to influence more directly the labour productivity in dry land area where size of holding is larger. This means that the powers themselves are short, quantitatively and qualitatively.

Operation cost of cultivation is also surveyed by APO. Naturally, it shows that it is cheaper in case of using draft animals than using mechanical power ; but if their efficiencies are considered, the cost of tiller is much cheaper than animal power. The problem, however, is the initial cost. An example in the Republic of China shows that the purchase of 10 HP power tiller is only feasible for farmers whose holding is more than 2 hectares, or 16 per cent of the total farmers, but small farmers who hire out the tiller with their labour can also afford it.

4. Suitability of machinery

The suitability of machinery depends on technical level, natural conditions, irrigation facilities, etc. of the countries. Change in traditional implement in countries in this region has been little. However, the following changes were observed.

1) Metal pieces added to wooden plows for adjustment and wear resistance.
2) Steel teeth replacing wood in harrow.
3) Rotary weeder replacing timed cultivator for intercultivation. Also, improved implements drawn by animal were seen in many countries.
4) Mold board plows developed for animal-drawn plows. However, steel beams and plow frames have been difficult to introduce for the following reasons:
   a) Increased cost
   b) The weight is too heavy to plow Steel plows are introduced because of longer life
5) Implement carrier, with easily attached tillage tools, seed-cum-fertilizer drill, harvestors, etc. is particularly interesting. It was seen in India.

Technically, small tillers are more efficient than animal drawn implements, but, so far, millions of farmers are still using animal powers. Power tillers also have some defects for dry and hard soil, because the power is too weak. In Asia, power tillers are performing satisfactory in wet land preparation, but they do not work well in dry land, due mainly to limited power of single axle-tractor to operate a rotary tiller.

5. Test and standardization

Standardization tends to reduce number of models and styles and simplifies spare parts and service operations. Indigenous implements are difficult to test and standardize. Often indigenous implements are individualistic, that is to say, each was made without precise pattern, and spare parts cannot be obtained and replaced on the implements. Modern machinery is easier to standardize.

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* This paper is summarized from the Report of "Expert Group Meeting on Agricultural Mechanization" (APO Project No. SYP/III/67) Vol. II which was prepared by the same auther published by Asian Productivity Organization in October 1968. It Was also referred to the "Report of the Survey on Agricultural Mechanization" prepared by Dr. Howard F. McColly, Professor, Michigan State University, U. S. A. and the author of this paper in 1969, whole text of which is included in the Report of the Expert Meeting (Vol. I) mentioned above. In this paper, technical problems included are highly indebted to Dr. McColly's view expressed in the latter report.

Young peoples are learning to operate a power-tiller

Agricultural Mechanization and Rural Welfare in South and Southeast Asia

Robert D. Stevens, Bashir Ahmad

I. Introduction

After preliminary observations in this introduction the paper focuses in Part II upon three critical economic characteristics of South and Southeast Asian nations which will influence the course of agricultural mechanization. They are ; rapid growth in rural population density, the likely decline in farm size, and low labor costs relative to machinery costs. Part III considers three elements of a needed comprehensive framework for analyzing agricultural mechanization and other development proposals. Finally, an appeal is made for increased multidisciplinary research on ways to rapidly increase the productivity of rural people, particularly in the areas of Asia with high population density.

This paper assumes the central focus of analysis is upon the welfare of rural people. Thus any use of inputs, machines, or other proposed changes are to be judged on the basis of their effect on people in the rural communities of Asia. The paper is limited to consideration of mechanization for small farm crop agriculture as in most of Asia this includes the vast majority of farm people. Plantation and other large scale agriculture are considered special cases, outside present space limits.

Briefly, the economic criteria for the analysis of all programs for increased income for rural people is the weighing of benefits against costs. The generally accepted formal method of benefit-cost analysis is considered in some detail later. In general, the projects or programs providing the highest net returns will increase the income of people in rural areas most rapidly.

For sound decisions about resource use analysis has to be placed in a longer run developmental framework. The peoples in rural areas of South and Southeast Asia are commencing an historic technical, economic, and social transformation from a traditional to modern agriculture of immense dimensions. The transformation involves the application of modern science and technology to agricultural production processes. The decades required for this transformation suggest that the year 2000 will be passed before the agriculture in this area of the world will be modernized.

Within this longer run perspective, what are the strategic, productive early steps in agricultural modernization? Is it most productive to deal with each local situation empirically crop by crop? Are separate studies by each professional discipline the most productive research approach? Should governments and international organizations increase support for types of effective multidisciplinary and international research in order to more rapidly determine more productive agricultural systems for modernization?

More fundamental questions must also be faced squarely by professionals. Should the assumption of the Asian Agricultural Survey be accepted"……that an expansion of production is the priority goal, i. e. matters of equity, backwardness and poverty are acknowledged, but given lower priority to production growth..."? 1/ Are the governments and societies of Asia going to permit types of agricultural modernization in which relatively few wealthy individuals apply very productive new inputs in agriculture at the expense of greatly increasing unemployment and the forcing of large numbers of people off the land? In a few locations this has already occurred and it is threated in much larger areas. In some cases, the cost to individuals, certain groups, or governments of particular modernization steps may be too great. Thus, the technical characteristics of a particular form of a major technological advance may seriously conflict with existing resource allocation and cultural patterns. The challenge therefore is to design and modify technology so that the greatest increase in productivity is achieved at least cost to society. The importance of attempting to assure that as many individuals as possible have access to the new more productive inputs is heightened by the fact that most governments in the area have few resources and small capacity to transfer income through taxation or other means from advantaged to disadvantaged groups. The conclusion must be : tailor the technology to the society. The alternative is to let technology put great stress on rural people who have limited ability to cope with the forced changes.

Mechanical inputs 2/ are an essential part of the package of medern inputs for agriculture. At any point in time and place, because of complex complementary and sub stitution relationships, it is not obvious which package of the biological(improved seeds, etc.), chemical (fertilizers, pesticides, etc.), water, and mechanical inputs provide the highest returns, and thus should have highest priority for investment. Exceedingly intricate relationships are involved, especially when major changes in crops and cropping systems are involved. Solutions to these complex questions require overall analytical focus on the whole system so as to determine how to increase from one period to the next the agricultural productivity of a specified group of rural people. The scope required for this analysis will need to be the farming area, or systems for production of a particular agricultural commodity. In this way the roles and priorities for each type of agricultural input, including mechanization steps, can be determined. One hypothesis based on developments in some nations is that in the early phases of modernization special purpose machines such as water pumps and pesticide sprayers will provide higher returns than general purpose tractors.

Deep involvement of governments in decisions about agricultural mechanization is appropriate for at least two general reasons. (1) Many government rules and regulations aid or retard mechanization

activities. The long list includes all forms of taxation or subsidy, any permits for business or tractor operation, and the cost of foreign exchange and the way in which it is allocated. (2) As governments will reap the economic, social and political consequences of successes and failures in agricultural mechanization developments, they consider these developments within their responsibility.

II. Economic Characteristics of Rural Asia Influencing Agricultural Mechanization

Three economic characteristics of rural South and Southeast Asia will greatly influence the course of agricultural mechanization. Most rural areas in the region will continue to experience rapid growth in rural population density, a decrease in the size of farms, and low labor costs relative to the cost of capital. These facts about the future economic environment have important implications for agricultural mechanization activities in these nations.

A. Rapid growth in rural population density.

High national population growth rates and the limited capacity of the small industrial and urban sectors to absorb large numbers results in very rapid increases in agricultural population densities. In most areas these increases in rural population density are estimated to continue for a number of decades. The FAO Provisional Indicative World Plan for Agricultural Development estimates that the agricultural population in Asia will rise from the 583 million in 1962 to 1310 million in the year 2020 before a decline in agricultural population begins[3a].

Dovring provided an analysis explaining these trends. With high population growth rates of 2 to 3 percent and with limited capacity of the non-agricultural sectors to absorb increased population, he showed that in many nations a minimum of forty to fifty years would be required before the total numbers of persons in the agricultural sector could be expected to decline.[3b]

Data on the growh of agricultural population increases in South and Southeast Asian nations supports these conclusions. Although unemployment is already serious in many rural areas, manpower and industrial employment specialist are pessimistic that industry and urban areas can create sufficient jobs even for the growing population already in urban areas. The report of the Pearson Commission stated, "The main burden of absorbing the increase in the labor force falls inevitably on agriculture.[4]/ There is little doubt that most rural areas of Asia will in the next few decades experience rapid increases in population with limited opportunities for employment outside of agriculture.[5a]/

Implications for mechanization : With expected continued high unemployment in rural areas due to increasing population densities governments will have increasing pressure to find more employment for people at home in rural areas. In this framework, agricultural mechanization steps which increase employment have highest priority, such as all types of mechanical water pumps, one man power sprayers, etc. Any mechanization programs which reduce employment need to be considered with great care so as to know the likely impact on the rural community.

Table 1. Selected Representative Examples of Growth in Agricultural population in Asian Developing Nations

	Agricultural Population (000)		Estimated for 1965
India	1951	249,122	340,655
Pakistan	1961	69,525	83,840
Philippines	1948	13,267	18,738
Thailand	1950	12,211	24,001

Source : FAO Production Yearbooks

B. Average farm size likely to decrease.

Due to population pressure on the land and current social and political developments in many nations average land area per farm will probably decline over the next decade or two in most nations of South and Southeast Asia. Recent changes in land per farm in the area support this thesis.

Current political and social developments in Asia suggest that various types of land reform will also reduce the average amount of land owned per person. In some of these nations, such as India and the Philippines, land reform laws are on the books but as yet have generally not been effectively implemented. In these nations recent political developments point either toward more effective implementation or stronger land reform laws which will decrease the average size of holding. In South Vietnam the implementation of a new land reform program is underway.

Implications for mechanzation. As the land area per farm is likely to decline or at the very least not increase appreciably, mechanization developments need to be tailored to these farm sizes. "About seventy percent of the farms in the region are less than 2.0 hectares. [5b]/ There will be little scope for mechanization programs which put pressure on farmers to purchase more land or which assume that successful farmers can increase the area operated. Exceptions would be for some situations in certain sparsely populated areas. On the other hand, mechanization steps which increase the cropping intensity through aiding increased multiple cropping will probably be highly profitable for rural communities.

C. Low labor costs relative to machinery costs.

In the developing nations of Asia the relationships between the prices of the various farm inputs are very different from those in more developed nations. In particular, the cost of labor is very much lower relative to the cost of capital. Visual evidence is seen when men are the motive power to move boats on the rivers or wagons through the cities. Motor power is in many of these situations still too costly.

Any capital items which must be imported are even more costly from the point of view of the economy. Foreign exchange for most of these nations is very short. Thus, its use must be limited to expenditure for the importation of goods which provide a very high return to the society. In this sense the cost to a nation of any machinery or goods which must be imported is much higher than its price implies. Thus, agricultural mechanization projects in which imported machinery with high costs to the society substitutes for low cost labor, would have to provide a very high return in order to be economically justified. Through various mechanisms such as multiple exchange rates, import licensing, taxes, and so forth, governments have selectively reduced or increased the costs of imported agricultural machinery. Pakistan, for example, has greatly subsidized the importation of agricultural machinery. In the future, governmemts will become more careful about the use of foreign exchange as levels of aid are reduced and the international export market becomes even more competitive. It is unlikely they will be able to justify any reduced foreign exchange costs of farm agricultural mechanization as compared to other capital investment projects in other sectors.

Implications for agricultural mechanization. Major differences in the cost of labor relative to capital in the nations of Asia suggest that whole new sets of agricultural technology are required to provide the highest economic returns to agricultural machinery in rural areas in these societies. Hans Singer has estimated that to date 99 percent of the world's scientific and of the technological innovation in the world has been carried out in the richer developed countries. [6a]/ Almost all technology has therefore been designed to be highly productive under relatively high labor costs of more

developed nations. In this respect the technology of the earlier simpler Japanese hand tractor systems may be more consistent with the factor price environment(low labor costs)than other presently existing tractor mechanization systems. The current rapid increase in the use of variations of hand tractor systems in Taiwan[6b] and Malaysia[7] support this view.

In other situations, larger 4 wheeled tractors and associated machinery designed for the economic and technical environments of the more developed countries will find some economic niches in which they may be productively used, most often largely on a custom basis. Examples of these developments are limited areas of upland crop in Thailand, Western Malaysia, the Indian Punjab, and West Pakistan. Whether these fourwheeled tractor machinery systems will continue to be economically and technically the most productive systems in these areas remains an open question as intensification increases and price ratios change.

Thus, the research and testing of machinery and machinery systems in Asia such as at IRRI and at Allahabad in India, will greatly aid in developing machines which will provide high returns in these very differnt economic, technical and social environments.[8]

A further special implication of the high cost of imported agricultural machinery is the importance of focussing on the net foreign exchange impact of machinery imports. If imported machines can be shown to be the highest return way of increasing agricultural exports or of reducing foreign exchange outflow, their value to the nation is greatly enhanced. The use of four-wheeled tractors for plowing in the uplands of Thailand resulting in great increases in the exports of maize and other crops is a case in point. Similar special developments have occurred in other parts of the world such as the very rapid development of wheat production due to the tractorization of the Jazira region of Syria.

III. Elements for a Comprehensive Analytical Framework for Agricultural Mechanization

There is an urgent need for an agreed upon analytical framework that would enable us to investigate the various issues involved in the programs of agricultural mechanization.[9]

There is little question that mechanization programs have inter-disciplinary dimensions i. e. engineering, biological and economic aspects. No single discipline is adequately equipped to make comprehensive analyses so urgently needed for making informed policy decisions by the governments concerned. A formal or informal interdisciplinary effort, therefore, seems to be essential.

A review of three elements for a comprehensive analytical approach will help to identify some of the important considerations for the analysis of future mechanization programs in South and Southeast Asian countries.

Technical Analysis : This analysis often places major emphasis on the need for a minimum amount of horsepower per land unit for agricultural efficiency.[10] Estimates are made of the gap between the minimum power requirements and the power that bullocks and men provide with traditional implements. The conclusion generally reached is that to achieve the specified "minimal power range" of 0.5 to 0.8 horsepower per hectare, mechanical power is necessary. This approach tends to imply that a tech nically efficient agriculture would increase agricultural productivity most rapidly. Under such an approach, the tendency is for public policy to focus on how to overcome farmers' resistance to mechanical technology. Government subsidies have often been recommended in situations where mechanical operations have not been financially profitable for farmers.[11]

Care in the distinction between technical and economic efficiency of a project is fundamental to improved decision making. Technical efficiency usually refers to the attainment of a maximum product from a given resource···say maximum yield per acre. In contrast eccnomic efficiency is determined by the value of the product produced in relation to the cost of the inputs used. A farmer maximizing profits would usually not use enough inputs to achieve maximum yield per acre under most economic conditions. If he did the additional cost to achieve maximum output would in most circumstances be greater than the additional value of the product.

Financial Analysis--Analysis from the point of view of the farm operator or project manager. Thorough technical analysis is essential but not sufficient for appraisal of the value to rural people of a project or program. In addition,financial and economic analyses are required for improved government decision-making.[12a] Financial analysis focuses on the receipts and the costs of the farmers involved in a mechanization or other programs. The procedure is to determine on the one hand the quantities of inputs (machinery, fuel, maintenance, repair, driver salaries, etc.), and on the other hand estimate the output of agricultural products for a series of years into the future. In order to do so the relevant prices are projected into the future anP multiplied by the corresponding inputs and outputs so as to yield money estimates of costs and receipts in each year.

Using an appropriate discount rate the conventional benefit-cost ratio and other project evaluation measures are obtained with the use of the following or similar equations.[12b]

$$\text{BCratio} = \frac{\frac{TR_0}{(1+i)^0} + \frac{TR_1}{(1+i)^1} + \cdots + \frac{TR_n}{(1+i)^n}}{\frac{TC_0}{(1+i)^0} + \frac{TC_1}{(1+i)^1} + \cdots + \frac{TC_n}{(1+i)^n}}$$

where TR = Total Receipts
TC = Total Cost
i = Discount Rate
n = Number of years included in the analysis

If the benefit-cost ratio is greater than one the project will be profitable to farmers and they will have incentive to accept it.

From the point of view of society financial analysis has shortcomings. This is because the prices of inputs and outputs that individual farmers face are likely to differ from the prices of some of these goods and services from the point of view of the society as a whole. In the developing countries the differences between private financial profits and the net benefits to society are often great. Thus in order for governments to make better decisions about projects an economic analysis is required.

The Economic Analysis--Analysis from the point of view of the nation as a whole. Because there is a divergence between private financial profit-ability and net benefits to society an economic analysis of investment projects is required. Two major questions of evaluation are involved :

(a) The costs for inputs and outputs included in the financial analysis do not cover all the costs of the project to society. For example, resettlement of labor displaced by mechanization is a cost to the society but is not included in the cost calculation of a farmer who buys and operates a tractor.

(b) Prices used for valuation of inputs and outputs often do not reflect their scarcities. This is due to market imperfections and government intervention and control in a number of important markets. Consider two examles.

i) Farm Product Markets : With government price support programs the farm product prices obtained by farmers and used in the financial analysis may exaggerate the value

of particular projects. Thus in an economic analysis the farm product prices may need to be reduced somewhat. This permits decision makers to test whether the level of the benefit cost ratio of the project was unduly inflated by the high government price supports.

ii) Farm input markets : The cost to a farmer of additional labor--the cost which would be used in a financial analysis--is the daily wage rate. However, if there is widespread unemployment and underemployment in the area, the cost to society of employing additional laborers is much less, perhaps close to zero, if they have no other gainful activity. Thus in an economic analysis of an unemployment situation, the cost of some kinds of labor may be greatly reduced. If there is also the common situation of an overvalued exchange rate and the official exchange rate is used for the import of agricultural machinery, the cost to the farmer of machinery relative to labor will be much less than the cost to society. Another price distortion requiring economic analysis is that the cost of credit is often subsidized for the purchase of machinery and other inputs. Such low interest rates much below market rates tend to reduce the cost of machinery compared to labor.

Economic analysis uses the same equations as discussed under financial analysis. But the receipts and costs are estimated from the point of view of society as a whole rather than on the basis of market prices facing the individual firm.

In the economic analysis considerable difficulty is faced in estimating the appropriate prices for inputs and products. The prices are estimated by examining supply and demand conditions in the appropriate markets.

The three analytical elements discussed above do not succeed in providing a comprehensive framework for the analysis of mechanization and other projects. For example, these analyses do not show the effects of a project on income distribution or upon employment in the area of the project. Improved analytical methods are needed.

From the review of the three analytical approaches we come to the conclusion that a comprehensive analytical framework for mechanization must include technical, financial and economic analysis. Only then will a project's technical feasibility, its financial attractiveness to farmers and project operators, and its net benefits to the whole society be known.

IV. The Need for Increased Multidisciplinary Research

The transformation of traditional agriculture into modern agriculture systems in South and South East Asia is a change of such a fundamental nature that it can only be compared to the scientific and industrial revolution in Europe and to the incredibly rapid transformation of the Japanese economy during the past ten decades. Many of the nations of South and South East Asia desire and are striving for an even more rapid transformation.

The speed and scope of these immense rural changes call upon professionals to analyse many sets of agricultural production systems employing new technology. Considering the shortage of trained professionals in the required fields effective experimentation, pilot testing and analysis of these systems will require the collaboration of professionals with different disciplinary training, including particularly agricultural engineers, crop scientists, soil scientists, and economists. Individual studies by professionals from one discipline will be much more useful if they fit into a comprehensive system of analysis of agricultural areas or commodity production systems.

The governments of South and South east Asia will not be able to aford the often uncertain and sometimes contradictory professional recommendations which are inevitable from a professionally fragmented approach of studies which examine an agricultural process or program separately from biological, chemical, mechanical or economic points of view. How can governments be expected to make improved decisions if the involved professionals cannot come to agreement on objectives, methodology, and recommendations. Professionals will be more appreciated and effective with government if they can speak with one voice about these immense issues of rural transformation.

Past difficulties in communication between agricultural engineers, economists, and other professionals may have been due to a lack of jointly accepted objectives on an agreed upon comprehensive framework of analysis. How can useful professional interchange between these needed disciplines be increased?

1/ Asian Agriculture Survey, University of Tokyo Press, 1969, p. 30.

2/"...any form of mechanical assistance used by the farmer, whether in forms of hand-powered, animal-powered, or engine-powered technology. " C.K. Kline, et al., Agricultural Mechanization in Equatorial Africa, Institute of International Agriculture, Michigan State University, 1969, pp.2-4.

3 a/Food and Agriculture Organization, Rome, 1970. Vol. III, Summary and Main Conclusions. p.16.

3 b Projections of Folke Dovering, "The Share of Agriculture in a Growing Population", Monthly Bulletin of Agricultural Economics and Statistics, vol. 8, August-September, 1959.

4/ Report of the Commission on International Development, Partners in Development. New York,1969. p.59.

5 a/For a more extended recent analysis see: Robert d'A. Shaw, Jobs and Agricultural Development. Washington, D. C. Overseas Development Council. 1970,

5 b/ Asian Agricultural Survey of the Asian Development Bank, Tokyo, University of Tokyo Press, 1969. p.642.

6 a/ H. W. Singer, "International Policies and their effect on Employment" Background Paper. University of Cambridge, Overses Studies Committee Conference, 1970.

6 b/ Ming Wu Wu, "Farm Organization and the Feasibility of Agricultural Mechanization in the Rice Region of Taichung Area, Taiwan ", unpublishe dM. S. Thesis, Department of Agricultural Economics, Michigan State University, East Lansing, Michigan, 1970, p.71.

7/ William J. Chancellor, "Survey of Tractor Contractor Operations in Thailand and Malaysia", Agricultural Engineering Department, University of California, Davis, California, 1970, p.11.

8/ An interesting specific illustration of how the organization of rural society can impinge on the economic and technical requirements for high profit machines is illustrateted by the high capacity portable field rice thrasher developed at IRRI. This machine was required because of the fact that rice is often harvested in the Philippines by large crews. The different labor organization of Japanese farming did not requirs this type of machine, and thus it did not exist. (Professor William J. Chandler, Personal Communication).

9/ For further discussion of the need for better analytical tools see S.R. Bose and E.H. Clark "Some Basic Considerations on Agricultural Mechanization in West Pakistan". Pakistan Development Review, Vol. IX, No. 3. Autumn, 1969.

10/ The World Food Problem. Volume II. U. S. Supt. of Documents,1967. p.397. The data support the thesis that at least 0,5 horsepower per hectare is needed to achieve high yields on this scale, and G. W. Giles, "Towards a More Powerful Agriculture", a report to the Government of West Pakistan. Distributed by the Planning Cell, Agriculture Department, Government of West Pakistan. November, 1967.

11/ Van Wersch, Herman J. "Rural Development in Morocco" Operation Labor (Operation Plow)". Economic Development and

(*Continued on page* 57)

INTERNATIONAL COOPERATION of AGRICULTURAL ENGINEERING for MECHANIZATION in SOUTH EAST ASIA

from the standpoint of ASAE

Robert E. Stewart

The American Society of Agricultural Engineers (ASAE) was founded in 1906. Its constitutional objectives are

. . . to promote the science and art of engineering in agriculture; to encourage original research; to foster agricultural engineering education; to advance the standards of agricultural engineering; to increase and extend the association of agricultural engineers among themselves and with allied scientists and technologists; to encourage the professional improvement of its members, and severally and in cooperation with other groups to broaden the usefulness of agricultural engineering.

Over the years ASAE interaction with agricultural mechanization in foreign countries has grown to significant dimensions two ways:

a. Through official involvement as an engineering society with international agricultural engineering associations. An example of this is ASAE's membership in Commission International du Genie Rural (CIGR).

b. Through involvement of ASAE members as individuals in development of mechanization throughout the world. Hundreds of members have so served, and their cumulative experience should constitute a valuable knowledge pool for South East Asian countries.

ASAE has a strong program of standards development for agricultural machinery. These standards aid mechanization through creation of designs which, when used by the various manufacturers, make their products interchangeable each with the other. The standards program also promotes safety in machine design.

The interaction between research and machine design is important for each country. This is because the machines from a foreign country may not adapt well to the native requirements. Research is always needed to set up design criteria for the native conditions. This research can best be done by people in the native country. However, the research done by others can be a rich source of methodology and ideas. ASAE has provided meetings for many years where research is discussed and researchers become acquainted; much of this research has been published by ASAE and is available to all interested persons.

Agricultural mechanization progress is partly dependent upon education. Farmers need technical education of some kind in order to manage machines effectively. The technicians who advise the farmers need education. Those who design and market the machines must be educated. The government personnel who plan and finance programs should be educated. Finally, the educators themselves must be educated. Some of the education will be formal, as in the university classroom; some will be informal as in the workshop and field. In any case, progress is enhanced by education. Education is a major objective of ASAE. Through its meetings and publications, ASAE insures the agricultural engineer the opportunity to learn of the latest technical advances. Thus, the agricultural engineer is continuously brought up-to-date and kept informed so that he can either pass on the information to others or use it personally on the job.

The organizational structure of ASAE may suggest the scope of expertise which could be mobilized to promote agricultural development in South East Asia. The Technical Council contains the following Divisions: Electric Power and Processing; Food Engineering; Power and Machinery; Soil and Water; Structures and Environment. These divisions inidcate that the application of engineering in agriculture is not limited to field machinery; rather, the application includes all factors which can increase production, raise quality, and reduce labor. Friends in South East Asia who might look to ASAE for technical assistance shoud keep in mind that mechanization is achieved in many different ways.

The divisions of ASAE's Technical Council are organized into a large number of subdivisions, or committees, which carry out the interests and needs of both agriculture and the members themselves. There are too many of these committees for detailed listing, but it may be instructive to examine the titles of some of the committees serving under the Power and Machinery Division. These are: Standards; Agricultural Chemical Application; Cultural Practices Equipment; Farm Machinery Management; Forage Harvesting; Soil Dynamics; Tractive and Transport Efficiency; Tractors; Fruit and Vegetable Harvesting; Farm Materials Handling; Tractor and Implement Hydraulics; Small Tractor and Power Equipment; Grain Harvesting; Forest Engineering. This list is suggestive of the technical coverage which ASAE is now attempting.

Another ASAE committee of interest is the International Relations Committee. All of its members have had extensive overseas experience and are able to view the problems with sympathy and understanding.

A final comment might be in order. ASAE has members in various nations of the world who are native to the area. There are advantages to such membership, particularly since one need not be an agricultural engineer for acceptance, and ASAE would welcome applications from South East Asia. This would enhance the possibilities for international cooperation and help to make we Americans more aware of world food problems.

Demonstration of a hulling and pearling equipment in West Java. (Though small, this equipment can deal with 3 ton a day)

MACHINERY DEVELOPMENT FOR TROPICAL AGRICULTURE

Amir U. Khan

Most developing countries are passing thruogh an agricultural revolution which will have far-reaching effects on agricultural production technology. Recent advanecs in plant breeding have demonstrated that it is possible to significantly raise crop yields in the tropical areas. The sharp rise in the income of farmers who have adopted new varieties has given impetus to mechanized cultivaion.

In order to keep up with these advancements in agriculture, great technological and industrial adjustments will be needed. This will entail a greater effort on the development and production of better suited agricultural equipment within the developing countries. Improving the traditional implements or adapting imported equipment from the temperate cliates will help, but will not relieve, the need for better suited machines in the developing countries. Attempts are being made to mechanize the tropical agriculture in most countries but the small size of farm holdings and the relatively low income of the farmers are major bottlenecks.

Mechanization constraints

Lack of equipment. The lake of simple, small, power-driven equipment that could economically mechanize the small farms is a serious problem. The farm equipment from North American and European manufacturers have found limited acceptance in Asia, only on the larger dryland farm holdings. In some developing countries attempts to introduce such equipment to small farmers through cooperatives or other forms of joint use have found limited success. It seems doubtful that this approach could be accepted by any large segment of the small farmers.

In Japan, the high price of rice and the rapid industrial growth has resulted in the mechanization of agriculture with relatively small machines. Such equipment is originally developed to meet the requirements of the Japanese farmer. It is gaining some popularity in tropical Asia but is often too complex and uneconomical for use by the tropical farmer.

High cost of imported equipment. The tropical farmer generally pays about three to six times as much as a farmer in tne industrialized regions for the same piece of equipment. Furthermore, the equipment has to compete with manual labor which usually costs only a fraction of what it would cost in the industrialized countries. An agricultural machine that is well accepted in an indus trialized country often is not as desirable under the set of economic conditions found in the tropics.

Lack of foreign exchange. Most developing countries are undergoing balance of payment problems in varying degrees. Their meager foreign exchange resources are channeled to high priority projects and the import of farm equipment is often carefully controlled. This implies that the mechanization of tropical agriculture will be severely restricted if mechanization is to be achieved only with imported equipment.

Complexity of equipment. The equipment available from the industrialized countries is developed for relatively better educated and more mechanical-minded farmers than those in Asia. The highly sophisticated design that is desirable in the advanced countries is often too complex for the farmers in the less developed regions. In addition, the equipment produced in the advanced is basically developed for mass production and is not suitable for low-volume production.

Problem of labor displacement. Many economic studies have pointed out the dangers of displacing farm labor with agricultural machines in the tropical countries. This problem is further magnified if the agricultural equipment is to be imported since such equipment can not generate new employment in the importing countries. The industrial growth in most developing countries is not rapid enough to absorb any significant displacement of labor from agriculture. The agricultural sector, therefore, must generate alternate employment opportunities by intensifying labor practices and developing agri-business and other related industries. The long-range socio-economic implications of displacing agricultural labor with imported agricultural machines, therefore, necessitate that an indigenous farm equipment industry be developed.

Manufacturing potential

The above constraints indicate a need for the development of small engine-powered equipment that can be manufactured within the developing countries by low-volume production methods. A strong desire for industrial development and the shortage of foreign exchange encourage the local manufacture of agricultural machinery. Indications are that the growth of agricultural mechanization will parallel the development of a small-scale indigenous farm equipment industry in most tropical countries.

There are encouraging signs in Taiwan, Thailand, India, Pakistan and the Philippines where, in recent years, small machine shops have started to economically produce tractor implements, stationary farm machines, pumps, and in some cases, diesel engines and walking tractors.

An interesting example of economical low-volume production is found in the Philippines. Numerous small establishments all over the country are producing the jeepney, a locally adapted version of the jeep vehicle. The vehicle chassis, all sheet metal components, and many other parts are fabricated with simple produ ction methods at competitive prices. The quality of fabrication is comparable to that found in the industrialized countries where highly organized capital-intensive mass production techniques are used. It seems that the economies of scale in manufacturing are more relevant in an economy where the cost of labor is high than in an area where labor cost is low.

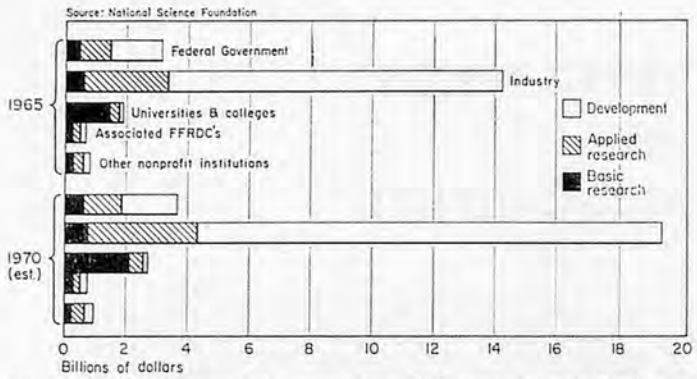


Fig.1 Expenditures on basic research, applied research, and development by sector in the United States, 1965 and 1970.

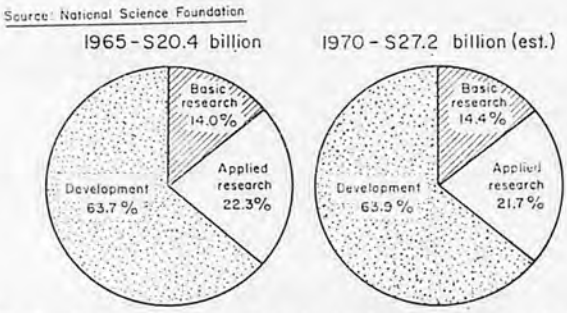


Fig.2 Distribution of total funds for basic research, applied research and development in the United States, 1965 and 1970.

Machinery development bottlenecks

The established manufacturers in the advanced countries have not found it profitable to develop equipment for tropical countries. It is also difficult for these manufacturers to develop machines for an environment with which their engineering staff is not as closely associated. With a few exceptions, such manufacturers have limited their efforts in the tropical countries to marketing studies and evaluation of their existing products. Understandably, these manufacturers prefer to develop equipment for their home market first and subsequently attempt to find new markets abroad.

Many Asian countries have publicly supported centers for agricultural mechanization research. Research in such institutions has been directed towards knowledge rather than application. This is broadly along the pattern of basic and applied research followed by the educational institutions in the industrialized countries. **Figure 1** shows the basic and applied orientation of research in the universities and Federally Funded Research and Development Centers (FFRDC) in the United States during 1965 and 1970. 1/

The design and development of agricultural machines in the advanced countries is primarily a function of the industry. The machinery manufacturers utilize the results of basic and applied research to develop new machinery which the farmer uses to mechanize his operations. The payoff of basic and applied machinery research at the farm level depends to a large extent on the development of agricultural equipment in a country. The importance of development activity in the United States is indicated in **Fig. 2** which shows that during 1970, out of a total R & D expenditures of $ 27.2 billion, 14 percent was for basic research, 22 percent for applied research, and 64 percent for development.

The struggling state of agricultural equipment industry in the developing countries does not permit channeling of any appreciable amount of funds for machinery development. Funds for research, however, are only available to publicly supported organizations in these countries. The development of new equipment for tropical countries has therefore received little attention from local governments or from either local or foreign manufacturers.

Machinery research and development priorities

Since the farm equipment industry is in no position to develop new equipment, publicly supported research organizations in the developing countries must meet this challenge by directing their resources to two primary areas: the development of new agricultural equipment for indigenous production and applied and adaptive type research on available equipment.

In Asia, a large segment of the land under cultivation is in medium size landholdings of 2 to 10 hectares. As a group, farmers with this size of land can support an intermediate level of mechanization. Often they find traditional animal or manual equipment inadequate for their requirements. Ironically, this large group of farm holdings has the least access to modern power equipment since machinery development research in most advanced countries is primarily concerned with equipment for larger landholdings. There is little doubt that in the long run, the larger, more economical equipment will play an increasingly popular role in the mechanization of tropical agriculture. Meanwhile, development engineers must give immediate attention to the machinery requirement of the large number of medium-sized tropical farm holdings that are too large to work economically with animals but are too small for the 30-plus horsepower equipment.

The large consumption of rice and the general lack of adequate transport facilities in the rural areas of Asia indicate a need for modern drying and processing systems for village level or individual farmer operations. Capital-intensive technology for drying and processing rice in large quantities is well developed in the industrialized countries. It is being applied in the establishment of centrally located commercial rice drying and processing plants in Asia. A well developed infrastructure, however, is an essential prerequisite for the establishment of large processing plants and its lack has considerably limited the scope of such plants in the developing developing countries.

An estimated 50 to 70 percent of the rice produced in the tropical countries is consumed within the rural areas and does

Fig.3 IRRI-developed table-type paddy thresher.

Fig.4 IRRI-developed three-row portable power weeder.

Fig.5 IRRI-developed drum-type paddy thresher.

not pass through commercial channels. Rice processed for rural consumption in tropical Asia is often of very poor quality. Development research is urgently needed to provide economical modern village- or community-size drying and processing equipment which could be locally manufactured in the tropical countries.

There is need for applied machinery research to assist manufacturers outside the tropical regions in adapting their existing machines and in developing new equipment. The evaluation of new machine concepts and field-testing of prototype and commercially available equipment will encourage the development of equipment for tropical conditions by the established manufacturers in the industrialized countries.

Equipment development challenges in Asia

Developing equipment for tropical conditions is often more challenging than for the advanced countries. Quite often an agricultural machine for the developing countries needs not only to meet the same functional standards of the machines for tne advanced countries but also has to be cheaper, simpler, and longer lasting.

The machine designer in the developing countries is faced with difficult and challenging problems. He has to work under serious constraints of production processes, engineering materials, and choice of ready-made machine components. He is often called upon to assume responsibilities which normally would be handled by specialists in the industrialized countries.

Production processes of turning, drilling, cutting, brake and roll bending, rivetting, electric and gas welding, ferrous and non-ferrous sand castings are the only readily available operations to the small fabricators in the developing countries. Mahcine components which can be produced with these simple operations have a greater chance of acceptance by small manufacturers. Production operations such as spur gear cutting, milling, shaping, spot welding, sheet metal stamping, power punching, steel casting, and simple steel heat treatments are often beyond the capacity of the small machine shops and can be used only on a limited extent. The least accessible production operations such as grinding, special types of gear cutting, gear hobbing, special heat treatments such as induction hardening, power forging, pressure die casting, malleable or ductile iron castings, and plastic mouldings are operations which are generally avoided for low-volume production.

Ordinary low carbon structural steel sections, plates, sheets and tubes are the only widely available engineering materials in the tropical countries. Medium and high plain carbon or alloy steels are not commonly available and should be avoided in designing machines for indigenous production. Chilled cast iron, however, can be specified to a limited extent for parts which may require hardened surfaces.

Role of established manufacturers

Most established manufacturers in the industrialized countries are aware of the potential market for farm equipment in the developing countries. They are reluctant, however, to commit resources for developing special equipment for such areas as it ts easier and less risky to market their existing line of equipment. The progressive forward-thinking companies can play an important role by developing special equipment for tropical agriculture. If the established manufacturers do not actively involve themselves at this stage, they may find themselves in a relatively poor competitive position in the near future. Leading international farm machinery companies need to play a more active role in developing the farm equipment industry in the tropical countries rather than look at these areas as mere markets for existing machines.

Recognizing the need in the developing countries for suitable agricultural equipment and for the development of an indigenous farm equipment industry, the U. S. Agency for International Development awarded a research contract to The International Rice Research Institute. Under this contract, the Institute has been engaged for the last three and a half years in developing new farm equipment for the production and processing of rice in Asia. Some of the equipment designs, which have been released so far to manufacturers in many parts of the world, are illustrated in **figures 3 to 5**. Interestingly enough, some of the machines which were originally developed for the tropical countries are now being evaluated by manufacturers from the advanced countries for their home markets.

The Institute considers this program of machinery development as one of its important activities during the 1970s. It looks forward to more active cooperation from established machinery manufacturers from all over the world.

1/National Science Foundation. "R&D funds by sector, 1955-70." National Patterns of R & D Resources. Funds & Manpower in the United States, 1953-70. Washington, D. C. September 1969.

(*Continued from page* 107)

1/ Source; Country Report on the Philippines Rice Processing Machinery Industry. November, 1969,

2/ Juinio, Alfredo L. 1970. Irrigation Development in the Philippines. Paper presented at the FAO/UNDP Regional Seminar on "Water Management" held in Manila, Philippines on October 7-16, 1970/

International Cooperation of Agricultural Engineering for the Mechanization in Southeast Asia

— from standpoint of Japan —

Hideo Kaburaki

Traditionally agriculture in Southeast Asian countries has been mainly dependent upon human labor and draft animal power. In those countries, labor shortage sometimes becomes a problem, as labor requirements are peaked in season. There is a strong need to complete the farm operation within the minimum time, so that multiple cropping can be facilitated. In such instances, timely operation is a more important factor than the saving of labor, as it affects the yield. It would be worth while mentioning that while labor saving is sometimes quoted as a common reason for the mechanization, raising the intensity of the farming organization as a whole should also be recognized. Recently efforts have been made in those countries to introduce high-yielding varieties, encourage double or triple cropping, operate large scale farming, and so forth, aiming at increased production of rice as a policy. Such situation has brought about and accelerated farm mechanization.

Also in Japan, most of the farm operations were dependent upon human labor and draft animal power. However after the world war, land tenure was abolished by Land Reform Law, which established more owner cultivators. This contributed largely to the enhancement of spirit of independence among farmers, promotion of agricultural investment, introduction of new techniques and ultimately to the increased agricultural production with a marked progress in farm mechanization. Especially in rice cultivation, machine system from land preparation to drying and storage has been nearly established, since rice transplanting machines and harvesting machines (such as binders and head feeding thresher type combines) were developed and improved which had been the cause of bottleneck of mechanization of rice cultivation.

It goes without saying that, the mechanization is geared with the progress of agricultural machinery industry. In the first stage of agricultural machinery industry in Japan, as seen in other countries, a wide range of items were produced on a small scale by small and medium enterprises. As the industry progressed, specified items were produced on a large scale by large enterprises. Unless the agricultural machinery are manufactured on mass production basis in a single large unit, it will be uneconomical and costly for farmers. Recently such large enterprises have come up in large numbers in our country, so that they can provide Japanese farmers with cheaper machinery. Besides the distribution of cheap machinery in domestic country, agricultural machinery industry in Japan is faced to the necessity to take part in export industry from the standpoint of the fact that Japan is now in a position to contribute much to the agriculture in Southeastern Asian countries, through technical and economical assistance.

Now, export amount for agricultural machinery hovers around 5 percent of the total production in the last several years and is still 7 percent, although it showed a slight step-up recently. The main reasons for this may be attributed to unreasonable price of agricultural machinery for farmers, inadequate supply of spare parts, a lack of after-service and so forth. However fundamental reason may be attributed to improperty or unsuitability of the machines to the agricultural conditions of importing country.

In the course of progress of agricultural mechanization, we generally stick to the following stages. In the first stage, we import certain agricultural machinery as a trial which seem to be suitable to our own agricultural conditions. Imported machines are tested and demonstrated on the farm, to see if they meet the requirements of cultivation with respect to farm mechanization. As the brands or models of the imported machinery increase in number, it becomes necessary to establish test standards for the selection of suitable machinery. Especially, in connection with quality and performance of the machinery, the standards should be stricktly defined. Any new model should be thoroughly inspected before it is put on the market.

In the second stage, imported machines are usually in need of some modifications in order to fully meet the local agricultural demands, as they are not always satisifactory in performances. In such instances, there need to be research stations or institutions staffed with qualified engineers to improve all the time the performance of the machinery, since the materials or part of the structure design of imported machinery are often subject to change.

In the third stage, it sometimes occurs that new machinery need to be developed without modification. Any country has her own typical agricultural conditions which may be characterized by soils, crops and so forth.

In the long run, any agricultural machinery which are subject to natural, social and economical backgrounds should be developed and improved in the country concerned where the machinery are placed. Any machine should be designed, along with 'on-the-farm' evaluation. In order to develop the new machinery in an efficient way, the most important thing is that the country should be well enough industrialized, that is to say, the factories or facilities should be well manned or equipped. As a matter of fact, indigenous machinery can not be manufactured in small scale industries or on artisans basis in efficient way. Industrialization in Southeast Asian countries differs from country to country. Some countries are poorly industrialized.

In this connection, I propose the following procedures by which Japan can contribute to the mechanization of agriculture, with special emphasis on the development of agricultural machinery.

1. Japan receives agric. engineers in the developing countries in order to educate and train them in the technique

New designed puddling machine in Thailand. This machine designed and made locally has big future.

for the development of agricultural machinery, along with the selection, use, care and maintenance of the machinery by actual field tests and demonstrations. Especially, as for the technique for the development of agricultural machinery, it requires training and education, whether it is a long or short term, to gain a certain level of technical skill.

For instance, in case of designing of land preparation machinery, such items as output, working width, number of speeds, etc. should be deliberately decided in contrast to the agricultural conditions, especially from the economical point of view. Japanese power tillers are sometimes said to have too many speed selections when used in Southeast Asian countries, as they are designed for multipurpose and precise operations in consideration of the typical agricultural conditions and farmers' needs in Japan. In such a case, it seems to be quite natural that typical power tillers suited to such regions should be and will be desighed. This is the only example for power tillers. Other agricultural machineries are not exceptions.

For the development of agricultural machinery, qualified agricultural design engineers should be fostered. They are required to master not only design technique or skill based on fundamental engineering but also the practical knowledge for testing the machinery with proper testing instruments. This certainly contributes much to the design of agricultural machinery. However it takes time to foster qualified engineers in the developing countries. In such cases, training and education in the developed countries should be highly encouraged.

2. Japan despatches Japanese agri. engineers to the spot in the developing countries where mechanization is needed and by close cooperation with local agricultural engineers who were trained and educated in the developed countries, the machinery suitable for the spot of agricultural conditions are developed and designed.

In this case, Japanese agricultural engineers should put themselves in another place and should not jump into a conclusion without careful survey of agricultural conditions and background surrounding agriculture. Neglect of important factors of those conditions will eventually lead to mis-mechanization, resulting in unprofitable farming.

For instance, conventional farm operations should not be made light of. Mechanization counter to the conventional operations will not make a rapid progress, as if habits can not be easily broken off. In such a case, it sometimes happens that mechanization of the conventional operations, say, motorization of the implements for draft animal should be taken into consideration, instead of introducing new machinery with new concept reverse to conventional operations. However the machinery with new concept should also be tested for its suitability. In case it is suitable to some extent, it should be improved and gradually replaces conventional operations.

As stated above, there may be two approaches to agricultural mechanization, namely motorization of the existing indigenous implements (from the conventional concept) and application of imported machinery by repetition of improvement and modification (from the new concept). In some cases, the former may be advantageous or the latter may be advantageous and in other cases both approaches may be requisite. It goes without saying that which approach to take should be decided and the machinery be designed in collaboration with qualified local engineers, from the technical and socio-economical points of view.

3. The drawings of the machinery designed by cooperation with local engineers, as mentioned above, are brought back to Japan for its trial manufacture. Although some developing countries are industrialized enough to produce the machinery, most countries have few facilities or factories well manned or equipped. In addition to this, even standard parts or genuine parts like bearings, bolts, nuts and so forth are hardly available in some countries and even if available, they are very costly. In such cases, it seems to be more economical and require shorter time to manufacture prototype machine in Japan than in those countries. After the prototype machine is trially manufactured in Japan, it is returned to the spot for the confirmation and estimation in connection with performance, efficiency and so on. If any defects with the prototype are found on the farm and they can not modified locally, it is shipped to Japan for modification. As a matter of fact, such procedures require repetitions until the prototype machine is found satisfactory to the agricultural conditions.

Such repetition of procedures may bring about huge expenditure including shipping cost, whether it is borne by Japanese Government, beneficiaries and joint contribution. However, in the long run, this will prove to be a very efficient way in the development of agricultural machinery.

AGRICULTURAL MACHINERY and IMPLEMENTS INDUSTRY in SOUTH EAST ASIA and RELATED ACTIVITIES of UNIDO

A. A. Swamy-Rao

INTRODUCTION

Local manufacture of agricultural machinery and implements has been given a significant importance in most of the developing countries of South East Asia. The development of the agricultural sector is of vital importance to the industrial growth of the countries and the region. This relationship between agriculture and industry is becoming very important in the South East Asian region where most of the countries are expected to achieve self-sufficiency in food production by 1975. In most of the countries the positive effects of the "green revolution" has laid an accelerated stress on the need for larger inputs and processing of resulting outputs. Programmes of industrialization during the United Nations Second Development Decade (1970—80) can benefit significantly by the growth potential of the agricultural sector. Conversely, the development of the agricultural sector would have to depend a great deal on the availability of supplies from the industrial sector.

In the South East Asian countries, a maximum supply from the domestic sector assumes great importance due to the scarcity of foreign exchange and the desire to develop local manufacturing industries. The agricultural machinery and implements are one of the major industrial inputs for agriculture and provides a good scope for local manufacture. Local development of agricultural machinery industries have priority in all the developing countries of South East Asia since it diffuses technology throughout the countryside and involves a large sector of the working population in its activities. As the agricultural machinery and implements industry deals with a large variety of products—from hand tools, animal drawn implements and hand operated equipment to power machinery and equipment—the problems of the industry and policies needed by the government for the development of this sector are varied in nature and magnitude.

I. The PRESENT and FUTURE DEMANDS for AGRICULTURAL MACHINERY and IMPLEMENTS

"The ECAFE/AIDC-UNIDO Fact Finding Team on Industries Manufacturing Agricultural Machinery" visited twelve countries (Ceylon, Republic of China, India, Indonesia, Iran, Republic of Korea, Malaysia, Nepal, Pakistan, the Philippines, Singapore, and Thailand) during November 1968 and January 1969, and surveyed the status of the industry for the first time. In addition, a preliminary analysis of the status of agricultural machinery industry, based on various reports, has been conducted by UNIDO with respect to Afghanistan, Khamer Republic (Cambodia), Fiji, Laos, Peoples Republic of Vietnam and Western Samoa.

The following are the highlights of the present and future demands of agricultural machinery and implements in Asian countries.

Four-wheel riding tractors : the level of consumption of tractors is high in Ceylon, India, Iran, Malaysia, Pakistan, the Philippines and Thailand. The total sales for 1968 in the countries visited were around 33,000, of which tractors within the range of 35—45 h. p. were highest. It was expected that in 1970 the annual sales as compared to 1968 would increase by 70 per cent and in 1975 by 250 per cent.

Power tillers. : in 1968, the total number of power tillers in the twelve countries visited was reported to be around 70,000. The total annual consumption was around 21,500. The annual demand was expected to increase to 38,000 by 1970 and to around 100,000 by 1975. In addition, the Mekong Basin countries (Khamer Republic (Cambodia), Laos and Republic of Vietnam) also provide a scope for a significant usage of power tillers at a later date.

Small engines for agricultural use : manufacturing plants to produce small engines are located in China (Taiwan), India, Indonesia, Iran, Pakistan and the Repubic of Korea. The production of small engines of various types (including the engines for tractors and power tillers) in the twelve ECAFE countries visited was about 277,000 in 1968, of which India produced about 90 per cent. However, small engines for agricultural purposes, of various sized and makes, needed to be categorized, according to the purpose of their specialized manufacture, as follows:

(a) 1–2 h. p. gasoline-fed micro-engines for knapsack sprayers and dusters: in India where such engines were manufactured, the production in 1968 was around 18,000 from a plant with an installed capacity of around 36,000. The demand for 1970 of such engines in the twelve ECAFE developing countries visited was estimated to be 90,000 and was likely to increase two-fold by 1975;

(b) 3–5 h.p. gasoline-fed engines for light agricultural applications: the aggregate production in 1968 was around 24,000. The increasing demand for 1970 was estimated to be about 80,000 and for 1975 about 160,000. Those estimates took into consideration the competition from diesel engines for similar agricultural application;

(c) 3–15 h. p. diesel engines for power tiller and stationary agricultural applications: in 1968, the combined production of such a category of small engines from plants in China (Taiwan), India, Iran, South Korea and Pakistan was around 140,000. The demand was increasing rapidly and would reach an estimated annual volume of 330,000 by 1970, in pace with the increasing demand for power tillers and pumps;

(d) 12–30 h.p. diesel-fed engines for medium duty agricultural applica-

tions: except in India and Pakistan, the demand for such engines, mostly of the horizontal types, was relatively small. With the increasing rural electrification, the need for such engines was decreasing, except for irrigation purposes and deep well installations at places where electricity was not economical;

(c) 30–75 h.p. diesel engines for riding tractors: in 1968, about 18,000 such engines were manufactured in India. It was estimated that the collective annual demand for 1970 of the twelve ECAFE coun tries visited would be 57,000.

Power-operated pumps : centrifugal pumps were widely used for agriculture in the twelve ECAFE countries visited. Propeller paddy pumps employed to transfer water between low head areas, such as between irrigation canals and paddy fields, were used mostly in the Philippines and Thailand. Deep well water pumps were used quite extensively in India, Iran, Nepal and West Pakistan. The total demand for 1970 of all types in the countries visited was estimated to be 440,000. In addition, the Mekong Group of countries also provides a good scope for the usage of pumps.

Plant protection equipment-sprayers and dusters: in all the countries visited there was a growing awareness of the need to protect crops from pests and other forms of plant diseases. Hand-operated sprayers were already used substantially while power-operated knapsack dusters and sprayers were still in the introductory stages. The estimated demand for 1970 of hand-operated sprayers and dusters was 330,000, while the production for 1968 was around 240,000. In the case of power-operated knapsacksr ayers and dusters, the aggregate production for 1968 was around 24,000, whereas the estimated demand for 1970 was 80,000.

Paddy threshers: the demand estimated for 1970 of pedal-operated threshers of the simple type was about 65,000. The total production in 1968 was around 30,000. Pedal threshers could easily be produced in all ECAFE countries, since they were simple to manufacture and the amount of investment necessary was small. The demand estimated for 1970 of power-operated paddy threshers of the simple type was about 50,000 and for 1975 about 150,000

Power wheat threshers: with the introduction of high-yielding varieties of wheat and multi-cropping patterns, the demand for power wheat threshers in wheat-producing countries such as India, Iran and Pakistan was expected to increase. The demand for power wheat threshers for 1970 was estimated to be about 26,000. In 1968 the production was only 11,000.

II. PRESENT STATUS of the INDUSTRIES MANUFACTURING AGRICULTURAL MACHINERY and IMPLEMENTS

Only tractors, power tillers, engines and pumps are manufactured or assembled in plants of medium size with reasonable levels of quality control and of technical co-operation with ancillary and supporting industries. Implements and hand tools are produced in relatively small units and in many cases without regard to quality. Large growth is expected in the maket for agricultural machinery and implements in all developing coun tries of South East Asia during the next decade. This expansion offers an opportunity to expand existing manufacture and the basic engineering industries, casting, forging, machine shops etc. Expansion of the agricultural machinery industry is viewed as an effective way of combining the application of large scale technology to small scale industries with savings in foreign exchange. The following are the highlights of the exsting manufac turing facilities in countries of Asia in general and that of South East Asia in particular.

Tractors: there are five tractor manufacturing plants, all located in India. All the plants are producing tractors built with about 75 per cent of local content. There are twelve companies engaged in assembling tractors, in Ceylon, Iran, Pakistan, Thailand and the Philippines. In 1968 the number of tractors manufactured was 22,000, of which about 12,000 were manufactured in India under a progressive scheme for substituting imported components by those locally-made. Another 6,700 were assembled but with limited local parts in India, Iran, Pakistan and Thailand. The rest were assembled in Ceylon, the Philippines and Thailand from parts which were almost totally imported in the from of CKD components. Manufacturing machinery was being installed to produce 30,000 tractors by 1970 and 74,500 by 1975. The number of assembled units estimated for 1970 was around 15,000. It is estimated that the output of tractor manufacturing plants which would be installed and/or expanded in the near future would not be able to cope with the projected consumption requirements by 1975. A regional production deficiency would therefore justify the economic manufacture of tractors of various sizes. For tractors within the 35–50 h. p. range, the collective demand is expected to be around 32,000, of which India and Pakistan would absorb about 80 per cent. The manufacturing capacities of both countries for 1970 in the given range of tractor sizes are expected to be approximately adequate. For tractors within the 55–65 h.p. range, the collective demand is expected to be around 15,000, of which 13,600 represented the combined demand in India, Iran, the Philippines, and Thailand. In Iran, a tractor manufacturing plant with an annual installed capacity of about 4,000 units is being installed.

Power tillers: out of an installed combined annual capacity of 20,600, about 15,000 power tillers were manufactured with various amounts of local parts in Ceylon, China (Taiwan), India, Iran, the Republic of Korea and Malaysia in 1968. In most of these countries, a substantial proportion of the components are made locally, except for the engines and transmissions or their main parts which are still imported principally from Japan. The local contents varied from 30–40 per cent and might reach 70 per cent in the near future. In Ceylon and Pakistan (East), licences for establishing power tiller factories had already been issued. Indonesia has plans to start power tiller factories. Plans are under way in the countries visited to increase the combined annual installed capacity to about 34,000 by 1970. It is expected that the aggregate annual demand for power tillers in the countries visited would increase by about 65 per cent in 1970 as compared to 1968. The number of manufacturing plants available by that time would be adequate for producing approximately 90 per cent of the aggregate demand. Owing to the increasing demand for power tillers, however, it is necessary to expand the manufacturing plants available. Furthermore, it appears that there would be a bigger market in the future should a less expensive, more rugged and simpler power tiller be developed and mass produced for the needs of developing countries of Asia where agricultural conditions, especially in rice-producing areas, are almost identical.

Small engines: low-speed diesel engines are mainly manufactured in India and in Pakistan. High-speed diesel engines are manufactured in China (Taiwan), India, Pakistan and theRe public of Korea. Small gasoline engines are manufactured in China (Taiwan), India, Indonesia and the Republic of Korea. Micro-gasoline engines are manufactured only in India. Iran, Thailand, Pakistan and the Philippines had plans to manufacture diesel engines. In Thailand there are plans to manufacture gasoline engines. The diesel engines produced are predominantly of the low-speed type. Very few countries have manufacturing

programmes for high-speed compact diesel engines of 5–12 h. p. suitable for automotive purposes and applications in agriculture. Considering 1–2 h. p. small gasoline engines, it is necessary to explore the possibilities of setting up a mass production manufacturing plant to supply, at a competitive price, all the requirements of the countries within the Far Eastern sub-region. At the same time, India should find ways of utilizing more of its installed unused manufacturing capacity. To meet the demand regarding 3–5 h. p. gasoline engines, it seems necessary to explore the possibilities of setting up a new plant in the Far East. With regard to 3–15 h. p. diesel engines in plants located in China (Taiwan), India, Iran, the Republic of Korea and Pakistan, the respective productions would have to be increased to cope with the proportionate demands. Steps would have to be taken by countries such as Ceylon, Indonesia, Malaysia, the Philippines and Thailand to manufacture such engines. Considering 12–30 h. p. diesel engines, there are manufacturing plants for such engines in Iran, the Republic of Korea, and Pakistan; the quality of production needs to be further improved. There is also a need to locally manufacture engines or components in countriest hat have a programme to locally manufacture tractors.

Pumps: all the countries are almost able to produce their respective requirements of conventional pumps for agricultural purposes. The technology requirements for the manufacture of such pumps are relatively simple, although there is a need to improve the manufacturing techniques, particularly in foundry practices. The aggregate production of power-operated pumps, which was estimated to be around 375,000 in 1968, needed to be rapidly increased to cope with the demand which is roughly estimated to be about 950,000 by 1975. Ceylon, China (Taiwan), India, Indonesia, Pakistan, the Philippines, the Republic of Korea, and Thailand are manufacturing centrifugal pumps. The Philippines and Thailand are also manufacturing power paddy propeller pumps, China, India, the Republic of Korea and Pakistan are manufacturing deep well pumps. Iran, Malaysia and Thailand had no significantproduction of power pumps for irrigation but, however, had plans to manufacture. Iran had already laid down a programme to manufacture 10,000 pumps by 1978. In Thailand two firms had plans to manufacture pumps. Nepal and Singapore had no manufacturing programmes. Hand pumps are manufactured in most of the countries. It appeared that in nearly all the countries foundry techniques and quality control needed to be improved.

Knapsack sprayers and dusters: there are plants producing power sprayers in China (Taiwan), the Republic of Korea and Pakistan. In Ceylon, China (Taiwan), India, Indonesia, the Republic of Korea and Pakistan, there are plants manufacturing hand sprayers. In Ceylon, Pakistan and Thailand there are plans to expand the Production capacity for sprayers. No substantial facilities for manufacturing sprayers exist in Iran, Malaysia, Nepal, the Philippines, Thailand and Singapore. Hand-operated knapsack sprayers, being relatively simple to manufacture at low cost, could be manufactured in every county. However, small 1–2 h. p. gasoline-fed engines for knapsack sprayers needed to be produced initially as to be economical, they would have to be manufactured on a large scale. On account of increasing national demands, countries such as Indonesia, Iran, Malaysia, the Philippines and Thailand would be justified in going ahead with the full scale manufacture of power knapsack sprayers, excluding initially the small engines that would have to be imported together, perhaps, with the nozzles.

Threshers: in none of the countries in Asia there is any organized effort to porduce an efficient type of power paddy thresher. However, appreciable efforts were being made to design and evolve improved models. Efforts were being made in the Philippines by the International Rice Research Institute and in Thailand by the Engineeing Division of the Rice Department. In China (Taiwan), India, the Philippines and the Republic of Korea, there are plants manufacturing pedal-operated paddy threshers. Ceylon, China (Taiwan), India, Iran and the Republic of Korea, have plants manufacturing power paddy threshers. The Philippines and Indonesia had plants to manufacture power paddy threshers. Power wheat threshers are manufactured in India and Pakistan. There was a great need for all countries to manufacture power threshers. The local designs of wheat threshers found in the Asian wheat-producing countries needed considerable engineering improvements. However, those introduced and manufactured in West Pakistan appeared to be the best suited for the requirements of the region. Iran and West Pakistan have recently introduced combine harvesters. No significant attempts to introduce them had been made in India until recently.

Rice processing machinery: with the exception of Japan, there is no country in Asia manufacturing a full range of rice processing=machinery on a significant scale. Rice hullers are manufactured in Ceylon, China (Taiwan), India, the Republic of Korea, the Philippines and Thailand. In Ceylon and Indonesia there are plans to manufacture rice hullers. Indonesia, Iran, Malaysia, Nepal, Pakistan and Singapore have no programmes at the moment.

Hand tools and bullock-drawn implements: hand tools are manufactured in most of the countries in an unorganized manner. Bullock-drawn tillage implements are also manufacture by the small-scale sector in most of the countries visited. There is a need to improve the techniques of manufacture of hand tools and bullock-drawn implements as well as their design and quality. No country seemed to have given much attention to their manufacture on an engineering basis. Besides the drawbacks in the implements, the low capability of bullocks to produce adequate draft power hand hindered production. Other factors were the diversity of models of tools and implements in use within the region, the current dearth of quality manufacture in small shops and above all, the difficulty of making available quality implements at economical prices. State run plants in Ceylon and Nepal, and a number of workshops in India are producing hand tools and bullock drawn implements at outputs below the rated manufacturing capacities.

Tractor and power tiller implements: small-scale producers or tractor/power tiller manufacturers and assemblers themselves fabricate the matching basic implements in accordance with the original or adapted specifications. With regard to tractor-drawn implements, primary tillage implements only are made in India, Pakistan and Thailand. Iran and Thailand have plants to manufacture more tillage implements. Power tiller accessory equipment such as cage wheels are manufactured in Ceylon, China (Taiwan), India, Malaysia, Pakistan and the Republic of Korea. It is necessary to manufacture a wider range of farm implements and equipment, especially sowing, fertilizing and harvesting equipment. Although accepted and widely used in the countries visited, the implements manufactured by small-scale producers need to be improved both as regards their material composition and the techniques of manufacture. Disc ploughs, mouldboard ploughs, tillers, seeding and fertilizer distributors, crop protection equipment, and in particular, specialized components such as tines, discs, bearings, shaers, mouldboards and bar points needs to be manufactured with regional collaboration in mind.

The summary of present and future demands and manufacturing programmes

TABLE 1. Summary of selected types of farm machinery, quantity, sales, demand and manufacturing schedules in the twelve countries visited* (Number of units)

Item	Quantity 1968	Annual Sales 1968		Projected annual demand		Manufacturing capacity			
						1968		1970	1975
		Total	Imported[b]	1970	1975	Production	Installed capacity		(known plans)
Tractors	176,300	33,130	11,430	59,225	118,125	21,900	26,950	45,200	74,450
Power tillers	69,525	21,450	6,850	38,550	101,800	14,400	20,600	33,900	71,000
Small engines, all types	1,298,300[a]	228,025[a]	5,100[a]	590,550	1,002,000	277,000	387,500	404,400[a]	441,050[a]
gasoline, 1–2 h.p.	77,250[a]	20,000[a]	(…)	90,150	185,800	18,000	36,000	36,000	40,000
gasoline, 3–5 h.p.	93,050	20,000[a]	(…)	81,100	160,900	24,100	35,000	35,100	42,000[a]
diesel, 3–15 h.p.	728,150[a]	150,000[a]	(…)	327,750	427,500	138,500	170,000	180,250	181,250
diesel, 12–30 h.p.	201,050[a]	75,000[a]	400	31,600	62,750	77,200	104,500	108,050[a]	110,050[a]
diesel, 25–75 h.p.	75,000	15,000	(…)	57,225	117,125	18,500	33,500	33,500	50,000[a]
Pumps, all types									
hand pumps	290,500[a]	8,000[a]	8,500[a]	162,500	418,000	6,200	(…)	(…)	(…)
power pumps, 3–15 h.p.	1,682,600[a]	313,500[a]	15,100[a]	384,700	820,000	340,700	351,000	358,800[a]	392,300[a]
deep-well pumps	74,000[a]	(…)	(…)	57,050[a]	135,100[a]	33,950	33,200[a]	35,500[a]	4,000
Sprayers & dusters, all types									
hand sprayers	781,500	178,000[a]	28,100[a]	328,200	640,500	241,500	253,000	273,000	(…)
knapsack	209,600[a]	19,000[a]	9,000[a]	80,150	204,500	23,500	56,500	65,800	(…)
Threshers, all types									
paddy thresher, pedal-operated	1,357,000[a]	8,000[a]	(…)	65,000	203,000	30,500	46,000[a]	66,000[a]	(…)
paddy thresher, power-operated	155,670	3,200	836	50,550	147,500	17,400	20,000	(…)	(…)
wheat thresher, power-operated	27,000	(…)	(…)	25,550	65,200	11,000	13,700	(…)	(…)

(a) Excluding estimates from certain countries.
(b) Representing the annual sales of agricultural machinery imported in the form of fully-built units.
* China (Taiwan), the Republic of Korea, the Philippines, Indonesia, Singapore, Malaysia, Ceylon, Thailand, Iran, Pakistan (East and West), India and Nepal.

in selected countries of Asia is given in Table 1.

III. PROBLEMS and NEEDS of the INDUSTRY to MEET FUTURE DEMANDS

The Problems of the manufacture of agricultural machinery and implements are two-fold. Firstly, there is the lack of technical skill in certain areas and secondly, there are the legal problems involved in patents and licensing. Simple items such as hand and bullock-drawn implements, hand sprayers, threshers, etc., can be manufactured locally without collaboration. In India, Pakistan, China (Taiwan) etc. engines, pumps, and even power tillers are being manufactured in certain cases without collaboration. However, in most cases of the manufacture of tractors, engines and power tillers, in order to bridge the gap between technologically advanced nations and developing countries it is necessary to enter into collaboration in order to produce quality and dependable products. Two of the drawbacks of licensing are the problems involved in local manufacture of patented components such as hydraulic pumps, electrical items etc., which are manufactured by ancillary industries, abroad, and the normal reluctance of the collaborators to allow changes of design to suit local conditions and to explore export potential. Sometimes there may be difficulty in securing imported components due to changes in design or to new models abroad. While taking all these factors into consideration, it is nevertheless necessary to enter into collaboration with established manufacturers in order to produce quality agricultural machinery–especially tractors, power tillers and engines–locally.

At the present time there is under-utilization of the existing manufacturing facilities for agricultural machinery in developing countries; hence it is necessary to such industries in order to reach the manufacturing capacity within the near future. However, the projected demand shows that in the longer term there is a need to expand existing manufacturing facilities. It is also necessary to diversify the product mix, and assistance is needed in both of these areas. In this regard it is necessary to explore the possibilities in allied engineering sectors towards co-ordinated industrial expansion. It must be pointed out that most of the simple agricultural machinery, such as hand tools, animal drawn equipment, hand operated pumps, sprayers and dusters, thereshers and a few tractor implements, including sowing and fertilizer distributors, can be completely manufactured in each country, in some cases by using imported raw materials. However, in the case of tractors, power tillers, engines and pumps, local manufacture has to be part of a phased programme based upon the level of machine shop, forging, foundry and tool room facilities and the level of ancillary industries.

It is very essential that ancillary and supporting industries should be developed along with a phased manufacturing programme of agricultural machinery and equipment. For their sustenance and growth, the ancillary industries need a large variety of steel raw materials, copper and copper products, long staple asbestos, alloy steels, nickel, chromium and other alloying metals, special steels, tin, lead, special steel rolled sections and cold rolled sheets etc. Most of these are to be imported, though some may be available in limited quantities from indigenous production. The tractor and power tiller industries are bound to draw heavily from the ancillary industries in the years to come. In India, however, a number of the equipment manufacturers had initially to manufacture some of the ancillary items under their own roofs due to the non-existence of certain industries; the present trend is to off-load those items to the ancillary industries. Sufficient data are not available on the status of ancillary and supporting industries in most of the countries of Asia. In order to increase the local content, it is necessary for full utilization to be made of local subcontractors towards supplying ancillary componets.

The raw material needs of the agricultural machinery and implements industries are mainly metallurgical ones. For tractor production, hot rolled carbon steel, hot rolled alloy steel, cold drawn carbon steel, cold drawn alloy steel, hot rolled plates, sheets and strips,

cold rolled sheets, as well as grey iron malleable, steel, and non-ferrous castings and steel forgings are necessary. Availability of steels such as EN-1A, EN-3, EN-8, EN-9, EN-42 and EN-45, which are normally used on tractors, as well as special steels such as EN-16, EN-18, SAE-5140, EN-34, EN-43, SAE-8620 and other steels required for gears, shafts, axles and other critical components should be taken into account. The gauge of steel required for harrow discs are 11/64", 5/32" and 3/16" and for plough discs 3/16" and +/32" and 1/4" for heavy duty discs. These discs are normally made in EN-42 or equivalent sheet steel which is cross rolled. High carbon steels equivalent to EN-42, EN-16, EN-45A etc. are required for soil working tools. For mouldboards of ploughs the steel normally recommended is soft centre high carbon steel, i. e. SAE 1095 over 1024. However, this is not available in the countries of Asia, and therefore mild steel plates are used. Medium carbon steel such as EN-8, EN-9 etc. are required for beams tines etc. Normally, the frames of the equipment are manufactured from mild steel. However, the present trend of farm equipment manufacturers in industrialized countries is to use medium carbon structural steel for a reduction of weight and for additional strength.

With this basic background information, the logical steps to be followed to promote the development of agricultural machinery and implements industry in the countries of Asia in general, and of South East Asia in particular may be summarised as follows:

(i) Formulation of antional and regional, professional, agricultural engineering institutions;
(ii) Creation of a regional centre for agricultural machinery and implements design, development, adaptation and technical service;
(iii) Formulation of national and regional agricultural machinery and implements and allied equipment manufacturers associations;
(iv) Establishment of a permanent development agency for farm mechanization and promotion of local manufacture in Asia.

In addition to the above-mentioned institutional organizations, it is necessary to analyse the specific needs of the individual countries with respect to specific products in order to project the present and future demands and trends in design specification. Based on this preliminary analysis, pre-investment studies on specific product lines which may include the economic volume of production and investment analysis are to be carried out. In addition, ways and means of how to expand the existing agricultural machinery and implements industry, and product diversification in other metal working sectors are to be explored in order to assist in the optimum utilization of existing manufacturing capacities. It is also necessary to identify and encourage local entrepreneurs to invest in the feasible manufacturing proposal in addition to the establishment of judicious manufacturing projects in the public sector. To assist the local manufacturers a rational policy and programme in design, development, adaptation and testnig has to be undertaken. Above all, an active investment promotion programme to encourage judicious licensing arrangements, is recommended.

IV. HIGHLIGHTS of UNIDO ACTIVITIES in the FIELD of AGRICULTURAL MACHINERY and IMPLEMENTS MANUFACTURING

The overall activities of the United Nations Industrial Development Organization in this field is orientated towards stimulating self-reliance in the accelerated growth of agricultural machinery and implements in developing countries. The activities in this field have expanded on a sound basis as reflected by the interest shown by the developing countries and a number of requests for technical assistance received. It is interesting to note that many countries have requested technical assistance to investigate the long-term needs in terms of product specifications, demand and production volume as well as capital, technical man power and raw materials requirements. The requests for technical assistance in specific cases are to analyse the problems associated with the establishment, development and growth of agricultural machinery and implements manufacturing with special reference to its effects on the metal-working and agricultural machinery sectors. Thus the major interest has been shown towards manufacturing feasubility studies and pre-investment analysis.

Another major area for technical assistance requests is the reinforcement or establishment of facilities for development, adaptation, prototype fabrication and testing facilities in agricutural machinery and implements. These requests are the results of the awareness of the developing countries in general and of Asia in particular, to manufacture only equipment suitable for the local soil and crop pattern, and utilize the locally available raw material resources to the full extent. The developing countries are also interested to enhance the local design engineering capabilities and also to ensure protection of farmers by establishing suitable testing and product performance evaluation facilities. Another important area for requests for technical assistance has been the establishment, organization and operation of facilities for repair and maintenance of agricultural machinery. The developing countries are fully aware of the need to improve repair, maintenance and spare parts manufacturing facilities and to initiate the necessary integrated training programme. These requests are directed for assistance to establish central workshops backed by mobile workshops. Specific requests for assistance for the evaluation of manufacturing proposals, rationalization of manufacturing programmes, investigation for the establishment of manufacturing plants for hand tools, animal drawn implements, crop protection equipment, engines, power tillers and tractors have also been received.

The supporting activities in this field are designed to act as a catalyst towards the promotion of technical assistance projects. As recommended by the expert group meeting on agricultural machinery industry in developing countries held in 1969, UNIDO has undertaken an intensified follow-up programme on the "ECAFE-AIDC/UNIDO Fact Finding team on industries manufacturing agricultural machinery" in 12 ECAFE countries. In 1971 it is proposed to commission certain specific studies in the selected countries of Asia and the Far East, to assess the requirements of specific agricultural machinery and implements with a primary view to support the proposed activity in 1972.

In 1972 a "Regional Study and Expert Group Meeting on the Design and Manufacture of Wet Land (paddy, rice) harvesting and Threshing Machinery in Developing Countries of Asia and the Far East "has been proposed. In addition to the publication of the report of the expert group meeting, a special study report on the" Analysis of Factory Planning for Hand-operated and Animal-drawn Agricultural Machinery Plant" has been prepared and the Industrial Branch Study Report on Agricultural Machinery and Implements Industry has been commissioned. A significant step in this direction is a close liaison and co-operation with FAO in implementing a large number of projects in agricultural machinery and implements.

Through these field action orientated programmes in manufacturing agricultural machinery and implements, it is anticipated to assist the developing countries towards self-reliance in manufacture-with special emphasis on adaptations of large-scale technology to the medium-and

(*Continued on page* 63)

Establishment of the Plan to Promote Agricultural Mechanization in Southeast Asia and Problems on Growing Agricultural Machinery Industry

Yoshikuni Kishida

I. Pre-conditions to promote agricultural mechanization in the developing countries

The pre-conditions to promote agricultural mechanization are almost common to any country. Natural conditions, shape of the land and soil texture together with their relation to crops, weather conditions, labor force, economic power and technology are the fundamental elements. The most important premise, however, is education in each country. As to some of these elements, there may be something common among several countries. But in most cases, each country has its own economic and natural conditions on which her conception of agriculture depends. Therefore it is proper that each country has her own steps of procedure to realize her agricultural mechanization.

Visiting Southeast Asian countries and observing agricultural conditions of many Western countries, I thought it necessary for each country to select the best way to promote agricultural mechanization by herself that is most suitable to her situation. Because conditions differ with countries in spite of categorical abstract of the term agricultural mechanization. And the system to promote mechanization should be also developed by each country.

It is fund supply, first of all, where lie difficulties for each country. Secondarily comes education problems. To solve these problems, each country should first form some minimum organization, I believe. And though it seems a circuitous road, it is most rational that those who belong to the organization would cooperate with each other and create something fit to their own country. It is the people on the spot who know best that the fundamental conditions I mentioned above differ with countries and that this causes the differentiations of the pattern of mechanization. It is evident that they will fail when they follow the pattern which is not of their own.

Not only that, originality and independence of a country highly depends on her historical elements. So each country has many problems which cannot be solved by technology only. So long as a country consists of unvisible atmosphere such as customs of farm houses, traditions, ideas, as well as natural conditions, she cannot neglect her historical tradition when she set about agricultural mechanization.

II. Development of the system of agricultural mechanization

The priority of crops differs with countries, which of course is accompanied with difference of the way of cultivation and production. I will pick up the common problems below.

1－1 What scale of agricultural mechanization is required to increase agricultural production.

1－2 How much will be labor shortage.

These two are the elements which first fix the area to be mechanized and the quantity of machines required. Next, they must estimate whether the state can allocate enough budget for the project. The expenditure for the following items must be charged to the National Treasury.

(1) Preparation of agricultural roads and farm lands required to satisfy the minimum conditions for agricultural mehcanization.

(2) Establishment of research institutes where they decide the scale of mechanization and test the machines in order to select the best ones for the crops. Also repletion of the staffs.

(3) Establishment of a special organization and training schools for instructors and advisors for agricultural mechanization.

(4) Establishment of facilities by which they can guide farmers in their agricultural techniques. Also supply the required number of the technical officials.

(5) Investment in agricultural mechanization and expense for the researchers who evaluate mechanization.

2 Cooperation of private organizations. For example, technological training for farmers by their agents, or guidance for those agents by manufacturers.

3 Establishment of the facilities required for maintenance and repair of machines or financial help for them.

4 Some law should oblige manufacturers and shops to install the facilities required for service activities.

It is evident that introduction of new machinery only could not always mean promotion of mechanization without full consideration and counterplan about these items. Besides the selection of machines, national investment is required to redevelop the agricultural machinery which accords with the crops and economic conditions of each country. In order to realize it, a certain long-term program to promote agricultural mechanization must de devised in accordance with economic power of each country. But our experience shows that they will fail if they recklessly introduce new machinery without satisfying the above mentioned items before everything

Formation of the national program for mechanization, expansion of universities and research institutes, substantiality of experiment stations where machines are developed, foundation of pilot farms, some national policy to encourage development of new machines and establishment of training schools for instructors and advisors are the major premises, so to speak. In order to reorganize them as one total system of agricultural mechanization, we must add to them cooperation with the countries that give financial assistance and between the Southeast Asian countries. Any investment would result in failure but for this total system.

III. Problems in promotion of agricultural mechanization--a few examples

Once in a foreign country, I saw hundred of big powered tractors piled up which had been imported ten years before.

Some of them were left unused and others broken to pieces. The cause of this is the shortage of repair parts, techniques and other attachments that help the operation of the tractors.

I know some countries are still harassed by the question of repair service and repair parts of the imported machines. Difficulty lies in the fact that repair service does not pay. That is, if a country has hundreds of imported tractors in all, they do not converge on one area, but are scattered. So a service man must go far when required, which costs much. In this case the investment for the agricultural machinery is too dispersed to realize mechanization effectively and it causes the machines complete damage before its due life will be ended. The investment and machinery should be totally introduced into the limited area.

I also know other countries where the big tractors proved to be unfitting to its soil texture and geographical conditions after they imported them without any long-termed tractor test and fundamental land preparation. This is also due to the insufficient training system for operators and to difficulty of maintenance because of uneven spread of tractors. That is, they imported machines in haste before making all arrangements for them.

It is, therefore, difficult for the countries to help the developing countries with their own pattern originally developed through their history of agricultural mechanization. So, something profitable for this country might prove unsuitable to that country. With enough experimental data, the responsible authorities ought to put a few years in making the plan and decide whether it is right or not to accept the proposal of assistance.

Among the advanced countries in mechanization, America started her mechaization from the fact that her territory is vast, and Japan from the fact that the management area is limited. The former highly estimates labor productivity in particular, while the latter has still a policy to attach importance to land productivity, otherwise the Japanese famers will not agree. But it is a question whether this policy would be applied for the Southeast Asian countries, because there are not so many countries which have so limited management area as Japan and they can expand it easily with machinery. The Southeast Asian countries should make more of land productivity than U. S. A. But when we come to think that two or three crops a year is possible there, it might be better for them to have more regard for labor productivity.

IV. Consolidation and expansion of private bodies

I believe it most rational for each country to develop and manufacture the agricultural machines by herself for reasons I have mentioned above. Agricultural mechanization must be accompanied with industrial development, which is applied to any country. And the primary object must be development of the machines rather than the production engineerings. And this must be the task of manufacturers. For some time national assistance will be required to provide the manufacturers enough energy to develop and produce the machines which are really demanded in each country. After that, they must study by themselves and train the shops as their agents and instructors of the farmers' associations. In future they must also be charged with service activities for farmers. Though they are apt to think only about sale of imported machinery and its assembly, surely they should develop their home made machinery in future. In order to realize it, what is necessary is to train design engineers of agricultural machinery, to say nothing of expansion of research institutes which help it. Secondarily, the shops as the agents and the farmers' associations should master techniques by which they supply farmers with parts and also should train them for repair and maintenance. This requires considerable amount of national investment.

That is, I am emphsizing that it is very difficult to promote agricultural mechanization without cooperation between the correlated industries. Dealers, in special, are an important measure which inform the national institutes and manufacturers of the farmers' complaints, needs and ideas. Many new machines have been developed through contact between dealers and farmers, and they proved most effective. Both in Western and in Japan, a good idea often comes from a farmer who is engaged in agriculture in practice. Therefore it is one of our serious duties to set up agencies of dealers which have immediate connection with farmers. Each country must also have the policy to enrich those agencies.

V. How to grow agricultural machinery industry ?

To determine the scale and ability of agricultural machines, we must take the above mentioned things into consideration. It is doubtful whether the foreign made agricultural machines would fit every country as they are. We must reform them somehow to conform the conditions of the country.

Then there comes the need to arrange the agent organizations and to bring up manufacturers. In this chapter I would like to point out some problems on promoting agricultural machinery industry. Here I picked up several items we should consider.

1 Cooperation with governmemtal assistance offices.

2 Decision of the priority of the kind of machines from the viewpoint of agricultural situations of each country.

3 Establishment of the suitable design of machinery in accordance with the technical level of the industry.

4 Arrangement of the fundamental technical facilities for manufacturs, or selection of machine tools, training of engineers and decision of the comparatively simple production method.

5 Governmental assistance for facilities of factory.

6 Assistance from foreign countries must be shared to industrialization, too.

7 When they are going to establish a joint-stock company, they must change the current yearly plan for import and domestic production.

7－1 Judging from the technical level, an engineering committee must estimate yearly possibility of industrialization. In many countries, they are now planning that 50% in three years or 70% in five years of the whole cost for imported machines should be changed into the domestic production, because they need to save foreign currency. But sometimes it is impossible because of the immature level of technology. The yearly plan for the increase of domestic machines depends on improvement of production technology which requires assistance from foreign countries.

8 In order to promote production of home made agricultural machines, there must be some encouraging policy, for example, prize contests for development of a certain kind of machines, prize money, contests of the similar kind of agricultural machines, governmental plan of assistance for these selected machines and national test system by which they can guide a better machine as their aim.

9 In Southeast Asian countries, it is often difficult to get raw materials to realize full industrialization. The shortage of proper raw materials causes unsatisfatcory press and molding. From this point of view, the policy to promote industrialization must also include the policy of engineering. This is not the case with agricultural machinery only.

VI. International cooperation

Each country has its own pattern and

level of national investment according to her economic power, and has the common trouble that she cannot do enough for it. Though it ts difficult to solve this problem, there may be some means of settling.

The advanced coutries with economic power are now planning to give assistance for the developing countries. The United Nations insists them to raise 1% of their GNP (Gross National Product) for the plan. And Japan is getting nearer to this line. The Japanese target amount for a few years later is 3 billion dollars of which 20 or 30% will be appropriated to agricultural assistance. It must be applied to budgeting of agricultural mechanization as to agricultural production increase.

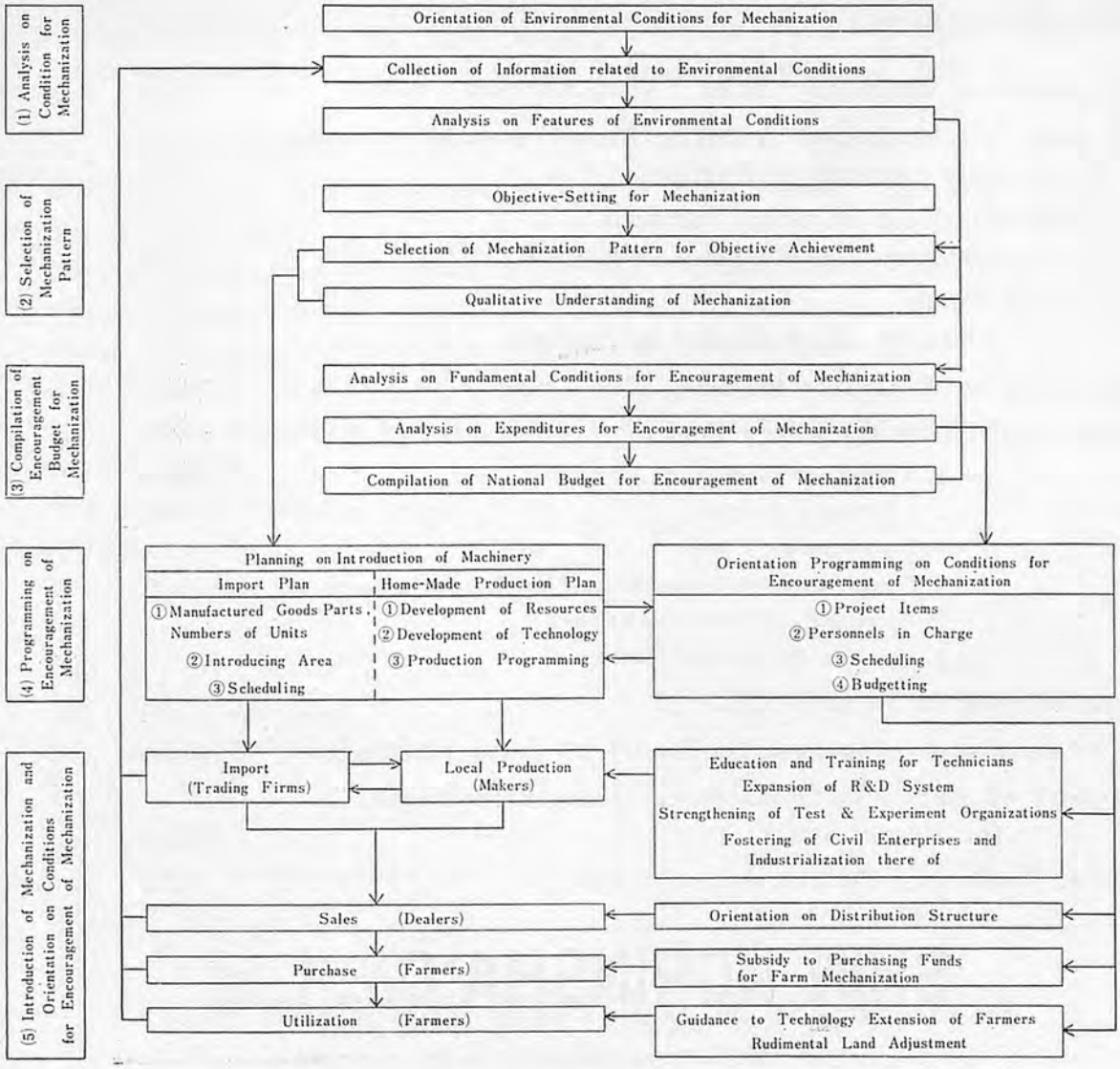
Here I should like to advise the authorities in supporting countries that each country supported must carry out her project on her own responsibility under strong cooperations with supporting countries. According to our bitter experience, it is not successful to supply the supported countries with things on our project only. So, the supported countries should make their own project in advance, if needed, they should require financial aassistance to make it. Mere introduction of agricultural machinery does not promote mechanization at all. Rather we must examine about expansion of research institutes and allotment of cost to enforce the governmental policy and to develop agricultural machinery for the developing countries under mutual cooperation.

Of course, the samples of giant and small-sized machines are necessary. We must improve them to make the suitable machines for each country. And it is a shorter road to lavish cooperation for such redevelopment. Financial assistance should be directed to establishment of training institutes for engineers, repair shops, model farms, laboratories and especially to refinement of technology which is required to promote mechanization. When these conditions are fairly satisfied, technological cooperation by Western countries, Japan and others will bear fruit, I believe.

VII. Conclusion

So long as natural features, climate, crops, customs, economic power, technical level, educational situations are different with countries, the policies for promoting agricultural mechanization must be differont accordingly. And what is most important is that the plan must be made by each country voluntarily and the supporting countries should respect the situations and independence of the supported countries.

Promotional System Chart for Farm Mechanization



PROMOTION OF AGRICULTURAL MECHANIZATION ON AN ENERGY CONCEPT

Loyd Johnson

Mr. Kishida requested me to explain my paper[1] on "Is Mechanization Possible Where Rice is King?" The original paper had a different title but the published paper basically deals with the need for low cost energy to supplement the rice producers' efforts during peak periods. Another paper[2] on "Mechanization to Improve the Agriculture of Developing Countries" stressed similar points such as :

a) "Agriculture is presently the basic source of products and energy in the developing countries.

b) These products and energy are derived from the use of sunlight by plants. The amount of energy available is proportional to sunlight intensity per unit of area and unit of time as well as the efficiency of the crop in producing desirable food or other products.

c) These energy-containing products are largely used as food for laborers and work animals.

d) Non-food sources of energy would reduce the food energy used by men and animals to produce crops and would also help to overcome the peak energy required to keep more land in production more days per year.

e) The non-food energy is the contribution that the industrial, urban, and other landless sectors may make to purchase their supply of food and agricultural raw materials. This exchange will result in the establishment of a market for both urban and agricultural products.

f) Power and equipment-or "mechanization"-are the products of non-food energy and they also are converters of non-food energy in performing the agricultural operations normally performed by men and animals.

g) Irrigation water, fertilizers, pesticides, and other farm supplies may also be considered as non-food energy or products.

h) Mechanization should be evaluated in this broader context rather than just as labor-saving devices."

Rational use of energy from food and non-food sources is a basic requirement for life and for a higher standard of living. Life cannot exist without food, but neither can a high standard of living be developed on food alone. If this were possible then the subsistance farmer with unlimited land and water resources would have a high standard of living. However the subsistance farmer is a limited converter of energy and cannot perform all tasks necessary for a high standard of living.

Non-food energy sources must somehow be introduced into South East Asia if the living standards are to improve. Mechanization of agriculture is probably a good place to start. However this mechanization must be to complement and improve overall use of presently available land, labor, and animal resources. Rapid mechanization which displaces rural labor faster than education, industry, and services can absorb the displaced human resources will result in high social costs due to urban slums, unemployment, theft, violence, and police action. Thus scientists, designers, engineers, economists, agronomists, politicians, manufacturers, and others must work closely together to achieve a higher standard of living through the balanced application of energy to rural and urban areas.

My own observations and viewpoints are that energy and construction inputs should start with transportation, processing, irrigation, land preparation, export crops, manufacturing of fertilizers, pesticides, farm tools and machinery, and rural electrification, in somewhat the order as listed. I would be dubious of importation of equipment for harvesting, except for export crops where low power costs are necessary for competition on the world market. The reasons for this choice of priorities are as follows :

1. **Transportation** requires large amounts of power. Any improvement in roads and application of power in trucks and trailers reduces overall costs to the rural, urban, and international markets. The power per ton-km over roads and fields by trucks and tractors may be estimated as between 0.25 to 1.25 horsepower hours with a cost of $0.05 or less per ton kilometer. One man cannot transport one ton, one kilometer during a day, thus his standard of living if paid $0.10 per ton-km for transporting items would be unsatisfactory both to him and to the urban or international consumer. This explains the importance of power in road construction and transport.

2. **Processing** – The hulling of rice, grinding of corn, and weaving of cloth have been mechanized in all but the most primitive economies. The man hour equivalent to hull a ton of rice by pounding or to weave a yard of cloth by hand loom could again be compared to modern mechanized methods to illustrate the resultant increase in living standard possible while selling a lower cost product. Under this concept the only justification for many handicrafts is the personal artistic satisfaction of the individual.

3. **Irrigation** – The water evaporated from a crop will normally exceed 54 tons per hectare per day. To lift this water 5 meters would require one horsepower hour at 100 per cent efficiency. At normal efficiency, considering water losses, etc., the power required for irrigation exceeds 3 horsepower hours per hectare per day. Since a man cannot develop one horsepower hour per day continuously, it is not surprising that manual lifts for irrigation have disappeared except for small gardens in areas with high water tables. Wells and pumps and irrigation gravity systems from reservoirs have made irrigation possible since manpower alone could not satisfy the water requirements of the crops. The

application of gravity hydraulic power or of pump fuel power has made possible the use of the land during the dry season of maximum solar radiation.

There is a direct relationship between solar radiation, evapotranspiration, and dry matter production by a healthy plant canopy intercepting the radiation. The author's personal belief is that this can be established within narrow limits by detailed research. The value of 6 kg of dry matter fixed per ton of water transpired is a proposed estimate. Thus 54 tons of water would produce about 320 kilograms of dry material with an energy input of about 3 horsepower hours to provide the water. The relative costs and values should be worked out to increase the utilization of the solar radiation to support life. Low cost water through low cost power is the amplification factor required.

4. **Land Preparation** – An example computation[3] of power requirements and costs indicate that 109 PTO Hp-hrs at a cost of $0.10 per PTO Hp-hr would be required to plow one hectare of loam soil to a 20 cm depth. The $0.10 cost per Hp-hr included a wage of $2.00 per hour operator's wage, full depreciation, interest, repairs, etc., for both tractor and plow.

Consider the case of the animal and man plowing the equivalent area to the depth of only 10 cm at 55 man and animal hours per hectare. Their equivalent wage is $0.20 per hour per man and animal. Interestingly enough that is the value placed on their services in the Philippines and much of Asia. "Is Mechanization Possible Where Rice is King?" was written to explain wage differentials as due to the international differences in power costs and availability. In the same article, the time element of land time this power could be cheap enough value was included to illustrate the value per hectare day of land as 10 to 30 kg of rough rice per day. With a 120 PTO Hp tractor the land is plowed in one hour while with an animal the plowing will take about 10 days. The lost production thus is 100 to 300 kgs of rough rice if animals are used.

5. **Export Crops** – Anyone traveling through the tropics will notice the drastic difference between the mechanization of export earning crops such as sugarcane, pineapple, cotton, etc., and the subsistance crops such as rice, corn, beans, etc. Yet rice, corn, and beans can compete in the international markets when mechanized.

6. **Manufacturing** – Under the present world balance of payments arrangements national manufacturing is needed to allow nationals to participate in the standard of living made possible by low cost power. The fact, that laborers displaced from mechanized farms must have an income to live, forces many to city slums to live by theft and part-time jobs. Migration to settle idle lands or to work in foreign factories has not been on a scale to solve the problem. Local manufacturing and other ideas are desperately needed to provide income to prevent a breakdown in the national and international social and economic systems as farm mechanization based low cost power becomes available. The manufacture of fertilizers, pesticides, farm tools, textiles, shoes, and items requiring many low skilled laborers is a critical part of any mechanization program.

7. **Rural Electrification** – The availability of electric power, water, schools, and health facilities would encourage many rural people to stay in the rural areas on partial subsistance farms instead of migrating to city slums. At the same and in adequate quantities for irrigation pumping and local processing of agricultural products to provide cash income to pay for the electricity and other urban goods.

8. **Harvesting of Non-export Crops** – I would be very cautious of the use of combines to harvest rice, corn, and beans on lands normally tilled by subsistance farmers. Absentee landowners are implementing this phase of mechanization with probable disasterous results unless all phases of the problem are considered. Hand harvesting of normally subsistance farms leaves a relief valve as both landowner and peasant must work together. This is a temporary solution at best, but the small amount of capital available for investment in rural areas could be better spent on other inputs in most cases.

In summary, agricultural mechanization can and should be promoted on an energy concept. This energy concept should include all phases of energy and consider the possible social effects. The Japanese people are perhaps the best example of a group's application of energy to increase their standard of living. Perhaps they can assist South East Asia and other underdeveloped countries to apply power rationally to agricultural and urban problems.

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1. Johnson, Loyd. "Is Mechanization Possible Where Rice is King?" *Agricultural Engineering*, Vol. 47. No. 8, pp. 132-135, March, 1966.
2. Johnson, Loyd, "Mechanization to Improve the Agriculture of Developing Countries" *Journal of Indian Society of Agricultural Engineers*, Vol. 2, No. 2. pp. 37-46. December, 1965.
3. Agricultural Machinery Management Data (Draft revision, unpublished of ASAE Data ASAE D230. 1. November 1970)

Big land needs to introduce more machinery

The Importance of Mechanization Indicated by Agricultural Production Function

in the Rice Region of Taichung Area, Taiwan

Ming-Wu Wu*

The basic purposes of the study are, firstly, to measure the resource productivity of the farm as currently organized, and, secondly, to study the importance of farm mechanization as indicated by a production function.

The rice region of Taichung area is selected for this study because the land, physical, climatic and other features of this region are representative of Taiwan, are homogeneous and suitable for intensive cultivation. The cropping pattern is also similar with very little variation from year to year.

The data were collected by survey. The Cobb-Douglas type of production is derived from a cross section sample containing 40 farms in the rice region relating to the production year of 1967. This type of production function is used because the function can reflect marginal productivities of each resource at the mean levels, which is useful in diagnostic analysis, particularly in the measurement of the degree a given resource is employed in production.

Production Function Estimated

Variables used in the model are defined in the following way:

(1) Y = the dependent variable, is the value of crop production, measured in NT (New Taiwan) dollars (US $1.00 = NT $40.00) and is the aggregation of the value of different crop products produced during the year.

(2) X_1 = input of cultivated land, measured in hectares.

(3) X_2 = input of human labor, measured by man-days actually worked on crop production.

(4) X_3 = input of machine use, measured by hours use of power tillers, including the operator of the tiller.

(5) X_4 = input of bullock labor, including the driver of the animal, measured in days of work in preparation of soil.

(6) X_5 = input of working capital used on crops, measured in NT dollars. It represents the variable capital input; such as the expenses for seeds, fertilizers, irrigation charges, insects, pests and disease control and other miscellaneous outlays for crops.

The derived results for the production function are as shown in Table 1. The constant a, and the value of the regression coefficients b^i are presented in the following production function:

$$Y = 290.59X_1^{.2136}X_2^{.4614}X_3^{.0312}X_4^{.1276}X_5^{.2523}$$

The parameters are estimated at the geometric mean level of each variable. But there were some zero observations in the inputs of machine use and animal labor in the original data. In calculating the respective geometric mean values, these zero observations were arbitrarily set at 0.1 unit for the machine use and 1 unit for the human labor, or no geometric mean could be calculated due to the multiplicative nature of the mean.

Table 1 Regression Coefficients and Related Statistics for Crop Production in the Rice Region of Taichung Area

Constant and Inputs	Regression Coefficients (bi)	Standard Error of Coefficients
Constant, (log a)	2.4624[a]	0.3885
Cropland, X_1	0.2136[b]	0.1026
Human Labor, X_2	0.4614[a]	0.1204
Machine Use, X_3	0.0312[c]	0.0267
Bullock Labor, X_4	0.1276[d]	0.0678
Working Capital, X_5	0.2523[d]	0.1283
Sum of regression coefficients, 1.0861		
Multiple correlation coefficient, R = 0.9365		
Coefficient of multiple determination R^2 = 0.8771		

a. significant at probability level of 1%

b. significant at probability level of 5%

c. significant at probability level of 24%

d. significant at probability level of 10%

Statistical Reliability of the Production Function Estimates

The multiple correlation coefficient, R, is 0.9365, implying that the correlation between the dependent variable and the combined independent variables is quite high. The coefficient of multiple determination, R^2, is 0.87, which indicates that the variation explained in output by all five independent factors is 87% on the sample farms. The remaining 13% of the unexplained variation in the dependent variable may be caused by the variables excluded in the estimates, such as management, soil fertility, weather and so on. Sampling and measurement errors may also cause the unexplained variation in the output.

The sum of the regression coefficients, Σb_i, was 1.08, which may be considered as constant return to scale, because when all factor inputs are increased by 1% from the respective mean levels, the gross farm receipt increases 1.08%, slightly higher than the change of input.

The coefficient of multiple intercorrelation of machine use was 0.2003. This indicated no important correlation among machine use (power tiller use) and the rest of the independent variables. The coefficients of simple correlation between machine use and the other independent variables ranged from -0.0650 to 0.5557 (Table 2). This also indicates no important substitution or complementary relation with other independent variables. Therefore, the marginal value productivity

Table 2 Simple Correlation between Machine Use and Each of the Other Variables, the Rice Region of Taichung Ares

	r_{31}	r_{32}	r_{34}	r_{35}
Coefficients of Simple Correlation	.5557	.5189	-.0650	.5015

(MVP) of machine use, as well as the regression coefficient, can be considered fairly reliable.

Marginal Productivities of Inputs

The marginal productivities can be defined as the change in the total physical product caused by a small change in the particular input, holding all other inputs at the mean levels.

In this analysis all prices of the variables are assumed constant. The optimum profit is reached only when all marginal value productivities of input factors ($MVPX_i$) equal their respective factor prices.

The $MVPX_i$ calculated from the production function are shown in Table 3.** The MVP of cropland was NT $16,591.60 per hectare, while the marginal factor cost (MFC) (at the official rent rate of 37.5% of the annual value of major crop) was NT $12,580.42, giving an $MVPX_i$ of 1.31 times the $MFCX_1$. The MVP of human labor was NT $85.22 per man-day, while the MFC was NT $60.00, giving an $MVPX_2$ of 1.41 times the $MFCX_2$. The MVP of machine use was NT $2,254.05 per hour of work, while the MFC was, on the average, NT $40.00, giving an $MVPX_3$ of 56.36 times the $MFCX_3$. This suggests that machine use was very productive in the sense that potential returns were especially higher than the marginal cost. The MVP of bullock labor was NT $494.01 per work day, while the MFC was NT $120.00, giving an $MVPX_4$ of 4.11 times the $MFCX_4$. The MVP of working capital was NT $1.35 per NT dollar which was 1.35 times higher than the MFC, because the MFC for a unit of this input was one NT dollar since the MVP was computed in gross terms.

Importance of Agricultural Mechanization

All $MVPX_i$ are higher than the corresponding factor cost. The value of the additional output produced exceeds the additional cost of the last unit for each of the five input categories. The MVP of machine use (tiller) was about 56 times higher than its marginal cost. This means that the farming operations in the area was greatly under mechanized. The per dollar additional input of machine use may earn NT $56.36 gross farm receipt.

The equating of the ratio of $MVPX_i$ to their corresponding $MFCX_i$ is the key to reorganizing the farm for optimum profit. However, if there is an input constraint, the optimum condition will be that the return per additional dollar input is greater than $1.00. The higher degree of constraints, the greater is this value.

Among the five input categories, an increase in the use of machine should be regarded as the first consideration, because the potential return per additional dollar added to the machine use was NT $56.36, which was the highest of all input categories.

It might be interesting to test the feasibility and degree of machine use in the production for a higher profit. Since the ratio of MVP and MFC of this input category was 56 : 1, it may be possible to increase the machine use by 40 times (Table 4). In this case the total cost is added by NT $1,696.00 while land, human labor, bullock labor and working capital remain at the usual level, will result an increase in the estimated gross farm income from NT $76,908.17 (present gross farm receipts) to NT $86,289.22, or NT $7,685.09 net increase.

The ratio of each MVP to the respective MFC, except for the input of bullock labor which has been constrained by the feed supply, are all approximately 1.5. So increasing machine use by 40 times over current farm operation may be favorably considered.

A more theoretical approach to allocating the available resources, under a given total outlay, for an optimum profit, is to compute the quantity of each input used based on the production function and cost function under present organization, with the total current outlay of NT $54,345.28. Thus, the Lagrange Multiplier equation can be expressed as:

$$L = 290.59X_1^{.2136}X_2^{.4614}X_3^{.0312}X_4^{.1276}X_5^{.2523} + \lambda(54,345.28 - 12,580.42X_1 - 60X_2 - 40X_3 - 120X_4 - X_5)$$

To maximize the profits, all of the partial derivatives with respect to each of unknowns (X_1, X_2, X_3, X_4, X_5 and λ) have to equate to zero. These unknowns were solved from the partial derivative equations. The results are presented in Table 5.

Under optimum consitions the current farm organization of the area under study suggested is to use 0.85 hectares of cropland; 384.80 man-days of human labor; 39.02 hours of machine use (power tiller); 53.21 work days of bullock labor and NT $12,638.44 working capital. The total gross farm receipts under those conditions would be NT $77,487.24.

Comparing the suggested farm organization with the original one, we may note that the biggest change in the resource allocation is the amount of machine use; which is suggested to be increased from 1.06 hours per farm to 39.02 hours. The gross farm receipts are increased from NT $76,908.17 to NT $77,487.24.

(*Continued on page 25*)

Table 4 Estimated Marginal and Gross Value Productivity with Machine Use Increased by 40 Times

X_i	$\overline{X_i}$	Log $\overline{X_i}$	b_i	b_i (log $\overline{X_i}$)	$MVPX_i$	$\frac{MVPX_i}{MFCX_i}$
X_1	0.99	-.0044	.2136	-.0009	18,451.20	1.47
X_2	416.52	2.6190	.4614	1.2087	94.37	1.59
X_3	42.40	1.6274	.0312	.0508	63.50	1.58
X_4	19.87	1.2982	.1276	.1657	549.18	4.61
X_5	14,427.67	4.1592	.2523	1.0492	1.50	1.51

Log constant $a = 2.4624$

Log $Y = 4.9360$ $\quad Y = 86,289.26$

Table 5 Optimum Input Magnitudes for a Given Outlay of Funds, and the Estimated Marginal Value Productivities, the Rice Region of Taichung Area

X_i	Magnitudes	$MVPX_i$ (NT $)	$MFCX_i$ (NT $)	$\lambda = \frac{MVPX_i}{MFCX_i}$
X_1 (ha)	0.85	16,382.81	12,580.42	1.3
X_2 (dys)	384.80	78.13	60.00	1.3
X_3 (hrs)	39.80	52.09	40.00	1.3
X_4 (dys)	53.21	156.27	120.00	1.3
X_5 (NT $)	12,638.44	1.30	1.00	1.3

Total current outlay = NT $54,345.28

Y = NT $77,487.24

Table 3 Comparison between Marginal Value Productivities and the Respective Marginal Factor Costs, the Rice Region of Taichung Area

Input	X_i	$MVPX_i$	Price of X_i ($MFCX_i$)	$\frac{MFCX_i}{MVPX_i}$
X_1 (ha)	0.99	16,591.60	12,580.42	1.31
X_2 (hrs)	416.52	85.22	60.00	1.41
X_3 (dys)	1.06	2,254.05	40.00	56.36
X_4 (hrs)	19.87	491.01	120.00	4.11
X_5 (NT $)	14,427.67	1.35	1.00	1.35

Plowing on paddy field with small riding tractor, which is belatedly becoming popular in Japan

MECHANIZED MAXIMUM CROPPING SYSTEMS for the SMALL FARMS of the RICE BELT of TROPICAL ASIA

Richard Bradfield

A high proportion of the hungry people of the world live in the tropical rice belt of Asia. In the last decade, a team of rice scientists at IRRI have developed varieties of rice and methods of growing them which are capable of doubling, and in some cases trebling, the yields of rice in the area. But in addition to more rice, the poor people of much of this vast area need a more diversified and better balanced diet which will supply adequate amounts of the proteins, fats, minerals and vitamins deficient in their present diets. This paper deals with studies of intensive cropping systems by the use of which the farmers of the region can produce, in addition to rice, many of the other foods needed on their own small farms, and can increase their incomes as well. To achieve these goals increased mechnization of their farms is desirable, as the amount of work required to grow 4 or 5 crops is greater than that required at present to grow one or two. In addition, mechanization is necessary to accelerate farm operations in order to gain time to grow the additional crops.

The IRRI is located at Los Banos in the Philippines at a latitude of 14° north of the equator. The rainfall pattern is typical of much of tropical Asia. The monsoon rains start, normally, about the middle of May and supply about 10 inches of rain each month until the middle of December. It declines then to from 1 to 3.5 inches per month during the dry season, which lasts through the other months December 15 to May 15. Mean monthly temperatures range from 25.1°C in January to 28.8°C in May and are very favorable for growing crops throughout the year. The soil at IRRI is predominately the heavy Maahas clay which is derived from volcanic ash and is very high in natural fertility A good structure can be developed by good management but it can be easily destroyed by mismanagement.

Practically all rotations under study are built around rice as it is the dominating crop of the region. Since rice requires much water, it is grown largely in the rainy season when water is plentiful. Since we hope to direct seed rice in dry soil without puddling whenever possible, it is ordinarily seeded early in the rainy season, in late May or early June, and the 110–120 day varieties are harvested in late September or early October when the rainfall still averages about 10 inches per month.

The other crops under study are sweet potatoes, soybeans, corn, sorghum and a fairly wide range of vegetables. All of these crops require a well aerated soil for good root growth. In order to provide satisfactory aeration for these crops any excess of water must be drained out promptly. Water management has been, at all times, one of the major problems in the development of satisfactory crop management systems. In the rainy season harmful excesses of water must be quickly removed and in the dry season shortages of water must be supplied by irrigation. The transition from one extreme to the other is often required in a period of just a few weeks.

The most difficult period for providing satisfactory water management is the major transition period when rice, which has been growing for several months in a soil practically saturated with water, is ready for harvest and any one of the other crops listed above has to be planted as soon as possible after the rice is harvested.

It was clear, from the start, that puddling the soil for rice would aggravate and prolong this transition period. This in turn would increase the length of the period in which the land was idle and would shorten the period available for growing upland crops.

This led us to consider the question : Is puddling necessary for the growth of satifactory crops of rice? A study of rice growing practices in other countries showed that good yields of rice are being obtained in several countries without puddling. Australia, for example, has one of the highest average national yields of any country in the world and they do not puddle their soils before planting rice.

It was obvious that, if good yields of rice could be obtained by direct seeding on unpuddled soil, the mechanization of soil preparation and of planting would be much easier.

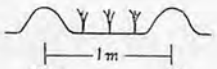
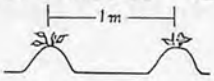
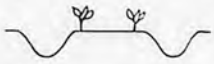
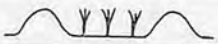
A carefully replicated experiment involving 4 methods of planting : (1) the conventional method of puddling and transplanting seedlings ; (2) seeding on flat unbedded dry soil the same as wheat ; (3) seeding on beds of dry soil with a furrow between beds for drainage and irrigation and (4) seeding on a broad furrow between two narrow ridges, was set up. It was repeated in 3 different seasons. The average yields for the 3 seasons were :

1969 wet season-5.06 tons per hectare
1970 dry season-5.63 tons per hectare
1970 wet season-4.10 tons per hectare (infested with blast)

The differences in yield due to differences in method of planting were not statistically significant. It seems clear from these experiments that rice grown in maximum cropping systems with upland crops like corn, soybeans, sorghum and sweet potatoes can ands hould be direct seeded on unpuddled soils. This will save time and labor and will facilitate intercropping during both the period of planting the rice crop in June and the maturation and harvesting period in September or October. It will also facilitate the mechanization of several operations.

Details of the system can probably be made clearer by referring to the numbered sequence of sketches in the middle of Table I. We will now describe in detail and in chronological order all the major operations performed during a typical cropping cycle of one year. Let us start our cropping year when the

Table I. TYPICAL CROPPING CALENDAR

Crop	Date of Planting	Date of Harvest	No. of Day	Tillage Operations Sketches	Av. Yields T/Ha Crop	Av. Yields T/Ha By-Product	Price (US$)	Gross Income per Hectare (US$)
1. Rice	June 1	Sept. 30	120	1. 	5.00	5.00	100/ton	500
2. Sw. Potato	Sept. 1	Dec. 24	114	2. 	25.00	20.00	40/ton	1,000
3. Soybeans (dry)	Dec. 27	Mar. 17	85	3. 	2.50	—	100/ton	250
4. Sw. Corn	Mar. 1	May 5	66	4. 	40,000 (ears)	15.00	.02/ear	800
5. Soybeans (vegetable)	May 1	July 1	60	5. 	6,000 kg (green pods)	6.00	.10/kg	600
6. Rice	June 1	Sept. 30	120	6. 		Total		$ 3,150

sweet potato crop is ready for harvest in December at the beginning of the dry season.

Sweet Potatoes.

(Sketch 2 in Table I). First the sweet potato vines are removed and hauled off the field with the tractor and trailer. Fertilizer (30-60-60) is distributed evenly by hand over the bottom of the furrows between the sweet potato ridges. Then we rotovate the furrows, using the deep penetrating slasher blades on the rototiller and the 22-inch axle, setting the outside blades as close to the sweet potatoes as possible without damaging the sweet potatoes. Plow out the sweet potatoes with a potato digger attached to the tractor. Pick up the sweet potatoes and haul them off the field. After the sweet potatoes are dug, the field will be fairly level. As soon as possible, while the soil is still moist, rotovate it using the general purpose blades on the 1 meter axle. Attach a 6" static ridging shovel behind the rototiller in place of the usual "skid." This will make a furrow for irrigating the next crop. (See Sketch 3) These furrows should be 1.0 meter wide from the middle of one furrow to the middle of the next. The width of all beds is standardized at one meter. The number of rows on the bed will vary with the crop to be grown, 1 row for corn and sweet potatoes, 2 rows for soybeans and sorghum and 3 rows for rice.

Soybeans.

Drill 2 rows of inoculated soybean seed 40 centimeters apart on the top of the bed. Try to get about 20 seeds per meter of row or 40 seeds per square meter. When the soybean seedlings emerge they should be watched closely for insects which will eat the leaves. If and when they appear, the soys should be sprayed promptly with an appropriate insecticide. As weed seedlings appear, the beans should be given a shallow cultivation. We ordinarily use the roto-tiller. The first operation is to rotovate the 40 centimeter space between the rows on the bed using the cultivator rotors. The second is to use an appropriate combination of rotors on the space between the beds.

The beans start to bloom in about 30 days and can be harvested as a green vegetable in 60 days. The Shih-shih variety, which we use ordinarily, is mature in about 85 days. If planted early in the dry season-mid December-the soys will usually require an irrigation about blooming time. As soon as the bottom of the irrigation furrow is dry enough to cultivate afte this irrigation, fertilizer (50-50-50) is applied to the bottom of the furrow and rotovated in using the ridging rotors on the outside to get any weeds on the sides of the furrows and to throw a little soil to the base of the soys. Sweet corn is then planted with hand jobbers in the bottom of the furrow in hills about 25 centimeters apart. If done promptly there will be enough moisture left in the soil to germinate the sweet corn quickly. In 30 days the corn will be knee high and the soybeans will be ready to harvest as a vegetable. Two systems of harvesting have been used. The leaves are pulled off the stalks by hand, leaving the beans attached to the stripped stalks. These are then cut with a sickle and marketed in that form. They are usually sold in bundles of 5 stalks held together by a rubber band at 10 centavos (about 2 US cents) per bundle. If these bundles are dropped in boiling water containing a little salt they will be ready to eat in 5 to 10 minutes. Children squeeze the beans out of the shells with their teeth and are almost always verey fond of them. These beans contain about 40% protein and 20% oil on a dry matter basis and therefore are very nutritious and just what the children need to balance their rice diet. The other method of harvesting is to cut the entire bean plant with a sickle and pass it through a thresher to knock the leaves and bean pods off the stalks, the leaves are blown out by the thresher and the green pods marketed as such. The housewife usually prefers this method.

If mature beans are desired, harvesting is deferred for 20-30 days and the dry beans thresed in the usual way. We sometimes harvest one of the rows on each bed as a vegetable and allow the second to mature. This is a good plan if the market for the green beans is limited. The remaining row of beans will be ready to harvest about a week before the sweet corn.

Sweet Corn.

This method of interplanting sweet corn saves about 30 days over the usual practice of planting the sweet corn after the beans are harvested. The yields of the two crops are not greatly reduced. The food produced per day is greatly increased. We produce the two crops in 90 instead of 120 days thus gaining 30 days.

While one can interplant sweet corn in soybeans when they are a month old,

with profitable results, we have not had good results with planting soybeans in sweet corn when it is a month old and within a week of tasseling. The corn shades the ground too much for the beans to make the necessary early vegetative growth.

Soybeans 2.

We have, however, had fair success by planting soys between the hills of sweet corn 7 to 10 days before the corn is harvested. In this case, after the preceding crop of green soys has been harvested, a side dressing of about 50 kilograms of N in the form of urea or ammonium sulfate is applied to the furrow in which the corn is growing. The bed from which the soybeans was just harvested is now rotovated to kill any weeds growing in the soybean stubble. This operation will also throw some soil into the furrow, covering up the fertilizer and initiating a ridge around the corn. Often this is the only cultivation the corn receives. If this is contemplated, a furrowing shovel is attached to the back of the rotovator to make an irrigation furrow between the rows of corn. The next irrigation for the corn is applied in this furrow.

After the corn is harvested the soybeans interplanted between the hills of corn seldom require any cultivation.

Rice.

When the soybeans are about a month old, about June 1, the middle furrow between the soybeans on the ridges is fertilized with 30-60-60 and rotovated. A board about 65 centimeters wide is attached to the rear end of the rototiller to smooth the soil in the bottom of the furrow in preparation for the planting of the rice. The rice is planted three rows at a time with a 3-unit Planet Jr. seeder with rows 25 centimeters apart. The soybeans and rice will grow together, the soys on the ridge, the rice in the broad, flat furrow between, until the soys are ready to harvest in about 30 days after the rice is planted. The rice will be 6 to 8 inches high at this time. Neither crop seems to be adversely affected by the competition.

The rice is generally cultivated once before the beans are harvested and once after if needed. By this time the rains are heavier and the subsoil filled with water. The rice is irrigated after this only in case there is an interruption of the monsoons.

Sweet Potatoes.

When the rice is headed, and about a month in advance of harvesting any accumulated water in the furrows is drained off and the ridges from which the soys were harvested in July allowed to dry for 3 or 4 days. They are then fertilized with 30-60-60 and planted to sweet potato cuttings. Unless there are heavy rains following the setting of the sweet potato cuttings, enough water is added to cover the bottom of the furrow about 5 centimeters deep. This is usually sufficient to carry the rice until time for the pre-harvest drainage about two weeks before harvest. The rice is harvested, leaving as much of the straw as possible as stubble. By this time the sweet potatoes are well established and starting to put out runners. We have gained about 30 days by interplanting them in the rice.

If the soil becomes dry enough before the sweet potato vines cover the ground, the middles are fertilized again, then rotovated with the ridging rotors. This makes the ridges on which the sweet potatoes are growing a little wider and the furrow a little deeper, thus providing better drainage and aeration for the sweet potatoes during the heavy rains of November. By late December the sweet potatoes will be ready for harvest and our annual maximum cropping cycle will be completed. We have grown 2 crops of soybeans, 1 crop of sweet corn, a crop of rice and a crop of sweet potatoes in the 12 month period. We have performed most of the necessary tillage operations with a small 6-H. P. rototiller which a farmer with a 2-3 hectare farm can afford to purchase if he can grow 4 or 5 crops a year on most of his land. Plowing is usually one of the most costly operations in crop production. We have produced high yields of 5 crops a year for 5 years without plowing.

In tropical countries with a 365 day growing season, where farms are small and land is scarce and high priced, one of the best ways for farmers to increase their incomes is to grow high yields of 4 to 5 crops a year by intensive maximum cropping methods of the type described in this paper. The widespread adoption of such systems of farming could increase the supply and improve the quality of food available to people with low incomes and could remove the threat of widespread hunger in these heavily populated tropical areas, for at least another generation.

The 6-H.P. tractor used in our maximum cropping work is a Landmaster 150, manufactured by Landmaster Ltd., Hucknall, Nottingham, England.

(*Continued from page* 32)

Cultural Change XVII. October 1968, pp. 43-45. Commenting on the failure of the tractor mechanization project in Morocco, Van Wersch says, "It failed because the large majority of the farmers failed to be convinced that modern machinery and techniques could be absorbed in their world, because they did not see any immediate profits from the innovation and pulled out of the scheme--the government should have recognized the budget deficits as inherent and considered it as an educational program". That would pay off only in the long run.

12a/ John King, Jr. "Appraising a Project" Ch. 1 in Economic Development Projects and Their Appraisal: Cases and Principles from the Experience of the World Bank, Baltimore : Johns Hopkins Press, 1967. pp. 3-15.

12b/ Ranger, Robert F. Benefit Cost Methods for Project.Appraisal--A Computer Program. Ag. Eco. Report. Number 149, Nov. 1969, pp. 9.

Many boats with engines are very popular and important for the life in South East Asia

The Tractor Contractor System in Southeast Asia and the Suitability of Imported Agricultural Machinery

William J. Chancellor

A pattern of small farms dominates the agriculture of most areas in Southeast Asia. The use of efficiently applied tractor power on small farms, however, permits farm labor to be devoted to tasks of more intensive production, and offers the advantage of more timely tillage and crop establishment than would have been possible with traditional power sources. The tractor contractor system extends to farmers with small holdings, the possibility of using large or expensive agricultural equipment units of high efficiency to serve their needs. Thus, the tractor contractor system appears to be well-suited to the existing pattern of agriculture in Southeast Asia.

Information on the features of tractor contractor systems in both Thailand and West Malaysia was obtained through a survey conducted in these two countries between August 1968 and May 1969. The survey was financed by a grant from the Agricultural Development Council, Inc., and was co-sponsored by the Agricultural Engineering Division of the Rice Department in Thailand, and by the Faculty of Agriculture, University of Malaya, in Malaysia. The survey involved 432 interviews, primarily with tractor sales agents, tractor contractors, and farmers who hire tractor service.

Dynamic Sequence of Motivating Events and Features of the Tractor Contractor System

Government-operated tractor stations first introduce the ideas of tractor tillage and of the contract system of operation to meet the needs of farmers with small holdings. Charge rates maintained at a level of potential economic feasibility for private contractors, and farmer demand in excess of government station capacity, influence private tractor contractors to go into business, subsequently diminishing the need for tractor station activities.

New agricultural production technologies presently being adopted have the use of tractor power as an integral part. This power permits the rapid tillage required for double cropping of rice, and provides the large tillage forces necessary in upland soils for the production of such crops as maize and cotton.

The use of efficient tractor power on small farms, with its saving of many hours of heavy tillage labor and its improvement of the timeliness of tillage, provides a strong incentive for farmers to undertake new incomeproducing activities in order to meet the costs of hired tractor tillage.

Release of rural manpower from traditional tillage activities gives farmers a new resource of working time, which they combine with other underutilized agricultural resources (land, water, and well-developed agricultural skills) to generate additional income by increasing the scope and intensity of their agricultural production enterprises.

For those interested in tractor ownership (usually farmers with aboveaverage holdings), the potential of cash income from tractor contractor services is the main factor which brings the idea of tractor purchase within the range of economic feasibility.

As a result of the mobilization of rural savings for tractor purchase and of the cash-earning potential of new tractor-aided agricultural production technologies, tractor marketing firms with access to overseas fund sources have become interested in drawing on these sources to provide credit for tractor sales to farmers.

Short-term credit contracts for tractor sales influence tractor buyers to seek a maximum amount of contract work in order to meet repayment schedules. This provides an incentive for them to achieve efficient operation by:

a) operating the tractor many hours each day, using several drivers per tractor,

b) traveling from one location to another to extend the working season of the tractor,

c) actively soliciting jobs from farmers or paying commission agents to do this,

d) maintaining low rates of charge for work done to maximize the appeal of their services to hiring farmers, and

e) repairing the tractor and equipment as quickly as possible after mechanical breakdown, to minimize loss of working time.

The opportunities for farmers to use tractor tillage are spread rapidly throughout most agricultural areas by means of competitive solicitation of farmers by tractor owners offering services at low cost. Continuing efforts by agricultural extension personnel are thus not required in this activity.

Extensive use of tractors provides the basis for the expansion of allied industries and business such as :

a) manufacturing of tractor implements

b) manufacturing of tractor accessories and repair parts

c) tractor repair workshops

d) tractor sales businesses

The new tractor-aided agricultural production technologies, as well as the above-mentioned allied industries and businesses, foster a demand for, as well as a potential benefit from, technical training of participants. The release of rural manpower from traditional tillage activities through the use of tractor contract services helps provide the time for these persons to obtain such training.

How the Tractor Contractor System Works

Internationally based tractor manufacturing and sales firms offer tractors for sale on 18- to 24-month credit contracts requiring 33 percent down payment. After having hired tractor service for several years, some farmers with larger holdings use their savings, or those of their family, to meet the down payment for tractor purchase. Purchase is made just prior to the tillage season. The tractor is delivered with an introductory operating

demonstration, the promise of one or more free service visits, and a 6 – to 12-month guarantee.

The tractor, driven by the owner and his relatives, is used to till the owner's fields and then is taken out to till the fields of others in the community who have checked the quality of work done and have contacted the tractor owner requesting his service.

Upon arrival of the tractor at the customer's farm, soft spots in the field are pointed out to the driver. The tractor then begins to work, with the hiring farmer staying to observe the work. When the work is completed, the tractor owner and farmer determine field size from records or by measurement, and payment for the work is made in cash within a few days of the completion of the job.

When the tillage season has ended in the owner's community, he then moves the tractor and driving crew to an area where tillage is still in progress. This may be as much as 100 km away. In this area the owner may contact farmers to solicit work, or he may subscribe to the services of the commission agent. The agent locates contracting farmers and for this, he receives from the tractor owner an amount equal to about 5 percent of the contract charge. Cash payments for tillage services permit tractor owners to meet fuel, repair, and driver wage costs while away from home. Minor repairs are done by the owner himself, but the services of a repair workshop are frequently used for major repairs.

When the demand for major tillage work ends, the tractor is put in storage. It is not used until the next tillage season except to thresh rice by treading, or to shell maize, during the short periods that these activities are required in the owner's community.

Both larger (45 to 70 horsepower) 4-wheel tractors (**Fig. 1**) and 2-wheel (8–11 horsepower) power tillers (**Fig. 2**) participate in tractor hire services in Thailand and Malaysia. The following table provides some information about the features of the system in these countries.

Item	Thailand (*average values)		Malaysia (average values)	
Holdings of farmers hiring tractors	9.4 ha		2.3 ha	
Experience with tractor service	4.8 yr		4.6 yr	
Proportion never discontinuing service	87%		90%	
Proportion changing contractors hired	83%		74%	
Proportion reporting contractor arrived as scheduled	56%		79%	
Most common tillage operation hired	Disc Tilling		Rotary Tilling	
Proportion of fields tilled in a dry condition	75%		21%	
Proportion of farmers finding work quality satisfactory	63%		84%	
Value of tractor service to farmers per unit cost	167%		151%	
Proportion of labor released by tractor service and subsequently redirected to agricultural intensification	65%		75%	
Percent of farmers paying cash for tractor service	63.9%		61.2%	
Proportion of farmers able to meet tractor charges from new income sources	82%		81%	
Proportion of tractor contractors that are farmers	90%		81%	
Holdings of tractor contractors	20.8 ha		4.6 ha	
Average tractor age	3.7 yr		3.8 yr	
Months of tractor work per year	5.07		3.84	
		4-wheel		2-wheel
Number of tractors per owner	1.71	2.03		1.39
Drivers per tractor	2.6	1.6		2.0
Tractor working hours per day	17.2 hr	9.8 hr		9.0 hr
Field area served per year (single operations)	258 ha	152 ha		27 ha
Annual operating hours per tractor	1360	1042		395
Maximum radius of operation	100 km	88 km		12 km
Percent of operating time spent traveling	24%	17%		10%
Percent of working season used for tractor or implement repairs	26%	15%		16%
Annual repair costs per tractor	$638	$332		$74
Contract charge per rated horsepower hour	$.038	$.069		$.155
Tractor work required per hectare per crop (rated hp hr)	271	279		131
Annual profit per tractor	– $561	$1370		– $50

*Values pertaining to tractors in Thailand refer only to 4-wheel tractors of 45 to 70 horsepower.

Fig. 1 Four-wheel tractor of the 50- to 70- hp type commonly used in tractor contractor operations in Thailand and Malaysia.

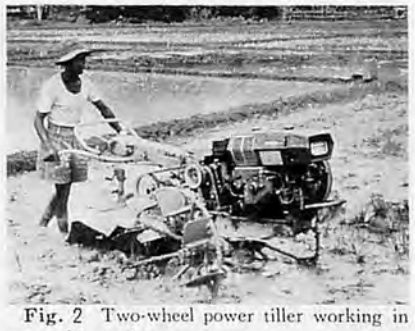


Fig. 2 Two-wheel power tiller working in wet field conditions.

Suitability of the Imported Equipment Used

Because of the economically competitive nature of the tractor contractor system, market emphasis is on those models of equipment which are of a sufficiently general purpose design that large world market sales have minimized production costs, and thus selling prices. Such general purpose models are sometimes not precisely suited to the individual uses found in each country. In addition, the emphasis on low price has frequently brought into the market implements designed for light duty applications, whereas recently cleared fields, flooded rice fields, and 24-hour per day contract operations require very heavy duty implements. The shortness of contract work seasons and the high proportion of work season time lost due to mechanical breakdown offer an opportunity for economic gain from use of equipment with greater durability. As buyers become more experienced, it is expected that the demand for such equipment will increase.

Problems with equipment durability stem from two main sources. The first is the lack of training or experience of operators in preventive maintenance. Equipment distributors have provided excellent training for mechanics. However, there exists a potential for gain by distributors as well as by tractor owners for operator training programs in preventive maintenance.

The second source of problems with equipment durability is the nature of the loads imposed on the tractor by the

Fig. 3 Rotary tillers working in a moist field. Note cage wheels on one tractor.

Fig. 4 Cotton planted in an upland field about 2 years after initial clearing. Tractors are used to plow such fields, resulting in numerous shocks to the tractor-implement system.

Fig. 5 Heavy auxiliary sway chain. Note many welded reinforcements on lower draft link and connecting rod. The use of disc implements restrained by tight sway chains cause many failures of draft and lift linkage parts.

Fig. 6 Driver washing tractor after work in a flooded field. Note water level above front wheel hub center.

Fig. 7 A tractor with rotary tiller crossing a field border by driving the tractor into the border at high speed (note large wave of water). This procedure imposed severe loads on the front axle and steering assemblies.

Fig. 8 Tractor with front and rear transport platforms fully loaded. Such loads cause frequent failure of front wheel bearings.

implements used. In areas where rotary tillers are used (Fig. 3), failures are most common all along the power transmission path from the engine to the tiller blades. Transmission gears, clutch plates, belts (on power tillers), power take-off shafts, universal joints, tiller drive gears, and roller chains are all frequent casualties.

Where disc plows or disc tillers are used for tillage of recently cleared land (Fig. 4), there are usually numerous roots and stumps, etc., which cause the tail wheel of these implements to be lifted out of the furrow frequently. Shocks and high side forces are thus applied to the tractor. Lack of experience on the part of operators and inadequate design of the tail wheel of light duty implements resulted in disregard for the purpose of the tail wheel and have produced attempts to control these implements with the use of very heavy, securely tightened, check or sway chains (Fig. 5). Resulting damage to the draft links and hydraulic lift mechanism has been great. Wear of steering linkages has been rapid due to the operator having to use the steering system to compensate for side forces generated by having these disc implements restrained by the tractor.

Operation in wet rice fields has posed certain other problems, such as those due to increased rear axle stresses when cage wheels (Fig. 3) or other traction aids are used. The opportunity for muddy water to enter front wheel bearings (Fig. 6), disc implement bearings, and rotary tiller bearings is great. None of these bearings are designed to operate satisfactorily after muddy water has entered. The crossing of field borders by driving the tractor into them at high speed causes a high incidence of failure of front axle parts (Fig. 7). The hauling of large quantities of material on frontmounted platforms (Fig. 8) also places unexpected stress levels on front axle parts.

Power tillers designed primarily for wet field conditions are capable of work on soils that are so soft that larger 4-wheel tractors cannot be supported. The cost of power tillers per unit of work capability is greater than that for 4-wheel tractors. Active economic competition, which is a part of the tractor contractor system, may tend to limit power tillers to these soft soil areas unless the economics of their production and operation can be improved.

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PROPOSALS FOR THE DEVELOPMENT OF ECONOMIC MODELS OF RICE MECHANIZATION※

K. H. Friedrich, W. J. van Gilst

Introduction

Rice is grown under different climatic, pedological and socio-economic conditions. It is the most important single agricultural commodity in the developing world. In spite of this undoubted importance, relatively little is known especially about the economic, management and mechanization aspects of rice production.

In many rice producing countries traditional farming systems still prevail, the major sources of power being human and animal. Expansion of the land under cultivation is seldom possible and even more rarely economically feasible with traditional systems. The introduction of modern technology seems the only feasible means of increasing production in rice growing areas.

A transition to modern farming systems includes improving both hand tools and animal-drawn implements. Mechanical power is a natural follow-up of efficient mechanization. Through improving hand and animal-drawn implements, the size of the farm operation can often be substantially increased, even though it still remains small compared to modern mechanized farming systems. Although the absolute size of a farm operation is not the only determination of success, it is a very important factor.

Modern farming systems are not just charaterised by the size and cost of mechanical power and equipment alone; but by their prudent application. Technology has progressed tremendously, e. g. High Yielding Varieties have boosted the possible yield achievements beyond what was earlier believed possible. Double cropping through improved water management, use of fertilizer and application of pesticides, further improve yields. The outlook is promising, but in practice lasting progress can only be achieved if all production resources are properly combined and supported by adequate production means. Perhaps the most important link in the chain is the utilization and/or development of machinery, in order to apply technological progress on expanded areas and by substituting scarce resources, such as human labour, in both amount and timely availability, and by making other inputs more effective.

A Method for Data Collection

The growing interest in the use of mechanical power and equipment poses the problem of determining the relative advantage of using various types of power and equipment. This paper attempts in part to describe a method of collecting and analysing data in order to ascertain actual costs and benefits of local implements under prevailing farming practices; and also to set forth steps of estimating and calculating costs of using improved and modern farm machinery and equipment. Detailed knowledge of present farming situation is essential for planning the development of the farm business. This includes crop rotations, cultural practices, labour requirements and labour organization, availability of production resources and constraints in farming. The relative profitability of different alternative systems and degrees of mechanization should be established in order to decide what system of mechanization and farm organization is best suited to particular conditions.

An important problem in collecting data is the wide variations between countries, between ecological zones and between socio-economic settings. FAO has been attempting to develop an uniform approach of data collection which will permit rapid comparison of results. The following method is presented as a first attempt to systematize internationally the collection and analysis of essential data. Modifications will be required to suit local conditions. (Copies of the actual investigation forms may be obtained from FAO, AGSM):

The following are the main sections of the Method.

The potential labour force of a household (or farm family or community) is determined and from this information the availability of household members for farm work is calculated. In addition, the seasonal availability of hired labour is indicated.

The available farm land is quantified according to quality, especially in view of its suitability for rice production. The possibilities of increasing the size of operation through rental arrangements are investigated.

The situation of farm buildings including machinery housing, storage and animal shelter is investigated. (Farm buildings are complementary items of different forms of farm organization.)

Existing systems of mechanization (farm machinery, equipment and implements) are analysed in detail with a view to their capacity and their cost. The draught animal situation is specified and analysed, if appropriate.

The annual cropping programme is established as a first step in determining different rotational possibilities. This also indicates seasonality of farming operation and its implication on the labour distribution.

Crop input/output analyses provide the actual performance test on incurred costs and achieved benefits under different methods and various degress of mechanization. Labour requirements and levels of direct inputs are tested and related to various cultivation practices.

Storage, processing and marketing arrangements are investigated and analysed. Special emphasis is placed on the producer prices received.

※ Background Paper
Working Party on Agricultural Engineering Aspects of Rice production, Storage and Processing
International Rice Commission
Sixth Session
Teheran, Iran 5—9 December 1970

Miscellaneous items include the credit and mortgage situation as well as the agricultural tax liabilities of the farm business. In addition, constraints recognized by the farmers are analysed and their preference with respect to the use of imaginary additional returns from farming are indicated.

In order to related the information to the existing agricultural situations, conversion rates, climatic data on rainfall, temperature and humidity are analysed and the supply position of agricultural machinery is indicated.

Method of Calculation

From this information different systems as well as varying degrees of mechanization can be analysed with respect to their cost structure, their input/output relationships and their relative advantage under different conditions. The following cost calcultions are produced as a suggested guide. It should be said that the various items do not require lengthy discussions. However, three different cost categories are distinguished:

(a) fixed costs (interest, insurance, housing)

(b) conditionally variable costs (depreciation and repairs)

(c) variable costs (fuel, lubricants, operating time and maintenance).

Between these different cost groups some relation exists, e. g. will good maintenance of the machinery decrease repair costs; the replacement of machinery after a relatively short time of use will decrease the repair costs, poor housing and extreme climatic conditions will have their effect on maintenance costs and on the lifetime of the machinery; ignorance of lack of training and a poor spare part supply will affect all cost items.

For the assessment of the relative advantage of draught animals the same method is applied. In this case the repair cost factor and the "borderline for variable depreciation" are omitted. "Operating costs" are determined by feed costs. The fixed cost factor is substituted by individual data on shelter, insurance and interest charges.

Method of Cost Calculation[1]

Data:

Purchase price	A =	..... $
Useful life in time units	N =	.....years
Useful life in work units	n =	.....(hr or ha)
Repair cost factor	r =	.....of A
Maintenance costs	w =	.....working hours
Operating costs	B =	..... $ /.....
Fixed cost factor	f =	.....of A
Yearly work volume	j =	...../year
wages	L =	..... $ /hour
Borderline for variable depreciation[2]	$\frac{n}{N}$ =	...../year

Details:

Fixed cost factor f

machines without shelter f = 0.03
machines with shelter f = 0.04
tractors f = 0.05

This factor could be substituted by:

a. shelter $m^3 \times$ rent/m^3
b. insurance 1.5°/00 of A
c. interest $\frac{0.6 \times A \times p}{100}$

whereby the factor (0.6xA) relates to the average investment value and
p = interest percent

Operating costs B
fuel consumption at 40%

Diesel = HP[3] × 0.11 = ...1/hour
Gasolin = HP × 0.175 = ...1/hour

lubricants—10% of the cost of fuel consumption

(1)—based on Schaefer-Kehnert, Kosten und Wirtschaftlichkeit des Landmaschineneinsatzes, Munich 1957 (2)—to determine, whether depreciation is calculated according to useful life in time units or in work units (3)—HP = flywheel HP.

The Calculation

			Case A $j > \frac{n}{N}$	Case B $j < \frac{n}{N}$
A. Fixed cost				
interest and general expenses	A x f	=	..... $ /...(1)	..... $ /...(1)
B. Conditionally variable costs				
depreciation	(a) $\frac{A}{n}$ = ...	=	..... $ /...	—
	(b) $\frac{A}{Nxj}$ = ...		—	..... $ /...
repairs	(a) $\frac{Axr}{n}$ = ...	=	..... $ /...	—
	(b) $\frac{AxrxNxj}{nxn}$	=	—	..... $ /...
C. Variable costs				
maintenance	Lxw	=	..... $ /...	..... $ /...
operating costs	B	=	..... $ /...	..... $ /...
	Total		..... $ /...	..... $ /...
	xj	=	..... $ / year	..... $ / year

(1)—hour or hectare

Relationship between Cultivation Area and Cultivation Costs of Different Mechanization Systems

In the following graph a schema of likely relationship between cultivation size and cultivation costs per unit of area of different mechanization systems is presented. It should be stressed that any real findings will most probably vary from these indications, according to local conditions and relative price differences. In conditions where small cultivation sizes prevail, the use of power tillers may very well be less costly per unit of area than draught animals or tractors with rotary cultivators. The points of cost equality are indicated in the graph. In the case of larger areas only one system of farm mechanization may be left for consideration. In addition the graph can demonstrate why custom work may—even where very small cultivation sizes prevail and the cost of the custom work includes profit for the owner—be more profitable than owned machinery and equipment or draught animals. This is so, because the capacity of that machinery is more fully met.

Method of Calculating Profits and Production Costs per Hectare and per Kilogram of Dry Rice

The Knowledge of relative costs of different mechanization systems does not provide any final answer as to the profitability of its application in rice production under various forms of management. Additional benefits may be derived in employing any special form or degree of mechanization, which have to be accredited to them. For instance, better and more uniform quality may result in better producer prices, or losses could be reduced. Higher yields may result through a more timely accomplishment of any job in question. A profit/ loss analysis and the calculation of production costs per kilogram of rice, as proposed in the following table, makes it possible to compare different methods of rice production under various forms and degrees of mechanization organization. When rice is demonstratively unprofitable, other systems of rice cultivation can be proposed or other crops can be introduced into the rotation.

Costs and Benefits per Farm

Comparing costs and benefits per unit of cultivation area or per unit of crop may not provide the final answer to the problem of the relative advantage of various alternative mechanization programmes. It may be necessary to find the effect of using new machinery or implements on a farmer's total income. As a farm is a business unit which needs balanced organization, the total farm income, instead of the income from any single enterprise, should be the criterion in determining the desirability of introducing new machinery or new practices. Let us assume that seasonal availability of rains, or double cropping of the lands may limit the time available between harvesting of one crop and the next land preparation—to which mechanization of rice cultivation is mainly geared—to, let us say, 30 days. Then using different mechanization systems and assuming no constraints on the availability of land, a farmer can cultivate (once) approximately the following areas of land:

(a) hand labour (1 labour unit)
1 hectare or 240 hr/ha

(b) draught animal
3 〃 or 80 hr/ha

(c) power tiller
20 〃 or 12 hr/ha

(d) tractor and rotary cultivator
50 〃 or 5 hr/ha.

In order to be realistic, a rational programme of utilization of agricultural machinery and implements must also take into account the following points that mechanization will:

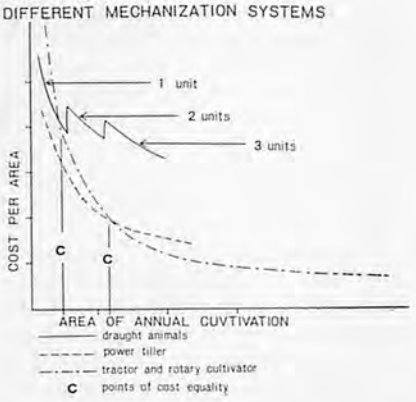
(i) make farm work easier and more enjoyable;

(ii) reduce labour requirements in peak seasons, and conversely

(iii) increase labour employment during slack periods;

(iv) help to enlarge farm business by introducing new enterprises, changes in cropping patterns, and reclamation of new land;

RELATIONSHIP BETWEEN CULTIVATION AREA AND CULTIVATION COSTS OF DIFFERENT MECHANIZATION SYSTEMS



(v) make soil improvement and conservation feasible;

(vi) provide better quality work and more timely operations at reasonable costs and hence will produce better farming results.

(*Continued from page* 44)

small-scale sector. The policies and activities of UNIDO in this field are specifically orientated to contribute – in a modest way–to the success of the "green revolution" in developing countries especially in Asia and the Far East, through a rational development of suitable, locally produced agricultural machinery and implements in addition to the local production of required industrial inputs of agricultural production and equipment, and technology for industrial processing of agricultural outputs.

1. The views expressed in this paper are those of the author and do not necessarily reflect those of the UNIDO Secretariat or ECAFE Secretariat.
2. The above paper reflects mainly the concepts and material presented in the "Report of the United Nations ECAFE/AIDC UNIDO Fact Finding Team on Industries Manufacturing Agricultural Machinery" (ID/WG40/11), the "UNIDO Report of the Expert Group Meeting on Agricultural Machinery Industry in Developing Countries" (ID/47) and the analysis by the author.

Method for Calculating Profits and Production Costs per Hectare and per Kilogram of Dry Rice

	units	unit price or cost	total
A. Value of Gross Output	……kg	…… $/kg	…… $/ha
B. Direct Inputs			
seed	……kg	…… $/kg	…… $/ha
fertilizer, N……	……kg	…… $/kg	…… $/ha
P……	……kg	…… $/kg	…… $/ha
K……	……kg	…… $/kg	…… $/ha
pest control	……	…… $	…… $/ha
water charges	……	…… $	…… $/ha
animal traction	……hr	…… $/hr	…… $/ha
mechanical power	……hr	…… $/hr	…… $/ha
equipment (a) ……	……hr	…… $/hr	…… $/ha
(b) ……	……hr	…… $/hr	…… $/ha
(c) ……	……hr	…… $/hr	…… $/ha
Total			
C. General Costs			
depreciation, interest, maintenance of land improvements			…… $/ha
interest on land capital			…… $/ha
interest on half direct inputs (excl. mechanization)			…… $/ha
		Total	
D. Labour Costs (excl. mechanization)	……hr	…… $/hr	…… $/ha
E. Profit/Loss per ha (A−B−C−D) =			…… $/ha
F. Production Costs per kg of rice (B+C+D) : units of A=			…… $/kg

A SECOND GENERATION PROBLEM OF THE GREEN REVOLUTION

— Food Grain Storage —

Merle L. Esmay

Shortages of food grains occasionally occur, not due just to a lack of production, but because a portion of already produced and harvested grain is lost through improper storage, handling and transportation.

Food grain losses after harvest of from five to 10 percent have been documented throughout the Asian countries in "The Report of the Survey on the Problems of Transportation, Storage, and Distribution of Food Grains" in 1968–69 by Chujiro Ozaki of the Asian Productivity Organization. In specific areas and districts, as well as during some seasons, the losses will run two to three times higher than this reported average 10 percent.

A 10 percent loss of the rice crop in India may amount to some 10 million metric tons. It is the amount of rice India has been short in some recent years. Thus, eliminating losses after harvest could have made available an adequate supply of already produced rice and prevented much hunger and suffering.

Dr. C. R. Wharton, Jr. (*Dr. Wharton, until* 1969 *was vice president of the Agr'l Development Council of New York City ; presently is president of Michigan State University, East Lansing, Michigan*) in a recent *Foreign Affairs* article discusses the reason new technology may not speak as widely and rapidly as supposed and predicted by some. Three of his six reasons pertain to possible deficiences related to engineering —two of which are directly related to storage, drying and handling of the harvested food grains. One reason is the inadequacy of market facilities to handle large influxes of food grains. The second reason pertains to multiple cropping and resulting difficulties associated with harvesting, drying and storing crops that may mature during wet seasons. The third engineering-related reason pertains to the need for water control for proper irrigation and drainage.

The storage, drying, handling and transportation of food grains in Asia cannot, however, be treated as an isolated engineering problem, as in actuality it is a people-related problem. The provision of adequate facilities to minimize food grain losses must be done in such a way as to reduce human drudgery and improve the well-being of all farmers and rural people. As an example, the movement of rice in one to two-hundred pound bags on the heads of men is not a very humane method of transportation.

Dr. Wharton's other three reasons for being concerned about the "Green Revolution" spread are related to unequal distribution of benefits and returns to all farmers and rural people. One, is that the adoption of new technology is slower among small marginal farmers who are understandably reluctant to experiment in the production of rice on which the very survival of their families depends. Second, the smaller farmers are less likely to have the capabilities of being able to obtain the necessary training to provide the new agronomic skills and expertise associated with new cereal varieties and required inputs. Third, there is often a failure by the government to make significant institutional reforms needed to provide real economic incentives and returns to small farmers and tenants.

Food Grain Losses

The new food grain varieties of the "Green Revolution," as for example IR-8 rice developed by the International Rice Research Institute in the Philippines, have the ability to mature more quickly and with disregard to the seasonal photo periodic variation caused by changing day length. This provides a great potential for the production of two or three crops of rice per year, called multi-cropping. This may mean, however, that some of the improved crops will mature with associated increased yields during the rainy season, The traditional methods of sun drying rice on the ground and storage in a few makeshift bags or boxes at the farm or village cannot than be depended upon to do the job without large losses.

Paddy rice may contain as much as 25 percent moisture when harvested in the field, particularly during the rainy season. It spoils and loses quality in a few days if not dried to a moisture content of about 14 percent. Wet rice deteriorates because of the accelerated activities of micro-organisms, insects and the internal metabolism of the rice kernels. High temperatures associated with the high moisture cause even higher rates of quality deterioration. Paddy rice and other food grains must then first be properly dried before they can be adequately stored.

Some food grain wastage occurs during the drying operation. Sun drying of paddy rice exposes it for consumption and contamination by rodents and birds. Also, sun drying, being a process dependent on natural conditions, is quite uncontrollable. There may be rewetting of the grain kernels by rain or dew as well as occasional over or under drying. Uncontrolled drying causes undesirable internal stresses resulting in considerable kernel cracking when processed. A low yield of good quality polished rice is an appreciable economic loss.

Even though the paddy rice is properly dried before storage, it must be maintained dry throughout the storage period or quality deterioration will occur. Storage losses may also result from rodents, birds and spillage. Transportation losses from spillage, wetting, rodents and birds may also take place.

Regional Program on Loss Reduction

The Asian Productivity Organization (APO) has been attempting to minimize food grain losses since 1968 through a regional program in its 14 member Asian Countries. APO was first established in 1961 to provide a means for cooperation

on a multilateral basis for the improvement of national productivity. Only since 1966, has APO included aspects of agricultural productivity in its annual programs. The overall objectives of the APO are: establish linkage between productivity and economic planning, hastening and strengthening the productivity movement in the entire region, fostering mutual help, dissemination of knowledge, and assisting national organizations activities.

With its headquarters in Tokyo, the APO holds conferences and symposia; sends out study missions; deputes technical experts; conducts training courses; provides fellowships; gives faculty support to seminars in member countries; invites individual country study missions; undertakes research; and maintains information activities.

The first major APO project in agriculture was initiated in 1967 and pertained to field mechanization and agricultural development. The food grain storage and transportation project was the second, in 1968. A survey of food grain losses and wastage was first made in all member countries. The second phase of this project consisted of a training school in 1969 for participants from member countries. It was this second phase of the food grain project, in which I was involved as a consultant sponsored by The Asia Foundation. My part consisted of developing some applicable drying and storage concepts; the preparation of three working papers on minimizing losses through improved drying, storage and transportation; and participation in the training school.

Food Grain Storage

Rice, as the most important Asian food grain can be stored as paddy (the rough form before the husks are removed), as brown (husked) rice, or as polished rice in bulk, bags, or other types of packages. In Japan, essentially all rice distributed through the marketing channels is sorted and transported in bags as brown rice. The rice retained by the farmers for their own consumption is mainly stored in small bulk bins as either paddy or husked rice. Most other Asian countries store their rice in the paddy (rough) form in bags. Some, however, as in Taiwan, store much of the market rice as paddy in bulk bins.

Japan, the Philippines, India and some other Asian countries are experimenting with bulk storage of the rough paddy rice in silo-type storages often called "country elevators." This has been a conventional type of grain storage in North America and Europe for many years. A bulk storage system to be complete not only requires specially designed and constructed storage structures, bulk handling equipment and mechanical aeration facilities but also a transportation system designed for bulk handling.

Although these are major deterrents to change, large countries, such as India, should be making positive plans for eventual bulk handling, storage and transportation. India will soon have the annual problem of transporting thirty-million metric tons of rice annually from areas of production to city and urban markets. This is a tremendous logistics problem if handled in bags, to say nothing of the inhumane aspects of man handling that mass of grain. Taiwan, although having some bulk storage, moves the rice into and out of the storage centers in bags, and has not as yet incorporated any mechanical aeration (ventilation) equipment.

Aeration or proper ventilation of stored rice for the prevention and/or dissipation of hot spots is very difficult to achieve in bags. Thus, in general bagged storage is not very satisfactory. Ventilation of bulk stored rice can be done effectively with comparatively small aeration fans. The management of bulk storage must vary by country because of differing weather conditions and required length of storage periods. The hot, humid conditions of the Asian tropical climates make it difficult to maintain the hydroscopic stored grain at a continuous low moisture content. Thus, good storage is necessary.

The procurement of adequate, modern storage, processing and handling facilities at large centers is not a major problem in most of the Asian countries. Technology and consultants are available from other countries for designing, construction and even supervision of operation. As these large centers are generally government or government subsidized projects, necessary capital is also made available.

Although these modern storage centers may prevent some spoilage and loss of food grains on a country basis they seldom are of much help to the individual farmers. During the rainy season, the farmer cannot transport his wet grain to a large center quickly enough to prevent spoilage. If the farmer should get his grain to a large privately-owned center, he may then be forced to take a very low price because it is wet, because the quality may have been lowered and because he must sell. A government-guaranteed fair price or cooperatively owned and operated centers benefit small farmers.

Farmers' Organizations

Solving the problems of food grain wastage and losses with improved technology cannot be separated from the social-economic patterns and conditions of farm people. The small independent farm operators who produce small per farm quantities of food grain, cannot justify the necessary drying and storage facilities to minimize food grain losses. This problem can be solved, however, by groups of farmers. The organized group can cooperatively procure and operate adequate facilities for food grain drying, storage and marketing. Not only can food grain losses and wastage be minimized through the cooperative introduction of technology, but the individual farmers can share the financial savings that otherwise accrue to local and central warehouse organizers and "traders."

The Village Grain Dryer

A small, low cost, easily operated, all-weather grain dryer is needed at the farm level or in the small villages. This is a difficult order. Grain dryers of all sizes and levels of sophistication have been developed and are being used in North America, Europe and Japan. The Japanese farm dryers come the closest to meeting the size specifications. More than a million paddy rice dryers are now in use on the small (2 to 3 acre) Japanese farms. The Japanese farm dryers, although the right size, are a level too high in sophistication. They use electricity for operation of the fan to force air through the grain. This assumes complete electrification of all rural areas. Although this is essentially the case in Japan, it is not true throughout Asia.

The simplest mechanical dryer is the batch type. This consists basically of a bin to hold up to a metric ton of grain through which warmed air is forced. Some sort of power is necessary to force air through the grain; and the air must be warmed to dry the grain effectively during the humid season. The moisture reduction of grain is brought about by the evaporation of water from the kernels. This involves not only evaporation from the kernel surface, but also diffusion from the kernel interior to the surface. Energy in the form of heat must be provided to bring about the evaporation and diffusion process. In mechanical drying, the heat is most generally supplied by forced warm air. The heat energy might also be provided by conduction or radiation.

Traditional sun drying utilizes a combination of solar radiation and convective heating by natural air. The basic concepts upon which sun drying relies are excellent. The main problem is that most Asian countries have extended rainy seasons with very little sunshine. Also

in sun drying the rate of heating, the kernel temperature level and rewetting are difficult if not impossible to control.

The Small Batch Dryer

The small batch-type dryer has great possibilities throughout Asia. It must be designed and constructed to use an internal combustion engine to operate the fan and excess engine heat utilized to warm the drying air. The batch bin can be constructed of indigenous material in most countries. The 5 to 10 hp engine and fan is not more complicated nor much different than the engine and pump being introduced in many countries for irrigation. The fan is designed to move air while a pump is designed to move water.

The same engine can be used during the dry seasons to pump water and during wet seasons to dry paddy rice. It can also be adapted to operate the small Japanese type drum thresher now being used extensively in Taiwan and some other countries. The threshing of rice on the traditional threshing floor with treading animals also is a problem during the wet seasons. The one multi-purpose engine can also be adapted to a small two-wheeled powertiller type tractor.

In many Asian countries, and East Pakistan is an example, the engine operated dryer could best be used at the village level on a cooperative basis. The engine and its various pieces of equipment might be leased to the village primary cooperative from a central cooperative machinery center or purchased outright by the village. In Japan, the million or so small dryers have been purchased by individual farmers although they generally have a capacity greater than needed by one farmer. In most cases, informal contractual agreements are made with three or four neighboring farmers to dry their paddy rice.

In any case, the operation, care, and maintenance of the engine and fan for grain drying purposes requires a man trained for effective use of the equipment. In Japan, this man is the farmer himself. In developing Asian countries, it must generally be a specially trained operator. The trained dryer operator must also be knowledgeable about paddy rice drying. He must understand that rice shrinks in volume and loses weight when dried, that waste heat from the engine if properly utilized will warm outside air from 10 to 15° F and should dry the paddy rice from about 25 percent moisture to 14 percent in from one to two days. The drying time depends on the design of the dryer and the weather conditions. Grain can be dried more quickly during low humidity climatic conditions. Natural unheated air drying is possible in some parts of the world but unfortunately not in the hot, humid weather of tropical and subtropical countries.

Food Grain Storage

The basic function of any storage structure is to maintain the quality of grain at its original high level throughout the storage period. Quality maintenance of paddy rice and other food grains is particularly difficult in the Asian countries that have monsoon rainy seasons. As with grain drying, the critical storage problem is at the farm and village level. The farmers need a small bin to store a metric ton or so of rice for their own family consumption. Also the rice surplus-growing farmer needs storage at his farm or village cooperative storage structure. A good village storage unit will minimize losses from rodents, insects, molds, etc., and provide independence for favorable marketing. The village farmers would in many countries be able to receive up to twice as much for their rice by not being forced to sell at harvest when markets are glutted and prices depressed.

Storage bins must be water tight and essentially vapor tight to prevent the dry paddy rice from reabsorbing excess moisture from the humid air during the rainy seasons. The technology for good storage is well developed at present. The problem consists mainly of adapting indigenous materials to storage bin construction and designing a convenient sized structure for the farms and villages. Small mechanical aeration fans must be considered for the somewhat larger storage units of the primary village cooperatives.

The Critical Objective

Food grain storage, drying,handling and transportation for Asian countries is a matter of properly adapting and utilizing already available technology. The critical objective at this time is to minimize food grain losses in food short countries and in our food short world. Technological developments must be planned carefully in view of the social and economic conditions peculiar to each country.

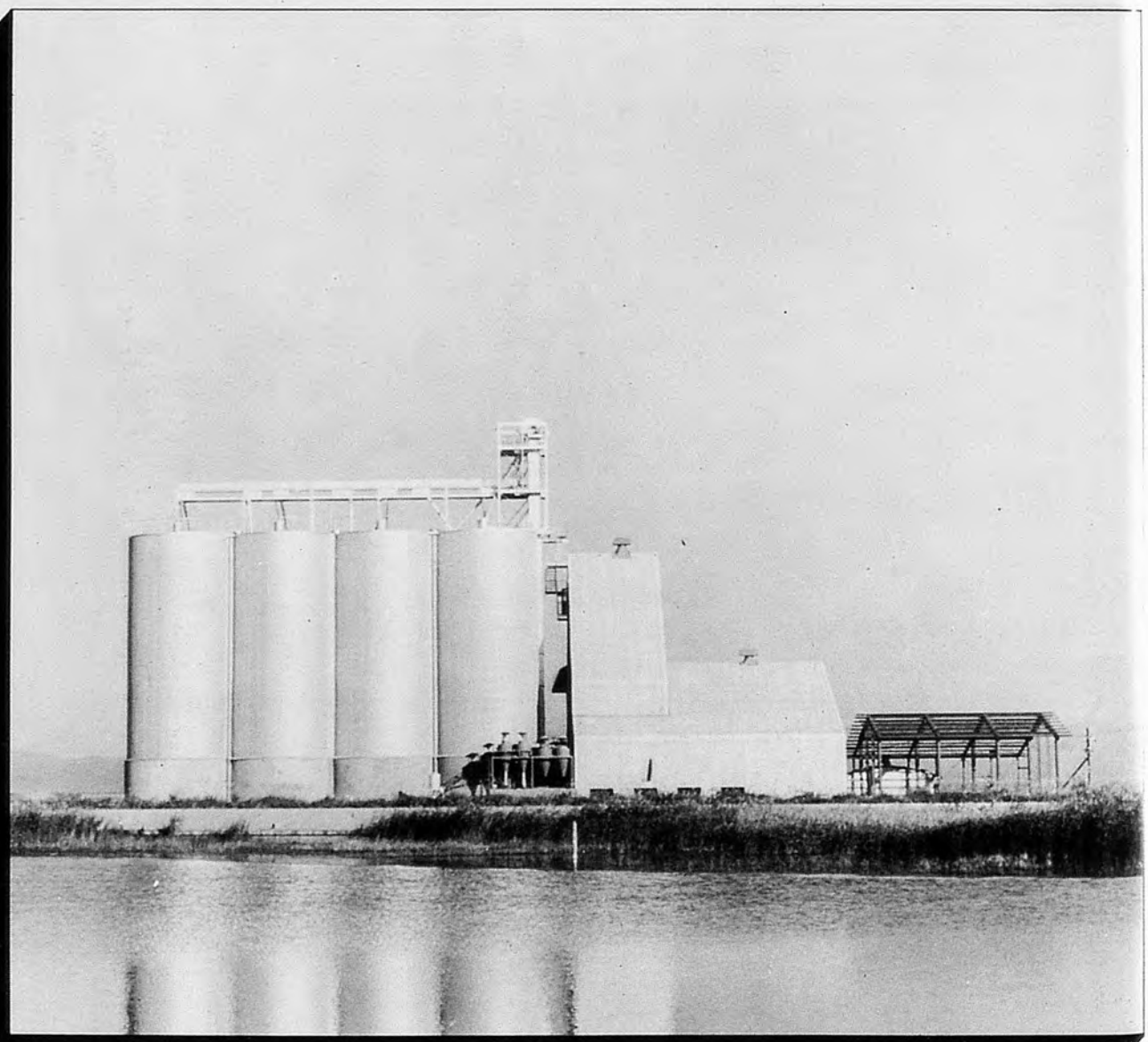
Mechanization must be introduced slowly and cautiously in labor surplus countries. Labor intensification mechanization should be developed and promoted initially. A mechanized operation should only be introduced as it becomes impossible to continue doing the operation in the old traditional way. Drying the increased yields of paddy rice during rainy season harvest periods is an example of this. Meaningful mechanization makes multi-cropping of new food grain varieties more feasible and thus, brings about increased labor utilization in growing the extra crops.

This article was originally published in *Program Quarterly No.57* of The Asia Foundation.

The road conditions are still bad. Transportation is the big problem.

SATAKE KNOWS RICE...YOU SHOULD KNOW SATAKE

The Satake Engineering Company of Japan has made a lifetime study of rice...every type of rice from every country. Therefore when you purchase Satake rice milling equipment (a single unit or a complete plant), you are buying machinery designed specifically for the variety of rice you are handling. But more, the research laboratories of this pioneer firm have designed and tested each step in the total milling process to do a better job. If you want a higher quality finished product and would like to earn a higher profit, you should know Satake, because Satake really knows rice. Satake machinery and complete mills in more than 70 countries will attest to this.



SATAKE ENGINEERING CO., LTD.
7-2, 4-chome, Soto-kanda, Chiyoda-ku, Tokyo, Japan

CABLE ADD.: SAHIKO TOKYO
TELEPHONE: 253-3111
TELEX: SAHIKO TOK 222-2133

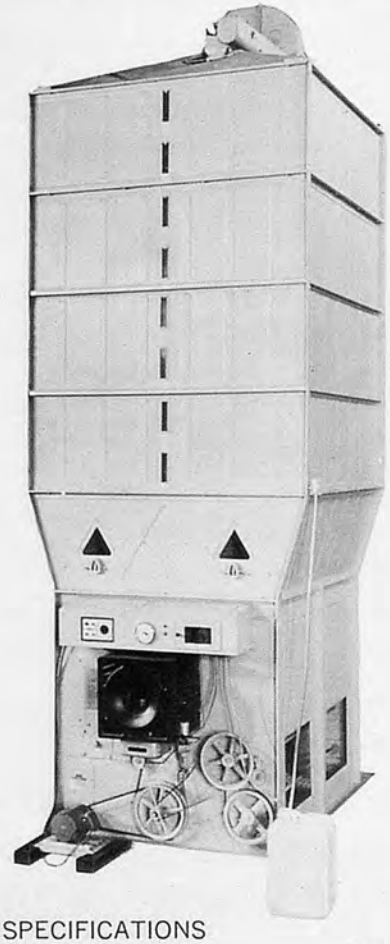
...AND YOU SHOULD KNOW ABOUT THESE TWO MACHINES

SATAKE SPEED DRYER

A thorough study of the drying process of paddy rice—what causes it to crack, the best temperatures, length of heating time, etc.—resulted in the Satake Type MDR-30 Speed Dryer. A short hot blast to dry the husk and then a gradual tempering to equalize the moisture in the kernel and husks, then repeating this process allows you to treat any wet raw paddy grain with perfect results. The MDR-30 is designed to handle large quantities at low operating cost. Can be driven by engine power where electricity is not available.

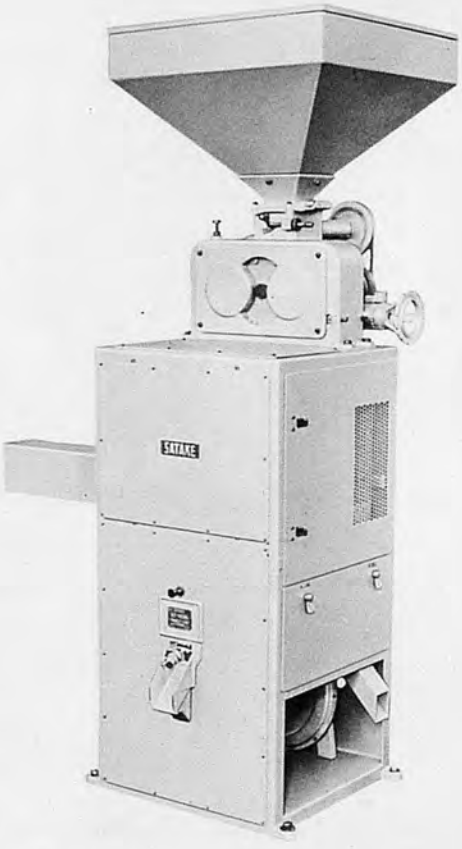
ONEPASS RICE PEARLER

Satake's Combine Onepass Rice Pearler SB-2B is the culmination of 70 years experience in rice milling. Gently is the best word for the action of this rice pearler. A rubber roll-type husker gently removes the husk without injuring the kernel and then gently polishes the husked rice to a gleaming, even whiteness. In the process, the husks and bran are separated and removed. All this in one complete cycle—from paddy to finished product with an hourly capacity of some 200kg. Economical to operate, the SB-2B requires very little space.



MDR-30 SPECIFICATIONS

1. Paddy holding capacity.....Approx. 3.0 tons
2. Drying speed 1.0%/hr
3. Drying capacity .....30kgs. of moisture/h
4. Dimensions .....L2.4 x W1.3 x H4.8m
5. Fuel consumption .....2.5~4l/h (kerosene)
6. Built-in motor .....2.2kW and 0.3kW



SB-2B SPECIFICATIONS

Type	Hourly Capacity on paddy		H.P. Required	Outside Dimensions					
				Length		Width		Height	
	kgs.	lbs.		mm	inch.	mm	inch.	mm	inch.
SB-2B	160~210	350~460	5	630	25	630	25	1,500	59

SATAKE ENGINEERING CO., LTD.

7-2, 4-chome, Soto-kanda, Chiyoda-ku, Tokyo, Japan

CABLE ADD.: SAHIKO TOKYO
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Message

The successful achievement of the Apollo 11 manned moon landing showed us another glimpse of ever-developing human ability. We human beings have been trying to see a new world in everything with unprecedent technology since the dawn of history. It may justly be said that the advancing speed of human ability has advanced from walking speed to the launching speed of a rocket. Rising curves of human progress and the lifted rocket have begun to be almost in one.

Pace of technical development should be faster than that of present various phenomena on earth. Therefore, "speed" will be a key factor to decide the growth of a company.

Change is imperative. Everything is changing day in day out, year in year out. A faster pace has insinuated itself into changes of the organization of manufacturing fields of agricultural machinery at home and abroad. Growing gap in scale and quality of the contemporary competitive companies has been accelerating its speed. To cope with the bright as well as the dark sides of varied changes, we at Toyosha Co., Ltd. have our own Guiding Principles of Management, which is our spiritual backbone of moral education. Along with the growth of our enterprise we have made ourselves of the fundamental philosophy and devoted ourselves fully up to developing high-valued products, which have made us a unique existence in the manufacturing circles of farm machinery.

Guiding Principle of Management

1. Believing in man's infinite power and courageously challenging the impossible.
2. Standing on highest ethics and polishing one's character through application to duty.
3. Seeking great goals, steadfastly strengthening company's organization, and making contributions to society.

Tatsuo Tanoue
President,
Toyosha Co., Ltd.

Milestones in the history of Toyosha Co., Ltd.

1863 Mr. Jubei Tanoue, the first president, devises an original plow and starts its manufacture.

1927 Occupies a market share of 60% of the total of domestic production of plows and harrows respectively.

1939 Sends plows to more than 10 countries via Mitsui&Co., Ltd.

1957 Embarks on the manufacturing of agricultural small tractors.

Product research or development, production system and distribution network in domestic market are almost organized. Makes the company's debut as maker of compact tractors.

1961 Starts a market research followed by sales in Southeast Asia.

1962 Hinomoto 4-wheeled tractor is the first to pass the government inspection, leading other makers.

1967 Sets up a new plant for engines, transmission.

Finds new outlets for products in Central and South Americas, increasing its market share in world markets.

1968 Model TE-140 gasoline engine is developed.

1969 Starts the production of Model MB-140(14hp).

Announces Model D-180 diesel tractor(18hp).

Exhibits Hinomoto products in Japanfair in the U. S.

Exhibits Hinomoto products in Tokyo International Trade Fair on the largest scale in the industry of agricultural machinery.

Sends groups of technitians for after-sales service and some members for a market reseach to overseas countries.

1970 Ranks top in the annual production of compact tractors in our country, enjoying 80—90% of exports of compact models.

Hinomoto products are exported to over forty countries.

Develops and commercializes Hinomoto Binder featuring the central-vertical releasing system. Its production volume stands at 20,000 units.

Exhibits products on the largest scale in the industry in Osaka International Fair "Inter-Engineering '70."

1971 Develops 20hp diesel engine Model TD-200 and new attachments (Backhoe, Snow Thrower, Mowers).

The items of patent obtained amounts to 1,000.

Rotary tilling, Philippines

Rotary tilling, Malaysia

Intercultivating a vineyard, Italy

Rotary tilling a hillside, America

What makes HINOMOTO different from the others.

1. Features of Hinomoto compact tractors

   Compact and heavy-duty :

   Through repeated overseas demonstrations and practical applications to each of local farming conditions it has been vividly proved that "Hinomoto" is not a light-duty compact tractor as seen elsewhere, which is scaled down from bigger models, but it is a self-perfect heavy-duty machine with varieties of originally developed attachments for smaller farming purposes, and applicable to various work to be done in gardens, orchards, nursery, farms of 5 to 6 acres and smaller plantations.

2. Integrated production system

   For complete performances' sake and good combinations of tractors and attachments, chassises, engines and attachments are all manufactured at Toyosha's own works with highly sophisticated technique. This "trinity" system enables us to make suitable products which answers the demands of every farmer the world over.

3. Simple operation

   No special technique nor special skill are required for driving a Hinomoto compact tractor. Unique Automatic Side Clutch mechanism offers the simplicity of operation. The MB−140 has only two pedals − clutch and brake pedals. When turning the steering wheel to turn the tractor this originally devised device automatically cuts off the engine power to the rear wheel on the same side of the turning direction of the machine. No obliging the driver to step on one of the brakes when turning the tractor.

4. Exceptionall rugged transmission

   The solid all-geared transmission offers 9 forword, 3 reverse and 8 pto speed, assuring 90% of the delivery of engine power to wheels and rotary attachments. The sealed all-gear drive transmission offers the right speed for every job required.

5. Availability of attachments

   Relationally developed attachments of HINOMOTO multiple the utility of HINOMOTO compact tractors. The value of a tractor depends upon the availability of attachments to be mounted on it. HINOMOTO is a all-purpose compact tractor with a wide variety of attachments.

6. We are ready to provide the most comprehensive service available today in the farm machinery market, and are ready to back up dealers or distributors organization in the field of before-and after-sales service with roving trained service engineers abrord.

7. "HINOMOTO" (Toyosha Co., Ltd.) offers the best products available. Toyosha Co., Ltd, with its 108 years of experiences in designing and manufacturing agricultural machinery, presents the best available under its capacity with a high respect to contributing to the betterment of the world agriculture.

HINOMOTO®

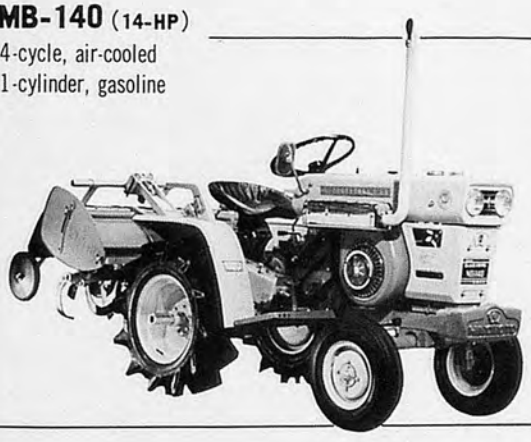
made Small, works Big

BACKHOE
(14-HP)

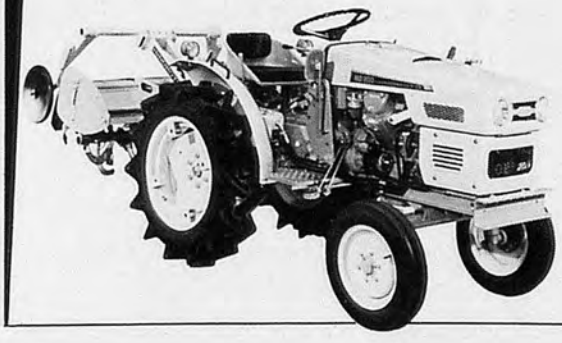
BINDER
(Rice Harvester)

MB-D (11-HP)
4-cycle, air-cooled
1-cylinder, diesel

MB-140 (14-HP)
4-cycle, air-cooled
1-cylinder, gasoline



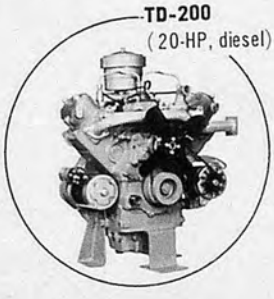
MD-200 (20-HP)
4-cycle, water-cooled
2-cylinder (V-shape), diesel



ENGINES

TE-141C
(15-HP, gasoline)

TD-200
(20-HP, diesel)



TOYOSHA CO., LTD.
55, Joshoji-16, Kadoma City, Osaka, 571 Japan

Whoever you are...
Wherever you live...
you can enjoy pleasant work with ISEKI

ISEKI has been contributing toward the technological development of farm machinery and equipment for over 40 years. So many Japanese people say: "ISEKI. Oh, I know it. It's a very well-known manufacturer of agricultural machinery."

Now, a great number of farmers in Southeast Asia, Near and Middle East, Europe and many other districts are using ISEKI's machines for the farming of paddy, field, orchard, dairy, etc. This is due to the fact, we believe, that ISEKI has been doing its utmost for the study of field conditions and other technical features in all these districts and it can manufacture good quality products suited to them.

You are welcome to contact ISEKI or its dealers. You will surely satisfy their excellent quality and high efficiency.

ISEKI AGRICULTURAL MACHINERY MFG. CO., LTD.
Overseas Division:
2-2, Nihonbashi-dori, Chuo-ku, Tokyo, Japan.

ISEKI

ISEKI brings more efficiency to your farms.

New ISEKI Power Tiller Models KE900 and KE1100 on the market

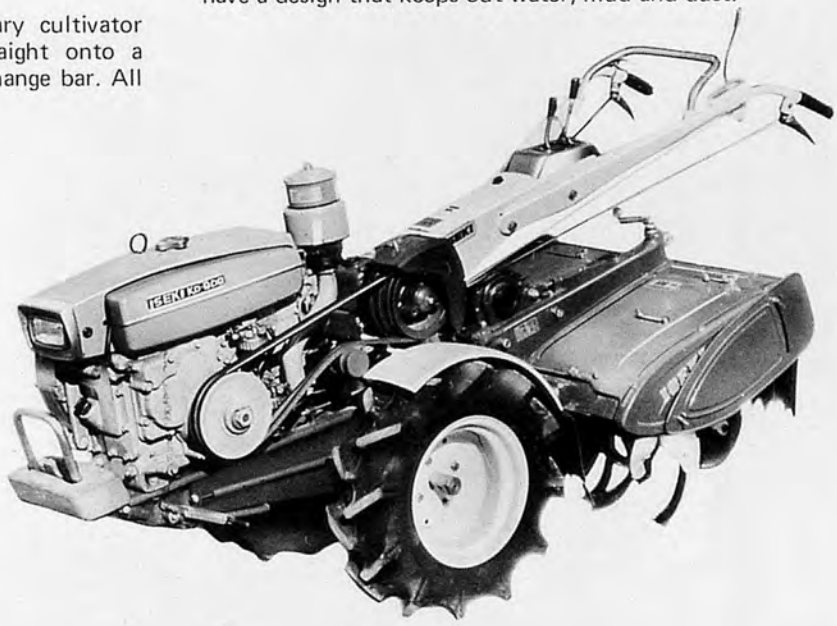
They keep making light work of heavy jobs. Ideal for tilling in grassy, overgrown or excessively wet fields, especially near levees.

Powerful working efficiency — You get four speed transmission for any tilling application and a big 82cm tilling width.

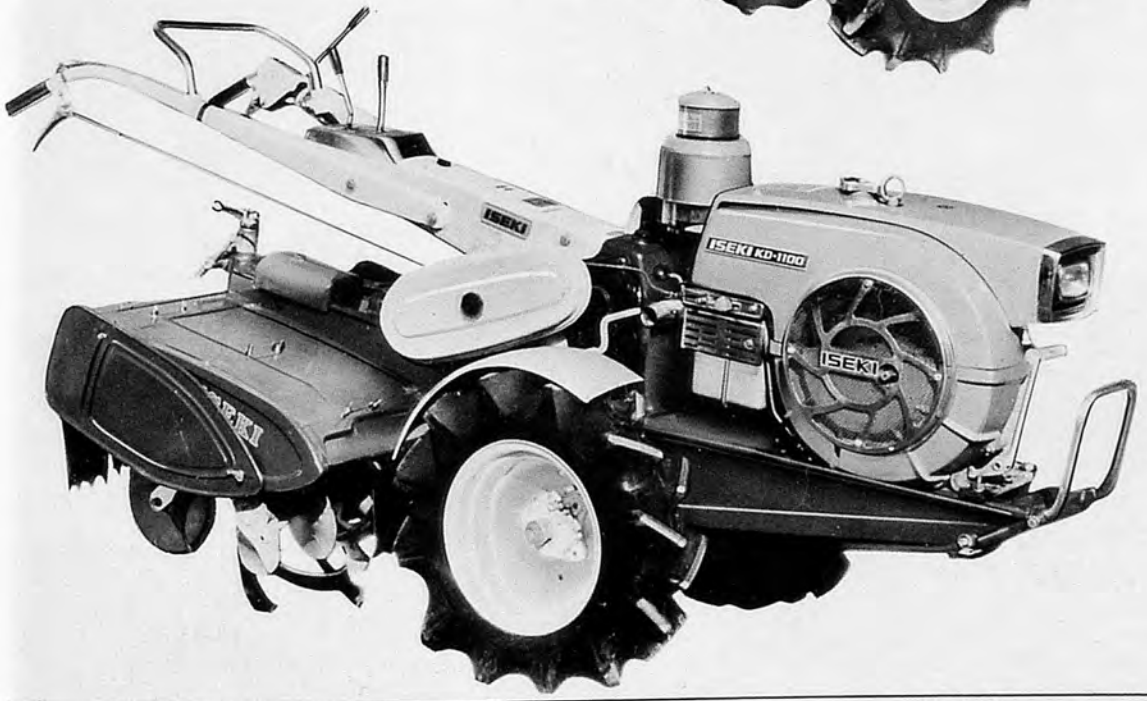
Easy to handle and maintain — The rotary cultivator simply hooks on; the wheels mount straight onto a pin-type boss and have a quick-change exchange bar. All control levers sit right by your hand.

Greater maneuverability — A rod type steering clutch makes work sure and smooth and for your safety these machines are equipped with a device that stops blade rotation when the tiller moves in reverse.

Super-efficient engines — The engines on these superior tillers have dynamic balancers to cut out vibration and have a design that keeps out water, mud and dust.



Model KE900



Model KE1100

Specifications		KE900	KE1100
Dimensions (mm) (L x W x H)	:	2330 x 840 x 1290	2330 x 840 x 1290
Weight (kg)	:	339	376
Engine	:	9 hp 4 cycle air-cooled diesel	11hp 4 cycle air-cooled diesel
Tilling width (mm)	:	600, 820 (Clean rotor type)	600, 820 (Clean rotor type)

Easy adaptability to climate and smart appearance for pleasant operation. This is ISEKI's machines.

Each of ISEKI products undergoes thorough inspection, durability and performance tests, and exacting quality control. Further, ISEKI is proud of the establishment of its integrated system of paddy farming, i.e. planting through harvesting. Its operation follows briefly:

Tilling and puddling	:	By tiller and 4-wheel tractor
Planting	:	By rice planter
Harvesting	:	By combine harvester or reaper binder
Preservation	:	By automatic thresher, automatic rice huller, grain dryer and huller/polisher

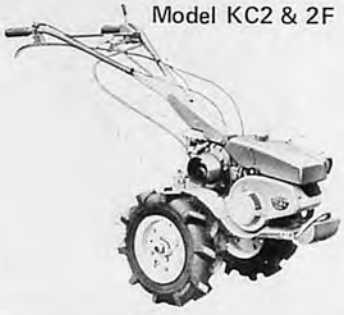
Surely, you can choose any of the machines with your request.

ISEKI Power Tillers

Model AC1

Model KS280

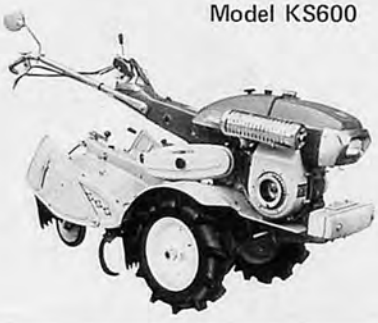
Model KC2 & 2F



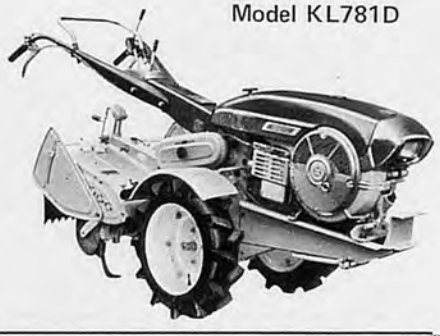
Model KC4 & 4F

Model KT500

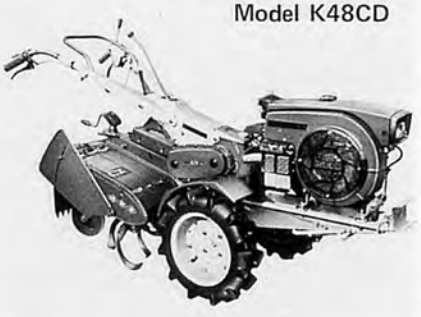
Model KS600



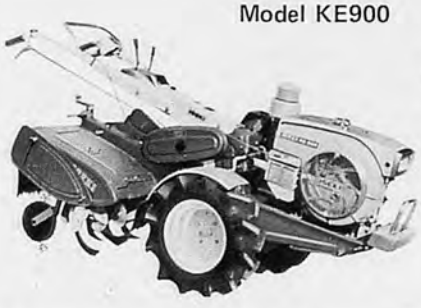
Model KL781D



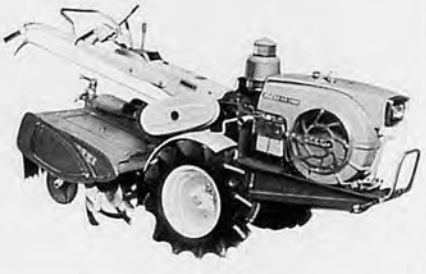
Model K48CD



Model KE900



Model KE1100



ISEKI 4-Wheel Tractors

ISEKI

ISEKI machines work best on your farms.

Model TM1200

Model TB1400

Model TB1700

Model TS2400

ISEKI Combine Harvesters

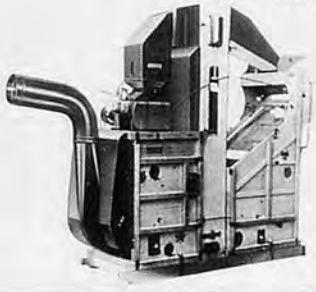
(Small type)

Riding type & walking type

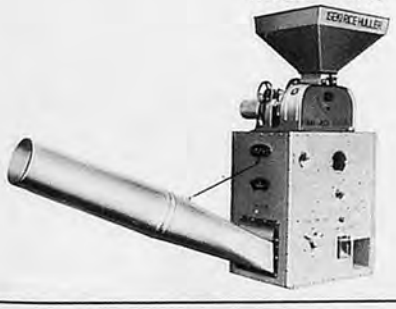
ISEKI Automatic Threshers & Hullers

Model D2L

Model M50CA

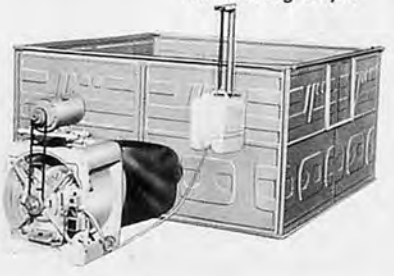


Model HC6B



Others

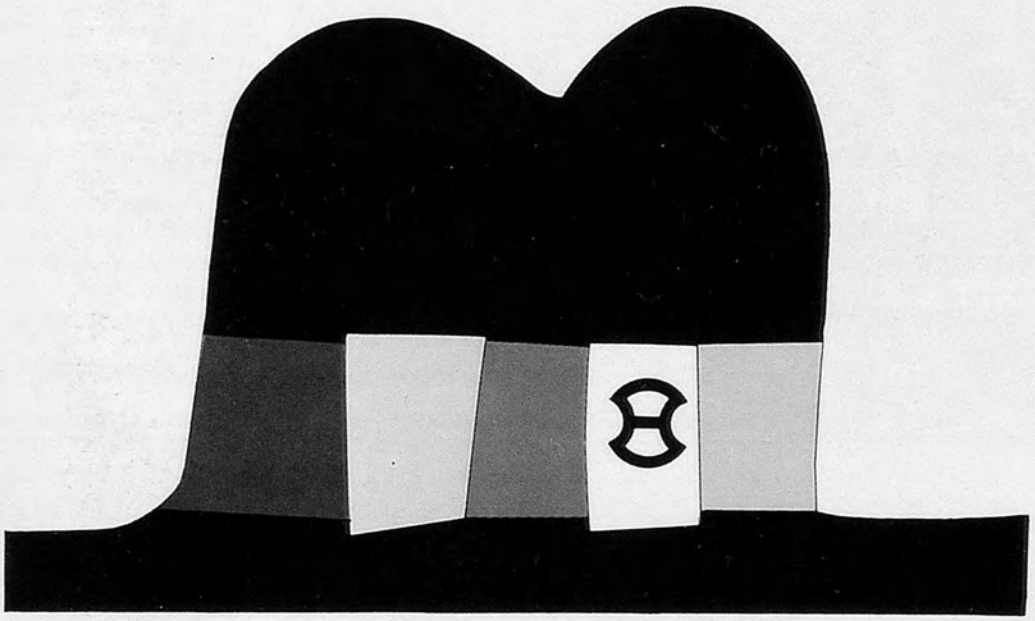
Ventilating Dryer



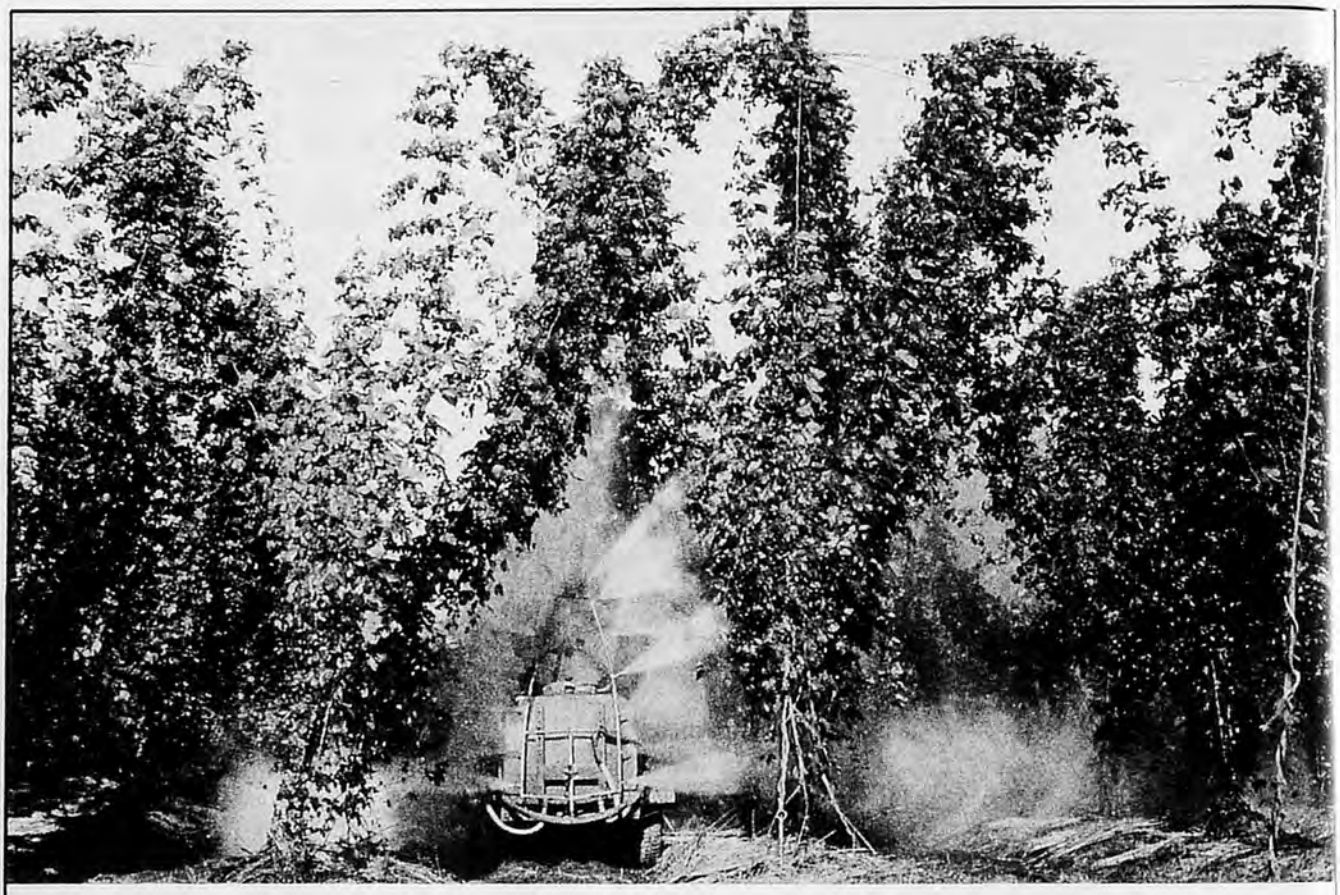
Rice Milling Unit

Rice Planter

Automatic Reaper Binder
RS250 & RS500



WHAT KIND OF MEN IS NICHIMEN?



Do you know what's going on there?

Yes, we are spraying hop trees in cooler area of the earth in order to help brewers get better quality hop to add their beer with more attractive and fascinating taste.

This is just a part of our job to protect plants from various insects and disease.

Thus not only in the tropical area where more spraying job is required, but also even in those cooler area our spraying equipment is at work all through the season.

Wide range of our sprayers will meet various requirement of spraying job, for larger area powerful coverage, for a piece of land handy spraying, for severer environment spraying job, and even for 20 meters (66 feet) high vertical Spraying.

Dial our local distributors for further information.

HATSUTA INDUSTRIAL CO., LTD.

59, 1－chome, chibunehigashi, Nishiyodogawaku, Osaka, Japan

CHAPTER II

PRESENT SITUATION AND FUTURE PROSPECTS OF AGRICULTURAL MECHANIZATION IN SOUTH EAST ASIA

AGRICULTURAL MECHANIZATION IN CAMBODIA AND ITS PROBLEMS

Te Sun Hoa

In Cambodia the first studies relating to the mechanization of agriculture go back to 1948. At that time of Protectorate, the French engineers planted a Research Center in the province of Battambang in the northwest of the country where they found great possibilities of arable land. The density of population was low comparatively with the other cultivated regions and many new exploitations were created with the capitals generally coming from another sources.

Unfortunately this Center could not function for a long time. It was abandoned, then reconverted to other activities. Nowadays, its name of Mechanized Agricultural Exploitations in Battambang (M. A. E. B.) is still conserved and remains for the inhabitants of that region as an organization for the agricultural development in the province. As to the grand plain of Battambang, it is considered even now as showing the best conditions of the agricultural mechanization.

Nevertheless in its majority, the Cambodian plain gives rather some characteristics in very small propriety owned by each farmer, the rent of farm and the share-cropping are practically exceptional cases.

In this regard, the Census of the population in 1962 allowed to pick up the following.

Total population ·····5,740,000
Agricultural population ·····4,391,000
Total family number ·····1,092,000
Agricultural family number ·····840,000
Average of holdings ·····3.5 ha
(2.5ha is paddy-field)

Classification of lands:

Category of holdings	Average of country
under 1 ha	30.70%
from 1 to 2 ha	22.30%
from 2 to 5 ha	32.60%
from 5 to 10 ha	10.40%
from 10 to 20 ha	3.40%
above 20 ha	0.60%

Main data in this Census are still valuable at the beginning of 1971, although the conditions have been improved by now.

Agricultural laborers are rather plenty in Cambodia. A family of five persons is considered to cultivate 3.5 ha of land with four members in it.

As to the principal means for farming, a family uses in general·····

a pair of animals--generally of oxen,
a plough,
a harrow,
a cart and
a certain number of other hand tools.

SITUATION OF AGRICULTURE FACING MECHANIZATION

If we confine ourselves to the only technical aspects, the agricultural mechanization in Cambodia is suffered at first with a big handicap, that is the lack of water management.

As a matter of fact, in total cultivated land of 2,898 million hectares in 1968–70, the irrigated land represents only 70,600 ha that is less than 2.5%

Naturally we could add also the well known disadvantages of very small holdings per farm. The size would be besides too small for the good mehcanization. But nowadays the latest point doesn't constitute no more a great obstacle. The industry of agricultural machinery has evolved so much that it succeeds in submitting in the least demands of land and that the problem has become more economical than technical at the stage of this argument.

Now let's examine the situation of the agricultural land utilization. In 1969–70 we picked up the following situation.

Total of cultivated land: 2,898
(thousand ha)

Rice ·····2,458 (85%)
Maize(Corn) ·····106
Hevea ·····70
Tobacco ·····25
Coconut palm ·····13
Jute ·····14
Others·····212

Except a few privileged cases, it is generally a question of one harvesting a year.

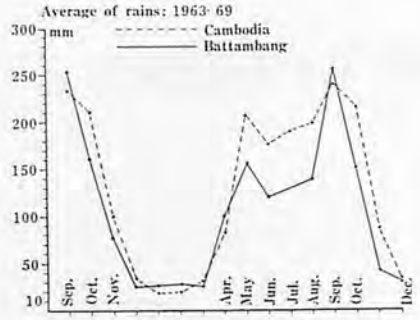
We know that the Cambodian agriculture is distinctly dominated by rice. Whether in good year or bad year it covers about 85% of the cultivated land. We dare say that the mechanization in Cambodia will at first go through the rice-growing.

Irrigation of dry season ricefields in Prey-Véng

GENERAL CHARACTERISTICS OF RICE-GROWING FACING THE MECHANIZATION

The utilized varieties are the Indica type. In most of cases it is the question of rice with long vegetative cycle that is more than 200 days. Straws are long and generally susceptible to laying.

At the beginning of each season the drawing work by animal begins after the first rain about May and June, when the earth is humid enough. Already at this first stage, the introduction of machine is revealed difficult for each of the water management. Indeed the administration of rains is required so that in this time of year the rains prevent rapidly the operation with tractor to make the land too wet. Then, in the province of Battambang in paticular where we can admit that the lands, beyond 5 hectares, must be cultivated with tractors because of lack of animals and the previous harvesting finishes so late, about at the end of February or at the beginning of March. The period



of time available for the work with tractor is therefore short. It explains that the 500 tractors or so in the province must be operated in the dry conditions, for March and April are really the last months of the dry season.

Meanwhile, everywhere else, the work after the traditional manner becomes more and more busy in proportion as the rainy season advances.

About 30% of paddy fields are broadcasted directly, the majority of which is in Battambang with more than 90,000 ha. Generally it is the question in the case of the floating rice covering the low zones along the side of Grand Lake. The sowing must be carried out very soon in the end of April or in the beginning of May after a brief repose of one month more, what permits the plant to fit the long period of the flood of that place. This method of sowing by hand, requires 2 man-days(1) on an average and uses one sack of 75 kg-paddy per 1 ha as seed.

But generally (70%) the transplanting method is the usual practice with the average of 17 man-days and of 50 kg seed. Afterwards the maintenance is limited to the repair of dikes in order to keep better the water. Contingently we initiate the subsidiary irrigations with hand-tools, when the water reservoir is available. The transplanting being done at random, all the work of weeding, of manure scattering and, if it happens, of anti-parasitic protection, are carried out completely by hand.

When the harvesting time comes finally, a great problem arises again every year for the exploitations of any importance. The employment of varieties with disposing cycle being not spread, especially because of the lack of the water management, all the paddy field comes to maturity almost in the same time.

According to the recent research at Tuol Samrong Agricultural Technical Center-- established in 1962 in Battambang-- the local varieties with the yield of 2 tons per hectare requires 12 man-days for the harvesting by a sickle. If we count also the transport, the threshing (done by tread of tractor), the winnowing and the bagging, the average of total labor amounts to 35.4 man-day and 0.8 tractor-day.

The same research showed that on the technical side the work of a combine-harvester is nevertheless possible for the local varieties if the ground is arranged previously to be dry. However the yield with the machine work and the losses are much better in the case of Japonica varieties with short and erect straw.

The mechanization of rice-growing especially in the harvesting work is, consequently tied up mainly with the amerioration works of varieties, which would constitute the second big obstacle against the using of machine after the water management.

If now, we examine the mechanization from the economical angle, the current situation would appear rather logical.

Let's take notice at first that the income of each inhabitant is estimated in 1966 as 4,169 riels(2) that, at the official rate is equivalent to 119 US dollars, while the income of a farmer was only 2,594 riels that is about 62%. While the salary per a day of common laborer is admitted to 30 riels although the tariff is normally less in the country.

As to the traditional rice-growing we picked up from Agricultural Department the following averages in 1968:

Rice production cost per hectare in riels

In the case of transplanting:

Cost of capital and material	1,436
Number of man-days	70
Cost of labor	2,182./3,618
Yield in paddy	kg/ha 1,630

In the case of direct seeding:

Cost of capital and material	1,043
Number of man-days	46
Cost of labor	1,663/2,706
Yield in paddy	kg/ha 1,400

Thus the rice-growing in Cambodia uses much labor which costs represents in the two cases, about 60% of the production cost of the paddy.

Now, if we want to examine the operations of harvesting, the research of Tuol Samrong Agricultural Technical Center mentioned the following costs.

Varieties (Yield kg/ha)	Cost of harvesting and of threshing in riels per ton	
	Traditional local method	Combine-harvester(3)
Nèang Menh Tuon 3,200 (local Var.)	893	974
IR5(4,600)	—	678

According to these figures we understand that the harvesting by machine is more expensive than by traditional method though the difference of about 9% is not so big. Besides the quality of work by machine is only satisfied on the field well arranged. But this unitary cost falls down rapidly when we deal with the variety IR5 known by its short and erect straw and its high yield.

The same research points out that the difference of cost among these two harvesting style was really much more important in the recent past, for the manual work was cheaper and that if this tendency would last, the employment of machine would be indispensable in the near future and even in the immediate with a year of abundant harvesting like the case in 1970-71.

In any case the present situation is revealed as a direct consequence of large percentage of the rural population. The labor is still abundant and relatively cheap. It accommodates itself readily to the agricultural debouchments which are unfortunately seasonal. But it may wait patiently the appeal which must be accomplished when the industrial sector will be especially developed.

As to the commercial phase nevertheless it remains still that such production will be able to exist only by the subsidy in order to be competitive on the international market.

Then, it becomes logic that on the level of family exploitations, the investments in expensive materials aren't justified, especially seeing that relative abundance of the local labor. But the mechanization had to be started with imported materials. Except some handy tools the prices of these materials pass beyond the capacity of the middle families' investment, in spite of the governmental encouragements that are the remission of tax for the importation, the establishment of a National Society for Assembling Tractors (SONATRAC) as well as the founding of credit system.

In 1961 we lifted the following park in whole country :

Agricultural tractors.....1,158
Motor-cultivator..... 751
Motor-pump.....1,292

The majority of tractors is utilized in three provinces : Battambang, Kompong-Thom and Pursat. In these regions utilization of these machinery is done in a little particular manner.

In a year, a tractor is used on the field for a quarter of it (practically from April to June), when the works are limited to the preparations of land. For the rest of time, it is utilized only in transport. The people of the region speak rather of the removal of products for which the tractor reveals itself as the most appropriate machine facing to the nature of access way. Besides it serves as complement of trucks in the peak period offering a great advantage for the latter. It avoids indeed the

rupture of load at the approaches of routes between the threshing field and the Ricemill Centers.

So the work in the transport becomes finally preponderant so much that in a certain moment--about in 1965-- a brand from East-Europe was coming into the local market especially owing to its high speed on road.

In all the cases it is by this way that the tractor has known a certain success in these provinces where here and there this machine has driven out somewhat the traditional harnessings, bringing a new mode in rural life which differs from the rest of the country. As a matter of fact we ascertain that since the introduction of first tractors about 1955, the power of new machines never stops raising up to attain during last 5 years about 50 Hp. It is the type of power that composes the majority of annual sale of SONATRAC since its foundation in 1966.

As a matter of fact in the first days they generally depended on the dimension of their own lands to make a decision, and with the neighbors' encouragements they bought about 30 Hp tractors. But rapidly the system of "Service Renting" has been set up and owing to its abilities in transportation over all-grounds, the tractor manages to function all year. From that moment the idea of "Service Under-taking" takes precedence of that of the "Owner with tools", and then we pay attention to the great capacities of work-- in tillage and particularly in transport-- in other words to the great powers, whatever his own land may be.

Really they take part in an indirect form of the collective utilization of materials, at least for the tractors. It is now in the usual practice.

In 1969 they payed to the contractors in Battambang between 350 and 400 riels per one hectare plowed according to the circumstances, while the unhulled rice was sold handly for 3 riels per one kg. A research executed by Agricultural Department about the same time has permitted to pick up the following expenses:

The case of a diesel tractor of 50 horsepower that works only for the preparation of ground at the rate of 1,700 hours a year and an average of 6 hectares a day (Battambang).

Fixed cost	17.60 riels
Proportional cost	79.00 –
Horary cost of utilization	96.00 –
Price cost per hectare of tillage	128.80 –

Thus the practiced tariff represents more than 3 times of the price cost, from which comes the result of the investment that is very rapidly paid off. That explains at the same time the rapid development as the demand, in spite of the reticence of certain technical enviroments and the foundation of the SONATRAC can be considered in some degree as the result from it.

Paddy transporting in Battambang

However the rural owners of tractors are not much served by an adequate after-service and the foundation of the National Society doesn't appear to improve the situation for all that. One of the reasons of it would be the feebleness of market which may form probably the third handicap of the mechanization in Cambodia. The effectiveness of machines in each concerned province, though notable already, might rest within the minimum fixed by the Commercial Direction of makers to lay claim to the facilities for any service. There are non-specialized shops that undertake generally spare parts. While, for the repair-works the owners often leave them for their drivers unless the breakdown requires the special equipment, in that case they have to bring the damaged part to the chief town of province or to the capital itself.

Naturally the drivers are recruited a little in the mass, often owing to the recommendations of friends or of neighbours. Those who have an proper technical diploma are rare. If they are less initiate, we send them to the Agent of Manufacturer for the practice of several days generally at the moment of the delivery of machines.

The problem of qualification for laborers is not peculiar only to the agricultural mechanization. As we looked everywhere else, it is tightly tied up with a lot of other factors among which the questions of agricultural price and of the formation of the professionals would be most urgent. In the meantime, the lack of qualified persons constitutes the fourth hadicap for the agricultural mechanization. Therefore, in the current conditions, they pay little attention on the prescription for general maintenance of machines and much less on the adjustment of tools according to the ground conditions. Evidently the machine as well as the yield are suffered from that.

Let's note finally that as to the energy, there is not an "agricultural price" for the oil products as it is practiced in some European countries for example. For this machines, the farmer pays 5 riels for the diesel oil per liter just like as the taxi drivers in town pay.

Thus in the 96.60 riels of the cost for tractor horary use culculated previously, the cost of diesel fuel and oil represents more than 53 riels.

As a matter of fact, the marketing of oil products is subdued to the price zones system, because the tariffing is made according to their geographical situation with respect to the Port Kompong Som where is the Oil-refinery. For example, one liter of diesel oil is worth 5.30 riels in Battambang in comparison with 5 riels[4] in Phnom-Penh.

The distribution of electricity follows nearly the same proceeding. One Kwh is worth on an average 5 riels in province to 3 riels in the capital. In any cases the country is not yet electrified.

After the tractors, the pumps can be considered as the second type of utilized material in Cambodian agriculture especially in the rice and fruit cultures.

As for the rice the zones of use of pumps differ nevertheless from that of tractors. We find them above all in dry season for the rice-growing in the Center and South provinces where about 100,000 ha are sowed each year. There, properly speaking, it is not the question for the second harvesting of the year, because of the culture zones are not the same. Generally they are the pieces of land gained from the forest flooded along the side of principal lakes.

The practice of this culture is dependent on a more elaborated technic. On the one hand they are zones with the high density of population in comparison with the average of the country. On the other hand the cultivation itself intervenes in the season which we could generally call "wintering" of the agriculture. So the cares are more generous while the irrigation assumes a particular importance. In the general case we are able to say that this cultivation in dry season become itself the function of the possibilities in water that we store up in a multitude of small reserves at the season of subsidence. From that, the water is drawn

in proportion as the need with the traditional lifting apparatus like the ladles, inclined chain-pumps, etc.... But now more and more appear the motor-pumps. Generally they are the small units for individual usage, permitting the seasonal displacement. The motors are the diesel type with about 7 to 8 horse-powers.

It is yet important to note that the utilization of these machines are not develpoed in the same manner wherever this cultivation is practiced. As for it, the province of Prey-Veng in the South of the country seems to be most advanced. On the zone of about 14,000 ha of dry season-rice, we count about 165 motorpumps by the side of traditional tools. When in the province of Kandal further in the north, on the area of about 5,500 ha, we don't count more than 14 in 1970. Its reason could be that the development of this utilization is relatively more important when there is a possiblity to extend the period of the functioning in the year, and that at Prey-Veng, except the dry season-rice, the motorpump serves also in other activities.

But the employment of motorpumps is more popular in the more intensive cultivations, such as the orange-trees in the central part of the province of Battambang. There, on the area of about 2,860 ha of citrus fruit we count 123 motorpumps in 1969. As a matter of fact during the dry season, the irrigation for orange-trees is indispensable and entirely executed by pumping, They are however the units which are almost similar characteristics to those of the rice-cropping zones but here the installation is generally done at the fixed position.

Finally the power tiller would constitute, by majority the third type of agricultural material which is worth noted.

During the period 1960-65, owing to the efforts of the importers, this type of machine has known a successful moment in the regions of the alluvium lands along the banks of Tonlé Sap, especially in the center provinces (Kompong Chhnang and Siemreap). There it is the question of the zones of dry cultivations which is practiced from November to March on the lands which is uncovered after a flooded period during three or four months.

In 1966-69 we noted the effectives about 570 units of power-tillers in use. From that time the number has very little developed. Its essential reason would be that the majority is equipped with a two cycles gasoline engine. Now afrer 1964 the price of this fuel has incerased directly from 6 to 12 riels per liter.(5)

As a matter of fact in the zones along the banks where the lands are small dimensions, this machine seems to give a good results. They are machines from 3 to 5 horse-powers and delivered with a certain number of attechments that are very appreciated by farmers of the region.

CONCLUSION

We know that in a free economy a certain balance is necessary between the agriculture and the industry. Some countries don't hesitate to make a wide use of the formula :

> "The agriculture supports the industry and the industry develops the agriculture."

If we think still more that the vast projects of water control are already considered, and that some of it are even on the way to realization, it becomes evident that it isn't the potential of natural factor which prevent. The development of the Cambodian agriculture and that of its mechanization.

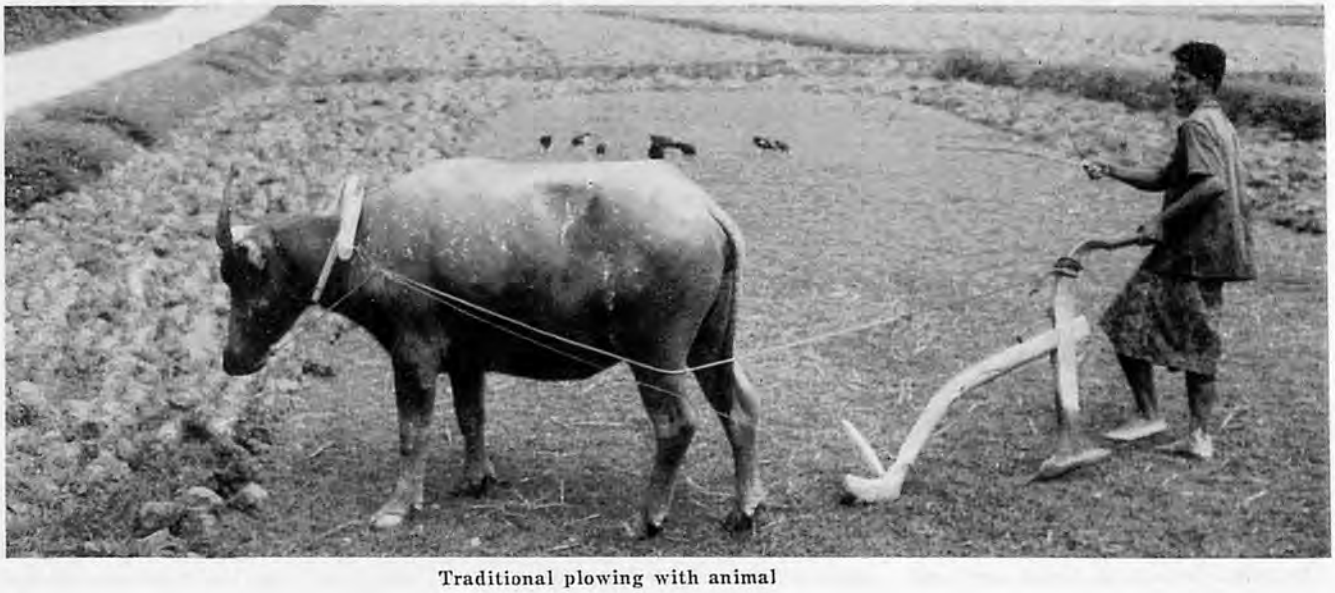
Meanwhile it appears very clear that, whatever the route may be, this development to be effective will pass necessarily through the successive phases of change, leading finally to a qualified agriculture for industrial and for market, in which the mechanization will play inevitably a part of foreground. In order to attain this objective a harmonious development of the industry tied up with the agriculture is pressing to realize in a first stage the indispensable balance for an economy of a deeply agricultural type.

At the country level the chain of the developmemt will require as the first link the rupture of the cycle of rice-monoculturs, while the link in view will remain the phase most elaborated that is the production of animal proteins, which enters now more and more in the nutritional needs for modern people.

Finally this change will not be able to be accomplished without an evolution in the country society. Whether they are called syndicates of producers as in France, or Associations of farmers in Formosa, or even Kolkhoz somewhere else, the groupings of Cambodian farmers will constitute necessarily the decisive stage of the agricultural development in this country.

notes

(1) One day's work is 8 hours.
(2) in economical counts in 1966
1 US dollar=35 riels in 1966
=55 riels since 1970.
(3) 2.30m of cutting bar
(4) 1 US dollar=55 riels at official rate
(5) This price is increased to 13 riels after some time, and rest unchanged up to now.



Traditional plowing with animal

CEYLON—Mechanization of Agriculture,

The Present Position and Future Development

V. E. A. Wikramanayake

Agriculture in Ceylon

Agriculture in Ceylon, in the pre-World War II period, was confined to the three main commodities of tea, rubber and coconut, together with scattered areas of cacao and spices. The three main crops were grown, as they still are, on large estates under a highly organized labor management system. These estates are owned by joint-stock companies and managed by "agency houses" that provide all the technical and managerial services. Mechanization is not applied to production of the crop but, if at all, only to its processing. Other aspects of agriculture were largely confined to peasant small holdings of rice, and shifting cultivation of other food crops like millets and condiments. Ceylon imported practically all of her food requirements. World War II, and the consequent limitations on imports, initiated the first campaigns for food production and brought home to the people the importance of food agriculture. Agricultural development has progressed steadily ever since.

World War II not only created a new awakening in agriculture, but also helped to prop up the tottering colonization schemes that had been initiated very much earlier. These colonization schemes were started in the "dry zone" where in ancient times, a planned succession of small and large reservoirs or tanks conserved water all the way down to the sea from the central hills, and provided irrigation for rice growing. The ruined tanks which formed the basis of the ancient "granary of the East," have been steadily repaired and renovated, and have made possible the alienation of land for food production and for the settlement of the landless multitude. Much of the available land resources are still undeveloped, and with the harnessing of the immense water resources available, can probably be made to produce all the food requirements of the country.

Agricultural development in Ceylon is mainly confined to the "dry zone" areas (the "wet zone" and central hills being the plantation land of tea and rubber with coconut occupying the coastal regions). Development has been based hitherto on extensive land alienation, and irrigation projects have been designed, not for the maximum intensity of cultivation, but with the intention of providing one rice crop per year on the largest number of standard-sized holdings. Pressure of population, the increasing demand for food and the scarcity of foreign exchange, are factors that will increasingly influence patterns of agricultural development and the criteria for irrigation project design. The emphasis is also changing from rice culture to the inclusion of other food crops and to systems of mixed farming.

Mechanization of Agriculture

The beginnings of mechanization of agriculture can be traced to the end of World War II when a fair number of four-wheel tractors left by the military authorities became available to government farms and seed producing stations. Subsequently government gradually equipped its own farms with four-wheel tractors and tyned cultivators to accelerate rice production on these farms. The village entrepreneur soon found a sound investment for his money and a system of four-wheel tractors, owned by contractors who did custom tillage and haulage for farmers, came into being. It did not take long for these tractors to replace the animals for threshing as well -- the replacement being exact, i. e., the crop is threshed by running the tractor over a heap of cut paddy on the threshing floor!

The growth of this system of "contract" operation of tractors, without the incentive of government subsidies or even official suggestion, gives the clue to the type of mechanization organization that is needed. Timeliness of operations is generally not critical. For rice cultivation there are generally 40 days during which tillage can be done each season without detrimental effects on crop yields. The planting of crops can therefore be staggered over the period of a month or more. These are ideal conditions for custom work and the ownership of tractors by individual farmers to ensure timeliness of tillage is rendered unnecessary.

The popular demand for tractors-on-hire has also forced the government to operate an increasing number of tractor pools; but as can be expected, these have not been financial successes by any means for reasons that are too well known in the light of similar undertakings in other parts of the world. Ownership of equipment by cooperatives has also not proved satisfactory, mainly due to lack of responsibility in maintenance and the difficulty of deciding priorities between farmers for machines of limited availability.

From the technical point of view, however, mechanization has, in the main, stagnated over the last two decades. A tractor owner would possess, besides a trailer, only a tyned cultivator. This implement is a sort of universal tillage tool, and, as can be expected, the standard of tillage leaves much to be desired, particularly since the custom charges do not specify quality of tillage. Broadly speaking, tractors have literally replaced animals in the traditional agriculture pattern, and up to three years ago, no concerted effort was organised to improve the application of power for farming. In 1967 the Ministry of Agriculture gave serious thought to this problem and in 1968 started the Farm Machinery Research Unit at Maha Illuppallama, as a centre for research, testing, design and training in farm mechanization. The development of this unit has now provided the country with the basic organization for research, development and extension in farm mechanization, in addition to being a competent authority on whom the government can rely for

advice on important policy for agricultural machines.

Mechanization Development

In Ceylon, as in many developing countries, the need for mechanization arises, not so much from a shortage of labor, as from the need to increase production by performing better tillage and other cultural practices, and thereby making the best use of other technological advances in crop production, such as improved varieties, fertilizers, and agrochemicals. Ceylon in particular is woefully short of draught animals. The available animals are small and untrained, and any programme of breeding or importation and training for field work is far too long-drawn out and expensive to make it worthwhile. Moreover, it is justifiably felt by many agricultural engineers that improvements in animal-powered implements provide but marginal benefit and are not worth the time and resources spent on such development.

The need, in all developing countries, is to increase the standard of technology and, at the same time, make full use of the available resources, the most universal and plentiful of which being labor. Mechanization of agriculture, as is practiced in most affluent countries, cannot be transplanted to the developing countries where unemployment and under-employment in rural areas is the rule. The problem must therefore be approached from the standpoint of an intermediate technology, where a new technology is made possible without the displacement of any part of the available labor force. In terms of agricultural mechanization, this means using machines of small capacity, so that a large number of machines can be operated by the same number of operators that would be needed if animals were continued to be used.

The two-wheel power tiller has proved to be the suitable machine for this purpose in Ceylon for many reasons, chiefly that they can be utilized to the maximum under the prevailing conditions of small holdings. The main objection to the use of small power tillers has been on the grounds of their being uneconomic as compared with the standard four-wheel tractors. A sample of data given below, taken from the test reports of the Farm Machinery Research Unit at Maha Iliuppallama, provides the factual position:

Table 1.

	6-hp power tiller	40-hp standard tractor
Operation	wet tillage of rice field	wet tillage of rice field
Implement used	rotary tiller	rotary tiller
Depth worked	4. 2 inches	4. 1 inches
Soil inverstion	99%	92%
Overall rate of working	0. 2 acres/hr	0. 94 acres/hr
Time lost in turning	5%	8. 3%
Fuel consumption	0. 4 gals./hr	1. 8 gals./hr
Overall cost of operation per acre	Rs 20/-	Rs 45/-

The above data is typical of the numerous tests that have been performed over the past two years for a variety of farm operations. The two-wheel power tiller is also quite versatile and can be readily adapted to operate systems of relay or multiple cropping that are being introduced.

The Organization of Mechanization

In a country like Ceylon, and in the context of existing conditions, it is very necessary that a policy of mechanization be not only outlined, but that the organization be created and maintained. If free development is allowed, it is quite apparent that the conditions prevailing hitherto remain unchanged except perhaps for an increase in magnitude. The standard four-wheel tractor is to be regarded as a speculation. Ownership is confined to village "madalalis" or business men who, in many instances, run their custom service as a corollary to the money-lending and paddy purchasing business. The result is an additional source of exploitation of the farmer.

The position has been fully realized by the government, and the Foreign Exchange Entitlement Certificate Scheme (FEECS—whereby a tax is imposed on certain imports involving foreign exchange) is being applied to four-wheel tractors while two-wheel power tillers are importable without FEECS. This decision coupled with an import quota system is the initial fillip given to the two-wheel tractor.

A scheme for the utilization of two-wheel tractors is now underway. The object of this scheme being to use two-wheel tractors through owner-operators drawn from the educated youth in the villages, who have hitherto been living unproductive lives in the village in expectation of white collar jobs, or else have moved to cities to swell the ranks of the urban unemployed or to graduate into crime. The scheme is coupled with a highly organized training programme and a credit scheme involving the People's Bank. The main features of the scheme are as follows:

1. Selected youth will be restricted in their operation to specific areas in the vicinity of their home village.

2. They will be provided initially with a course of training in operation and maintenance of their machines and a two-wheel power tiller with plough, rotary tiller, trailer, wet-field wheels and water pump on a loan repayable in five years. The loan will be guaranteed by the mortgage of equipment and by two guarantors in the village who have not defaulted on agricultural loan repayments.

3. There will be no control exercised on rates of fees charged, and initially three owner-operators will be detailed to each village so that competition will be created. The supervision of the owner-operator's business, i. e., the maintenance of his equipment, keeping of obligatory records, and assistance in repairs and other problems will be the function of the government agricultural extension service.

4. Training will be continuous, in the form of periodic short courses arranged during slack seasons at district centres.

Pilot projects are in operation in four villages at present and it is calculated that 50 days of tillage work per year will enable the owner to break even if charges are one-half that of four-wheel tractor contractors. Since there are 60 to 80 days of tillage work possible per year, and short-haul transport, and water pumping work available throughout the year, it can be expected that the owner-operator can earn a very good income depending on his initiative and application. The scheme is to start with 100 units, doubling the number every quarter until 4000 units are in operation at the end of one year. This is necessary, so that training programmes can be simultaneously developed to help keep pace with the requirements.

No one make of tractor is to be used. At present there are, at least, eight makes of power tiller being sold and serviced in the country. Steps are being taken to work out a system of government conrtol over the dealers so that spares and repairs service could be maintained. The competition so created can be expected to weed out unsatisfactory dealers in time. There is certainly more work in each village than can be handled by three tractors, and, depending on the success of the pioneers, other youth may later take up this type of custom work voluntarily. On the other hand, there is always a danger that these two-wheel tractors may finally end up being owned by the local "madalali" and the original owner-

operator becoming an exploited laborer. This aspect of the scheme demands a great deal of vigilance by the extension service. The more successful owner-operators may, in time, be able to widen the scope of their operations by purchasing other attachments like threshers or power sprayers which can be powered by their tractors.

Future Needs in Mechanization Development

There are two trends in agricultural development that will have a big influence on mechanization. One is the development of irrigation facilities for the highlands (hitherto irrigation projects have only catered to rice production), and the other is the introduction of intensive mixed farming and systems of relay or multiple cropping. These trends will not only demand more power, but the higher incomes from more intensive cultivation could, in the future, enable individual farmers to purchase their own tractor. Land alienation policy will, however, restrict farms to the smallsize family farm and hence the two-wheel tractor will be with us for many years to come.

Perhaps the most important and far-reaching factor that augurs well for the future, is that now a definite outline of policy regarding mechanization has been enunciated. Furthermore, the projected plans are closely integrated with other programmes of agricultural development and social organization. This, more than any other, will accelerate the development of training programmes and extension services, so necessary to keep mechanization going, and provide the incentive to the researcher working on the modification or development of tools for farming.

One aspect of mechanization is still to develop, namely, the local manufacture of tractors and tools. Steps have already been taken to encourage local manufacture of spares such as tynes, steel wheels, tractor frames and so on, and before long one may expect these items to be produced in greater quantity, and eventually the manufacture of tractors locally would be a feasible proposition. This aspect of mechanization has to be viewed with a lot of caution, particularly in a small country where the market will be relatively small. The incorporation of new developments and better designs will be very expensive and the small amount of labor required under modern systems of manufacture will not compensate. A far more feasible proposition will be to make only those components that can be turned out by small and uncomplicated industries utilizing existing machine shop and foundry facilities, and to import only these items that either call for modern technology or require heavy capital expenditure when modifications or innovations have to be made.

This article has briefly covered the broad picture of present and projected development of farm power in Ceylon. In Ceylon, as in most developing countries, lack of power is one of the most important factors that limit agricultural production and negate the spectacular advances often being made in varietal improvement, agro-chemical use and agronomic practices. The need to develop food agriculture is urgent and, under these circumstances, the state has to step in, if rational application of farm power is desired. This is more pertinent in circumstances where power involves the expenditure of large sums of precious foreign exchange, and where the impact of mechanization has to affect social organization. A definite policy on power has been enunciated by the Ceylon Government and the implementation of this policy is underway. The author feels that this approach has been long overdue, and that the foundations are now laid for sound and far-reaching programme of mechanization development, research and training.

A power tiller is still rare in the rural village

An improvement of traficability in the wet field. Traficability of tractor is one of the biggest problems.

AGRICULTURAL MECHANIZATION IN LAOS AND ITS PROBLEM

Takeji Nakata

I General View

1. Geographical position and features

Kingdom of Laos is a landlocked country which occupies the central to the northern part (lat.14°～22°) of Indochina, and is bounded by China, Vietnam, Cambodia, Thailand and Burma.

The territory of some 236, 800km² is long and slender, that is, it has a length of nearly 1, 000km from south to north but a width of only 150km—400km at the most. Most of the country is mountainous and the plain lies only along the left bank of the Mekong River between the plain of Vientian and that of Pakse. The height of the plain is 100～180m above the sea level and that of the mountains which run from north to east this country is 1, 000～2, 000m. The Annamite Cordillera, running from south to north of the eastern part of this land, is forming the boundary between Laos and Vietnam.

The cultivable land is estimated to be some 1, 800, 000ha. (about 7% of the territory), out of which 1, 300, 000 ha is cultivated at present——approximately 900, 000ha equals to paddy fields and about 400, 000ha dry fields. The main crop is paddy rice. In addition to it, corn, potato, coffee, and tobacco are also planted.

The climate of Laos is clearly divided into dry and rainy seasons. The dry season lasts six months from November till April, and the rest is the rainy season.

Fig. 1 The plow generally used in Lacs. Every farm house has 1.5 plow of this type on the average.

Fig. 2 Japanese plow is excellent for turning of soil and deepplowing. But it forces an operator unnatural posture. There is still room for improvement (to make it fit to their stature).

This is what we call the monsoon climate. Vientian which belongs to the tropical area records 21°～28° C of monthly mean, but sometimes over 32° C of it. The rainfall amounts to over 1, 500mm a year on the plain, and over 3, 000mm among the mountains, which strongly influences to the econemical lift of Laos.

2. Population and inhabitants

According to the statistics by the Government of Laos, the population of Laos in 1966 was 2, 698, 000. So the population density was 11. 4 persons per 1 km². Out of 2, 698, 000, nearly 140, 000 persons are supposed to be living in capital Vientian. Though population of engagement by industry is not clear, approrimately 90% are engaging in agriculture. People are centering on the plain along the Mekong River, while among the mountains there live Thaidam Yao Meo Kue and other tribes. Though the change of the population is not clear, the increasing rate of population is supposed to be about 2. 3%.

3. Education and religion

Education in Laos is still insufficient in spite of considerable improvement by the Government after independence. Though the special educational system for agriculture is not established yet, the FAO Pilot Farm in the southern part of Vientian is practicing short-term training every year for some 40 farm youths of the nearly villages.

Budhism is the main religion of Laos, and is embraced mainly by the Laos tribe. So, education by Budhistic monks is flourishing.

4. Agriculture and forestry

Agriculture is the chief industry of Laos that controls national economy. As stated above, the agricultural population occupies nearly 90% of the whole population and the cultivated field is 1, 300, 000 ha, equivalent to about 5% of the territory. But their agricultural production is so low, that most farmers can not make their living by farming alone. Rice is the main crop. Besides, corn, potato, coffee, tobacco, sugar-cane and cotton are grown. Sesame and poppy are also cultivated on high lands.

5. The condition of electric power supply

The small scale diesel dynamos are now used to supply the main cities of Laos with electric power. But as they must import fuel, electric fee is guite high in comparison with that of other countries. In spite of high power rate in Vientian——VS 12 cent per 1 KW/h, electric power demand in and around Vientian is increasing and is resulting in the electric power shortage. When Nam Ngum power plant is completed and its exuberant power supply begins, it can not only meet power demand of Vientian and farming villages but also largely contribute to industrialization of this

area.

II Present Status of Agriculture in Laos, Agricultural Mechanization and its Problems

1. Plowing work and its problems

Plowing work here involves both root plowing in the dry season and plowing of paddy field and dry fields at the beginning of the rainy season. They are using beet hoes for reclamation and construction working. Though they require very hard labor because of the angle of helve of 60°～85° and of their heavy weight, they are most suitable to turn soil. But there seems to be some room for improvement in the truth that they would not use bow hoes, thistle spuds and three prong digging hooks at all according to their old custom. They are clinging only to drag hoes without considering to improve the hoe itself, which causes low work efficiency, small yield and rough plowing work. Especially the three prong digging hook may bring revolution in plowing operation.

Their agriculture depends on natural phenomena. As to the animal plow, they begin plowing after seven or ten days of rain when soil is soft enough for animals (especially a buffalo or two heads of cattle in places) to work.

The beam, plow body and plow staff, however, are made by each farmer to his own measure. As he desides the furrow bottom, angle of suction, hitch point, center of gravity and others by his own experience and intuition, they sometimes lack rationality. He must get the share at an ironmonger in a town (400～500 kip : approx. ¥300). Width of the share : 10～12cm, weight : 15～20kg, plowing depth : 5～7 cm. and it takes 3.0～3.5 hours to plow 1 lay ($40 \times 40 m^2$). Considering the horse power of a buffalo, if the plowing depth comes to 10～15cm, it will be very convenient for turning of soil and crops. In order to plow deep with the present plow, something must be thought about the bull tongue and support stay of the plow body. Combination of their plow body with the share and bull tongue of a Japanese animal plow would well fit for the work.

As to a power engined plow, a 4 or 5 furrow trailed disk plow of 15～25 inches attatched to a big tractor of 40～60 ps is very popular especially in a burned field and a copse. Considering the rapidly growing plants and the ground condition by rough root plowing which causes heavy burden for machines, a big tractor of some 2500kg is needed here. It is our regret that we have no Japanese tractors that are egual to the task.

For clod breaking, however, after, plowing by bigpowered tractors, Japanese medium-powered tractors fit well. Farmers here are saying that big machines are so expensive, that the moderate prices of Japanese ones are very attractive for them. Real mechanization would be carried out both in rainy and dry seasons, when Japanese efforts to develop a strong-powered efficient plow result in a manageable one of 15～25ps. It is necessary to cut down running cost by considering damage of tires on account of roots after bush cleaning and the like.

As to paddy fields, needless to say, perfect operation is done because buffalos are well serving for the work. But in respect to fuel, a diesel engine would be more profitable than a gasoline engine.

2. Harrowing

Harrowing in Laos is done by horse hoes, most crude implements for pulverization, which are inefficient and require heavy labor of operators. Therefore, it is well practicable work for men of 18～45 years old, but not for women. A break harrow of weight within 30kg will be welcomed by farmer, because a too heavy machine is inconvenient when crossing rivers and swamps. A rotary break harrow or a rotating type would be most suitable because the former has small draft force and high harrowing effect while the latter refuses adhesion of the very viscous red clay here. It takes 2～2.5 hours to finish 1 lay. It needs much time because plowing work is rough.

Harrowing by a tractor is surely very efficient not only in dry fields but also in paddy fields. Rotary cultivation by medium or small sized power tiller after plowing by a big plow is quite efficient and suitable for extensive agriculture. So, we are now keenly expecting the development of a high-powered tractor which combines them together. Big sized machines alone can not make them happy.

3. Management

Both in rice cropping and in vegetable growing in extensive agriculture, they leave things to take their own course after seeding and rice planting. Those who are exercising care of their crops must be less than 5%. Few farmers know about weeding and sprayers though

Fig. 3 This is very light—12～17kg, but requires quite is heavy labor.

Fig. 4 Plowing by a big tractor, which also does harrowing of 30%, is very convenient for subsequent operations.
The machines belong to five to ten big farmers. Lease rate is 3,000～4,000kip/lay.

Agricultural Bureau and other authorities sometimes give public demonstrations. If they buy those machines, however, it is rather uneconomical because the working hours per year is so low. For the present, hatchets for mowing and tending are important necessaries for them to manage and maintain border levees and cultivated fields.

4. Pump

It would be easy for farmers to make the plan for operations if they have water in their cultivated fields all year round. But in reality, as they have rain of a year during March and April, which sometimes causes damage not only in rivers but also in rice fields, farms and forests, pumps are now their necessity.

There lies many difficulties to select a pump. Different from Japan, we must take into consideration sludge, muddy water, change of water level, select of power source and troubles by driftwoods. It is also necessary to know about running cost after installation and about easy repair method. There are 500～600 portable vertical pumps in Laos now, out of which 90% are 5～7 ps pumps of Thai make. They recently have

Fig. 5 Demonstration of a mist sprayer on the farm. It is so convenient that it is often took for practical use in villages. They have poor knowledge of chemicals, in particular.

Fig. 6 Cultivating work on a banana orchard of a rich farmer. The two in front are engaging in root plowing. The machine is a Japanese make. Efficiency of a machine fully depends on its selection and operations.

got several Japanese pumps of 500～700 ℓ/min. But as they are not vertical but fugal type, they are often out of order in rough handling in spite of their generally good performance. If the water source is near, vertical type would be most handy, cheap and convenient. Hereafter, a vertical pump of 500～800 ℓ/min. and 5～7 hp, in particular, will be popular on account of its cheapness and easy repair. It will also become necessary to plan installment of a pump of big capacity in stead of clinging to the small type only.

5. Thresher

They have no special threshing machines. Treading and beating work is serving for them. As there is excessive labor, the whole villagers cooperate with each other in threshing work without using machines. This is, however, one of the most irksome works for them. If certain education is given on the basis of a long-termed plan, they will someday know how to spend lobor more effectively. Now Japanese machines such as Chain-beeding type thresher are so easy to get here. I made a great mistake when I introduced a fost thresher, which proved to be unsuitable here. But something tells me that the diffusion of pumps will be followed by the popularization of thresher in the near future.

6. Rice pearling mill

Rough rice after threshing is lacking for self sufficiency of the farmers far from being purchased by the Government. Different from the way of Japan, they

Fig. 7 Beating operation: 100～120kg/day by a man Treading operation : approx. 250kg/day by a man.

Fig. 8 Japanese type pedal thresher made in Laos. As it mixes up much dropped rough rice and chaffs, a wind fan fox separating must be attached, at the same time. They are not patient enough to continue treadle work for hours. It costs them 9500 kip. It is made by utilizing secondhand bicycle.

are using the rice pearling machines which also serve as hullers. The situation of prevalence of rice pearling machines in Laos is :

small-sized dual purpose machine less than 15ps·····280～300units
big plant 20～25t/day···approx. 15units

Big plants belong mainly to the Chinese merchants near the capital city for commercial use. As to a small-sized dual purpose machine, each village has one or two of it, and the farmers are sharing them. As regards a rice pearling machine, in particular, that of Thai-make (originally English make) is cheap, and a Japanese diesel engine is used as the power source in most cases.

Some are making a business of shelling and rice milling (0.5kip per 1 kg of rough rice). Most of owners like to get the rice-bran which is used as feed for pigs and chikins. Though broken rice and loss of power is considerably high on account of simple and rough machines, it is not a serious problem because it is their self-feeding rice. Rather, it is an urgent business for Japanese manufacturers to develop some simple, manageable and highly efficient machines. A rice pearling machine is one of the most prevalent machines at present, because it is charged not to an individual farmer but to a village.

7. Equipments for transportation

Fig. 9 Old wooden burr used in Laos. It is used for rice pearling. It takes 3 children 1—1.5 hours to mill 10kg of rough rice.

In comparison with Japan, they have their own problems about the road conditions, the land and the pattern of villages. Carts are very popular in Laos, they are quite useful in jungles, waters, paddyfields and rivers. Though their maximum loading capacity is only about 500kg, they are very convenient especially in copses and rivers. Besides carts, their carrying work is done by carrying-over-shoulder work which requires hard labor. Though a handy and small sized equipment with wheels made of hard woods sums to be serviceable, they are too conservant to adopt anything new however good it is for them. It is our duty to introduce such an implement as a wheel barrow that is cheap and durable. A tractor with a trailer usually works five or six times as much as an ox-cart, but it largely depends on the road conditions. Transport by cars is limited to only when carrying woods by one or two trucks of a village.

8. Smithery

It is necessary to research the equipment which will meet the demand of Laos before speaking of mechanization.

I had a chance to demonstrate how to make hatchets by utilizing the waste materials and scrap-iron on the farm. Though it was hard work to use fire under this hot weather, the condition that they can bring the hatchets they made to home caused some effect. It was very interesting to make the broken spring of car or steel pipe into the scoops or something like that.

Fig. 10 Ox-cart used in Laos. It is serviceable in waters of 60～70cm deep and copses. It costs 70,000 kip.

Fig.11 Practice of smithery in a corner of a repair shop. He is tackling with a used blade of a power tiller.

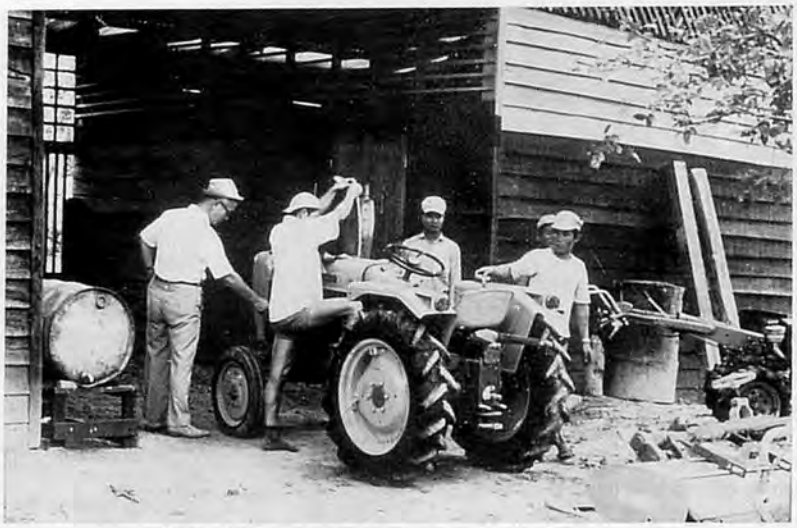


Fig.12 Warning, inspection and oil supply before operation.

I keenly thought it more necessary to improve the implements which are familiar to our every day life rather than to spend much money on improvement of big machines. Most ideally, I am expecting the establishment of the vocational education system like a training center so that they can learn there how to make the manual and animal implements which really fit the condition of Laos.

9. Internal combustion engine and oil

Besides the Japanese engines, there are many big and middle sized gasoline and diesel engines which are manufactured in U. S. A. and Europe (less than 15ps).

But as they have no knowledge about machinery, its maintenance and repair, they let the machines alone on the fields or under the eaves when they get out of order. In order to prevent these accidents we must fully think of fuel, operation, and selection of the type of machines.

As to engines, those of 1,500～1,800 rpm are most useful on both durability and handling. But it is necessary for us to selsct the machines carefully with due regard to coarseness of mobile oil and imcompleteness of inspection service

A small powered gasoline engine of 3～6 ps is most popular, and they must have no less than 5,000 of this type in Laos. 90% out of them are used for fishing boats in raing and dry seasons. As fishery is more easy source of income than rice crop, they are permeating into every part of the country both as the measure of transport and as the power source. This must be a clue when we promote agricultural mechaization here.

Though they have some independent electric power plans in the cities and towns, they ought to think of their economical long-term operation program which is based on the analysis of the present condition of engine drive. Becuuse all the oil, in particular, is imported though Batngkok.

Marketing price of oil	(1 ℓ)
Gasoline	48kip
Petroleum (90%for lamps)	20〃
Light oil1	18〃
Oil #30～50	220〃
Oil #90～125	300〃

Fig.13 Boats with overbcard engines are stirring in the market by the river (gasoline engine of 3～6 ps).

Mechanization of Agriculture in Pakistan,

Present Status and Future Prospects

N. Ahmed

Mechanization of Agricultur is yet at its very initial stage in Pakistan. We have just started with it taking one or two operations here and there. But Mechanization can play a real big role here also as in other developed countries of the world. Leaving aside the question of full scale mechanization which will bring within its scope each and every bit of farm-operations to be done with the help of this or that machine, the necessity of mechanizing the basic operations like land preparation, providing supplementary irrigation to the crops, fighting the insect pests and disease of them and harvesting etc, can not be over emphasised, at least to improve the quality of the work of all of those operations and in some cases to actually do the job successfully. In fact, there are some operations like big scale irrigation and Plant Protection works which, if we do not take the help of a power pump or of a sprayer or duster, is unthinkable to get done successfully what ever number of human labour we employ. Now, Pakistan is predominantly an Agricultural country and its economy is entirely dependent on the volume of its Agricultural produce. It is imperative therefore, that we think about mechanizing this basic Industry of the country, gradually but at a maximum possible speed not only to feed the teeming population of the country but also to better their lot to a human level.

Everybody here, including the Government, is fully aware of this vital need of the country. But even at this rudimentary stage of Agricultural Mechanization in the country, specially here in Eastern wing, difficulties are being felt, which if not taken care of from a proper angle and just now will darken the future of mechanization unrecognisably and with it all the hopes for a richer and fuller life for millions of human beings. Therefore this is a great task before the entire Nation calling for proper evaluation of the present situation, finding the drawbacks and remedies thereof and thinking out a practical programme of mechanization commensurate with the environments of the country and the people. Now, to understand the nature and reasons of these difficulties referred above, some background informations about the farmers, their farming conditions and the country itself is essential.

The country.

Pakistan is divided into two distinct regions-West Pakistan and East Pakistan, having quite different climates, land types, cropping patterns and other geographical conditions. The distance between the two wings is about 1,000 miles-in between lies the Indian Republic. East Pakistan lies in Tropical Zone and West Pakistan in arid or semi-arid Zone. The first two crops here in East Pakistan is Rice and Jute and there in West Pakistan Wheat and Cotton. But still, the general socio-economic conditions of the people of these two parts of the country have many common features which is completely predominated by Agriculture. 75% of Pakistan's entire population is still dependent on Agricultural and due to comparatively slow pace of Industrialization of the Eastern wing of the country during post-independance period of last 23 years, about 85% of the population here is completely dependent on Agriculture having no other choice of livelihood. It needs to be pointed out here that just after the Independence, East Pakistan, which was formed by dividing the previous Bengal province of British India, was completely devoid of any Industry as the whole of it was left at Calcutta and surroundings, which had been the capital of that province and Calcutta and the remaining lesser part of the province was declared to be part of the present Indian Republic in the name of State of West Bengal.

Many of the conditions effecting Agriculture and Mechanization thereof, having big differences in the two wings of Pakistan as pointed earlier, they may be conveniently dealt with separately to arrive at possible conclusions decisions.

East Pakistan.

This comprises an area of about 55,000 sq. miles, about 14% of the total area of Pakistan but about 55% of the entire populatlon of the country lives here thus reducing it to one of the most heavily populated area of the world- about 1200 persons per sq. mile. Thus, pressure on land in this predominantly agrarian country is very heavy here which directly effects the economy of the people. The situation has been further aggravated by the absence of proper Industrial development in the province. On the average, about 2.7 units of human beings and over 1 unit of cattle population have to subsist here on 1 acre of land which is primitively cultivated.

This is a tropical zone having a humed climate with an average temparature of 52°–95° F depending on seasons of which there are five distinct ones-Winter, spring, Summer, Rainy and Autumn, but rainy season often overlaps with summer and autumn. Winter is not at all severe here but the summer and also the major part of rainy season is very damp, sweaty and much tiring. The rainy season here, in fact, stretches, normally, from the middle of April to middle of October. But the Monsoon which determines the rainy season here is not at all regular and in some year it is late and some year rather early which again effects the rain-fed farming of the country, some quite destructively. The hottest months of the year are July and August.

The average annual rainfall in the country is about 80″ which in some years may go up to 100″ and even more some times. But this huge amount of rainfall is not at all evenly distributed through out the year-about 88% of this entire rainfall precipitates during the summer months of April to September and during the other half of the year there is not more than 10″ of rainfall in the

country. In fact, during the Winter months of December through March, the country is almost completely dry not having more than 2–4″ of rainfall. As the farmers of the country have to depend completely on Nature for their farming operations, naturally, the above pattern of rainfall distribution has given rise to two distinct cropping patterns in the country-the "Kharif" or summer cropping season, seeningly having no problem regarding soil moisture and the "Rabi" or winter cropping season, faced with a gigantic problem of providing adequate artificial irrigation facilities to the land for a successful crop-raising. Though during the "Kharif" season there is plenty of rainfall, still it does not mean that soil moisture is not a problem at that time for farming as hinted earlier. In some year, the advent of Monsoon may be very late, effecting greatly the sowing of "Aus" rice or summer rice and Jute and after that, it may come then, even suddenly, and continuous heavy precipitation may bring untimely floods, some times completely damaging the standing crops at its early stage or may just hit them before harvesting again causing huge damages, or, in some years due to insufficient precipitation and early ending of Monsoon, the transplanting of "Amon" rice or Autumn rice which is the main rice crop of the province, is badly affected. But again, the opposite sequence also may happen i. e. due to excessive Monsoon, in some years, Transplanting cannot be done in time due to late recessing of water from the fields, while in other cases, the T. Amon fields may dry up during the later part of its growing season effecting greatly the normal yields of that crop.

Now, it is to be observed here that facilities to provide supplementary irrigation for these crops will greatly help to face the above problems successfully.

In "Robi" or winter season, as already mentioned, the country remains completely dry and it becomes difficult even to open the land for the next crop at the later stages of the season because of its hardness. Of course, the land can be prepared just after the harvest of the Autumn Rice but absence of proper amount of soil moisture in the following days completely inhibits the raising of crops at this season if there exists no elaborate and dependable irrigation system in the area which is mostly lacking now.

As a result, only 1.5 million acres out of total 23 million acres of this fine Agricultural land of the country is cultivated during this period with partial or adequate irrigation facilities available at hand. Of course some more area, the percentage of which is rather negligible, is cultivated for raising short-duration minor crops like pulse, mustard, groundnut, potatoes etc. But the yields of these crops could be very substantially increased if irrigation could be provided for them.

Now, it is evident, as already discussed in this paper a short while ago, that both the major Rice crops of a year in the country is just an uncertainty in the hands of a whimsical monsoon. So, this 6 months of dry period are now being considered by all to be the best period for crop production in the country to avoid the dangers mentioned above and hance, should be utilised to the maximum. But the only limitation in the way of this utilization is the lack of adequate irrigation facilities in the country though we have sufficient surface water sources for the same and also a dependable under ground source of water. The only thing we need now is the modern appliances for its economic and rational use.

To speak something more about the surface water resources for this vital irrigation works in the country, it is worthy of mentioning here that we have a number of mighty rivers in the country flowing a total length of about 15,000 miles and comprising an area of about 5% of the entire land. The whole country has been crisscrossed by these rivers and their tributories and no area in the country is far away from these rivers or their branches–they are all perennial and never dry up. According to a survey conducted by world Bank mission, we can straight away launch an irrigation programme to use 35,000. 2-cusec pumps without any ground-work preparation even and with some preparation, we can utilize a far bigger number in the days to come. Then, we can sink a good number of deep tube wells also for the purpose.

Soil and topography of the country.

This is a vast stretch of plain land formed mainly by the deposits of the 3 great Rivers and their numerous tributaries except that there are a few hills and jungle areas to the east and northeast of the province at the border. They are, in fact, the continuation of Assam hills in India and Burmah hills with which the country has borders. Besides, to the south at the Bay of Bengal towards the western part, there is a big jungle called "Sunder bons" famous for its Royal Bengal tigers, beautiful deer, crocodiles, numerous kinds of birds and flocks of monkeys. But all of these hills and jungle areas together comprises only 13% of the entire land. The average altitude from sea level is below 80′ excluding the hilly regions, though about 50% of the land lies at an average altitude of 15′ only,

The soil is mostly alluvium because of its deltaic nature and is generally fertile due to fresh silt deposits every year, but responds very favourably to the fertilizer application. It is evident from the point of fresh silt deposition that most of the land in the country becomes inbundated every year during the peak of Monsoon which regularly brings flood to those rivers. This is a riverine country in its true sense and the whole country has been criss-crossed by those rivers as already mentioned. These rivers have great influence on the entire socio-economic and cultural pattern of the whole populace of the country who equally shares their boons as well as the curses.

Agricultural condition.

The following tables will help to understand the Agricultural condition in the country.

Land utilization.

Total land area-	35.0	million acres.
Total cropped area-	21.0	〃 〃
More than once cropped area-	10.0	〃 〃
Total acreage-	31.0	〃 〃
(crop intansity about 145%).		
Current fellow-	1.5	〃 〃
Cultivable waste-	1.5	〃 〃
Forest-	5.0	〃 〃
Not available for cultivation-		
(Rivers etc.)	5.5	〃 〃

Average size of holdings and numbers thereof:-

Size.	Number (Million)	Percentage.
Under 1.0	1.11	17 %
1.0 to under 2.5	1.75	26.6%
2.5 to under 5.0	1.76	26.7%
5.0 to under 7.5	0.83	12.6%
7.5 to under 12.5	0.64	9.7%
12.5 to under 25.0	0.31	5.6%
25.0 to under 50.0	0.09	1.4%
50.0 land over	0.02	0.3%
Total	6.57	100 %

It will be seen from the above figures that in East Pakistan there are about 6.5 million holdings of which more than 70% is of less than 5 acres which is regarded as economic size, where as the average size of holding, on the whole, is 3.5 acres only. The type of holdings are shown below:-

The cultivators.

The total population of the country is believed to exceed 55 million at present which was recorded to be 50 million in 1961 Census. The growth rate, on the average, has been about 1.8% per annum. The over-whelming majority of this total

Type.	Percentage	Average size. by total area	By cultivated area.
1. Owner cultivator	62.1	3.2	2.7
2. Owner cum tenant.	35.6	4.2	3.8
3. Tenants-	2.3	2.5	2.3
4. Total	100	3.5	3.1

population, about 94.8%, is rural. The literacy of the people is rather low which, though has increased substantially after the Independence in 1947, is about 30% at present. Of this huge population, about 80% is directly dependent on farming without any alternative choice of livelihood.

The main crops and production there of as per census of 1961-62 are shown below.

Crops.	Acreage (million acre)	Production (million ton)
Rice-	21 (present 23)	9.5 (present 11.7)
Jute-	2.06	6.97 million bales (1 bale-400 lbs)
Sugar cane-	0.29	4.42
Tea-	0.08	59 million lbs.
Tobacco-	0.11	0.031
potato-	0.14	8.6 million mnds. (1 mnd=82 lbs)
Wheat-	0.15	0.04
Banana-	0.08	1.06

It will be seen from the above table that the production level is very low for almost all the crops in the country. As has already been mentioned, Rice is by far the main crop, the production level of which also is as low as to be only ⅓ or even ¼ of that of the countries advanced in Rice growing. The 2nd crop which is the main cash crop for the majority of the farmers of the country, is jute, a fibre crop. Though East Pakistan enjoys a monopoly in its production, yet the farmers donot generally get a fair price of the crop due mainly to their inability to stock the goods for a better market but to sell the same immediately after harvest due to their precarious economic reason. The second big factor in this connection is a hoard of middle men at every step who steal the lion's share of the enterprise. As a result, the jute growers of the country have sustained losses regularly except on few occasions which has been very far and between and their economy has been shattered due to continued loss year after year. But still, they grow the crop for 2 reasons, Istly in a blind hope to get a better price for the next crop. The reason of that hope, of course, has been due to the fact that during the days of war some of them got fantastic prices for their produce 2ndly, some of them have some pieces of land which is typically suited for the crop. In recent years the Govt, of course, have been trying to do something against these evils. Besides, the fate of the main crop, Rice, has already been seen to be the most precarious one in the hands of a whimsical nature.

Economic condition.

Naturally, the average farmer of this country is rather a very poor man. He is mostly illiterate, ill-fed, ill-clad and is almost sunk in debt. Almost 100 percent of them lead a sub-human life. He is rather conservative because the miseries of life have shed off from him all faiths and hopes in life. The average per capita income of him is Rs. 191.00 only annually (about 40 U.S. dollers). The National income which showed an increase of 5.8% in 1960-61 and of 9.8 % in 1961-62, was entirely due to increase in Industrial Sector, the average per capita income being Rs. 443.00 there.

Farming methods.

A farmer here has almost no capital. He, therefore, pursues this only profession of his life with the help of age-old, outdated and most inefficient indeginous tools and implements, in most cases made by himself. He cannot, in most cases, afford to supply the modern imputs of production to his dear land and his only source of farm power has been a pair of bullock, mostly reard in his own house at a standard far below the sub human level of his own. Naturally, this pair of bullock is the most wretched animal in the world-they are of no breed, there is no food for them- the man and animal ratio on an average farm is so big and the competition for a produce from that limited holding is so keen that the necessity of growing fodder for them is almost completely forgotten. As a result, these animals, a huge number of them, total 23 millions, out of which about 10 millions are working-have already degenerated and their power is very very limited and inadequate for any kind of farming operations. Consepuently, his operations are less than half done, he is beyond the schedule of time and his yields are less than even what was feared of.

Need for Farm Mechanization.

In a country so over populated and with abundance of unemployed labour forces, the urgency for an immediate Mechanization, seems to be rather miscalculated. Many people in the country itself also, in fact, is afraid of a huge labour displacement and consequent upsetting of Rural economy completely by Mechanization.

Here in East Pakistan, we donot think of Mechanization in terms of labour saving, which, of course has been the main consideration for Mechanization in many countries, but in term of increasing their efficiency and also in term of creating more jobs for them. The need here is for increasing production by planned activation of the factors of production with the help of modern devices and an adequate Farm Power for successfully running the wheels of those devices.

The salient factors, so, for, that immediate need for a mechanization in the field of Agricultural in this land, may be summarized from the discussions above as follows.

1. To increase the per-acre yield which is very very low. Of course there are other important factors of production besides use of machinery, but it has already been seen that the Ist basic factor of production i. e. land preparation is at its lowest standard, mainly for want of adequate farm power for which at present those delapidated bullocks are used. Moreover, to have the best from the other factors of production also, one must use modern technology which is the result of man's endless quest for better in every thing.

2. To bring into cultivation the remaining 21.5 million acres of land which is about 97% of the total cultivated area and which remains fellow at present for half the year during the winter months only due to lack of proper irrigation facilities.

3. To free the present 2 main rice crops of summer and autumn which are completely rain-fed, from the vagaries of nature by providing supplementary irrigation facilities, when necessary and thereby to ensure the production.

4. To save the crops from destruction by insect pests and diseases, the extent of which some times is simply colossal. Even in normal years when there is no heavey attack, the cumulative damage effect of these pests and disease, according to a rather conservative estimate, is from 10-15%.

In 1967-68, out of total 31 million acres of cropped area, only 2.7 million acres were treated against the attack and the savings thereby in term of money was estimated to be about U. S. dollar 1.8 million. The amount of saving, if the whole area, which is going to increase at least 2 folds after a full scale mechanization, can be easily imagined. And there are all sorts of them for about all the crops, in this humid heaven of them.

5. To cope with time after we have started to utilize the now-idle dry period to raise a third major crop from the

same soil. Because this is a tropical zone and we can grow a crop through out the whole year if we supply the inputs to the soil properly and adequately, but in that case the interval between 2 crops for the land preparation will be greatly shortened and unless we use some quick-moving operational units, it will not be possible for us to tide over the situation.

6. And lastly, to free man from the drudgery of manual labour, to enable him to enjoy the benefits of modern technology, the benefits of modern civiliszation man has so dearly built up for himself and his fellow brethren.

Now, to come to that labour displacement again, we are going to increase our acreage by about 2 folds and there is scope yet, at least here, to increase the production rate up to 3 or 4 times of the present rate which is common with some of the advanced countries, thus, it is possible that the total job availability will increase by about 6-8 folds taking into consideration the increase in acreage in winter through irrigation. Of course, a major portion of it will be done by machines, but there is other side of it also the standard of living in the country is going to rise tremendously thereby and the life amenities will be in demand in a far bigger scale then ever and new jobs and new avenues for it will be created; to day's hut will turn to a modern building and to-day's village into a township and so on.

The unprecedanted devastation of cyclone and tidal bore of 12th November last in the coastal areas and off-shore Islands at Bay of Bengal, perhaps, going to create a new chapter in the history of our farm mechanization. Almost every thing has been washed away in the affected are, specially in off-shore Islands, there is almost-nosign of any cattle population any where at those places and naturally, for a prompt rehabilitation of the Zone comprising an area of at least 1 million acres, we cannot think of any other way but mechanization. Accordingly, 1650 power tillers and 1650 4-wheel tractors are being procured initially up to 1971 from all available sources to start with the job. This is to note here that we have been rather compelled to go for mechanization for this great task shaking off all the doubts and speculations against mechanization and this is our hope that may the experience of this rehabilitation work give us a lead in the cause of mechanization. May we emerge out from the obscurity of suspicion, doubt and no-confidence and step into a clear horizon vivid with the benefits of mechanization in the country.

In fact, considering the speculated difficulties of mechanization at its early stage, there is a fraction of people in the country who actually think that mechanization is not possible in this country, it would be an uneconomic proposition, if at all comes into existance.

The Present Status of Farm Machinery in the Country.

At present we have only about 2,500 power tillers, about 2,000 four-wheel tractors, about 20,000 power pumps of 2 cusec capacity (1 cusec=1 cubic foot per sec=about 62 lbs/1 sec), about 2,000 deep tube-wells of same capacity, about 14,000 power sprayers and about 35,000 hand sprayers and dusters. As has already been mentioned, this is only the very beginning of farm mechanization in as much as the scope for utilizing these machines in the country is enormously vast. According to an Indicative world plan for Agricultural improvement by F.A.O., a minimum of 0.2 H.P. is necessary for developing countries, which means we can consume at least 14 million H.P. at the above rate in the form of Farm Machinery at a later stage of our development when we can easily raise our cropping intensity to about 300% as mentioned earlier, where as the present consumption is hardly more than 0.6 millior H.P. from the existing machinery.

The Difficulties Experienced at the Present Stage.

The most severe pointer of these difficulties is the fact that after the introduction of power tillers in the country in 1965, the distribution rate of the same amongst the farmers gradually increased up to the 3rd year and the it started decreasing sharply and in the 5th year that is the current year- the number dwindled to almost nil beyond all expectations and out of about 1,200 imported during the 4th year, almost the entire quantity is still remaining undistributed and as a result no more import was made during the current year. At present simply there is no demand for these machines in the country.

We have, of course other basic dificulties also for mechanization, like (1) fragmentation of holdings to miserable extents, (2) lack of belief in modern appliances and techniques on the part of an illiterate and conservative farming population, (3) complete lack of capital, (4) inadequacy of average holding size to possess and maintain a mechanization set economically, (5) lack of communication facilities in the villages and more so within the fields for the movements of the machinery and (6) wet land cultivation of low lying areas, in some cases, for rice culture.

After a very careful and thorough study of all those problems it was decided to use the smaller machines like power tillers initially to cope with the situation. This selection promised to eliminate almost all the difficulties mentioned above and through a good extension activity of the Agricultural staff of the country and also the other propaganda machinery of the Government, the machine also gained a good stand in the country. Govt. has been allout to help the farmers for the cause of mechanization. It has already started to advance credit for the pruchase of these machines by the farmers through Agricultural Development Bank of Pakistan for which it was specially established. Normaly the entire amount of the price of a power tiller set is paid as loan to them by the Bank against a mortgage of suitable area of their land. Because these power tillers, almost all of which are of Japan origin, were found to be the best of basic machinery for farm mechanization in the country in the perspect of its present socio-economic structure. But still then, why we landed at such a stranded position-why all the aspirations and expectations of a bright future with a richer and fuller life are being nipped in the bud ! It will be most miserable for us if we indulge in loosening the confidence of our farmers in machinery and in a better way of doing his jobs, so painstakingly induced in him.

The only factor responsible for the above situation, has been the lack of basic understanding about these machinery amongst the farmers who are the ultimate human ingredients of this noble venture. The acute shortage of technicians and Farm Mechanics in the country and hence the non-availability of proper and timely servicing facilities and also of necessary spares for the machines, are also equally responsible to agravate the position. It must be clearly understood at the very outset that a machine of any kind urgently calls for a proper knowledge in its handling and also for a constant and expert attendance for its vital maintenance and hence, an Infra-structure of skilled operators and a maintenance crew is a must to hope for any success in the concern. In fact, due to the above short-comings, the case of Farm Mechanization in the country, specially with the help of power tillers, has been so much damaged that in the local News papers the machines have been nicknamed as POWER KILLERS. Due to mishandling of these machines by ignorance and for lack of servicing facilities and spares, more than 50% of these tillers in private sector has gone out of work with in 6 months to 1 year of

their introduction. The most natural consequence of which has been that the affected farmers were at a complete loss in the busy cropping season as to what to do about his only profession of life at that critical time. Many of these farmers of very limited capital or no capital at all, lost the season completely and sustained a great economic blow to recover from which it will take years for them.

To repair the damage thus inflicted on the cause of farm mechanization in the country, is a Herculean task and it will take a long time to return even to the original position which was only the trial-and-error beginning of great task just like the faultering steps by an infant trying to learn walking, not to speak of any furthurance of that humble beginning.

Consequently, the policy of farm mechanization in the country is already tending to take a change and there are at least 2 schools of thoughts trying to find a solution of the dead-lack. The East Pakistan Agricultural Development Corporation, an autonomous body with full vested authority to work for all-round Agricultural development of the province, has been trying since long to hire out the machinery and equipments to the willing farmers keeping the complete management of maintenance and operation with them. Specially in the case of power pump irrigation, utilizing the surface water and deep tube-wells for underground water, they have been doing a big job using at present about 20,000 low lift pumps with a target of 40,000 in near future and 2,000. 6″ deep tube-wells with a target of 20,000 by the end of present plan period in 1975. Besides, at present they have elaborate plans to acquire sufficient number of 4-wheel Tractors of 35-55 H.P. for similar service.

The East Pakistan Agricultural Development Corporation offers these services to the farmers at a subsidised rate to the extent of 50-75% at a huge governmental expenses.

But this sort of arrangement cannot continue for good. Unless the organization is very big and very well-managed, it cannot serve the purpose efficiently and perhaps, can at no time, serve the whole community in an Agricultural country like ours. On the other hand, the famous "comilla project" run by the Pakistan Academy for Rural Development, envisages an all round co-operative farming with the help of modern techniques and appliances, of course gradually, taking on or more "Thanas" (an administrative unit of which there are 450 in the province) at a time as unit area for action. The idea for developing spirit of co-operation amongst the farmers is very important and essential for a developing country like ours. This may, ultimately, be the only solution for all of our problems, specially regarding capital formation amongst a poor farming class, provision of marketing facilities and facilities for storing and other processing of their produces.

But right at this moment, with an illiterate, rather conservative and pessimistic farming population, it must be realised by a rational thinking that large scale mechanized farming by farmers' co-operatives with big 4-wheelers combines, Arial spraying and dusting and community installations for storing, drying and other processings, is yet a vision of distant future, we must understand that we cannot change the thinking and attitude of them over night. In the above perspective, we must leave some rooms for individual enterprises also in the country for which and also for special topographical features of the country, the smaller machines are more suited. It is a well known fact that an individual enterprise in all countries, at all ages has a better chance of achieving the final goal as it becomes one's own creation, his personal show and he tries his best to excel in his performances.

Moreover, for that type of big scale mechanization, in many case, big tasks like preparation of the field and some times even of the soil itself to bear the weight of the machinery, are necessary, besides, of course, basic foundation works like lay out etc.

So, in my opinion, we must accomodate the individuals and the smaller machinery in the future mechanization programme of the country. For this and to cope with the difficulties mentioned previously, we must, first of all, get down in to training our farmers before they pruchase any machine and also build up that "Infra-structure" of technicians and farm mechanics for the vital maintenance of those machinery and provide servicing facilities and spares at the farmers' level as soon as possible. Of course, it will not be possible to provide such facilities through out the whole country by any single organization like Government. But we must create examples, taking selected areas for primary introduction of farm machinery and then, automatically, under simple economic rules, the neighbours will follow the suit gradually and an allout mechanization will be conceivable, at least.

But the country is surely headed for mechanization and the Government, the people and every body there is thinking and working for it, as we simply cannot afford but to do it, failing which, the whole Nation with a rapidly growing population, will face sure starvation in near future. Even at present, it is important to mention here that we are deficit in food production and 10% of our total need amounting to about 1 million per year is to be imported from out side at the cost of precious foreign exchange which this country, with an predominantly Agricultural economy, cannot continue any longer.

In West Pakistan, the conditions are so different regarding holding size, land tenure system, the soil, the crops and even the climate that it needs a separate treatment altogether.

At least, the holding size is much bigger there comparatively, the population is much less per unit area and being in Arid Zone the farming is not at all dependant on a whimsical nature as here. On the contrary, they had to develop a systematic irrigation programme since long past which encouraged the Mechanized farming, at least at a quicker pace then at this wing of the country. In West Pakistan the Mechanization of Agricultural has already taken a definite shape and now they are very eager and have been working hard to develop it further for a total improvement of the conditions there. Specially, regarding bringing more areas under cultivation they have a very big scope for using machines and also to save the Agricultural labour the demand of which has been increasing there for employment in the rapidly growing industries.

But for a detailed account of all these aspects of that wing of Pakistan, it is proposed to discuss it separately at some other occasion.

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on the part of average farmers. All these problems have to be dealt with one by one, before great strides can be made in mechanizing farming operations in Taiwan.

Under the four-year plan beginning in 1970, efforts will be made to improve the quality of agricultural machinery, reduce cost of production, and subsidize farmers for purchasing machines, besides setting up more township agricultural mechanization promotion centers and training more farmer operators for fuller utilization of existing machines. Meantime, the research and development of agricultural machinery will be strengthened through training more research workers and installation of more research facilities in government agencies and agricultural colleges. It is expected that through these efforts the feasibility of large-scale machanized farming in a cooperative manner can be determined for further agricultural development in Taiwan.

Plowing with buffaloes in Southeast Asia

THE PRESENT PROBLEMS AND THE FUTURE OF FARM MECHANIZATION IN THE PHILIPPINES

Reynaldo M. Lantin

INTRODUCTION

The Philippines is basically an agricultural and a developing country. In the three island groups, namely, Luzon, Visayas, and Mindanao, comprising the country the main source of livelihood of the people is farming. Yet, inspite of the modern age of machines, agriculture in the Philippines has been only barely touched by mechanization although some progress has been made during the last decade.

Several factors inter-acting in a complex manner influence the mechanization of the Philippine farms. Except for a few agricultural development programs which indirectly promote mechanization, the government has allowed the progress of mechanization to take its natural course which proceeded at a very slow pace. Indeed, there is a need for a government program to promote mechanization in a systematic and workable manner.

If ever a mechanization program is to be conceived it has to be long-range. It should consider the mistakes of past experiences and the conditions prevailing in the country. The future of mechanization in the Philippines will depend upon how its course is charted, how its program is to be implemeted and how the many and varied factors directly or indirectly affecting the program behave through the years ahead.

THE PRESENT STATUS OF MECHANIZATION IN THE PHILIPPINES

An appraisal of the state of mechanization in the Philippines would necessarily include pertinent information on the land, water and power and machinery resources as well as other related data. Such resources and other factors influence the present situation and would affect the future of mechanization in the Philippines.

Number and size of farms. The Agricultural Census of the Philippines in 1960 shows that the Philippines is basically a country of small farms. The number of farms with sizes of three hectares and below comprises 62.3 percent of the total number of farms. Only 5.6 percent of the total number of farms are above 10 hectares. The details of the number and size of farms are shown in Table 1.

It is estimated that there are as many households as there are farms. One of two farms of sizes less than one hectare are operated by one household. In farms with sizes of more than 100 hectares an average number of 30 households work on the farms or an average of 3.3 hectares per household.

Land ownership. One of the problems confronting the Philippine society is related with the tenancy system. While the landlord normally goes about his work in the town or city, the tenant and his family strive on a subsistence level in the farm. The usual form of management by the landlord is through an overseer or "katiwala" or "encargado". This overseer is oftentimes a tenant himself holding the choice area and usually has a bigger area compared with the other tenants.

Large estates owned by a few rich landowners are often tenanted and are termed "haciendas". It is in rice haciendas where agrarian friction and discontent among farmers arise due to an absentee landlord, and a non-understanding overseer. The farmer is constantly in debt at oftentimes usurious rates.

The land reform program aims to transfer ownership or let the farmer lease the land to the farmer but such a program is hampered by lack of funds and other difficulties in implementation.

Some landlords and tenants have arrangements whereby the landlord buys the equipment which is normally a power tiller and the tenant uses it on a rent to own basis. Rates of interest in these cases vary from zero to usurious ones depending upon the kind of landlord the tenant has.

Table 1. Number of farms by size (1960)a/

Size of Farm (ha.)	Number	Percent
Below 0.2	20,019	0.9
0.2— 0.5	69,074	3.2
0.5— 1.0	160,680	7.4
1.0— 2.0	642,060	29.6
2.0— 3.0	458,914	21.2
3.0— 4.0	253,087	11.7
4.0— 5.0	152,398	7.0
5.0— 10.0	289,730	13.4
10.0— 15.0	86,164	4.0
15.0— 20.0	13,667	0.6
20.0— 25.0	9,788	0.5
25.0— 30.0	7,378	0.3
50.0—100.0	2,466	0.1
100.0—200.0	1,777	0.05
Above 200	1,042	0.05
TOTAL	2,167,644	100.0

a/ Source: Agricultural Census of the Philippines, 1960.

In other landholdings such as sugar estates, the farm is managed normally by the landowner or some hired farm managers. The landowner invests on machinery and equipment and the workers are paid in wages. The landowner sometimes maintains the workers even during the slack season in order to be assured of labor during harvest time when labor is at peak demand. Extra laborers called "sacadas" are hired during such time and recently thier plight and alleged exploitation by their "encargados" and landowners were expressed and have been one of the subjects of student activism.

Power and machinery resources. Human labor and animal power constitute the major source of power in Philippine farms. The total human labor force was estimated to be 11,757,000 in 1966 1/. Of this figure, 10,936,000 or 93% of the total labor force were gainfulty employed; 6,290,000 or 57.5% were employed in agriculture, forestry, hunting, and fishing. Therefore, the unemployed totaled 821,000 or 7% of the total labor force.

Work animals in the Philippines constitute the water buffalo or carabao, cattle,

and horse. The carabao is the most common work animal especially in the wetland rice cultivation. Both cattle and carabao are used for tillage and cultivation work for upland crops and transport of products. The horse is primarily used for transport especially where there are no feeder roads. Table 2 shows the population of work animals from 1960 to 1970.

A small farm would normally have as basic farming equipment a wooden plow, a harrow, a sled, a bolo or knife, ascythe,

Table 2. Number of work animals on the farm, 1960 to 1970. a/

Year	Carabao	Cattle	Horse
1960	2,484,200	252,100	69,200
1961	2,449,500	274,600	70,600
1962	2,249,600	217,200	—
1963	2,298,500	272,700	70,800
1964	2,158,500	335,400	81,500
1965	2,440,000	527,100	100,300
1966	2,734,900	425,000	105,300
1967	2,864,800	389,800	153,700
1968	2,927,200	362,800	99,100
1969	2,361,600	254,900	67,000
1970	3,012,100	305,900	—

a/ Source: Bureau of Agricultural Economics, Department of Agriculture and Natural Resources.

and other small hand tools. The bull cart is common in coconut areas.

In 1960 there were 1,916,207 plows, 1,377,916 harrows and 47,987 sprayers.

The carabao as a main power source develops about 0.75 horsepower although tests have shown that it can develop a little more than one horsepower. Horses and cattle are power sources in upland crop areas and fruit tree areas.

The human labor on the farm consists of the farmer who does the tillage, ditching, hauling, threshing, and other heavy jobs. His helper either his wife or his son or both. The son is young, normally helps in pasturing and feeding the animals and doing chores around the farm. The wife does household work and helps the farmer in some jobs like planting, threshing grain, cleaning, and other light jobs.

Small engines are becoming a mechanical source of power on the farm. A farmer who recognizes the importance of power in the farm would normally like to own a small engine and complementary units the most common of which is a pump. Small engines are normally used in small threshers and rice mills. Those units with electric power generators are found in isolated farms of 50 to 100-hectare size operated by the landowner. Its use is primarily for the provision of electricity in the farm house. Engines with such generators are more for industrial rather than agricultural uses in the Philippines.

Table 3. Number of small engines imported, 1962 to 1968. a/

Year	Diesel	Gasoline and Kerosene	Total
1962	1,073	1,946	3,019
1963	5,369	3,995	9,364
1964	7,707	9,503	17,210
1965	21,389	7,264	28,653
1966	34,273	4,085	38,358
1967	33,771	5,317	39,088
1968	17,560	9,888	27,448
TOTAL	121,142	41,998	163,140

a/Source: Central Bank of the Philippines. Country Report on the Small Engines for Agricultural Purposes.

Table 3 shows the number of small engines imported during the years 1962 to 1968.

A minor source of power used for pumping water is the windmill. Recently, a company started marketing an all-direction windmill but still the use of such has not gained much popularity probably because of strict competition with the small engine and pump sets.

The small tractor is fast becoming a popular piece of farm equipment in Philippine farms. At least five Japanese and one British brands of hand tractors are sold in the Philippines. In a case study of four sociologists from the University of the Philippines, College of Agriculture, the researchers noted that the population of hand tractors has increased over a six-year period. The study oevealed that farm income increased from 33 to 44 per cent because of adoption of improved methods of farming

Riding tractors are the common power sources in larger size farms. According to the 1960 General Census there were a total of 7,921 tractors with a ratio of one tractor per 1,301.5 hectares. In Northern Mindanao, there were 367 tractors with one-half of the number in the province of Bukidnon.

Based upon the survey conducted by the Bureau of Agricultural Economics in 1967, the total number of tractors was 5,252 of which 4,357 were using diesel fuel and 895 were using gasoline. Of the total, 4,792 were wheel type and 460 were crawler type.

In the period from 1966 to 1969 there were 2,083 tractors imported in connection witn the implementation of the farm mechanization loan program of the Central Bank-World Bank (IBRD) through rural banks.

Table 4 shows the number of tractors in 1967 classified according to horsepower rating class.

In addition to existing irrigation pumps and engine, there were 262 pump and engine units imported from 1966 to 1969. Four companies manufacture irrigation pumps in the Philippines.

Rice processing machinery were mostly imported. There are, however, four local companies manufacturing rice hullers and at least one manufacturing cone-type rice mills. There are more than 3,000 cone-type rice mills in the country today.

Table 5 shows the importation of threshers, and hullers and cleaners during the period from 1963–1968.

Farm income. Farm wages vary according to the type of crop produced and according to the type of job being done. Table 6 shows the average daily wage for three years in rice, corn, sugar cane, and tobacco production. No wage date for 1970 are as yet available.

It is estimated that there was an increase in farm wages in 1970 because of the implementation of the floating rate exchange of the peso to the dollar. During the one year period the rate went up from 3.90 to 6.435 peso for one U. S. dollar. The legal minimum wage rate for agricultural workers for 1970 up to the present is 4.75 peso.

Although the farm wages have somewhat increased during the three-year period, the value of the money went down.

Table 4. Number of tractors in 1967. a/

Horsepower Rating	Units
1	12
2	11
3	44
4	136
5	63
6	404
7	226
8	105
9	34
10—14	160
15—19	61
20—39	307
40—59	1,349
60—79	1,046
80—99	747
Unknown	547
TOTAL	5,252

a/Source: Bureau of Agricultural Economics Department of Agriculture and Natural Resources.

Table 5. Number of imported rice processing machinery, 1963—1968. a/

Year	Threshers	Hullers & Cleaners
1963	50	2
1964	70	10
1965	73	10
1966	133	964
1967	278	31
1968	3,844	636
TOTAL	4,448	1,653

a/Source: Central Bank of the Philippines. Country Report on the Philippines Rice Processing Machinery Manufacturing Indsutry.

Table 6. Average daily wage rate in Philippine pesos (US $1.00=3.90 peso) corn, sugar cane, and tobacco production.a/

Kind of Work	Rice			Corn			Sugr Cane			Tobacco		
	1967	1968	1969	1967	1968	1969	1967	1968	1969	1967	1968	1969
Plowman (with carabao)	4.25	4.50	4.78	3.67	3.58	4.42	3.67	3.58	4.24	3.67	3.58	4.41
Plowman (with riding tractor)	5.94	5.63	6.22	—	—	6.28	—	—	6.74	—	—	7.00
Plowman (with walking tractor)	—	—	5.78	—	—	5.51	—	—	5.17	—	—	6.37
Planter	3.66	3.06	2.93	2.89	2.91	2.48	2.89	2.91	2.74	2.59	2.69	2.88
Weeder	2.90	3.35	2.72	—	—	2.81	3.16	4.29	3.01	3.46	5.04	3.16
Sprayer	3.11	—	3.05	—	—	2.95	—	—	3.30	3.18	—	3.24
Harvester	3.61	3.51	3.14	3.54	2.78	2.98	—	4.39	3.18	2.93	—	2.64

a/Source: Bureau of Agricultural Economics, Department of Agriculture and Natural Resources

With the floating rate become more of an impossibility for the farmer because of increased prices.

Even with credit facilities, the farmer has to put up a large collateral for the amount he will borrow. With too much bureaucracy in government lending facilities, the small farmer almost does not take advantage of such.

The picture of farm income is somewhat changing for the better because more and more farmers begin to recognize the role played by modern inputs like chemicals, fertilizers, weeding, straight-row planting, and others. In a survey made of a barrio, the increase in income was attributed by the farmers themselves to the increased harvests.

Increased income by the farmers contribute to the promotion of mechanization because of the potential of the farmer to pay for the extra investments.

Soil, field and climate. The Philippines is located in the typhoon belt. An average of 20 typhoons hit the country every year with a few causing severe and devastating effects. During the rainy season, the cultivation of upland crops become very difficult unless tillage and planting are well-timed. It is at the onset of rainy season that upland fields become busy especially if these fields are nonirrigated. The necessity of timely performance of farm operations in the upland fields to obviate the effects of the monsoon rains and the typhoon, provides a rational for the greater need of mechanizing the farm.

Difficulties in flooded rice paddies include traction, and flotation problems. Although such problems are partly solved by the use of special wheels, bogging down especially by large tractors in places with deep or without hardpans are still to be solved. Better design of such wheels and other traction aids, tractors, and implements are needed.

Water resources. Irrigation water is a necessary input in the production of crops. The availability of water is a factor in the promotion of mechanization.

The aggregate area of irrigated lands in the Philippines developed by government agencies and the private sector is categorized below 2/

AGENCY	HECTARES
National Irrigation Administration	601,000
Irrigation Service Unit	169,000
Presidential Assistant on Community Development	86,000
Agricultural Productivity Commission	6,000
Private Sector (Community Irrigation Systems, etc.)	225,000
TOTAL	1,087,000

Private programs and projecting farm mechanization. In general, rich farmers or landowners tend to mechanize their farms. Since they normally have the necessary capital or credit line from banks and other lending institutions, they have greater capacity to purchase tractors and equipment. Large farms like corn, sugar cane, and pineapple which are mechanized are the most productive ones. The number of such farms, however, are few.

There are private farm development projects wherein agricultural machinery are loaned to the farmers who are closely supervised by qualified farm management. Such a scheme helps the farmers increase their farm income through greater productivity without being hampered by capital outlay for machinery. Such projects are few and on a test pilot basis, but in general, are somewhat successful.

Modern grain processing projects employ almost fully mechanized handling of grains. The integrated rice processing project is Bay, Laguna employs mechanized operations. In small rice milling enterprises handling and most other operations are done by hand.

Most private large farm projects are complementary with some kind of crop, food, or feed processing industry either owned by the same management or under contract with a processing company. Therefore, the produce from such farms always have a ready market and operations are not hampered by fluctuating prices of consumer goods. Most gugar milling, pineapple canning, vegetable canning and other food processing industries also own farms to at least partly support their mills or factories.

Small farms under contract with such companies are compelled to produce high quality products or are provided with incentives to produce more because of assured prices and markets. For example, the mentioned integrated rice processing project in Bay, Laguna has provided incentives to farmers in Laguna and even in farther provinces to produce high quality and high producing varieties specified by the company. To intensify their rice production, farmers become eager to own at least a power tiller. Such a sincere desire is important in the attainment of mechanization of his farm.

WHAT MECHANIZATION SHOULD ACCOMPLISH

The introduction of mechanization in a developing country such as the Philippines should lead towards more productivity and profit for the farmer. Other benefits derived from mechanization are of secondary importance in the present stage of development especially in small farms. Unless its management is done haphazardly, mechanization will not worsen the present situation that a small farmer is encountering. In fact, if the introduction is well-managed and well-thought there should be increased benefits for the farmer.

Mechanization does not necessarily increase the yield per unit area but should increase the overall productivity by enabling the farmer to plant crops on time and hence more crops per year at a lower cost of production. Mechanization, therefore, provides an opportunity for the farmer to intensify his farming. On the other hand, a small farmer needs to intensify his farming to justify mechanization. Therefore, they should be complementary with the result in giving the farmer a better standard of living.

Mechanization should not lead to over-investment such that the farmer could not get back the cost of machinery. In such a case, mechanization does more harm than good because it leads to an economic inbalance to the farmer himself.

In the introduction of mechanization, the labor force should be absorbed by an industry or industries created relative to mechanization itself. Since mechanization eases up labor for devotion to other activites, such activities could be either wholesome leisure thereby increasing the standard of living, or other productive activities such as cottage industries or other farming enterprises such as poultry and livestock raising. Mechanization, in other words, should not displace labor.

On the contrary, its introduction should be such that it should directly and indirectly absorb labor. Therefore, a well-designed and well-planned mechanization program should be conceived in order to derive benefits and avoid bad consequences.

Mechanization in the past were introduced haphazardly and because of several isolated bad effects, mechanization has never caught up as fast as it should in the Philippines.

PRESENT PROBLEMS OF MECHANIZATION

Although the Philippine government desires that its farms be mechanized in order to increase productivity, the mechanization of Philippine farms is hampered by several problems many of which cannot be solved even for a few years.

1. **Expensive mechanical power source, equipment, spare parts and service.** The capital investment for even a small farm is quite high because most mechanized equipment are imported. The low rate of exchange of the Philippine peso and the taxes imposed on the equipment contribute to the high costs. In small farms where production is low, complete payment for machinery may not be attained and therefore, mechanization becomes a losing underaking. If, however, intensified farming such as multiple cropping is practiced, the investment for machinery may be recovered in two years or less because increased income from such system.

Even if some equipment were locally manufactured, the cost would still be high because of the high cost of raw materials and high capital investment in manufacturing since manufacturing equipment are imported.

Materials of construction should take advantage of native materials. With simple design and excellent craftsmanship the equipment could be of high quality.

Small factories located in the barrios rather than in the cities would involve less overhead costs and would have the advantage of introducing the rural people and youth to the manufacturing activities. Power source need not be a problem in electrified barrios. The start could be modest and the program should include rapid expansion. Machinery produced could be evaluated right in the barrio and with the farmers in close cooperation.

A particular machine may be manufactured in two or three models, the basic differences of which are cost and degree of sophistication. For example, one model could be a very simple hand or animal-operated machine while a third model could be a PTO driven high capacity one intended for large farms. A small farmer can trade-in or sell his simple machine as his status increases due to increased income and they buy the next expensive model.

2. **Inadequacy in design of available equipment.** What makes most imported farm equipment all the more expensive is their inefficiency in working under local conditions. Some modifications and redesigning have to be done to make such machines at least functional. This situation has been the result of a lack of suitable testing and evaluation program to find out the efficacy of imported equipment.

3. **Low level of technology for mechanical operations.** The educational attainment of most farmers in the Philippines is at most elementary education. By the process of natural selection the farmers are the ones who have little mechanical aptitude. Those who have such aptitude normally go to the town or city and get employed or have part-time job in driving, shop repair, welding, carpentry, craftswork, etc. The farmers have little or no exposure at all to the modern machines for the farm and as such he is hesitant to even try handling a powered equipment. A program of farmer education in handling and managing farm machinery is a must in a mechanization program.

4. **Tenancy system.** With the tenancy system in most Philippine farms innovations are difficult to attain. An absentee landlord who does not care at all in making improvements in farm operations is a serious problem. In the present Land Reform Code, leaseholding is provided, but implementation is hampered by lack of funds. Recently, there is a move to provide the farmer with inputs because from experience ownership and tenure of land alone did little increasing productivity.

5. **Inadequate machinery manufacturing technology.** The proportion of engineering graduates especially mechanical and agricultural engineering to other career graduates is very small. In a country where manufacturing and engineering technology is needed, more students should be attracted to the engineering profession through scholarships and other incentives given toqualifed ones. Reshaping of the curricula to emphasize manufacturing technology and machinery design would be relevant to the present needs of the country. Although steps are being made towards these, the pacing is slow.

6. **Technical problems.** Many technical problems in machinery operations need to be solved through research. For example, the most efficient design for wheels to work in flooded rice fields, transplanters, harrows and rotary tillers, weeders, sprayers, threshers and other machines to work in the upland and wetland fields are still needed.

The economic and social aspects of mechanization need to be further investigated and researches in these areas are being undertaken. More extensive researches on agro-climatic problems and man-machine relationships are a requirement in mechanization program.

The formulation of a suitable mechanization program for the country needs a wealth of technical, economic, social, political, educational and other data.

7. **Problems related to irrigation of farms.** The development of irrigation is beset by problems in financing problems related to the improvement of irrigation service, inadequate credit for farmers, problems pertaining to the improvement of the farms, problems in marketing and other minor ones.

8. **Other problems.** Other problems of mechanization are related with the economic, social, and political developments in the ocuntry. For example, the floating rate exchange of the Philippine peso gives uncertainty to prices especially those of imported items like farm engines, machinery, and spare parts. The sales of tractors has sharply declined since the implementation of the rate.

With regards to peace, order, and security in places where cattle and carabao rustling are unchecked, the farmers turn to contract mechanical plowing and harrowing of their farms because of lack of work animals.

GOVERNMENT PROGRAMS AND POLICIES AFFECTING FARM MECHANIZATION

The Philippine government is aware of the importance of and the benefits to be derived from mechanization of the farms whether these farms are large or small. It has therefore set some programs to promote farm mechanization.

1. **Incentive to manufacture agricultural machinery.** The Board of Investments which was created for the promotion of investments in the Philippines gives some incentives to pioneer industries. The manufacture of small engines for agricultural uses belongs to the top priority of support. The pioneer status of such an industry entitles it to priveleges which include.

a. Tax-free importation of manufacturing equipment
b. Anti-dumping protection
c. Remittance of earning and repatriation of investment
d. Accelerated depreciation
e. Net loss carry-over
f. Post operative tariff protection

In spite of such incentives, however,

only two companies registered with the Board of Investments. Due to the pioneer status of such manufacture of small engines in the Philippines companies who try to venture in this area normally tie up with established foreign firms as a start for technical and financial reasons. In order to ease up difficulties in such a pioneer industry the company is given a period of at least five years to progressively increase the local content of the products being manufactured. So far, production of such small engines has not reached for the marketing stage.

Another mechanization-related industry which are provided with investment incentives is the setting up of integrated rice processing equipment. Grain dryers, rice mills, and equipment necessary for grain handling, storage and marketing are included in such an integrated grain processing facility. The first of such an integrated rice processing facility was inaugrated in December, 1970 and is now being under operation although not at full capacity of 20 tons of rice per hour for at least eight hours.

2. Credit facilities to finance farm machinery. In 1968 the International Bank for Reconstruction and Development or the World Bank granted the Philippine government a loan of $ 5 million to finance the purchase of farm machinery by farmers through the rural banks.

Very recently, the World Bank granted a loan amounting to $ 16.5 million for the support of the grain processing industry. Investors may take advantage of this loan through the Development Bank of the Philippines.

Other typer of credit in the form of relatively smaller loans are available from the Agricultural Credit Administration. Farmers can avail of these loans for the purchase not only of machinery but also of fertilizer, seeds, chemicals, and other necessary inputs to the farm.

In spite, however, of less strict requirements compared with other lending institutions, many farmers still are not able to meet such requirements, so much so, that those who badly need loans are not granted. What, perhaps, is needed is a big slash on red tape and on so many other requirements, if really and with sincerity, the small farmers are to be helped. Instead of strict requirements, very colse supervision by qualified agricultural personnel on the use of credit for the farm may be more effective. Work of such personnel will be on an advisory and supervisory nature on the activities of the farmer. He would be responsible in seeing to it that the farmer through improved methods and proper farming management including mechanization would be able to pay the loan promptly.

3. Long term loans with foreign governments. The government of Denmark has agreed to loan the Philippine governmet an amount equal to $4 million with 20 years to pay. The agreement lcovers a purchase of 2,000 diesel engines and 2,000 diesel engine and water pump sets consisting of 4-inch and 5-inch pumps from Denmark. Because of the expressed Philippine government policy for promoting local manufacture of pumps, the pumps are to be manufactured initially. The loan is to be administered through tne Development Bank of the Philippines where the farmer or farmer cooperatives apply for loans. The technological aspect of design, installation and supervision will be provided by the Irrigation Service Unit. The loan has practically no interest payable in 7 years. The total dynamic head of the pumps is 35 feet and the discharge is 300 gallons per minute. A normal installation would cost between 7,000 and 9,000 peso.

4. Irrigation program. A four-year development program aims to irrigate an additional 330,000 hectares. This program is currently under implementation.

THE FUTURE OF FARM MECHANIZATION

One can only guess about the outcome of mechanization for say in the next decade in the Philippines. If there is a workable farm mechanization plan which can be implemented, then the guesswork is more or less educated. As of now, no viable plan is at hand and the so-called mechanization of Philippine farms only follows its natural course.

The few development programs of the government are not integrated towards a common goal. Consideration of the problems related to mechanization by way of providing solutions are necessary for an effective mechanization plan. Many other programs of the government makes mechanization only incidental.

Very important in the mechanization program is the increasing [of the productive potential of a farm. Irrigation system makes the possibility of a year round production as in multiple cropping. Also to be considered is the education of the farmer of modern methods through extension work or some training programs. Feeder roads to transport products increases the efficiency of production. If the production potential is increased then payment capacity of the farmer for the equipment is increased. Unless production can pay for the capital investment in mechanization it would be unwise to go to mechanized farming for mechanization's sake.

Research on agricultural machinery covering design development, testing and evaluation, machinery management and all other aspects of mechanization for the Philippine farms should be undertaken. Research in farm machinery is being undertaken by a few institution such as the International Rice Research Institute and the University of the Philippines, College of Agriculture. Private companies have practically no research program aside perhaps from investigations of special problems they encounter in connection with the farm equipment which they deal. It is to be seen that some kind of a full-time research institution like the Institute of Agricultural Machinery in Japan and the National Institution /of Agricultural Machinery in England is needed for the Philippines.

The education of agricultural engineers with specialization in machinery design, machinery management irrigation and drainage agricultural land development and crop processing should be supported by a scholarship program to attract bright young students from high school. Upon their graduation, they should be capable of setting the leadership in machinery manufacturing, research, education, and promotion of mechanization in Philippre farms. In order for them to follow this through, incentives should be given to them to make the proper initiations. Examples are credit facilities for capital and provision of an environment for them to practice their profession.

Although the government has a manpower training program, quality graduates of engineering technicians are yet to be seen. Such technicians provide the agricultural engineer the partner to follow through his plan of action to help in mechanization.

Progressive manufacturing of farm equipment in the Philippines is necessary for the realization of a successful mechanization program. The manufacturing industry together with the related indusries created will be able to absorb the labor force digplaced by mechanization. This is apart from introducing mechanization through importation because if such is done in full scale, no industry would be able to absorb the displaced labor. The fact that manufacturing starts on a small scale basis and originates from the barrio will condition there with mechanical aptitude to gradually comprehend the mechanics of manufacturing.

A farm electrification program is essential in farm mechanization. The Philippine Congress has a pending bill supporting rural electrification. This is one way of providing cheap power to community households.

(*Continued on page* 37)

Rice transplanting machines—a terminal of rice crop mechanization are spreading in Japan

PRESENT PROBLEMS AND THE FUTURE OF AGRICULTURAL MECHANIZATION IN TAIWAN, REPUBLIC OF CHINA

Tien-song Peng

I. Past situation

In the past, the development pattern of agriculture in Taiwan was the better utilization of labor slack in agriculture, and labor intensive cultivation was stressed under the pressure of mounting population in recent years.

Since 1965, after three successive economic development plans, Taiwan's economy has turned to another phase of development, marking the end of labor slack in face of rapid industrialization. Under the Government policy of enlarging the capacity of industrial labor absorption, Taiwan's agriculture has been experiencing labor shortage for the first time in its history. The transformation of agricultural structure has hastened the tempo of agricultural mechanization since then.

Over the past decade the agricultural mechanization program initated by the Joint Commission on Rural Reconstruction has been progressing steadily to keep pace with the agricultural and industrial development in Taiwan. For instance, the number of power tillers for land preparation is now increasing at the rate of about 4,000 units a year, and up to the end of 1969 there are more than 24,000 power tillers in use in rural Taiwan. It is estimated that 40,000 more units are needed in the very near future in order to cope with the problem of labor shortage. The increased number of power tillers has brought about a yearly decrease of some 10,000 head of draft animals, as shown in Table 1.

Besides power tillers, the number of other farm machines, such as power sprayers, power threshers, water pumps, etc., are also on the increase in the rural areas, while the demand for other machines is growing steadily for mechanizing other farm operations (Table 2).

II. Present problems

Agriculture in Taiwan has been advanced to the stage that agricultural mechanization is bound to gain in popularity for the replacement of not only animal labor but also human labor being absorbed by the booming industry. However, many factors have to be considered prior to the introduction of any type of agricultural machinery, and meantime many problems remain to be solved.

A. Technical problems

1) **Land and soil**

It is an established fact that climate, land, types of soil, kinds of crops, farm management and economic status of a farmer are the factors to be taken into account in the introduction of agricultural machinery. However, it is considered that types of soil affect greatly the design and the durability of tilling machines such as power tillers.

The texture of soils in Taiwan is closely related to the nature of parent rocks. The slate alluvial soils and the mudstone alluvial soils in the southern part are probably the heaviest soils in Taiwan, ranging from loamy clay to silty clay loam. The sandstone and slate alluvial soils in northern and central Taiwan are from sandy loam to loam. The soils in the eastern valley vary in texture, but they are, for most part, loamy soils. Generally speaking, most soils in Taiwan are of loamy texture, and sandy soils are generally confined to a limited area along the sea coast. The heavy soils of slate and mudstone parent materials seldom contain over 40 percent of clay particles. Therefore, the soils in Taiwan (Table 3), with few local exceptions,

Table 1. The increase of power tillers and the decrease of draft animals in Taiwan

Year	Total (unit)	No. of power tillers					No. of draft animals
		Made locally	Imported	Horsepower			
				Under 5	5 – 8	Above 8	
		(%)	(%)	(%)	(%)	(%)	
1960	3,708	46.17	53.83	34.87	38.59	26.54	417,122
61	5,313	41.05	58.95	26.71	45.66	27.63	414,208
62	7,504	46.74	53.26	21.60	49.95	28.45	405,056
63	9,079	51.90	48.10	19.23	53.25	27.25	389,448
64	10,201	57.04	42.96	17.67	50.91	31.42	379,973
65	12,213	63.15	36.85	15.88	50.52	33.60	370,370
66	14,272	68.46	31.54	14.28	49.37	36.35	360,294
67	17,240	73.80	26.20	13.13	42.52	44.35	337,878
68	21,153	78.61	21.39	11.60	35.15	53.25	323,085
69	24,640	81.73	18.27	10.79	30.96	58.25	305,237

Table 2. Numbers of major agricultural machinery/implements in use in Taiwan

	Power sprayer	Hand sprayer	Hand duster	Rice thresher	Pump	Grain dryer
1960	317	104,150	10,803	177,338	8,378	—
61	966	115,699	10,337	181,693	10,114	—
62	804	125,899	9,517	184,244	11,678	—
63	1,028	139,439	12,764	193,772	19,728	—
64	2,949	147,954	15,822	203,329	28,654	—
65	4,489	161,506	13,558	205,784	32,107	—
66	6,123	166,817	16,788	194,247	35,301	—
67	9,734	180,780	21,886	204,337	42,330	210
68	12,901	180,477	19,121	201,706	49,310	470
69	14,791	181,576	22,421	198,504	52,037	1,699

Table 3. Types of soil on the arable land of Taiwan

County	Sand and loamy sand		Sandy loam		Loam, silt loam and silt		Clay loam, sandy clay & silty clay loam		Sandy clay, silty clay, clay	
	%	Area(ha)	%	Area(ha)	%	Area(ha)	%	Area(ha)	%	Area(ha)
Taipei	0.75	269.5	19.34	6948.9	43.45	15611.6	36.02	12942.0	0.45	161.7
Taoyuan	2.54	1399.8	18.13	9991.4	26.15	14411.3	52.98	29197.3	0.20	110.2
Hsinchu	0.31	163.8	45.62	24101.0	35.36	18680.7	18.41	9726.0	0.30	158.5
Miaoli	2.17	1139.0	66.29	34795.6	20.33	10671.2	11.15	5852.6	0.06	31.5
Taichung	0.26	120.2	22.04	10189.1	70.28	32490.4	7.42	3430.3	—	—
Changhua	1.76	1178.7	41.03	27477.8	2.96	1982.3	54.35	36398.2	—	—
Yunlin	1.92	1665.6	57.40	49794.5	39.86	34578.6	0.82	711.4	—	—
Nantou	0.06	20.5	11.40	3898.8	48.80	16689.6	39.71	13580.8	—	—
Chiayi	0.30	212.6	38.25	27107.8	56.24	39857.3	5.21	3692.3	—	—
Tainan	—	—	39.36	38072.9	60.64	58657.1	—	—	—	—
Kaohsiung	0.65	343.6	26.35	13928.6	50.81	26858.2	22.17	11719.1	—	—
Pingtung	2.07	1395.2	34.35	23151.9	49.41	33302.3	14.44	9732.6	—	—
Taitung	0.35	99.6	16.56	4711.3	53.28	15158.2	29.80	8478.1	—	—
Hualien	0.19	46.4	33.81	8259.8	43.51	10629.5	21.49	5250.0	—	—
Yilan	0.07	10.6	16.49	2489.9	83.04	12539.0	0.40	60.4	—	—
Total (ha)	8065.1		284919.3		342117.3		150771.1		461.9	
Total (%)	1.02		36.23		43.51		19.17		0.04	

Table 4. Production and operation of the two principal power tiller plants in Taiwan

	China Agricultural Machinery Co., Ltd.	Hsin Taiwan Agri. Machinery Co., Ltd.
a) Production capacity	2,400 units/yr	2,400 units/yr
b) Actual production-1969	1,153 〃	2,055 〃
68	1,844 〃	1,670 〃
67	1,572 〃	1,268 〃
66	930 〃	996 〃
65	702 〃	876 〃
64	490 〃	741 〃
63	604 〃	373 〃
62	673 〃	618 〃
61	229 〃	79 〃
c) Total fixed capital investment(NT $)	54,000,000	27,000,000
d) Local investment-bank(%)	44.4	12.22
-others(%)	18.6	19.72
e) Japanese investment(%)	37.0	68.06
f) Employment (approx.)	450	360

pose no or little problem to the utilization of agricultural machines.

Although sticky soil comprises less than 20 percent of the total arable land in Taiwan, yet the design of agricultural machines introduced from abroad has to be strengthened in order to suit the local conditions. For instance, about 30 items of the Japanese power tiller such as rotary shaft, frame for setting engine, bearings, seals, gear casings, etc., have been strengthened when the machine was manufactured locally.

2) **Climate and crops**

The climate, kinds of crops and farmers' customary practices also have something to do with the adaptability of a machine. For example, the Japanese-type small rice combine does not function quite well during trials, especially its cleaning device which does not perform properly when the moisture content of the grain is too high during the early morning or after a rainfall. However, most of the paddy fields in Taiwan are too soft at the harvesting time to support heavy machines; and the small, uneven land tracts makes the use of the machine less practical and inefficient, in addition to higher grain loss. To fully utilize this machine will require either a new variety of rice or a change in the field size, as the present rice varieties in Taiwan were originally developed for easy threshing by manual labor.

3) **Farmers' customary practices**

Speaking of farmers' customary practices, the rice farmers of Taiwan used to leave stubble and part of straw in the field, so the rotary tine of power tiller will not plow deeply enough and consume more power if it is not equipped with a straw-loosing device on the rotary shaft.

B. Problems concerning marketing of farm machinery

1) **High cost of machinery**

There are two major agricultural machinery manufacturers in Taiwan, which cooperate technically with two Japanese agricultural machinery companies, to produce power tillers and other farm machines with some parts imported. The production and operation of the two manufacturers of power tillers are shown in Table 4.

In spite of the increasing demand for farm machinery by Taiwan farmers, prices of farm machines, especially power tillers, produced by local manufacturers are generally beyond the financial capacity of average farmer. For instance, the average price of a locally made power tiller is about 30 percent higher than that of the same type sold in Japan. Higher interest rates, the turnout of a small number of products and poor management are the main reasons for the high cost of machinery produced.

Besides the higher first cost to obtain farm machines, most of the farmers who own farm machines have to pay a stiff rate of interest on bank loans at an average annual rate of 11.52 percent.

2) **Small-scale farming and fragmentation of land**

The average size of land owned by the farmers in Taiwan only amounts to one hectare, thereby constituting a factor limiting the full use of power machines. On the other hand, the area of arable land totalling some 900,000 hectares is cultivated at least once or twice a year; so the work of land preparation, pest control, fertilization, harvesting, etc., must be completed at short intervals. Here the advantage of cooperative use of the machine is worthy of serious consideration. In fact, some farmers had jointly purchased farm machines for cooperative use, and many machine owners have found it profitable to work for their neighbors on a remunerative basis during their leisure hours.

Small-sized plots and a labyrinth of footpaths in the paddy fields render the farm machinery extension work doubly hard. Under a government program of land consolidation in recent years, about 200,000 hectares of the small fields have been consolidated to facilitate agricultural mechanization. More paddy fields are scheduled to be consolidated to expedite the agricultural mechanization program in the near future.

3) **Low purchasing power of average farmers**

In Taiwan today, the prices of fertilizers, pesticides and agricultural machinery are relatively high, in comparison with the returns a farmer gets for his farm produce. Although the successfully

implemented land reform program in Taiwan has enriched the farmer's livilihood and enhanced their interest in raising agricultural productivity through technological improvements, yet, since 1965, the structure of agriculture has had a marked change as a result of rapid development of industry, which has increased the cost of production to the extent that the total agricultural output has been lowered even with relatively larger capital input in recent years, as shown in Table 5.

Table 5. Annual changes in output and input of Taiwan's agriculture

Items	1952 – 1964	1965 – 1968
Total output	4.19	3.01
Total input	1.74	4.18
Crop area	0.80	0.19
Labor input	1.25	0.55
Chemical fertilizer	5.84	9.70
Feed input	4.83	15.68
Implement and depreciation on farm equipment and buildings	2.31	8.16
Multiple cropping index	0.71	−0.20
Crop yield index	3.33	1.40
Land productivity per hectare	4.15	2.62

Source: Compiled by Rural Economic Division, JCRR

4) Farm population not mechanically-minded

The average farmer, as a rule, lacks mechanical sense. Thus, the bottleneck to agricultural mechanization can only be removed through unfolding an extensive program of educating the rural population. To help the farmers as well as the basic-level agricultural extension workers know more about agricultural machinery, the government agricultural agencies, in collaboration with the agricultural colleges and farmers' associations, have conducted many training classes with good results as reflected in the increased number of farm machine owners.

5) Diversified and intensified cropping systems

Almost all the small farms in Taiwan are run in a diversified way without much use of specialized machinery. Under the intensive cropping system, farmers grow one orop after another and practise relay-interplanting before the harvest of the previous crop. For this reason, compact machines that can be maneuverable between rows are what a farmer needs. However, due to the increase in farm labor wages in recent years, the intensive cropping system has been rendered less intensive.

6) Lack of after-service for machines

As farm machines are used on various kinds of soils and crops and operated by farmers who are devoid of operating skills, the machines are liable to be damaged if improperly handled. So, it is important to keep the machines in good condition all the time, especially during the time of farming. In other words, the afterservice to keep the machines in good repair is so important to the manufacturers that a lack of such service not only affects the performance of machines but also shakes the confidence of farmers in them. Since Taiwan grows more than two crops a year and the interval between two crops is rather short, the time-table of farming may suffer some delay once the machine is broken down during the busy farming season.

In the early days when many types of power tillers were available on the local market, there were more than thirty brands of power tillers used by Taiwan farmers. Though each brand was of a small number, the owners spread all over the island, and the after-service was totally lacking. After most of the small manufacturers stopped producing power tillers and no more such machine was imported, there were many machines in need of after-service.

The change in models or improvement made on the designs of imported agricultural machines are relatively fast. Thus, it renders the after-care of machines difficult for lack of spare parts due to the limited number of each brand or model imported. Moreover, the designs of some newly developed machines are too complicated to be handled by individual farmers. For instance, the most popular power tiller model made in Japan with 6 forward speeds and two backward speeds for tillage seems to be too complicated in design to be operated by the general farm population. If the machine can be so designed that it will be handled easily by the average farmer it will be in good demand and the problem of after-care will relatively simple.

C. Problems concerning supply of farm machinery

1) Lack of suitable farm machines

Up to the present, farm machines in use are mainly for land preparation, pest control, water pumping, transportation of farm products, and, on a small scale, grain drying, rice transplanting and rice harvesting, but machines for other farm operations, such as, seeding, transplanting, fertilizer application, cultivation, harvesting of different crops are still lacking. Furthermore, modifications have to be made on most of the imported machines in order to make them adaptable to local conditions.

2) Lack of manufacturing techniques and limited capitalization

There are many family-sized machine shops engaging in the manufacture of agricultural machinery and implements. Without saying, these small manufacturers do not have qualified engineers as well as sufficient capital to produce machinery of good quality. For lack of an effective quality control system and unavailability of precision, manufacturing and inspection tools, one can not expect them to produce things of superior quality, unless technical guidance can be given to raise the work efficiency of the machine shops. And the small factories are generally short of operation funds and have to pay high interests for loans from private sources, thus making them unable to produce lower priced products.

In the early days when power tillers were in great demand in Taiwan, the inexperienced small manufacturers tried blindly to copy foreign models, but failed to produce serviceable power tillers, and thus became bankrupt in face of cut-throat competition. The situation has since been much improved after the local industrialists have absorbed manufacturing techniques, experience and foreign investment to set up two larger factories to produce power tillers and other agricultural machines in Taiwan.

3) Insufficient number of qualified engineers

As most farmers in Taiwan are still not mechanically minded and the machines are apt to be overworked during the busy farming season, the introduced machines are usually in need of modifications in order to fully meet the local demands. Although government agencies and agricultural machinery manufacturers have their own groups of agricultural machinery research personnel trying to improve the performance of oexisting machines and develop new ones, yet due to the very limited number of qualified research engineers, the work progress has been rather slow.

4) Limited production and high interest rate of bank loans

Owing to the limited domestic market at present and high interest rates of bank loans, the cost of manufacturing an agricultural machine is high and actually too high for the individual farmer to own, thus accounting for the smaller number of machines sold. So, in order to expand the local market for agricultural machines the price has to be

lowered. Meantime, the bank authorities should reduce the rate of interest on loans to local manufacturers as well as to farmers.

5) **Heavy burden of maintaining after-service**

Most of the farmers who got their farm machines from making bank loans are anxious to render paid service to others in order to make more money to pay for loans. According to a recent survey, about 55.7 percent of the total hours spent in a year by owners of large type power tillers were devoted to working for others for additional income (Table 6).

Because of the short interval between two crops and a tight farming timetable, each farming operation has to be done within a certain period. But when the number of agricultural machines has been increased to the extent that the competition among machine owners for rendering paid service to others would become very keen and the profit less and less. On the other hand, to reap more profit the machine owners are apt to use the machines as long as possible during the farming season. So, under such prolonged utilization by unskilled hands, the machines have to be well taken care of by the manufacturers and/or their selling agents stationed at principal townships for rendering after-service to the machine owners, otherwise the extension activities of the agents would be greatly affected. This naturally imposes a heavy burden on the manufacturers.

6) **Lack of standardization of machine parts and attachments**

There is a growing demand among the local agricultural machinery manufacturers and concerned government agencies for standardizing certain agricultural machine parts and attachments which are not interchangeable due to too many different brands of the same item. This problem can only be solved through the combined efforts of the government agencies and manufacturers.

III. Implementation of a four-year plan

For expediting the agricultural mechanization program in Taiwan, a four-year plan has been mapped out by the Government in 1970. One of the important steps taken is to lower the price and improve the quality of agricultural machines manufactured locally. It is expected that more long-term, low-interest loans, besides government subsidies, will soon be made available to the local farmers, an indispensable step towards agricultural mechanization. The salient points of the plan may be briefly described as follows:

A. Type and number of farm machinery

For the four-year period, it is planned to extend some 120,000 sets of fram machines such as power tiller, sprayer, thresher, combine and dryer, with the power tiller constituting the major type of farm machinery. The number of power tiller sets to be extended is tentatively set at 6,000 for the first year, 8,000 for the second year, 11,000 for the third year and 15,000 for the fourth year.

B. Measure to be taken

1) **To improve machine quality and reduce production cost**

The prices of locally made farm machines are on an average about 30 percent higher than those of the same types sold in Japan. Under the four-year plan the prices of power tiller and other machines have been lowered about 10 percent. Meanwhile, the Government is making plans to strengthen inspection of farm machines, supervision of manufacturers and improvement of machine quality.

2) **To subsidize farmers for purchase of farm machines**

Through government subsidies, farmers will be enabled to purchase more farm machines, such as power tiller, rice transplanter, small rice combine, grain dryer, power reaper, sprayer, etc., for adoption of mechanized farming operations.

3) **To set up more township agricultural mechanization promotion centers**

The existing township agricultural mechanization promotion centers numbered 24 will be strengthened, and 30 more such centers will be established according to the plan by recruiting more qualified technicians and providing more facilities for servicing different kinds of farm machines. Meanwhile, efforts are to be made to fully utilize the existing machines and train more farmer operators. And a farmers' training center will be established for young farmers to learn the skill in using farm machinery as well as to disseminate the general agricultural knowledge.

4) **To strengthen research and train more research workers**

The research work on farm machinery can only be strengthened through recruitment of more qualified research workers and installation of more research facilities in government agencies and universities currently engaged in agricultural machinery research. It is planned that a large group of technicians or research workers are to be sent abroad or to local universities for advanced study or short course training in the immediate future. For training engineers to conduct the research work, the establishment of an agricultural mechanization research institute is under planning.

5) **To speed up modernization of agriculture in selected areas**

A pilot project is underway to use still bigger and highly efficient farm machines, especially wheel tractors, in some selected areas where the land is suitable for using such machines cooperatively. At present a tract 100 hectares in size has been laid out for establishing a cooperative mechanized farming unit. Our immediate plan is to develop mechanized farming by making use of small machines, and at the same time adopt bigger machines for demonstration, in hopes that the transition stage from manual labor to mechanical farming operation can be shortened.

IV. Conclusion

The program on agricultural mechanization for increasing the land productivity and for better utilization of farm labor is progressing steadily, and a four-year plan has been set afoot for accelerated extension of mechanized farming in order to offset the labor shortage which is being increasingly felt in Taiwan.

In the implementation of the program, however, there are still many technical and socio-economic problems, such as insufficient number of qualified technical personnel, lmited capital input of local agricultural machinery manufacturers, high cost of production, family-sized farms and fragmentation of land, diversified and intensified cropping system, low purchasing power of individual farm families, and lack of mechanical sense

(*Continued on page* 101)

Table 6. Utilization of power tillers in Taiwan

	Large tiller		Medium-small tiller	
	hrs/yr	%	hrs/yr	%
Work on own farms:				
Tillage	230.1	26.81	327.5	54.03
Transportation	92.8	10.81	104.3	17.21
Work for other:				
Tillage	329.3	45.72	102.9	16.98
Transportation	85.5	9.96	33.6	5.54
Other	57.5	6.70	37.8	6.24
Total	858.2	100.00	606.1	100.00

The Present Problems and Future Agricultural Mechanization in Thailand

Anusorn Boon-it

Farm Land

Thailand has a land area of 321,250,000 rai, of which 23.53 percent of the total area is the farm land. Approximately 82 percent or four-fifth of the total farm holding is under cultivation ; wood land occupies 8.03 percent, other uses about 9.24 percent; forest area makes up 56.23 percent of the total country area swamps and unclassified land occupied 0.53 percent and 19.71 percent respectively. (TableI)

The irrigation system covers a total area of about 14 million rai or about 20 percent of the total area. Out of this 14 million rai about 12 million rai is covered by major irrigation projects

Population

The total population of Thailand is 27.09 millions according to the statistics in 1960 and over 34.5 millions in 1970 (The last census of National Statistic offiice and the birth rate from 1960–1970 is 2.7. The agricultural labor force occupies 81.6 percent in 1960 and now it is approximately 76 percent. However, it happens that from 1960–1970 the agricultural labor force has been increased to 2 million persons, that is in 1960 the labor force engaged in agriculture was 10.3 millions but now it becomes 12.5 millions. Therefore even the percentage of agricultural force is decreased but the absolute number of it is still increasing.

The Present Problems

Agriculture is the main occupation of the Thai people as well as the major sources of economic development. During 1961–1968 the share of G. D. P. originated from agriculture base on 1962 prices was 4.6 percent. From 1969–1971 it is estimated that the increase percentage will also be maintained at 4.6 percent. This is due to the fact that the 1970 development budget has been already prepared, and the accelration of agricultural development is a time consuming process. Having considered the production capacity, marketing potential and other factors which will inhibit development efforts, the agricultural development strategy sub-commitee deems it possible that the target rate for the expansion of agriculture during the period of the Thai National Economic and Social Development Plan 1972–1976 should not less than 5 percent per annum. It is envisaged that the value added of goods and derived from agriculture will increase from 35,842.9 million Baht in 1971 to 47,296.1 million Baht in 1976. The increase is about $\frac{1}{4}$ of the gross domestic product (TableII). In order to increase agricultural productivity many problems have to be solved.

1) Land

The survey of the National Statistical Office (1968)indicated that in the Central Plain and the Northern Region farmers who rent the land amounted 40.66 and 18.28 percent respectively. For other regions, even though the ratio is fairly small the trend is on the increase over the period of years. This is due mainly to rapid rate of population growth and the cultivated area almost limited. Another survey carried out by the Land Development Department indicates that

Table I b. Summary of Land Utilization of Thailand, 1965

Area : Rai 2.5rai = 1 acre 6.25rai = 1 hectare

Region	Total land	Forest land	Swamp land	Farm Holding land	Types of land use of farm holdings					Summary	
					Paddyland	Tree land	Wood land	Upland Crops	Othersd	Totoa Classified	Unclass-fied
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Northern	55,927,500	44,250,742	19,273	4,567,529	2,678,855	251,178	201.321	1,029,186	406,989	48,837,544	7,089,956
North-Eastern	106,391,250	41,065,858	395,665	26,561,040	15,183,180	547,752	3,487,781	4,348,006	2,994,321	68,022,563	38,368,687
Central Plain	115,063,125	62,411,552	354,739	33,668,095	19,390,672	2,146,966	1,806,879	7,554,007	2,829,571	96,434,386	18,628,739
Southern	43,868,125	23,232,842	624,994	13,918,853	3,238,599	7,486,363	1,282,081	720,216	1,191,594	37,776,689	6,091,436
Whole Kingdom	321,250,000	170,960,994	1,394,671	78,715,517	40,491,306	10,432,256	6,778,062	13,641,515	7,422,475	251,071,182	70,178,818
Percentage											
Northern	100%	79.12	0.03	8.17(100)	58.65	5.50	4.41	22.53	8.91	87.32	12.68
North-Eastern	100%	38.60	0.37	24.97(100)	57.16	2.06	13.13	16.37	11.27	63.94	36.06
Central Plain	100%	54.24	0.31	29.26(100)	57.49	6.37	5.36	22.40	8.39	83.81	16.19
Southern	100%	52.96	1.42	31.73(100)	23.27	53.79	9.21	5.17	8.56	86.11	13.89
Whole Kingdom	100%	56.23	0.53	23.53(100)	51.40	13.24	8.60	17.33	9.42	80.29	19.71

Table II The estimated Gross Domestic Product (GDP)2509 at 2505 constant price

	% of GDP 2511	average rate of increase 2504-2511	Expected average rate of increase 2512-2514	GDP2511 at 2505 constant price	2512	2513	2514	Expected rate of increase 2515-2519	2515	2516	2517	2518	2519
Agriculture	30.2	4.6	4.6	31,319.0	32,759.7	34,266.6	35,842.9	5.7	37,878.7	40,035.1	42,319.6	44,739.9	47,296.1
Crops	20.9	4.5	4.3	21,729.2	22,684.9	23,670.2	24,685.1	6.0	26,200.8	27,809.5	29,517.0	31,329.3	33,244.6
rice	9.7	4.3	3.1	10,163.5	10,478.6	10,803.4	11,138.3	2.3	11,391.1	311,649.7	11,914.1	12,914.6	12,427.5
rubber	1.5	5.4	2.1	1,600.3	1,633.9	1,668.2	1,703.2	4.4	1,778.7	1,857.5	1,939.8	2,025.7	2,105.0
corn	0.8	12.2	3.5	893.1	924.4	956.8	990.3	6.4	1,053.5	1,121.7	1,192.2	1,268.3	1,455.7
tapioca	0.5	7.8	0.0	540.1	540.1	540.1	540.1	2.2	552.2	564.6	577.3	590.3	600.1
kenaf	0.4	16.6	17.5	422.0	495.8	582.6	684.6	11.0	759.9	843.5	936.3	1,039.3	1,149.3
others	7.8	4.4	5.9	8,110.2	8,612.1	9,119.1	9,628.6	10.0	10,591.5	11,650.6	12,815.7	14,097.3	15,507.0
Livestock	3.8	1.2	1.5	3,967.0	4.026.5	4,086.9	4,148.2	3.0	4,272.6	4,440.8	4,532.8	4,668.8	4,808.9
Fishery	2.8	15.6	10.0	2,887.1	3,175.8	3,493.4	3,842.7	7.0	4,111.7	4,399.5	4,707.5	5,037.0	5,389.6
Forestry	2.6	5.1	5.0	2,735.7	2,872.5	3,016.1	3,166.9	4.0	3,293.6	3,425.3	3,562.3	3,704.8	3,853.0
Mining and quarrying	1.8	12.1	12.1	1,834.6	2,056.6	2,305.4	2,584.4	10.0					4,162.2
Manufacturing	14.5	10.4	10.4	15,098.8	16,669.1	18,402.7	20,316.6	11.0 2/					32,720.0
Construction	7.8	17.9	10.0 3/	8,503.5	8,858.8	9,744.7	10,719.2	7.0 3/					15,034.2
Electricity and Water supply	1.2	22.8	22.8	1,210.7	1,486.7	1,825.7	2,242.0	15.0					4,509.4
Transportation and Communication	6.4	6.6	6.6	6,670.0	7,110.2	7,579.5	8,179.7	7.0					11.332.3
Whole sale and retail trade	19.5	8.5	8.5	20,265.2	21,987.7	23,856.7	25,884.5	9.0 2/					39,826.5
Banking, insurance and real estate	3.4	15.9	15.9	3,525.3	4,085.8	4,735.4	5,488.3	16.0					11,527.3
Ownership of dwellings	2.0	3.1	3.1	2,082.4	2,147.0	2,213.6	2,282.2	4.0					2,776.6
Public administration and defence	4.4	7.4	7.4	4,615.2	4,956.7	5,323.5	5,717.4	7.0					8,018.9
Services	8.8	6.2	6.2	9,098.8	9,662.9	10,262.0	10,898.2	7.0					15,285.4
GDP	100.0	7.6	7.6	103,773.5	111,781.2	120,515.8	130.055.4						192,488.9
Growth rate					7.8	7.8	7.9		average 2515−2519=8.0%				

Remarks : 1/ This figure may be changed due to the readjustment in 2512.

2/ Because of the increase of the agricultural sector's growth rate from 4.6 to 5.7 other sectors which will be directly affected are manufacturing and trade and their average growth rates are accordingly readjusted.

3/ Due to the heavy U. S. military construction in 2507-2511, the average growth rate of this sector during this period appeared to be high. After this period it was expected that there would no longer be heavy U. S. military construction and the average growth rate would decline.

the number of farmers losing their land titles has increased year by year. The poor farmers cannot pay their debts and thus lose their land titles to the capitallists. Furthermore, land prices have also increased. This is a serious problem which will become farther aggravated if nothing is done to resolve it. The government has no definite policy on agricultural land and there is no special law governing utilization of farm land.

2) Market & Agri-business

The market system is extremely backward. There are too many middlemen at different stages. Concurrently there are only a few big and influential merchants or trading associations, leading thus to the low competitive nature of the market.

The proportion on share of the marginal prices that the farmers receive from their products is very low when it is compared to that of the services which merchants or middlemen render

The factor supporting marketing and agri-businesses transportation, warehouse, and harbour facitities are not fully available, particularly the transportation networks in remote villages where connections with outside markets are impossible in some seasons.

The government has a very limited role in the selling of farm products from the farm level to the middlemen. There is no direct government agency responsible for this purpose. An agricultural news service is still operating in a narrow sphere. Government lowns for marketing are almost non-existent moreover those government or state enterprices dealing with agriculture marketing are not capable of offering full services to the farmers.

3) Agricultural Credit

At present the agricultural credit avilable is less than 10 percent of the total requirement. At the end of October 1966 the loan from the Bank for Agriculture and Co-operatives amounted to 967 million baht, from the Bangkok Bank 100 million Baht and from other commercial Banks about 50 million Baht. The total agricultural credit is about 1,100 million Baht, which is less than 1 percent of the total credit requirements. The Bank of Agriculture and Co-operatives gives short-term (one year)

Table III Number of Graduates from Various Universities In 2510, 2511 and 2512

	2510 Graduates	2511 Graduates	Percentage Increase 2510-2511	(1969) 2512 Graduates 1/	Percentage Increase 2511-2512
Grand Total	4,543	5,128	12.88	6,066	18.29
Science	1,311	1,661	26.70	2,095	26.13
Science	131	268	104.58	284	5.97
Engineering	329	345	4.86	424	22.90
Medicine	457	686	20.96	876	27.70
Agriculture	284	362	27.46	511	41.16
Social Science	3,232	3,467	7.24	3,971	14.54
Humanities	189	378	100.00	676	78.84
Education	1,282	1,326	3.43	1,725	30.09
Decoration	84	146	59.52	155	8.21
Social Science	1,677	1,629	-2.86	1,426 2/	-8.39

1/ Estimated from final year students.
2/ Excluding students from the Faculty of Social Science, Thammasart University.

and medium term (three to five years) and the interest charge of 9-12 percent per annum. The commercial banks usually give one year credit. The credit terms of private lenders vary, but the usual term is one year and extendable. The big farmers also require medium and long term credits, which are still not avilable at present.

The present credit facility is insufficient for retiring the debts of most of the farmers. The farmers, therefore are forced to rely heavily on capitalists and middlemen, thus putting them in a very weak bargaining position in all aspects.

The needs and convenience rather than the production and marketng plans have been used as criteria for evaluating agricultural credit. Furthermore, the coordination between the public credit institution and the technical departments appears to be lacking. All these factors supporting the conclusion that the existing agricultural credit facility has not yet been avilable for agricultural development.

4) Agricultural Man Power

Major problems concerning the development of agricultural manpower are

a) Unemployment and underemployment

b) Lack of technicians in agricultural fields and lack of public extension workers. The labor survey covering 14.5 million people indicated that in 1967 agricultural labor force amounted to 11.6 million people, or about 80 percent of the total labor force. This ratio will not decline until the problem of rapid rate of population growth in the rural areas is solved. As for the middle and high level manpower, the major problem is the lack of both quantity and quality. At present all universities can produce only 500 agricultural graduates, or about half of the requirement. About 1,400 middle level manpower can be produce as compared to the requirement of about 2,100 (about two-thirds). This requirements, figures not include additional private requirements, which are on an increasing trend. (Table III)

c) Although agricultural extension has coverd the whole country there are no definite extension programs. The present extension program are not relevant to research or marketing, the number of extension officers is far too small and most of them don't possess new agricultural knowledge and technology. Extension services in the field of agricultural economic in farm management and marketing, Agricultural Engineering in the field of Farm Machinery are almost non-existent.

5) Agricultural Institution

The formation of cooperatives and other agricultural associations has generally not been initiated by the farmers themselves. These association are initiated and controlled by the government, and control has not been completely handed over to the farmers. The farmers understand that this is the government's machinery to help them in various aspects, they don't feel that they belong to these institutions. This is the weak point of Thai agricultural institutions. These associations are not as strong as ideally desired, but the hope of agricultural development rests with them, they are the machinery for pulling farmers together for mutual assistance.

Present cooperatives are not correctly formed. Most of then are formed for the member of each cooperative being around 20. In comparison to the kingdom's 5 million farms the number of agricultural association is extreamely small around 10 percent are member of this institution. Generally the present cooperatives and farmer groups are not effectively using agricultural loans. This forces them to rely on agricultural credit offered by Banks and other commercial institutions instead of their own institution. Most of the present loans are made in the form of seasonal production loans but the repayment schedule makes 75 present of the loans turn out to be medium term and long term loans.

The economic problem realized by most of the farmers at present is the unusual difference between wholesale and retail prices set by the middlemen who offer transaction services needed by producers and consumers. The services such as transportation of goods in remote areas, delivery of production materials (seeds, fertilizers, insecticides, etc.) including credit offering have long been handle by the middlemen who customarily have influence over the fluctuation of prices. One possible solution to minimize the degrees of difference in wholesale and retail prices, in other words, to lessen the influence of the middlemen over the farmers, is to build up a strong network of basic facilities, i.e., network of roads linking farm storage areas and wholesale depots, greater credits for agricultural materials, and guaranteed prices for economic crops. Once the farmers have strengthened the sales force by themselves, negotiations with the middlemen would gradually become more justified. Thus minimizing the existing influence of the middlemen and narrowing the gap between wholesale and retail prices.

At present, rice, maize, kenaf, rubber and tapioca are five major crops which contribute about two thirds of the total value added derived from all crops in 1969. It is envesaged that the demand for these major crops will be decreasing. So the most important development strategy is to strive for further diversification by stressing production on other crops. However, there is still a need to maintain the present levels of production for these five major crops.

It is envisaged that domestic demand for rice will rise as population increases. Serious problems will prevail in the foreign market. According to the projections, rice production will reach 14.5 million tons in 1976. (The ECAFE projection is 16.34 million tons) and there will be a surplus of 3 million tons of paddy or 2 million tons of milled rice for export, It is obvious that serious problems will be faced in marketing this surplus since there will be increased are striving for self sufficiency in rice, hence, there is an urgent need to improve the competitativeness of Thai rice in the world markets. In terms of production cost, Thailand is already in a favorable position compared to other countries (according to a survey conducted by NE DB in 1966 and the N. S. O. in

Table IV Rice Premium and Rice Export B. E. 2499-2511

B. E.	Rice Export (tons)	Rice premium (Baht)
2499	1,238,433	811,226,367
2500	1,572,579	933,694,870
2501	1,124,521	815,396,424
2502	1,070,169	778,217,720
2503	1,191,869	748,966,473
2504	1,562,726	914,921,959
2505	1,276,788	760,473,427
2506	1,378,749	846,391,889
2507	1,833,137	1,311,008,784
2508	1,851,029	1,198,794,218
2509	1,460,381	982,086,398
2510	1,442,762	1,056,206,101
(1968)2511	1,022,444	1,388,005,444

Source: Export Trade Division, Foreign Trade Department.

Table V Rice Premium Rate Announcement (to be effective after December 3, 2512)

Rice Classification	Former rate (baht per metric/ton)	New Rate (baht per metric/ton)	Reduction (baht per metric/ton)
100% white rice and 5 % white rice	1100	1000	100
10%, 15% and 20% white rice	1100	900	200
25%, 35% and 45% white rice	1100	800	300
Long grain glutinous rice and short grain glutinous rice	1250	800	350
High grade glutinous rice flour and normal grade glutinous flour	400	200	200
Vermicelli	100	50	50

Source : Ministry of Economic Affairs

1969, rice production cost was approximately 981 Baht per ton and 1,028 Baht per ton respectively).

However, this advantage has not been fully exploited due to the imposition of the rice premium, a tax on export. Hence, policy has to be formulated to reduce the rice premium gradually on an annual basic, particularly during the harvest season from December through March. A reduction of the rice premium will give rice to a higher retailed price of rice, the increase of exports and at the same time, the increase of the purchasing power of the famers. (Tablel IV)

In 1964, total cultivated area in the kingdom stood at 75 millions. At present the total cultivated land is 80 million rai, 45 million rai of which are used for rice farming. 3 million for rubber plantations and the rest for fruits, vegetables and others. The result of the land classification survey indicates that the present cultivated area can be expanded to some extent. In general the quality of soil is fair, except in some regions, particularly the Northeast where the soil is fair, except in some regions, particularly the Northeast where the soil quality is rather poor. Inconclusion, it can be said that the prospects for agricultural development in this country depend on more intensive land use and incorporated type of farming business.

Future of Agricultural Mechanization

At present land holding per farm family has been decreasing (average land holding is about 20 rai per farm family)and availability credit is limited. The custom farm service seems to be more increasingly popular for the farmers. The services obtained from this are tillage operation, rice threshing corn shelling, and transportation of farm products in remote areas. Thus reducing the time and labour costs in the major production costs. The custom farm service provides an alternative labour force to the majority of the farmers. These development seem to be continuing at a fast pace.

As mentioned above, great shortage of available capital, smaller of holding, low prices agricultural products, lack of qualified people, all these factors have prevaild during these 10 years. It is of interest to examine how this rapid development took place in the face of these unfavorable factors.

The availability of up land areas to be cleared and new technology as well as market demand for maize, tapioca jute, and cotton are some of the special opportunity factors. The increase in irrigation facilities is another factor. By 1976, it is estimated that 16 million rai or ⅓ of 48 million of rice cultivation areas, will be irrigated. At the same time total cultivated area will also be increased to 90 million rai or 30% of the total area of the country. About the production of the crops, corn grains has been increased from 0.9 million tons in 1963 to 1.35 million tons in 1969 and in 1970 2 million tons is expected to be exported. Tapioca flour production has also been increase annually. (Table VI & VII)

Mechanization in Thailand has been geared primarily to improve and modernize farming methods in the rice fields. Some basic machines now in use are low lift type water pump, puddling machine simple two wheeled tractors. Which have been used widely in the deep muddy soil of transplanting rice area. These locally made machines have just been produced 2-3 years ago. Now the rate of local production of simple two wheeled tractor is about 3,000 units per year and the increase in output's about 40-45 percent during 1968-1972. It seems that this two wheeled tractors will gradually replace the draft animals in the rice producing areas by this decade

As for four wheeled tractors, 22,000 units are on farm (1969). Most of them 50-69 horse power range and imported from the U.K. It is expected that the import of four wheeled tractors will be slightly increased at the conservative rate of 15-18 percent per year during the period of 1968-1972.

The rapid expansion of the use of tractor is the cause of many changers and development in Thailand. Technical development for small manufacture and local workshop have improved the production of attatched implements. Such as disc tiller, disc plow, disc harrow, corn and peanut sheller, which are very popular and well recognized among the users. Most of the designs are either imitation or modification of the imported models. However, suitability to local conditions is priority in re-designs. The prices are reasonably cheaper than imported goods and quality suitable for local working condition.

Most of the manufacturing plants of water pumps are in the vicinity of Bangkok and Thonburi. They produce small centifugal pumps (low head type) and low lift pumps. But the quality of the centifugal pump is not satisfactory due to keen compitition among manufacturers with marginal returns and absence of laws concerning quality control.

As the local production of farm implements is being increased, the import of gasoline and disel engines, the main sources of power is also increased. The power range of these engines is 6-10 horsepowers, They are used with low-lift pumps, centrifugal pumps, boats and puddling machine. The major exporting countries are the United States and West Germany. In 1966 Thailand imported gasoline engine of not over 10 Horse

power 33,116 units, in 1968 imported 59,628 units. The diesel engines, for two wheeled tractors, centrifugal pump, and some processing machine, are mostly imported from Japan and United Kingdom, (for diesel engines of not more than 30 horse powers from Japan, 17,040 units and 38,134 units in 1966 and 1968 respectionly). During 1966-1969 the number of small engiens imported has risen steadity about 40 percent annually.

The corollary shortage of farm labors, and draft animals in peak farming season indicator the significant need for increased mechanization. Weeding and harvesting rice are serious problems that farmers have to be faced. Most of native rice varieties are long stem that tend to lodge and shatter easily. So it difficul to get a satisfactory result from the harvesting machine. This problem will be solved in the future by the new standard rice varieties R. D. 1 &R. D. III which have been introduced to the farmers this year, this high yielding varieties are of short stem (about 110cm.) that is suitable for rice reaping and combine. At present most of the farmers grow only one crop and harvest in the dry season, If double croping is to be practiced, mechanical harvesting and drying are inevitably concerned as processing and storage methods would have to be timely planned and carried out.

The future of farm mechanization in Thailand depends primarily on increase of industrial labour force and greater competition among intensive farmers. To change the traditional existance farming to a more organized business is not possible with out the development of mechanization. The degree of progress mechanization is, however, limited by the minimum size of holding and the prospect of trade promotion in the world markets.

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Table VI Agricultural Production 2508-2512

	2508	2509	2510	2511	2512(1969)
Rice 1/(metric tons)	10,028,882	8,558,170	9,217,984	11,845,522	9,594,854
Rubber 2/('000 tons)	210.6	217.4	218.0	220.0	229.0
Corn 2/ (〃)	935.1	1,021.3	1,122.0	1,250.0	1,350.0
Tapioca 2/ (〃)	1,557.0	1,475.0	1,891.0	1,871.0	2,000.0
Sugar cane 2/ (〃)	5,074.2	4,480.0	3,827.0	3,500.0	3,500.0
Mung bean 2/ (〃)	110.2	124.8	131.8	128.0	115.0
Ground nut 2/ (〃)	119.8	130.6	219.9	216.6	195.0
Soya bean 2/ (〃)	31.3	19.1	37.9	35.0	37.0
Sesame 2/ (〃)	13.1	18.3	19.9	18.5	15.0
Coconut 2/ (〃)	1,097.0	1,170.0	1,069.0	1,000.0	1,250.0
Castor bean 2/ (〃)	39.0	31.6	41.9	45.5	40.0
Cotton 2/ (〃)	49.1	59.8	88.8	84.0	89.0
Jute 2/ (〃)	6.5	8.7	10.9	9.6	8.5
Kenaf 2/ (〃)	303.1	528.6	661.4	350.0	174.0
Remie 2/ (〃)	0.8	1.1	0.4	0.4	—
Tobacco 2/ (〃)	62.8	75.5	88.4	80.0	90.1
Forestry 2/('000 cubic meters)	5,635	4,116	3,849	4,495	4,708
Fishery 4/	577.0	615.1	720.3	847.43	890.0
marine('000 tons)	494.2	529.5	635.2	762.18	800.0
Fresh water (〃)	82.8	85.6	85.1	85.25	90.0
Livestock 5/	49,149.0	62,496	61,298	—	—
elephants (〃)	11.1	11.1	11.1	—	—
horses (〃)	180	174	175	—	—
Buffaloes (〃)	6,878	6,691	6,868	—	—
Cattle (〃)	5,236	5,104	5,167	—	—
Swine (〃)	4,291	4,805	4,045	—	—
chickens (〃)	31,005	33,992	35,723	—	—
Ducks (〃)	11,620	11,719	9,699	—	—

Source : 1/Rice Department 2/Agriculture Department 3/Forestry Department 4/Fishery Department 5/Livestock Department

Table VII Estimated crop production. 2519

Crop	2511			2519		
Principal crops	Prodution (ton)	Production area (rai)	Yield/rai (kg)	Production (ton)	Production area (rai)	Yield/rai (kg)
Paddy	11,858,298	46,750,000	253.65	14,500,000	48,000,000	302.08
Rubber	243,273	3,956,412**	61.49	320,000	4,500,000 *	71.11
Corn	1,350,000	4,909,103	274.99	2,200,000	4,000,000	314.30
Tapioca	1,800,000	775,283	2,321.73	3,000,000	800,000	2,500.00
Kenaf	183,594	920,312	199.49	500,000	2,000,000	250.00
Other Crops	2509			2519		
Sugar cane	3,827,000	778,000	5,000	6,000,000		
Mungbean	131,800	840,000	161	310,000		
Soya bean	37,900	285,000	137	150,000		
Ground nut	219,900	981,800	230	400,000		
Selame	19,900	187,000	109	30,000		
Castor bean	41,900	271,000	161	60,000		
Coconut	1,069,000	1,545,000	50	1,500,000		
Cotton	88,800	523,000	179	200,000		
Kapok	273,000	330,000	910	300,000		
Tobacco	88,400	537,000	165	150,000		
Vegetables	914,900	1,160,000		2,500,000		
Fruits	1,904,500	1,710,000		3,000,000		

Remarks : The rubber production area includes only that area which yields rubber.
Source : The Agricultural Economics Division, Ministry of Agriculture.

Present Situation and Future Problems on Farm Mechanization in Vietnam

Truong-Dinh-Huan

[A] Natural Conditions

1) Climate

S. Vietnam is situated in the "Monsoon" area, its climate is characterized by two seasons, a wet season from May to November and a dry season for the rest of the year. The temperature varies from 8° C to 30° C in the highland. The mean relative humidity is 80%. The average of precipitation is 1,600m/m a year.

2) Soils

Soils in VN are classified in the follwing main soil groups :

(a) alluvial soils
(b) regosols
(c) grumsols or black tropical clays
(d) red and yellow podzolic soils
(e) gray podzolic soils
(f) low humic clay soils
(g) red and yellow latosols
(h) compact brown latosols

[B] Technical Problems on Farm Mechanization

Technical problems concerning introdudtion of farm machinery with special reference to soil and cultivation conditions.

In this report we will refer principally to the growing situation in Vietnam, the most important crop that during the 1968–1969 harvest--including 2% for the upland rice--occupied 85% of the arable land (2.4 to 2.8 million hectares). Rice is grown on alluvial soil and specially on flooded soil which are largely of clay, sand or sand-clay texture.

With these soil characteristics, the farm machinery used for rice production in Vietnam requires certain technical features:

1) Machines for soil preparation

This operation includes plowing, harrowing, pulverizing, and levelling. Tractor must be equipped with grip-increase components such as large metal wheel with lugs to reduce slip. Rubber tire proves helpful during to use by droflated tire with the dry season but it is recommended special valve to fill the tube with 75% of fluid (water preferred).

In the rainy season, besides grip-in creased, tractor with rotary tiller or mudtiller is more efficient than with disk plows or disk harrows.

In a word, the problem is to make good use of tractor's power by decreasing the influence of slip and high resistance of clay.

The structure of soil is affected by flood and can only be improved with better water control-irrigation and drainage --facilities whose construction takes time and requests an important fund. So far only about 18% of rice growing area has actually benefitted by artificial irrigation system.

2) Other farm machines used in weeding, crops protection

Small and simple units are better if properly adapted to small land-owner's needs. we suggest to apply the hand-push rotary weeder because the weeding operation, if carefully performed by hand, takes about 120 hours per hecter. So most of the times, weeding has not been done and the yield decreases

Chemical herbicide is not yet familiar to Vietnamese farmers and would render little effect due to the badly leveled rice field, and also due to the high cost of imported herbicide. Hand push rotary weeder has been propagated in recent years by AMD (Agricultural Machinery Directorate) and is appreciated.

3) Harvester

Except in some regions in central Vietnam, generally the hervest is completed in wet field, so, small power harvester, or harvester binder are not completely adapted on this muddy and slippery field. The inclination of paddy of some rocal rice varieties prevents proper operation of the harvester. However we could overcome this difficulty by using a lower cutting blade. Nevertheless this modification seems unsuccessful in an leveled surface of the rice field.

We have just introduced a rice cutter with a long handhold to replace the traditional sickle. We also start to use some power reaper with an attachment for rice cutting. But, both of those two new machines are suitable only for the new miracle rice whose plants are short and strong.

4) Thresher

Up to now, almost all rice in V. Nam is threshed by hand, in the field. Specially for the floating rice whose plant is long and flexible, the hand threshing is impossible. Farmers use buffaloes for threshing this rice by stepping on the bulk of paddy or, since a few years, a tractor is used instead of buffaloes.

We started to use some threshers (drum-type, pedal operative or equipped with a small engine). Some of those are local made from a design prepared by AMD. Some are imported from Japan. Lightweight units are recommended because of easy transportation on narrow roads, village lanes, and in the field. As far as the upland rice is concerned, we doubt the profit of mechanical threshing because of the slopy terrain and the low yield of this variety.

5) Drying and storage of rice

All local valieties of rice are harvested in dry season and dried by sunshine. Due to the high humidity of the air, about 90% of the rice are stored in farm of paddy by farmers.

Since 1968 where the new "miracle rice"-IR5, IR8, IR20-was introduced to V. N, artificial in drying becomes necessity to dry the rice harvested in the wet season.

AMD has developped a simple dryer with flat bed, using a blower actioned by an engine. An additional heater is used sometimes to increase the heat from the exhaust. This model has been adopted by some farmers and a lot of dryers have been made locally. However the problem must be studied more seriously because V. N expects to harvest more

than 2 millions tons of paddy in the wet season of 1971.

[C] Present Situation and Future Aspect of Research Activities on Development, Improvement and Utilization of Farm Machinery

Actually in Vietnam, the Agricultural Machinery Directorate (A. M. D), Ministry of Land Reform and Agriculture and Fishery Development, is the only agency to carry out a research activity on farm mechanization. This humble unit, with limited number of specialities, began its research since late 1967.

First, the job of the AMD has been to gather all facts concerning various cultivating facilities used for different crops and to record the necessary time for each operation with regard to traditional implements and pure man power. These records will then be analyzed to find out key points for a step by step mechanization program which fits the overall economic situation, farmer's knowledge, and the industrial development of the country.

This work is still on the way. Since 1968, with an increasing quantity of farm machinery being imported, AMD has begun testing some of the modern machines donated by foreign aid programs or by local importers generally upon AMD Director's request. The results acquired from these tests have been communicated to the concerned importers.

Along with these testings, a research office was created in AMD. This young unit, in charge of testing and adaption of the most usefull imported machines and implements, has completed a modified paddy weeder, designed an efficient grain dryer(for rice, corn and sorghum) and particularly a manual rice transplanter.

However, it is our regret that, with limited resources of man-power and equipments, AMD cannot extend these encouraging operations. AMD has also experimented some large capacity and modern equipment, in land levelling since 1968. This project is now considered successfull for upon realizing benefits from levelling, some private peoples undertake land levelling, a service which for years remained unknown to farmers.

Furthermore, a seeder/fertilizer was adapted for direct seeding of rice and corn and is now in use in the Mecong delta.

A reaper (or power scythe), after series of testing, showed efficient in bush clearing, grass mowing and particularly in new rice(IR8, IR5) harvesting.

A portable thresher, actiond by pedal and or/by engine was also developped and as simple as possible in order that it would be manufactured in small shops in the country where main material as wood is amply available.

Long weeds or straws sometimes cause the power tiller to stop.

In the future, probably since March 1971, a new regulation will become effective, that binds all agricultural machinery importers and manufacturers to have their machines tested and evaluated by AMD. An official representative of the company is present during the test. All costs of the test and evaluation operation are paid by the importers or manufacturers to thre AMD fund.

To face with this new responsibility, AMD hopes more technical informations from the Institute of Agricultural Machinery (Japan) and new testing equipments from Japanese manufacturers who are investing in assembling and producing farm equipment in Vietnam.

[D] Evaluation and Improvement of Japanese Farm Machinery

After efficiency testing some of the Japanese made agricultural machinery in 1970, we could offer the following recommandations:

(1) Power thresher and winnower must be set under consideration between the paddy in Vietnam and that in Japan. Usually, in V. Nam the paddy is threshed when completely dried, and then could be subject to being stuck in the threshing box. By the some reason, we suggest that drum RPM be reduced to decrease lost of rice.

(2) Harvester can be used only on the dry land. The cutting device should be made adjustable to meet spacing of the row of rice.

(3) Rotary tiller: quality of steel must be improved because lot of blades wear quickly or sometimes are broken when operating on hard soil.

(4) Rice huller and polisher: small type of huller and polisher is now greatly appreciated by farmers but we recommend a better and more enduring compound instead of the rubber roll.

[E] Policy for Farm Mechanization

The general policy of Republic of Vietnam aims at helping the farmers with adequate facilities to increase yield. In the field of Agricultural Mechanization, the following points are to be stated;

(1) Testing, adaption, improvement and propagation of simple, efficient farm implements to reduce man power and to solve the problem of shortage of labor.

(2) Testing and introduction of various modern machines to increase yield.

(3) Encouragement and financial help in manufacturing agricultural equipments on a small scale level to make good use of all actual shops in the country.

Along with this long-term program, the Government of the Republic of Vietnam must satisfy the urgent need for farm machinery due to shortage of man power and draft animal in the war time. In response to this need, since 1968 important amount of farm equipment has been imported.

Recently, the Government of the Republic of Vietnam has decided to change its policy from pure import to assembling and manufacturing industry. This change is evidently responsible regarding the large requirement of mechanical power for agriculture and agricultural industry in the future.

Binders, which began to spread fully in 1967, are the clue to completion of rice crop mechanization

Present Situations and Future Problems on Farm Mechanization

in India, Indonesia, Malaysia and Nepal

(Farm Machinery Industrial Research Corp.)

IN THE CASE OF INDIA

1. Mechanization Activities

1) During the Third Plan period, facilities for research, development and testing of animal and power operated equipment were established. Special programmes for demonstrations and popularization were also taken up.

2) The need for a large-scale mechanization programme was recognised during the Third Plan period. Production of tractors and different types of power driven equipment was organized. For meeting the requirements of personnel trained in the operation, maintenance and repair of tractors and other sophisticated farm machinery, training centres were set up at national and State levels. A National Farm Machinery Testing Station was established at Budni in the State of Madhya Pradesh for testing of tractors, pump sets and other power operated equipment. Graduate and post-graduate courses on farm machinery, soil and water conservation, irrigation and drainage, processing, etc., were organized in the different Agricultural Universities.

2. The Need for Mechanization

1) During the past few years, there has been an un-precedented rise in the demand for all types of farm equipment. Farmers more than ever before, are eager to buy well designed tools and equipment for maximizing production from land. With the rise in wages for manual labour and cost of maintenance of bullocks, use of tractors and other equipment has become necessary and more economical.

2) With the introduction of high yielding varieties and multiple cropping, lack of power on Indian farms for performing the different agricultural operations has become a major bottleneck in further increasing the area under multiple cropping.

3) The country is faced already with a problem of migration of the rural youth to the city. All types of equipment that reduce drudgery on the farm to some extent arrest the rural "brain-drain" and have long term benefits to the city as well as to the farm.

3. Demand Trends and Supply

1) The Working Group on Agricultural Machinery and Implements has estimated the annual demand of wheeled tractors and power tillers during 1973-74, at 90,000 and 80,000 nos. respectively.

2) There are currently 5 firms engaged in the production of tractors with a sanctioned capacity of 30,000 tractors per annum.

3) The manufacturers have achieved an indigenous content of about 85% and imports are limited to special items like hydraulics. With steps taken to sanction new manufacturing units and few organizations, having developed their own designs of tractors, it is expected that production would rise to about 70,000 nos. in the next 3-4 years.

4) There are two firms currently engaged in the production of power tillers. Since production is far below the requirements, the gap between indigenous availability and demand is partially met out of imports of Yanmar, Kubota, Mitsubishi, Iseki and Satoh power Tillers from Japan.

4. Improved Implements and Power Operated Equipment

1) With a reasonably well-developed industrial base, there is no difficulty for manufacture of most of the agricultural implements. There is, however, considerable scope for organizing production of certain types of specialized equipment, the demand for which is yet to develop.

2) For ensuring quality and interchangeability, some of the important implements and tools have been taken up for standardization by the Indian Standards Institution. Besides standards for components and assemblies, test codes on agricultural machinery and implements are also being standardized for enabling the Regional Testing Stations in taking up comparative testing of similar equipment so that the results of tests would serve as an aid to the purchasing agencies, in the selection of makes and models based on performance, Extension workers and Govt. Departments in selecting makes that may be taken up for popularization.

5. Support Facilities for Accelerated Growth

1) Visualizing the extreme urgency in increasing the agricultural production through efficient supply of inputs, especially agricultural machinery implements, during the Third Five Year Plan, Agro-Industries Corporations, which are Govt. companies were set up in the different States.

2) During the Fourth Plan, subsidies have been discontinued and popularization has been sought to be achieved through demonstrations and supply of credit. Land Mortgage Banks, Cooperative Institutions and Nationalized Banks have been encouraged to provide long term credit for tractors and other costly machines and medium term credit for loss costly machines.

3) The small and medium farmers who form the majority have to be enabled in modernizing their farm operations by providing machine hire facilities at reasonable rates. Agro-Industries Corporations have, therefore, been encouraged to set up machinery hire units and workshops.

4) For meeting requirements of a large number of personnel trained in the operation, maintenance and repair of agricultural machinery, Govt. of India have set up training centres in agricultural machinery utilization, at Budni (Madhya Pradesh) and Hissar (Haryana).

At the above two Central Institutions, besides training to users, training for trainers is also organized.

6. Special Emphasis Required for Sound Development

1) The farmer in his anxiety to tide over the peak seasons, initially concentrates on mechanizing tillage operations. The tractor or power tiller possessed by him is thus under-utilized and he is also called upon to utilize manual and bullock power for performing some of the operations. In a developing economy, it may be realized that mechanization efforts should be to tide over the critical seasons so that the maximum production potential of land is exploited, with minimum displacement of the existing labour systems.

2) Small and fragmented holdings are a serious handicap for efficient utilization of implements. Special efforts would be needed for improving the layout of fields, where necessary, by consolidation of holdings.

3) It has been the experience in India that the high temperatures during the harvest seasons together with the shedding characteristics of wheat increases the losses in harvest. Timely harvest has thus become a very important factor. Mechanization no doubt would reduce harvest losses, but the need exists in the development of varieties better suited for mechanical harvesting.

7. Design, Testing and Development

1) Before large-scale introduction is taken up, very little effort is made to assess the suitability of the machines for the special conditions that exist and in adapting the machines to suit local conditions. When indigenous production is taken up, use of locally available materials presents problems of modifications and control of quality.

2) The standard of operation and maintenance in developing countries also tends to be poorer and, therefore, satisfactory performance can be achieved only if the machines are designed to withstand a reasonable amount of abuse both in operation and maintenance.

3) The developing countries would find it difficult to invest large sums for the establishment of these facilities. It would, therefore, seem appropriate if countries in the same region having identical farming and crop conditions make joint efforts for research, development and testing.

4) One of the major problems faced by the developing nations in the rapid development of mechanization is the lack of high grade steel and other raw-materials needed for the production of agricultural equipment. Foreign exchange resources being meagre, to the extent possible. Local production has to be organized, instead of importing complete machines.

5) For organizing production of new implements, there could be considerable exchange of technical know-how among the developing countries and even of components and assemblies, depending on raw-material availability and development of local industry.

8. Special Areas Offering Scope for Mechanization

In India, very little attention has hitherto been paid in the mechanization of transplanting of paddy, which is one of the major operations involved in the raising of this crop. Also, adequate attention has not so far been given to mechanization of orops like potatoes, groundnut, sugarcane and cotton. Special efforts by way of research, testing and evaluation are needed in adapting machines developed in other countries. Comprehensive systems of mechanization have to be thought of, rather than modernizing few of the operations involved in the raising of these crops.

IN THE CASE OF INDONESIA

The farm mechanization target covers the following :

(a) to increase the efficiency of the man-power,

(b) to raise the farmer's standard of life,

(c) to assure the quality as well as quantity of the agricultural product,

(d) to accelerate the transition of farmers from agrarial to industrial type,

1. The Problem to Be Solved

1) The efficiency and the difficulty to get the spare parts for imported agricultural machinery caused the most hazardous problems for the development of the usage of agricultural machinery.

2) The factors that affected the rise of different technical problems are the type and texture of the soil, rice field plot, topography and the operators condition.

3) The interfence for the usage of the agricultural equipment usually involved,

(a) Lack of power efficiency, farm material and slippage in the case of hand tractor.

(b) on the crop harvesting equipments the difficulty arises during the operation, since the rice is harvested when the soil is still in wet condition caused by poor drainage.

(c) the weeds that become a problem is *Imperate cylindrica* which often grows in a very large area. So far there is no special weeder available to overcome the spreading out of the weeds.

4) The distribution of the population and the limited land holding of an average of 0.5ha are the main porblem, especially in the island of Java.

5) The shortcoming of the skill or the technical know-how of the farmer and the agricultural extension, caused the ignorant of properly maintenance, and repair.

6) The average income of the people is low, while the supply of credit for the farmers to buy agricultural equipment is not sufficient.

7) The ability to buy is low, caused by the low price of yield, that is why majority of the farmer don't have enough capital to buy agricultural equipment.

2. Evaluation and Improvement of Farm Machinery

1) Taking into consideration the size of farm house-holds and the type of farming in Indonesia, most of the Japanese made farm machineries can be used. Some modifications, however should be made in the design and construction of those machineries to match the specific condition in Indonesia, such as weight and wheel shape for powertiller, rubber and other parts for processing machineries and some other items.

2) The quality of material used for these equipment needs more attention to guarantee a longer life time with a minimum consumption of replacement parts. Our smallholders cannot afford to lose their investment in equipment in 3 or 4 year, because this may cause a serious financial disaster. We have to provide them with the equipment that can be operated simply and safely and still last for at least 6 or 7 years.

3) In using the crop protection equipment especially power sprayers and speed sprayers we still face the difficulty caused by the irregular size of the rice field plots.

4) A higher hardness of rubber rolls and better quality material that resist the grinding action of the husk should then be used.

3. Socio-Economic Problem Related to Farm Mechanization

1) Processing unit, crop protection equipment and pump set will have a higher priority than tillage equipment.

2) An intensive training to increase their ability and skill is necessary and especially a smooth and sufficient supply

of spare parts should be guaranteed.

3) The policy of the Government is to provide spare parts that can be produced locally with the cooperation of the manufacturer abroad

4) Gradually the domestic production of equipment and machineries will be stimulated. Manufacturer from abroad are invited to make a joint production with our manufacturer to reach this goal.

IN THE CASE OF WEST MALAYSIA

1. Background Information

1) With double cropping, time becomes critical. Farming operations which before could be done at a more leisurely pace, now has to be done according to a very tight schedule.

2) Malaysia is pursuing a policy of self-sufficiency in rice production. At the same time, she is also trying to raise the standard of the rural populace.

3) The Malaysia government is also putting an emphasis on crop diversification. This will no doubt put a further strain on labour and power requirements. Here lies another scope for mechanization.

2. Technical Problems on Farm Mechanization

A. Problem concerning Introduction of Machine.

1) One of the nagging problems is to acquire the right kind of machine to suit the local conditions. Size has been the dominating factor in this respect.

2) The soil is soft up to a foot or more in certain places. Tractor wheel sinkage results in a drastic reduction in tractive efficency. Some sort of traction aids are necessary to avoid the tractor bogging down. The types of traction aids needed varies with the different conditions.

3) Access to many farms are still only through small country paths. In many cases the situation has improved but accessibility to large machines such as combine harvesters still poses a problem even in the better established areas.

4) Good water control is necessary for successful mechanization. Malaysia in the past few years has come up with a number of large irrigation schemes. However, there is still the problem of drainage. These large schemes usually has a well laid out drainage canals as well as, but the trouble is with the erratic rain that falls in Malaysia.

B. Present Situation and Future Aspect of Research Activities on Development, Improvement and Utilization of Farm Machine.

1) Farm mechanization in Malaysia, is limited almost exclusively to rice. Even here it is further limited to tillage operation only.

2) The tractor trade is largely dependant on the large rubber and oil palm estates which use tractors mainly for haulage.

3) With double cropping playing a more and more important role in Malaysia farming, timeliness is becoming increasingly more critical in the other operations as well. Lately, attention has been focussed away from tillage and on to harvesting.

4) Drying of rice is another field which is going through a process of mechanization. This again is brought about by double cropping.

5) The present and future trend is to go in more for testing and modifying available machines to suit local conditions on one hand, and on the other, to work out the best methods to utilise these machines, either through new farming methods or through improved organization of farm management.

6) Considering the cost involved and the shortage of qualifies people Malaysia would do well to rely on more advanced countries for this type of research, at least for some years yet to come. Some amount of development work must be done to cater for problems which are peculiar to this country or region alone.

7) Tractors in Malaysia are owned either by individual farmers, farm cooperatives or by contractors who are not themselves farmers. Individual ownership is limited in the main to the power tillers because the majority of farmers are smallholders.

3. Evaluation and Improvement of Farm Machine

1) The conventional combine has been tried and found to function reasonable well in Malaysia conditions. However, the problem of accessibility and transportation has caused considerable difficulty in introducing them. Ease of transportation is a necessity because, these machines could only be owned by contractors who need to travel from place to place.

2) Smaller, Japanese type harvesters has also been introduced. They function just as well as the large machines and are not faced with problem facing the larger combines. However, they are much too slow and the cost of harvesting comes out to only slightly less than by the present method. A number of different concerns, however, including IRRI are developing a new type of harvesters which could reduce the size of the combine considerably without a loss in capacity.

3) Another development that we in Malaysia are looking into is the possibility of developing an all purpose tractor especially designed for rice cultivation. What is envisaged is a power unit that can literally float on the soft mud and capable of channeling that power to either a rotary cultivator or a specially rigged harvesting unit.

4. Socio-Economic Problems

1) The average size of rice farm is around 3-4 acres. Such small farm size makes it almost impossible for most farmers to have their own machines.

2) The initial cost of farm machine is high by any standard. In spite of this, there has been a rapid increase in the number of tractors in the last few years. The answer would appear to be in the samller Japanese made machines. But even these are still beyond the pocket of the average farmer.

3) Malaysia has a fairly large labour surplus. As a result, wages are relatively low especially in the agricultural sector. Besides the unemployed, there are many more who are under-employed.

4) Machines need trained operators and mechanics to maintain them. In a society hitherto unconcerned with anything mechanical, it would take a long time and a great deal of effort to train the people for these jobs.

5) The government is encouraging greater use of machinary on the farms. This encouragement comes in the form of setting up centres for training of farm operators and mechanics, sending instructors in farm mechanics fof training overseas and having credit schemes for the purchase of machinery and a host of other measures.

6) It is also the government's policy to create more jobs in the country and towards this end it has embarked on an industrialization programme which includes the assembly of tractors, and farm machines. Manufacturers are encouraged to set up assembly plants in the country with favourable tax and other incentives.

IN THE CASE OF NEPAL

Nepal is an agricultural country. Nearly 90 percent of the people depends on agricutlure. Sixty percent of the national income comes through agriculture.

Eighty-five percent of the country's export is agricultural products. Nearly 13 percent of the total land area is arable land and land under permanent crops.

1. Agricultural Development

1) The third economic development plan of Nepal (Five Year Plan 1965–70) came into operation from the fiscal year 1965/66. Under this plan top priority has been given to agriculture.

2) In 1964 the new land act was enacted by which the land reform became most important agricultural policy in Nepal. The main idea behind this land reform program in Nepal is to increase agricultural production and improve the socio-economic condition of the farmers by just and equitable distribution of land among the tillering class, and finally elimination of the feudalistic landlords. In this current plan for increasing agricultural production greater emphasis has been laid on the use of improved varieties of seeds, fertilizers, plant protection chemicals, irrigational facilities and improved agricultural implements. In order to secure the timely supply of various agricultural inputs to the farmers in all parts of the country. Agricultural Supply Corporation was established in the year 1966.

3) Research and development work on agricultural implements and machines on local conditions have been started with the establishment of Agricultural Engineering Research and Development Centre at Birgani since 1961.

2. Requirements, Availability and Receptivity of Farm Implements

1) Double cropping of the land with paddy and wheat has considerably shortened the time for preparation of the land for one crop and threshing of the another.

2) The first thing which the farmers of Nepal ask for improving their agriculture is irrigation water. Greater emphasis has recently been laid to minor irrigation schemes and economic and scientific use of irrigation water.

3) The labour reqirement is generally peak during planting, weeding and harvesting season of the paddy crop. The double cropping pattern has considerably relaxed the slack periods. The demand for efficient agricultural tools and implements specially for preparation of land, threshing of paddy and wheat, and their sowing, is rising up to improve labour efficiency during the peak periods. However, the agricultural labours during the slack season do not find adequate job and seem to be surplus.

4) Considerable emphasis has been given in the development plans for the promotion of rural small scale industries. Arrangements have been made for the procurement and supply of equipments needed for such industries, and credit facility is provided for sound plans.

3. Plan for Agricultural Mechanization

1) Agricultural mechanization programme in Nepal has been based on the following facts and conditions prevailing in the country :

(1) Three fourths of land in the country (in the northern and central region) are hilly and mountainous with steep slopes and narrow strips of land and has no farm or transport roads for the movement of machines. (2) The average size of land holdins in Nepal is 1. 24 hectares and those of hilly regions are still further low. (3) The power machines and their lubricants and fuels have all to be imported and their cost is generally high. (4) Acute shortage of the technicians to support scientific use, operation, care, repair and maintenance of agricultural implements and machinery.

2) Considering the above bare facts, the agricultural mechanization programme in Nepal has been taken up in the following lines :

(1) Training of technicians, craftsmen and the agricultural workers on the usefulness of improevd agricultural tools and implements and their operation, care and maintenance. (2) Development and introduction of separate hand tools and animal drawn agricultural implements suited to hills, and the smaller holdings of the Terai. (3) Introduction of tractors and other power machines in bigger land holdings of Terai region where movement of these equipments and their fuels are possible and the service facility and spare parts are available. (4) Credit facility for the farmers both at long and short terms at reasonable rates for buying these equipments.

3) The study on the types, size and materials for agricultural implements suited for different parts of the country is now being undertaken by Agricultural Engineering Research and Development Centre.

4) Great emphasis has now been laid on the repair and maintenance service facilities to be provided by the dealers and local manufactuers on the types of equipments they sell or produce.

5) In the field of education and training, junior technicians, skilled craftsmen, operators and mechanics are given short term training locally and are sent abroad for intensive and higher training.

6) His Majesty's Government of Nepal is very keen in the promotion of manufacturing bullock drawn and hand operated implements locally and in import of agricultural machinery and power equipments from abroad. For the manufacture of such equipment which can be locally made, Government of Nepal has provided funds, technicians and business support. For the promotion of import of useful agricultural machinery to Nepal, Government of Nepal has sufficiently reduced the import tax on these equipments.

These summaries are based on *PRESENT SITUATION AND FUTURE PROBLEMS ON FARM MECHANIZATION IN INDIA* (by P. John Zachariah), *PRESENT SITUATION AND FUTURE PROBLEM ON FARM MECHANIZATION IN INDONESIA* (by Soedijanto), *PREZENT SITUATION AND FUTURE PROBLEMS OF FARM MECHANIZATION IN WEST MALAYSIA* (by A. Mutalib bin Ahmed), which were presented at the Symposium on Farm Mechanization in Tokyo on 12th-17th October, 1970, and *Country Paper on Agricultural Mechanization-Nepal* (by S. N. Regmi). Summarizing was done by Farm Machinery Industrial Research Corporation.

Rice transplantation in Japan

The Status Quo and Problems of Farm Mechanization in the Developing Countries

(Farm Machinery Industrial Research Corp.)

Preface

It goes without saying that the agricultural promotion in the developing countries depends upon the introduction of modernized technology centering upon farm mechanization. It is also beyond dispute that this argument constitutes the undercurrent of the growth and progress of national economy.

As a matter of fact, however, it is not easy for the developing nations to fulfill their farm mechanization project, because they must, before anything else, settle a number of problems such as the adjustment of agricultural foundation, countermeasures against surplus labour, economic improvement of farm households, advancement of mechanical knowledge, betterment of distribution structure, promotion of research and experiment, technique of cultivation, etc.

For the purpose of grasping more clearly such controversial phenomena, categorical analyses on the status quo of the developing countries have been made. These data came from "The Status Quo of Farm Mechanization in the Countries of the Southeast Asia", a report submitted to the "Symposium on Study concerning the Tropical Agriculture in 1970" sponsored by the Ministry of Agriculture & Forestry of the Japanese Government. Eight countries participated in the Symposium; namely, Republic of China, India, Indonesia, Malaysia, Pakistan, the Philippines, South Vietnum and Japan. The analyses on Korea and Laos have been picked up from different data and source.

It is needless to mention that should these analyses be done from another view point, they might become different ones. Consequently, encouragement of farm mechanization could be arried out by means other than ours. In this sense, the analyses cited here are intended to give the developing nations various problems common to them – problems with which farm mechanization are confronted.

1. Objectives and Effects of Farm Mechanization

1) Measures to Realize Increase in Food Production and Self Sufficiency

① Improvement of land productivity by means of mechanization to secure agricultural production in terms of quality as well as quantity. (India, Indonesia, the Philippines, Malaysia and Korea.)

② Realization of two crops a year and timely operation for the increase in production in the existing rice producing district in order to accomplish food self-supply. (Malaysia)

③ Preservation of food production by the aid of improvement of land productivity resulted from agricultural mechanization, presuming that some destruction to and abolishment of, farm land might occur in the future. (Korea)

2) Measures for Agricultural Management and Improvement of Farm Household Economy.

2.1 Diversified Operation and Conversion from Agriculture

① Exuviation from self-supporting operation to enterprise-minded farming and the conversion to planning management with target to expand the scope of operation in large farms and to encourage intensified farming in small and fragmented farms. (Indonesia)

② Materialization of diverse crops a year or intensified farming through the introduction of high yield and early maturing varieties, more particularly, necessity for mechanized harvesting in paddy field. (Indonesia)

③ Realization of proper timing operation to promote per-year- two-crops or per-year-diverse-crops and measures for minimizing loss emanating from untimely operation, (India, Indonesia and Thailand)

2.2 Increase in Farm Households' Incomes and Level-up of their Standard of Living

① Increment in small farmers' incomes by the aid of intensified farming through the introduction of simple farm implements and tillers. (Thailand)

② Mark-up of farmers' standard of living by means of mechanization. (Indonesia, Malaysia and Thailand)

3) Measures to Increase Labour Productivity and to Mitigate Labour Shortage in a Busy Season.

① More and more aggravated tendency towards the outflow of labour forces from agriculture in parallel with the rapid economic development. Consequently, increase in number of aged labour having been caused, labour shortage in a rice planting and a harvesting season has been keenly felt. It is feared that unless an appropriate mechanization has been pushed through, the agricultural development planning would encounter with a serious deadlock. (Korea)

② Tendency towards increased exodus of rural youths to urban areas or labour shortage arisen from complicated farming operation for cultivation under high yield varieties or per-year-diverse crops. As a result, necessity is felt for mechanization to curve down agricultural wages as well as expenditures for feeding and management of livestocks. (India)

③ In spite of the fact that there exists an abundant labour in an unbusy season, necessity has been mounting even keener for mechanization with which to tide over labour shortage in a busy season. (Malaysia)

④ Measures to pacify labour shortage in a busy season emanated from industrialization. (West Pakistan).

2. Problems to Be Solved for Promotion of Mechanized Agriculture

1) Fundamental Problems and

Japanese chain feeding typed combine changed peak of harvesting work largely

Premises on Farm Mechanization

1.1 Problems on Surplus Labour

① There exist a trend towards labour shortage in a busy season. On the other hand, is a surplus in farm labour in an off-season. A fear, therefore, that mechanization might ultimately end in unemployment is ruling farmers' psychology. (Malaysia, Laos and Indonesia).

② There are some cases where mechanization is economically less effective; The reason — A relatively low level of wages due to the chronical existence of farm surplus labour. (Malaysia)

③ Surplus labour problem is highlighted by that of Java Island, where an average arable land is no larger than 0.5 hectare per farm household. However, there may be some possibilities of modernized farming by means of mechanization in the district other than the main island where population is less and land is larger. (Indonesia)

④ In order to absorb surplus labour, Board of Investment is trying to prompt industrialization following mechanization, however, delay in the latters' progress has caused the former to lay somewhat behind the schedule. (The Philippines)

1.2 Problems to Adjust Agricultural Foundation

① Fragmented field demarcations due to the land succession system and other factors necessitate comprehensive land exploitation, land melioration including farm land adjustment, to all of which mechanization is clearly prerequisite. (Republic of China, India, Malaysia, Pakistan, The Philippines and Korea)

② Requirement for the improvement of farm road and drainage facility for the introduction and transportation of large machinery such as combines, tractors, etc. (Malaysia, the Philippines and South Viet-Nam)

③ Farmland mostly comprising of slopes, sandlots and rocks such as granites, where there is much waterflow as against a little precipitation, is subjected to Chronically threatening water shortage. (Korea)

1.3 Economic Conditions of Farm Households

① There are a great number of farmers who can not afford farm machinery, as they belong to a low income bracket, engaged in a small scale self-supplying agriculture where they can hardly get credit facilities. (Indonesia, Malaysia, East Pakistan and Thailand)

② In introducing farm machinery, importance is attached to not so much its efficiency as its economy; The reason-Small scale agricultural operation is doing harm to the progress of mechanization. (Malaysia)

③ Fragmented fields postulate, in the introduction of machinery, for giving a priority to such machines as congruous with its field conditions. After some introductory progresses have been staged on, a large scale mechanization should be prompted by joint management. (East Pakistan)

④ It is true that relative number of labourers engaged in the farm production shows a decreasing trend, however, absolute number of farm workers is still on the increase. On the other hand, a farming scale having become less and less, systematizing agricultural structure will challenge farmers for the level-up of their economic life in the future. (Thailand)

1.4 Problems on Education and Technical Training

① Necessity is felt for education and training farmers enabling them to enhance the ability of operation and maintenance of farm machinery owing to still insufficient mechanical knowledge on the part of farm households. (Indonesia, Malaysia, Laos, Pakistan and Korea)

② Training and fostering of mechanics so as to make them conduct servicing and inspection is a prerequisite to the introduction of machinery. Such training and fostering should be done in parallel with those of farm households (Pakistan, Laos, Korea, Indonesia and Malaysia).

③ Technical training towards farm households is to be given on a 2-men-per-tractor basis. This is due to the compulsory military service and such training, it is desired, should be done on the responsibility of machine makers. (Korea)

④ Necessity is highly felt for education of influential extension agents who are capable of persuading farmers into accepting the significant roll and merit of farm machinery. It is the case with public relation, too. (Pakistan, Malaysia and Korea)

⑤ The establishment and expansion of agricultural machinery training center is badly needed for the education of highclass technicians and th advancement of servicing technology on a variety of farm machinery. (Republic of China and India)

1.5 Problems to Orient Distribution Structure of Farm Machinery

① Non-existence of reasonable distribution structure for farm machinery and their parts does a hindrance to effective utilization of imported machines. It is especially important and problematical at the first stage of mechanization to establish servicing system and initiate a supply channel of spare parts. (Indonesia, Pakistan and Korea)

② Training and education of technicians is a prerequisite to the creation of servicing organization and parts supply system. For this, not only makers, effort, but also the Governments support is strongly desired. (Pakistan, Indonesia, Malaysia, Laos and Korea)

③ Inasmuch as foundation on which to commence domestic production of parts already exists, the carrying-out of local production is really an important task for the nation. (Indonesia)

1.6 Problems on Introduction of Varieties Pertinent to Mechanized Farming

① As the present varieties under cultivation are easy-to-handle for manual threshing, considered necessary are the improvements or introduction of new seeds fit for mechanized agriculture. (Republic of China and India)

② Extension of electric service to rural districts. (Indonesia and Laos)

2) Status Quo and Future Tendency of Agricultural Mechanization

2.1 Status Quo

① The utilizations of farm machinery hitherto rendered serviceable have been restricted to tillages such as plowing, puddling, land preparation, management operation such as distribution of agricultural chemicals and water lifting, transportation and drying of unhulled rice on a small scale. (Republic of China)

② Introduction of diverse crops and two crops a year has undergone a change in farm operation, prompting the utilization of machinery. The scope of such uses, however, has been confined to tillage with tillers. This is due to the Government's policy of increasing rice production and encouraging a small scale farm operation throughout the nation. (Malaysia)

③ Mainstays of farm machinery are hand spraying and dusting equipment, power sprayers and dustors, tillers, tractors and pumps. However, their absolute number is still negligible, leaving room for a wide range of extension in the future. (India and Pakistan)

④ Total number of tractors in the current year has reached 19,000 units, a rapid increase compared with only 8,000 units in 1965. Progress of industrialization is bringing about labour shortage in a busy season, which, coupled with a tend towards diversification and intensification of agricultural management, indicates an urgent need for mechanized farming. (West Pakistan)

⑤ Economic conditions on the part of farm households hardly permit their private use of tractors, except for the case where a very few commercial cultivators or a limited number of large farmers are operating tractors under lease

contract. (Thailand)

2.2 Future Tendency

In relation to the prompted mechanization to increase food production under the National Economic Development Planning, finishing machines, spraying and dusting equipment, tillers, pumps, etc. will appear before the footlights. It is also desired that weeders should be developed in order to destroy rampant weeds in a vast stretch of fields. (Indonesia)

② Inasmuch as rain-water is only supply source to various crops, operation to destroy overgrowing weeds poses a serious problem. Conventional means of weeding by man or animal causes a keen labour shortage in a peak season, which, in turn, forms the background to an extraordinary hike in wages - a hike which occupies almost one-third of total expenditures. (Thailand)

③ It is growing more and more important to run diversified agriculture and to conduct a two-crops-a-year cultivation of low land rice. Also highlighted is a mechanized harvesting of paddy in terms of timely operation as well as a mechanized drying in connection with climate conditions. Simultaneously, a mounting concern over realizing mechanized operation is being directed to crops other than rice. On the other hand, demand for multi-purpose tractors for rice cropping is increasing, too. (Malaysia)

④ In spite of the fact that owing to hard soils and on account of prevailing custom work, tillers have been very popular in this country, farmers begin showing an increasing interest in heavyduty tractors. (Thailand)

⑤ Food production is on the increase due to the Governments priority policy on agricultural production. However, labour productivity being still at a low level, agriculture leaves a specious room for the introduction of labour towards the future. (Pakistan)

⑥ If effective tillage equipment that is concurrently capable of harrowing is developed, that machinery that follows should be 15-25 HP tractors, tooth-wheel type break harrows, pumps, rice polishers, etc. At the moment, surplus labour is eliminating demand for threshers. However, it is quite natural that with the advent of agricultural mechanization, an emphasis be laid upon Japanese-made automatic threshers. (Laos)

3) Major Problems Concerning Development,Designing and Inprovement of Farm Machinery. (Propositions to Farm Machinery of Japanese Makes)

3.1 Necessity for Improving Designs Pertinent to On-The-Spot Requirements

① Weather conditions, qualities of soil and crops, management forms and economic conditions of farmers should be taken into consideration for the introduction of agricultural machinery. A special attention should be paid to the durability of farm machinery in view of the soil state. (Republic of China, Indonesia, Malaysia and Thailand.)

② Propinquity of management scale and form has made the introduction of Japanese machines all the more necessary. However, fact-finding study is conceivably essential to make farm machinery consistent with the local state of affairs. (Indonesia and Laos)

③ As the size of machines has a close relations with management scale of agriculture and socio-economic conditions, study should be made on this aspect.

④ Model change should be made with special circumspection, because abundant supply of spare parts or well-prepared servicing can hardly be expected. (Republic of China)

3.2 Strengthening of Durability of Machinery and Parts

① To strengthen the durability of machines and parts is considered important not only in terms of soil conditions but also an excessive use of machinery in a peak season. (Republic of China, Malaysia, Indonesia and Thailand)

② In order to minimize wear and replacement of parts and to enfarce the durability of machines, it is imperative to upgrade the specifications in materials. (Indonesia)

3.3 Problems on Running and Handling Machinery

① Inasmuch as farm households in the developing countries are technically not at a high level and their purchasing power is not large enough, simple and yet easy-to-operate machines should be designed for agricultural operation. (Republic of China, Indonesia and Thailand)

② Mechanism of speed change gear of tillers viz. 6-2 seems to Be too sophisticated. (Republic of China)

3.4 Improvements to be Made on Tillers and Tractor

① Specifications have been strengthened in this country on 30 or more component parts such as rotary shafts, engine frames, gear cases, bearings and seal system. Accordingly, necessity is felt for designing machinery pertinent to locally made component parts. (Republic of China)

② As there is a farming practice of leaving stubbles and cut leaves in the fields, machinery that should be developed is an equipment with which to prevent straws, stumps, leaves, etc. from cling to a rotary shaft. (Republic of China)

③ Tillers or tractors operating in low land paddy fields are apt to submerge. Consequently, a special attention should be paid to their weight, shape of wheels, material, etc. (Indonesia, Malaysia and South Vietnam)

④ Hard soil sometimes causes a failure to a cutting edge of a rotary tiller. Study, therefore, should be made to obtain stronger materials, (South Vietnam)

3.5 Improvements to Be Made on Harvesters.

① Soft soil caused by a poor drainage facilities does not permit heavy duty machines to harvest low land rice. Even a light small machine also is subjected to the requiremnent for an improved travelling equipment. (Republic of China, Indonesia, Malaysia and South Vietnam)

② As rough rice usually contains a high percentage of moisture in a harvesting season, it is desired that an improvement be made on sorting system so as to work in 24 hours a day — early in the morning or immediately after the rain is over. (Republic of China)

③ Reaping equipment should be so reconstructed as to be suitable for a variety of widths of rows. (South Viet-Nam)

④ Japanese small combines make no trouble in their introduction to the fields or their transportation. However, from an economic point of view, there can hardly be found any spread between the Japanese and domestic combines. An effort, therefore, should be exerted to mark down the cost of the Japanese machines as much as the counterparts developed by IRRI, which are under experimental operation. (Malaysia)

3.6 Improvements to Be Made on Threshers and Finishing Machines

① Firstly, a light machine should be designed for an easy transportation as well as for effectual threshing that is similar to "Throw-in Type." Secondly, a simple adjustable equipment for the number of revolutions of a cylinder and a blower should be devised in order to thresh unhulled rice which is an easy-to-thresh variety. Thirdly, an improvement should be made on the designs of the machines so as to make them well perform even at a low speed of revolution by simple adjustment (South Vietnam)

② Wear-resistance of rubber rolls for rice hullers should be strengthened. (Indonesia and South Vietnam)

4) Expansion and Improvement of Research Organization

4.1 Present State, Problems and Future Trend of Study and Research

① In order to prompt mechanized rice planting, an effort should be made

to develop joint seedling and to make design modification to rice planting machines and automatic thresher combines. In parallel with this effort, an attempt should be done to develop not only ground nut seeders and diggers as implements for tillers, but also potato diggers, manual soybean seeders and equipment for tea, flax or jute. (Republic of China)

② Research activities hitherto developed have been confined mainly to an economic evaluation of farm machinery. The future target, however, is likely to be concentrated on the test and improvement of mechanized agriculture, aimig at the introduction of machinery appropriate for the local conditions. There will be no alternative but to depend upon industrialized predecessors, as far as research and development are concerned. This is because of the lack of accumulated capital and shortage of technical staffs. (Malaysia)

③ What should be taken up as an application of research to a new aspect is the mechanization of rice transplanting and mechanically systematized operation of cotton, potatoes, sweet potatoes and ground nuts. However, it is difficult to conduct research and development of the machinery related thereto, it should rely upon the technical support from the advanced countries. For this, an effort must be directedl to try a lot of experimental application more easily. (India)

④ It is expected that for the contribution towards the improvement of the worlds cereals market, an emphasis be placed upon study on the processing and storage of cereals to enhance economic utilization of local materials, which will go in parallel with mechanized cultivation of low land rice. (Thailand)

⑤ The first step for research and development should be forcused upon the systematic collection of basic data through theoretical evaluation on the capability, performance and features of commercial machinery. That research and development which require an enormous sum of money and a lot of time should be carried over after the completion of the first step. (Korea and India)

⑥ It is not easy for developing nations to make an investment on the experiment, research and development of agricultural machinery. It is, therefore, advisable for them to set up an organization for joint activity by the countries whose management form and cultivating conditions have a common point. This is the case with training and education, too. (India)

4.2 Expansion and Improvement of Institutions for Research and Development

① An ardent demand should be made for the establishment of Institute for Research on Farm Machinery or the like for training and fostering students and specialists in order to improve designs and speifications and to develop new machines and implements. (Republic of China)

② The Goverment has reportedly a policy under which, in order to secure the funds for expansion and improvement of research and experiment on farm machinery, a taxation corresponding to 1 % of machine prices be leveled upon the machinery of importers' and manufacturers' (Thailand)

③ Expansion and improvement of research activity is highly desired to make surplus labour emanated from systematized guidance to the mechanized agriculture contribute towards the national production structure. To attain this target, a priority should be extended to the strengthening of research activity as well as improvement of test on performance and materials of meachinery, for which an authetic Farm Machinery Inspection House is held responsible. (Korea)

④ An effort should be made to encourage mechanized farming centering on small machines and simultaneously an attempt to establish mechanized farming structure by means of large machines for rice cropping and field jobs. (Republic of China)

⑤ A consideration should he given to the strengthening and expansion of research on puddling machines suitable for rice plantting and the creation of reasonable tillage in parallel with the solution of bottlenecks that are hindering mechanization, the so-callel fragmented land ownership for exampe. (Pakistan)

4.3 Training and Education of Researchers and Technicians.

① A stress should be laid upon the positive policy under which to despatch for study researchers and technicians to foreign countries or colleges at home even for a short period. (Malaysia and Republic of China)

② Considered necessary are the increase in number of agricultural specialists with the aid of education at colleges and fostering of medium-ranking technicians at agricultural senior high schools and the expansion and improvement of experiment and research organizations. This forms a premise to the promotion of farm mechanization. (Korea)

3. Salient Points to Promote Farm Mechanization

1) Agricultural Development Project and Readjustment for Land Foundation

① Encouragement of home-made farm machinery under the 4-year Economic Planning to accelerate farm mechanization, to initiate a long-term-low-interest loan system and to create a pilot project for evaluation on the possilbility of a large scale mechanized agriculture under joint organization. (Republic of China)

② Encouraged importation of farm machinery to increase food production and to augment home-made parts under the First-5-Year Planning on the National Econmic Development. (Indonesia)

③ The inauguration of "Committee of Farm Machinery" a Council to promote agricultural mechanization and the Committee's report to carry out the planning. (Pakistan)

④ It is considered necessary that for the purpose of endowing a stronger power to the "Council of Farm Mechanization", an organization to discuss basic problems for promotion of farm mechanization, the Committee to expertize specific matters be created as the substructure belonging to the Council. (Korea)

⑤ A large scale irrigation plan to prompt self-supplying rice production by means of two crops a year has been carried out. As a result, some part of the irrigation problems has been settled satisfactorily. However, an important challenge to come is how to systematize drain facility.

⑥ The carrying-out of a farmland adjustment and consolidation project or the acceleration of a structural improvement project with the aid of farmland adjustment and consolidation work] (Pakistan and Korea)

2) Encouragement of Domestic Production and its Problems

2.1 Present State and its Premises

① Joint ventures wiih foreign capital have rendered the country to increase her domestic production capacity to such a high level as about 30,000 units of production per year and as an 85% self-supplying in her parts production. Main imports are limited to hydraulic equipment. The bottle necks for the domestic production of farm machinery lies in the shortage of raw materials including steel. In order to tide over these difficulties, it will be necessary for the developing nations to effectively activate not only the exchange of know-how but also the interchange of raw materials, parts or assemblies. (India)

② The spread of tractors has caused a favourable influence over the domestic production of implements for tractors, corn threshers, pumps, simple 2-wheeled tractors and the improvements of puddlers as well as accelerated technological progress on the part of small makers or local factories. (Thailand)

③ It is generally admitted that power tillers have a lot of advantages, when viewed from the agricultural structure and the economic conditions under which farm households are placed. To manufacture such tillers in their own country, standardization of the specifications is a presequite. Accordingly, an attempt is being made by the Committee to set up the specifications pertinent to testing of various kinds of machinery. (Pakistan)

2.2 Measures to Encourage Domestic Production

① Measures for more qualitative improvement of and lower prices for domestic farm machinery pushed on under the 4-year Economic Planning to accelerate Farm Mechanization. (Republic of China)

② The production of a variety of machinery is being promoted centering upon joint ventures with foreign enterpries and rapid progress of home-made farm machines. In the light of increasing demands for agricultural machinery is the future, necessity is more keenly felt for the creation of much more strengthened production structure. (India)

③ To attain the target of increase in food production under the First-5-year Planning on the National Economic Development necessity is emphasized for joint ventures, technical collaboration with foreign counterparts to manufacture parts and to encourage home-made machines. (Indonesia)

④ Preferential treatment to the taxation on a tractor assembly plant to promote production of domestic machines. (Malaysia)

⑤ Preferential treatment of various kinds to comprehensive processing and finishing equipment for rice, cereal dryers, rice polishers and storage facilities related thereto as well as to the measures to encourage domestic production such as small engines for farm operation. (The Philippines)

⑥ It is expressly clear that imported farm machinery alone could no more satisfy the increarsing demands in the future Consequently, an emphasis, in parallel with the import of new machines, should be placed on the measures to vivify domestic production through the protection for machine industry inclnding a parts assembly factory. (South Viet-Nam)

3) Promotive Measures to encourage the Purchase of Farm Machinery

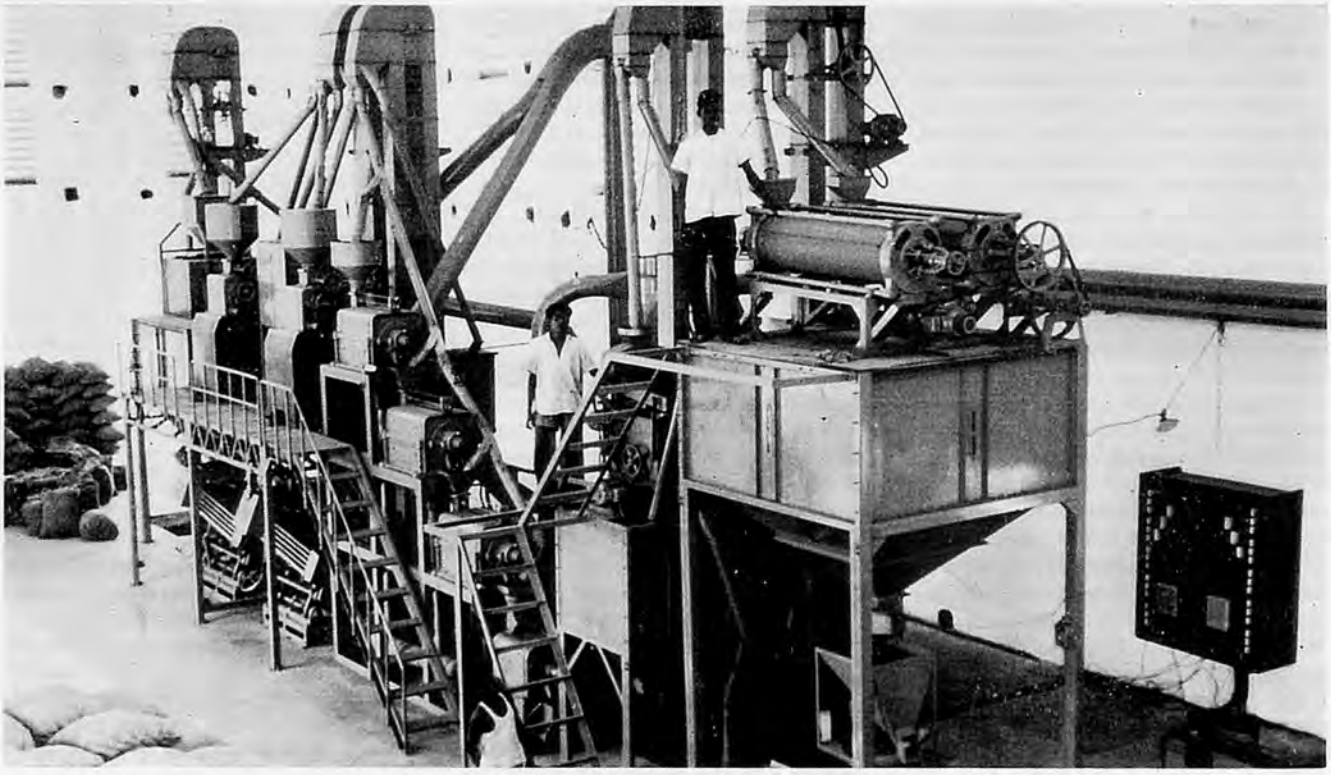
① Encouragement should be made to utilize a wide range of the government's subsidy for the purpose of mitigating the burden on the part of farm households in order to introduce tillers, rice planten, small combines, dryers reapers, sprinklers, etc. (Republic of China)

② Purchase of form machinery under a long-term instalment, the establishment in each State of Agro-Industries Corporation, an organization created by the investmeut of the government, and the offer of a long-term credit system as well as a medium-term loan facility in cooperation with bankers. (India)

③ The establishment and utilization of a credit servicing system and any other organization that may facilitate purchasing farm machinery. (Malaysia)

④ Necessity for extending loan facilities for the purchase of agricultural machines to the Government or other organizations in order to simplify procedures to obtain credit from the Pakistan Agricultural Development Bank. Necessity for much higher rating on farmland as a means of hypothec and necessity for granting the subsidy to farmers who badly need fertilizers, irrigation facilities and farm machinery. (Pakistan)

⑤ In order to extend a proper support to farm households, accordihg to their farming scales, which are classified into three categories such as small, medium and large, an investigation on the farming characters of these types of mechanized agriculture is considered important and necessary. (Korea)



Rice processing center in India. Processing and storage of grain are increasing importance as the second generation problem of "Green Revolution."

SUPPLEMENT

Main Indicators for Agricultural Mechanization in South East Asia

(Farm Machinery Industrial Corp.)

Selected Indicators

Indicators		Burma	Cambodia	Ceylon	Taiwan	India	Indonesia	Laos	Malaysia	Nepal	Pakistan	Philippines	Thailand	Rep. of Viet-Nam
Gross National Production (1966)														
Total amount	mill. $	2,983	('65) 730	('65) 1,530	3,112	('65) 45,000	9,977	('58) 137	3,019	('64) 1,966	11,100	5,984	4,434	('65) 1,920
Per capita amount	$	60	120	150	230	90	100	70	280	...	90	160	130	120
distribution of agriculture	%	32.7	41.5	41.0	25.6	('64) 51.0	51.6	...	33.8	('64) 65.2	('64) 47.8	29.9	33.4	28.6
Income per Capita '60	$	56	...	126	120	65	...	...	222	...	73	208	88	139
〃 '65	$	61	115	131	184	89	91	...	252	...	95	136	106	130
〃 '67	$	59	('66) 121	137	('68) 246	73	...	...	('66) 256	...	112	150	127	('66) 104
Exports														
Total amount '66	mill. $	190	('65) 105	('65) 400	536	('65) 1,686	679	...	1,256	...	601	857	688	('65) 35
Agricultural amount '65	〃	...	...	397	283	690	...	...	707	...	330	691	499	...
Imports														
Total amount '66	mill. $	158	('65) 103	('65) 310	622	('65) 2,912	583	...	1,104	...	900	957	1,213	('65) 370
Agricultural amount '65	〃	...	...	185	175	1,041	...	...	483	...	287	229	88	...
Population														
Total '67	1,000	25,811	6,610	11,701	13,142	511,625	110,899	2,770	9,403	10,492	120,185	34,656	32,680	16,973
Agriculture '65	〃	15,334	4,695	5,582	5,846	340,768	70,762	2,146	5,161	9,295	77,030	18,738	24,001	13,705
Economic Active Population (1965)														
Tatal	1,000	9,895	2,775	3,662	3,780	207,598	37,885	770	3,285	4,950	38,455	('66) 11,757	15,905	('66) 7,325
Agriculture	〃	6,135	2,220	1,831	1,755	145,319	25,005	625	1,805	4,555	26,150	('66) 6,290	12,405	('66) 6,165
Ratio of agriculture	%	62	80	50	47	70	66	81	55	92	68	('66) 53	78	('66) 85
Land Use														
Tatal area '67	1,000ha	('66) 67,803	18,104	6,561	3,596	326,809	('54) 149,156	('64) 23,680	('66) 33,263	14,080	('65) 94,647	('66) 30,000	('66) 51,400	17,091
Agr. land area '67	〃	...	...	...	...	194,200	...	('64) 1,600	('66) 5,670	1,831	('65) 28,217	...	('66) 11,415	...
cultivated land '67	〃	('66) 16,087	2,984	1,875	902	136,200	('54) 17,681	('64) 800	('66) 3,485	1,052	('62) 25,500	('66) 8,330	('66) 9,113	2,760

Indicators		Burma	Cambodia	Ceylon	Taiwan	India	Indonesia	Laos	Malaysia	Nepal	Paki-stan	Philip-pines	Thai-land	Rep. of Viet-Nam
of which irrigated land '62	1,000ha	...	...	300	530	28,400	...	...	(West) 250	...	11,000	910	1,690	...
〃 (I. W. Plan, FAO) '75	〃	...	...	500	600	35,200	...	...	(〃) 280	...	14,000	1,560	2,240	...
〃 (〃) '85	〃	('66) ...	...	640	650	42,000	...	...	(〃) 310	...	18,400	2,100	2,650	...
Meadows and pasture '67	〃	('66) 354	580	13	...	14,809	... ('64)	800 ('66)	2,112	...	... ('66)	2,988 ('66)	2,028	...
Ratio of Agr. land use '67	%	('66) 22.3	19.7	28.9	...	59.3	... ('64)	6.8	17	13.0	29.7	37.8	21.7	...
No. of Farm Holdings														
Total	1,000	('63) 12,148	...	('62) 1,174	('68) 877	('62) 61,780	('63) 12,148	...	('60) 577	('62) 1,496	('60) 12,155	('60) 2,168	('63) 3,214	('60) 1,893
Owner	〃	...	...	('62) } 1,171	('65) 67%	('62) 37,100	('63) } 12,144	...	...	('62) 73%	('60) 52%	('60) 968	('63) 2,563	('60) 835
Party owner or tenant	〃	...	...	}	('65) 21%	('62) 14,140	}	...	...	—	('60) 29%	('60) 311	('63) 127	('60) 58
Tenant	〃	...	...	('62) 3	('65) 12%	('62) 10,540	('63) 4	...	...	('62) 27%	('60) 19%	('60) 865	('63) 118	('60) 1,000
Others	〃	...	...	—	—	—	—	...	...	—	—	('60) 23	('63) 407	—
Average Size of Farm Holding	ha	...	2.5 ('62)	1.5	0.9 ('65)	2.2 ('62)	1.1 ('63)	...	4.4 ('60)	1.2 ('62)	2.3 ('60)	3.6 ('60)	3.5 ('63)	1.6 ('64)
Cropping Land Area														
Total area	1,000ha	...	...	('58) 1,449	('67) 1,690	('62) 156,100	...	...	...	...	('66) 23,780	('64) 8,304	('67) 9,336	2,934
Rice	〃	('67) 4,800	('67) 2,020	('58) 405	('67) 546	('67) 789	('64) 36,080	...	('68) 960	('68) 389	1,100	10,754	('66) 3,109 ('64) 6,452	('67) 2,429
Food crops	〃	...	...	('58) 108		('67) 362	('64) 81,400	...	...	...	661	9,614	('66) 2,438 ('64) 758	('67) 188
Cush crops	〃	...	...	}		('67) 432	...	...	...	...	158	3,173	('66) 689 ('64) 738	('67) 42
Vegetable	〃	...	...	}	}	}	...	...	...	...	...	}	('66) 52 ('64) 200	('67) 12
Fruits	〃	...	...	('58) } 936	}	} 107	...	...	...	...	...	} 239	('66) 402 ('64) 147	('67) 64
Other tree crops	〃	...	...	}	}	}	...	...	...	...	...	}	1,614 ('64) 950	('67) 190
Other crops	〃	...	...	}	}	}	...	...	...	...	...	}	— —	9
Production of Main Crops (1968)														
Rice	1,000ha	4,763	2,324	562	790	36,966	7,964	960	389	1,200	11,297	3,332	6,259	2,394
	1,000t	8,023	3,251	1,347	3,299	59,642	15,224	932	1,051	2,322	20,065	4,445	10,772	4,366
Maize	1,000ha	150	113	13 ('67)	24 ('67)	5,716	3,269	40 ('67)	4 ('67)	440 ('67)	620	2,256	707	29 ('67)
	1,000t	60	154	17	64	5,701	3,102	22	3	850	629	1,733	1,500	34
Millet and sorghum	1,000ha	218	...	25 ('67)	11 ('67)	37,767	...	...	...	110 ('67)	1,210	...	...	...
	1,000t	55	...	11	17	17,058	...	...	...	130	592	...	...	...
Sugar cane	1,000ha	47 ('67)	...	7 ('67)	96 ('67)	2,037 ('67)	125 ('67)	...	...	10 ('67)	671 ('67)	306 ('61)	150 ('67)	21 ('67)
	1,000t	1,600	...	100	8,128	96,884	8,720	...	...	170	26,371	15,525	4,500	600
Sweet potetoes and yams	1,000ha	1 ('67)	1 ('67)	20	240	219	360 ('67)	2 ('67)	9 ('67)	...	48 ('66)	130 ('61)	27 ('67)	35
	1,000t	...	13	76	3,445	1,559	2,023	15	94	...	496	683	190	235
Cassava	1,000ha	... ('67)	2 ('67)	73	21	335	1,519 ('67)	1 ('67)	22 ('67)	...	...	83 ('61)	130 ('67)	35
	1,000t	2	23	346	342	4,520	11,291	10	330	...	...	514	1,800	260
Pineapples	1,000ha	...	... ('67)	... ('67)	... ('67)	...	...	...	... ('67)	...	('67)	... ('61)	... ('67)	... ('67)
	1,000t	...	20	20	296	...	...	...	350	...	92	208	280	37
Soybeans	1,000ha	...	9 ('67)	...	52 ('67)	...	676	...	...	...	...	1 ('67)	57	8 ('67)
	1,000t	...	8	...	75	...	398	...	...	...	...	1	51	6
Groundnuts	1,000ha	473	21 ('67)	5 ('67)	95	7,091	390	21 ('67)	2 ('67)	...	76 ('67)	30	101	30 ('67)
	1,000t	336	21	5	106	4,476	455	1	4	...	113	15	149	34
Coconuts	1,000ha	152	... ('67)	... ('67)	...	7,685	...	...	... ('67)	...	1,757	... ('67)	81	... ('67)
	1,000t	11	33	2,000	...	949	5,035	...	776	...	529	7,100	30	131

Indicators		Burma	Cambodia	Ceylon	Taiwan	India	Indonesia	Laos	Malaysia	Nepal	Pakistan	Philippines	Thailand	Rep. of Viet-Nam
Tea	1,000ha	...	...	242 ('67)	34 ('67)	348 ('67)	124 ('67)	...	3 ('67)	...	42 ('67)	...	...	7 ('67)
	1,000t	...	...	2,207	244	3,825	784	...	31	...	297	...	...	42
Tobacco	1,000ha	72	22	11 ('67)	11	424	216	6 ('67)	4 ('67)	8 ('67)	116	94	83	8 ('67)
	1,000t	54	118	68	21	369	110	30	27	53	170	65	90	79
Cotton	1,000ha	190 ('67)	2 ('67)	2 ('67)	2 ('67)	... ('67)	15 ('67)	6 ('67)	...	...	... ('67)	...	89 ('67)	...
	1,000t	21	1	...	1	2,157	3	2	...	...	1,022	...	27	...
Jute	1,000ha	40	8	...	7	804	3 ('67)	...	...	29	878	...	121	1
	1,000t	21	6	...	11	691	5	...	...	30	1,036	...	150	1
Abaca	1,000ha	...	...	...	...	...	1 ('67)	...	2 ('67)	...	...	171 ('67)	...	...
	1,000t	...	...	...	...	...	3	...	23	...	...	809	...	...
Natural rubber	1,000ha	...	...	...	...	...	...	...	...	...	...	...	...	...
	1,000t	9	47	149	...	67	75	...	1,110	...	...	14	259	34
No. of Livestock and Poultry														
	(1966)													
Cattle	1,000	6,617	1,737	1,659	105	176,000	6,800	380	311	585	35,700	1,575	5,167	1,033
Buffaloes	"	1,372	654	765	262	53,220	2,900	865	326	209	8,730	3,926	6,878	665
Pigs	"	1,282	1,057	128	3,110	4,900	3,150	995	...	30	94	5,494	4,045	3,185
Poultry (chickens)	"	...	3,019	6,256	10,860	115,230	104,000	11,573	23,770	1,656	...	66,489	37,000	...
Milk cows	"	1,700	620	1,000	...	54,750	...	...	157	...	16,532	...	...	...
No. of Tractor on Farms														
(1963~1969)														
	'63 No.	...	...	...	...	...	1,135	...	130	210	1,307	5,226	6,629	969
	'64 "	...	674	...	...	...	...	37	130	...	1,495	...	10,075	...
	'65 "	2,891	...	1,700	...	40,000	...	55	183	...	1,600	...	13,285	...
	'66 "	3,452	...	2,546	379	53,966	...	66	201	...	...	...	16,985	...
	'67 "	4,511	...	3,802	...	...	...	...	243	...	...	5,252	22,685	...
	'68 "	...	...	12,000	...	75,000	5,000	...	1,300	700	22,000	12,000	28,000	...
	'69 "	...	...	...	...	...	...	...	...	...	...	...	...	...
No. of Power Tiller on Farms														
(1963~1969)														
	'63 No.	177	31	11	9,079	...	...	6	49	11	...	...	...	...
	'64 "	...	27	11	10,201	...	...	...	20	...	...	...	...	...
	'65 "	...	27	...	12,213	2,000	...	...	27	...	...	...	1,000	...
	'66 "	...	45	13	14,272	4,700	...	...	35	15	2,500	7,500	2,800	...
	'67 "	...	...	14	17,200	...	...	...	...	...	...	...	...	...
	'68 "	...	...	...	20,400	4,000	...	...	...	...	...	...	...	...
	'69 "	...	...	...	24,600	...	...	...	...	...	...	...	...	...

Tractor Requirements and Rate of Annual Supplies, 1965, 1975, 1985 by FAO-IWP.

Country		Tractor Park			Harvested Hectare Per 40 HP Tractor Unit[2]			Rate of Annual Supplies of Tractors								
								1965			1975			1985		
		1965[1]	1975	1985	1965	1975	1985	As replacement	For growth	Total	As replacement	For growth	Total	As replacement	For growth	Total
India	2wheel	2,000	50,000	500,000	3,652	1,056	267	50	450	500	2,000	13,000	15,000	20,000	130,000	150,000
	4wheel	40,000	160,000	650,000				2,500	6,000	8,500	9,000	24,000	33,000	35,000	95,000	130,000
Pakistan	2wheel	200	6,000	30,000	2,453	760	224	10	40	50	200	1,800	2,000	3,000	7,000	10,000
	4wheel	10,000	40,000	160,000				500	1,000	1,500	1,500	6,000	7,500	8,000	24,000	32,000
Ceylon	4wheel	7,000	13,000	22,000	253	175	125	400	400	800	800	850	1,650	1,650	1,150	2,800
Malaysia	4wheel	6,000	10,000	15,000	395	289	217	600	300	900	900	500	1,400	1,400	600	2,000
Philippines	2wheel	2,000	5,000	20,000	1,088	605	268	200	300	500	600	900	1,500	2,000	4,000	6,000
	4wheel	7,000	16,000	40,000				500	600	1,100	1,100	1,400	2,500	2,500	3,500	6,000
Taiwan	2wheel	12,200	35,000	100,000	660	265	100	700	1,000	1,700	2,000	8,000	10,000	12,500	17,500	30,000
Thailand	2wheel	1,000	5,000	15,000	543	253	138	50	150	200	250	1,250	1,500	2,000	2,500	4,500
	4wheel	15,000	40,000	80,000				600	2,400	3,000	3,000	3,500	6,500	6,500	6,000	12,500
Total	2wheel	17,400	101,000	665,000				1,010	1,940	2,950	5,050	24,950	30,000	39,500	161,000	200,500
(7 countries)	4wheel	85,000	279,000	967,000				5,000	10,700	15,800	16,300	36,250	52,550	55,050	130,250	185,300

1) Due to lack of reliable statistics, many of the 1965 figures for Tractor Park have been estimated.

2) On the basis that five 2−wheel tractors of 8 HP = one 4−wheel tractor of 40 HP.

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Mitsubishi Farm Tractor R1500

Mitsubishi Farm Tractor R2500

Model	R1500	R2500
Dimensions: L × W × H mm(in)	2,025 × 1,130 × 1,240(79.7 × 44.5 × 48.9)	2,365 × 1,520 × 1,370(93.0 × 59.9 × 54.0)
Dry weight kg(lb)	600(1,322.8)	950(2,094.4)
Ground clearance mm(in)	350(13.8)	410(16.2)
Tire size	Front:4.00-12 4PR Rear:8-20 4PR	Front:5.00-15 4PR Rear:11.2-24 4PR
Engine	760 cc, 15HP, water-cooled, diesel	1,192 cc, 25HP, water-cooled, diesel
Transmission	5-forward, 1-reverse	6-forward, 2-reverse
Brake	Water-tight, internal expansion	
PTO	Low:540rpm High:816rpm at 2,400 rpm engine speed	Low:545rpm High:765rpm at 2,200 rpm engine speed
Implement linkage	Hydraulic, 3-point linkage	Hydraulic, 3-point linkage

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CT151 gasoline, 3.5 HP
CT314 gasoline, 4 HP
CT336 gasoline, 4.5 HP
CT334 gasoline, 6 HP; kerosene 5 HP

CT532 Kerosene, 7HP; diesel, 7HP; gasoline, 7.5HP.
CT553 kerosene, 8.5HP; diegel, 8.5HP ; gasoline, 7.5 HP
CT83-2 kerosene, 11 HP; diesel, 11 HP

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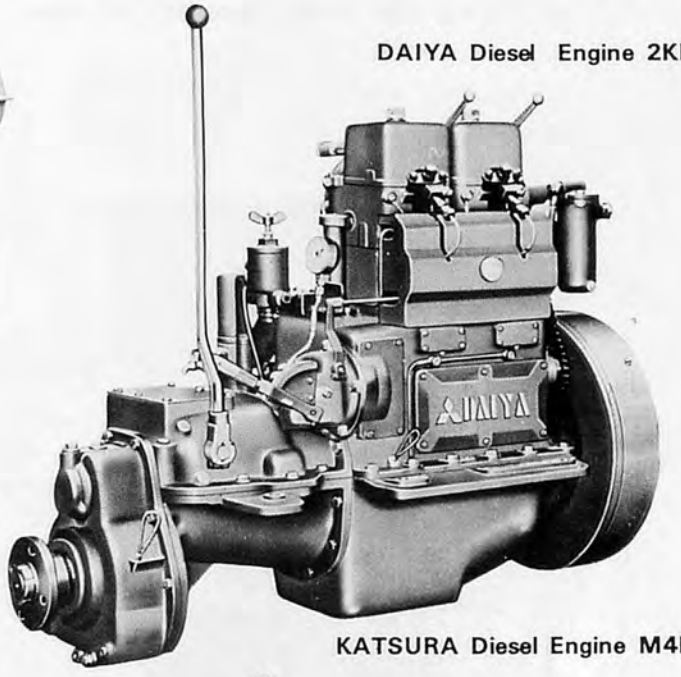
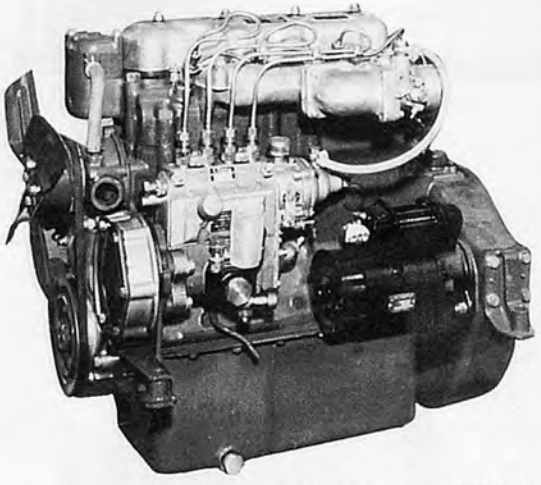
MEIKI Engine G450

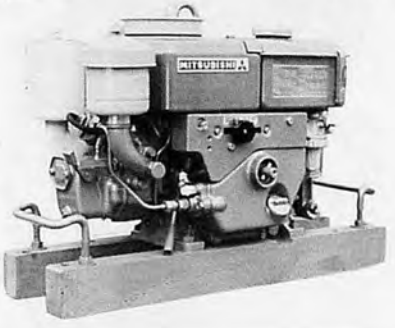
DAIYA Diesel Engine 2KE



KATSURA Diesel Engine M4H



Diesel Engine 4DQ11



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Air-cooled Kerosene

Mitsubishi Diesel Engine Series (6-840HP)

Mitsubishi KATSURA Engine Series (3-14 HP)
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Mitsubishi DAIYA Diesel Engine Series (4-250HP)

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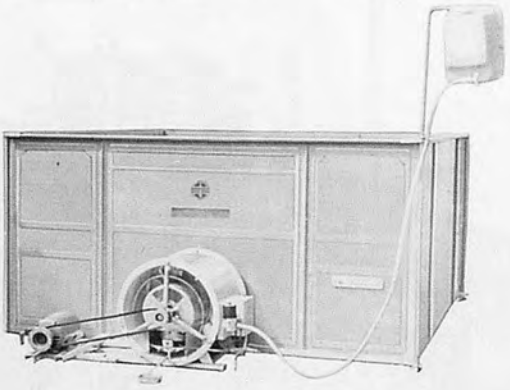
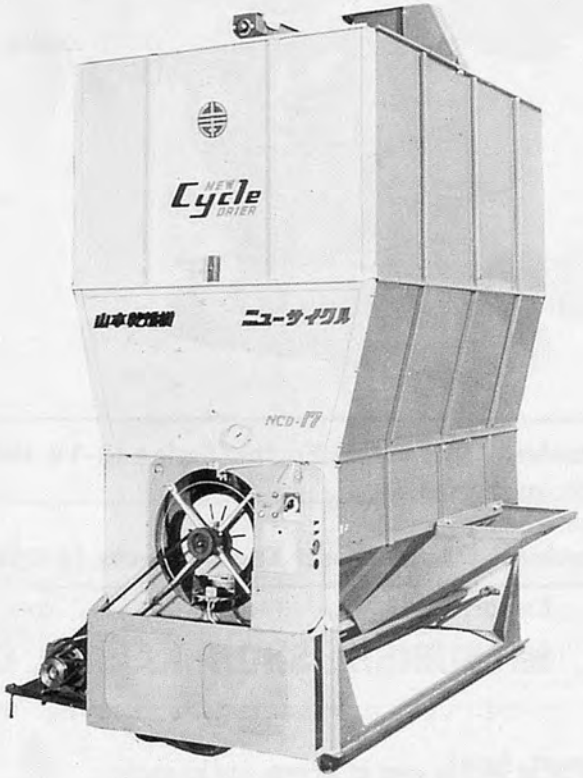
Layer type FB-38

for drying the small quantity of rice.



New Cycle Dryer Series

for drying the large quantity of rice.



Rice Depot

for drying & storing the rice with low temperature.

Moisture Meter

to measure moisture of rice.

AGRICULTURAL MACHINES

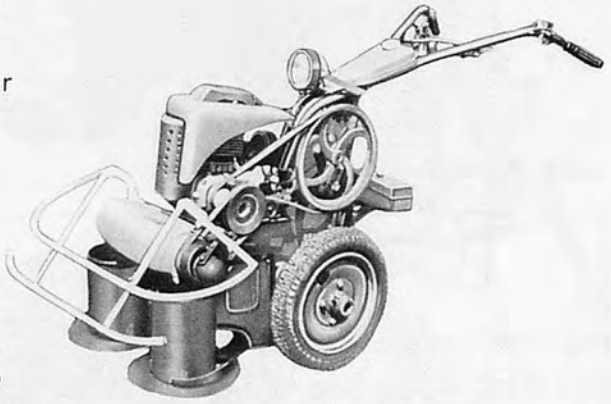
Cutter Series & Other Products

Cylinder type cutter CL-15

for cutting the straw & grass.

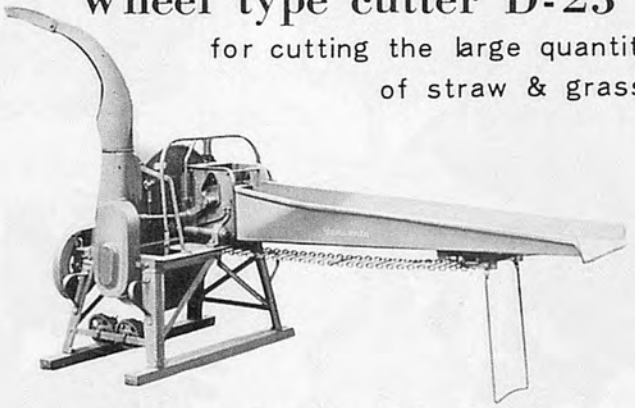
Setting to Combine Harvester

for cutting the straw
threw out from
Combine Harvester



Wheel type cutter D-25

for cutting the large quantity
of straw & grass.



Grass Mower

for reaping & mowing
pasture or grass.

YAMAMOTO MFG. CO., LTD.

Head Office : Tendo-city, Yamagata, Japan

Branch : Oyama, Nagoya, Osaka, Fukuoka, Iwamizawa

ADVANCE YOUR FARMING WITH VARIOUS ROBIN PRODUCTS !!

Suitable for women use, It weight is only 7 kg lighter than a human power sprayer !!

Robin 3K shoulder type power sprayer Model RS02IIR

World most renowned Robin Dust & Mist Blower!!
Model NF32ADM

Robin Combine
Model GH52

Robin Binder
Model RH35

Robin Tiller
Model L6

Robin Power Rotor
Model RC05II

Robin Power Sprayer
Model AS25

Robin Pump
Model S15A

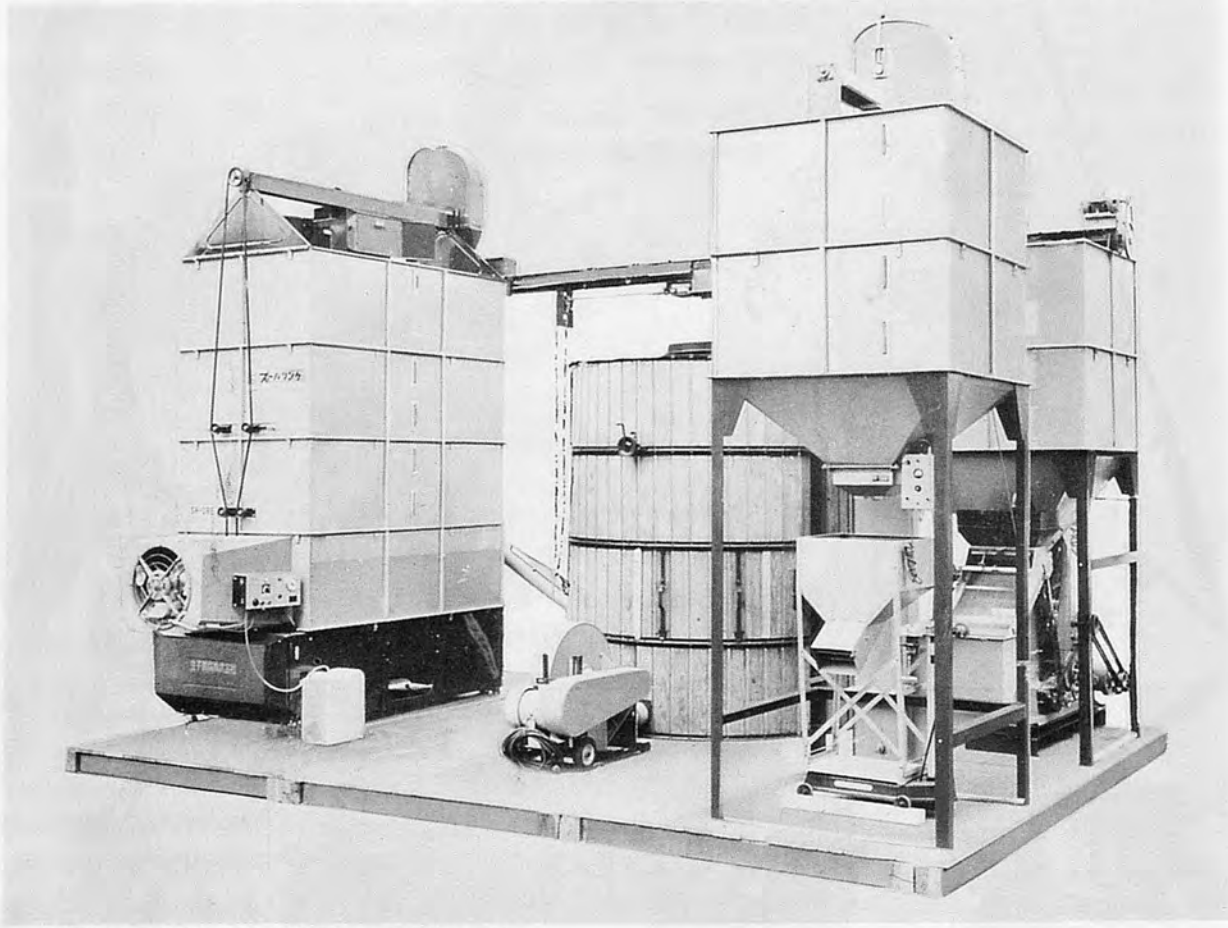
Rabbit Chain saw
Model CL60

Rabbit Fire Pump
Model P406S

SYSTEMATIZED TO PRODUCE TASTEFUL RIC

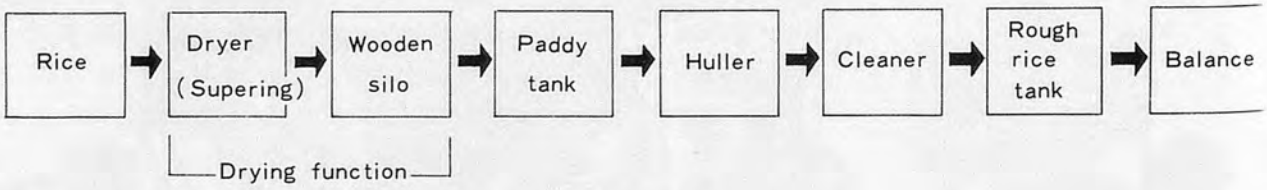
"ISSIN-GO" *RICE CONDITIONING SYSTEN*

The Consistent Equipment to Produce Tasteful Rice, Saving Labour.



RICE CONDITIONING SYSTEM

Drying Function + Storing Function + Adjusting Function + Carrying Function



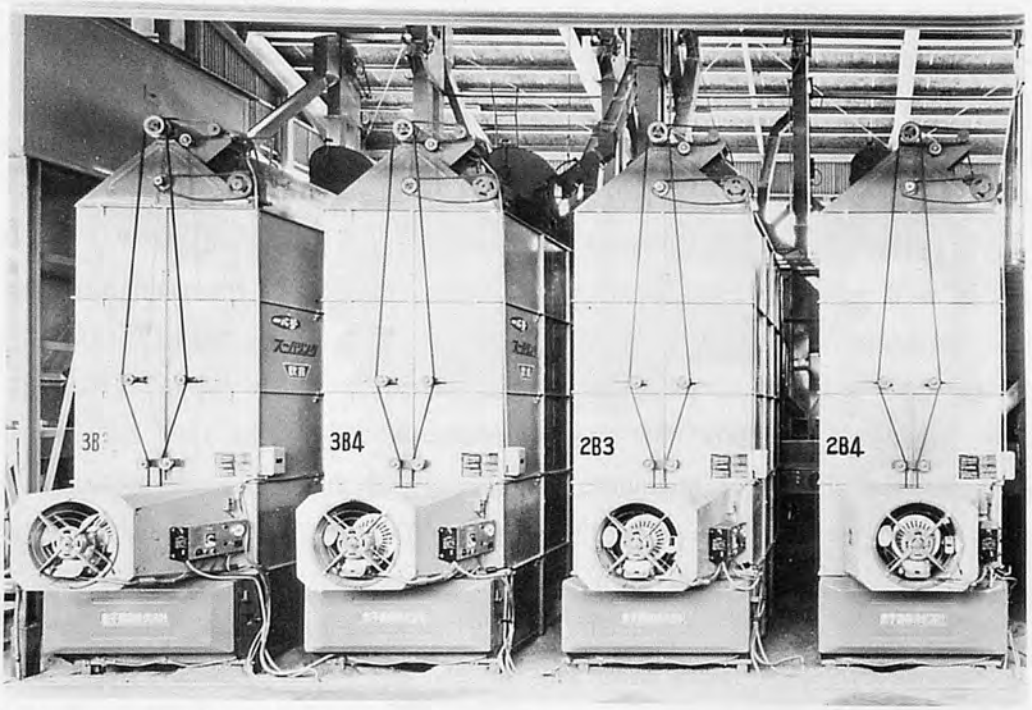
What is Rice Conditioning Drying System?

Combination Drying System by Supering Drying Machine of big air of moderate temperature and by wooden silo of natural air of ordinary temperature. That is, much moisture contained paddy is dryed to a certain degree (18-20%) by Supering, and after that, dryed by natural air of ordinary temperature.

SYSTEMATIZED TO PRODUCE TASTEFUL RICE

"ISSIN-GO" "SUPERING" GRAIN DRYER

Supering Dryer, which is carrying on the centre function of Rice Conditioning System.



It is now the time for systematize farming. It is Isshingo Rice Conditioning System which can realize drying, storing, adjusting and carrying consistently and produce tasteful rice, which is mostly desired now, ideally, saving labour. From the small scale farmer to the large scale cooperative can install this system freely according to the quantity they dispose of. Compared with the Rice Centre, we have had, our system has the following characteristics. The paddy direct from the Combine can be handled by this system. The capacity of this system is large compared with the space it occupies. This is the system of large production, but the price is cheap. Compared with the country elevator, the air output of this system is bigger end drying is handled at ease and without worry. As the humidity control of this system is very easy for a long period of storing rice, this system is good and safe. This system can be used by species or by individual.

KANEKO AGRICULTURAL MACHINE CO., LTD.

Hanyu City, Saitama Pref, Japan.
Cable Address: KANEKO GYODA (JAPAN)
Telephone: 0485-61-2111
Telex: 2942-462

KONMA ENGINEERING POWER PROMO

There no denying the fact that Japanese method of rice cropping, harvesting, though highly mechanized at present, was not far from the unproductive one till 50 years ago which had been inherited from farmers to farmers over many centuries. But this has been brought up as the most rational way of production under the conditions of the society in each time. In the case of changing this to the modern production method, it will be more acceptable for farmers to introduce machinery-techniques which are picked up among partially low productive elements to be replaced with the highly productive ones without destroying the traditional way of production extremely.

On this viewpoint, Konma Seisakusho Co., Ltd. has been developing new agricultural machines every decade for rice mechanization. (See the following table)

In Japan the system of small-scale mechanization is now established, so that the land less than 5 hectars is well managed by a couple. We are now thinking of the mechanization system for large scale management. Though it is necessary to try to increase productivity of vegetable growing and animal husbandry by mechanization in which Japan is behind, on the other hand, we believe it the duty for the Japanese who live on rice and the only contributable thing for the Japanese engineers of agricultural machinery to promote technical cooperation for rice mechanizathion with the foreign countries which need to increase more the production of rice as their main crop.

Therefore, KONMA with long history in the field of rice mechanization would like to promise you to spare no efforts to cooperate with you for it.

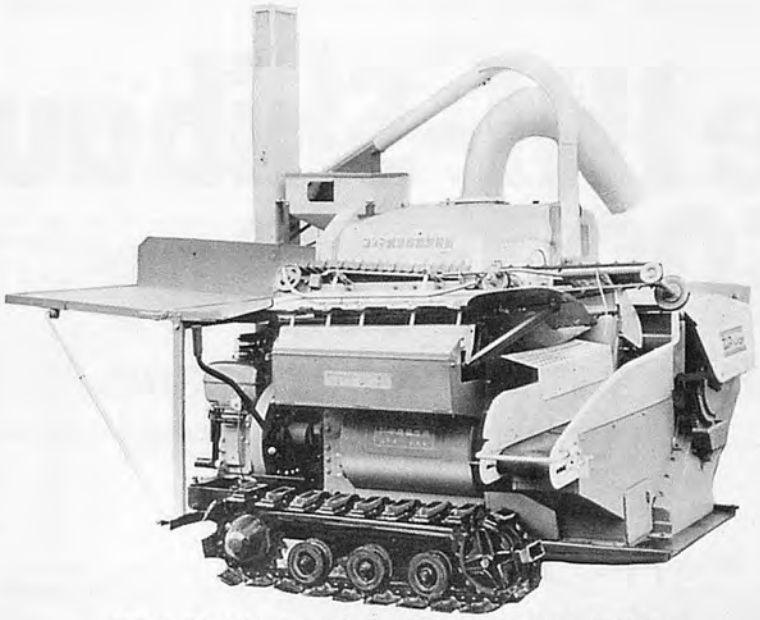
The most important thing what KONMA has understood through the long experience of developing agricultural machinery is the way of consulting the question whether the machine is suitable to the traditional agricultural method, cultural standard and the size of the land of the area. It is evident that a mechine such as acceptable to farmers will not be developed if we neglect to experiment and test them on the spot, because every agricultural machinery originally has the nature of variety and needs the fine service.

From this standpoint, we would like to tell you what and how we are going to do. Our company is the specialized manufacturer of threshers, rice hullers, paddy cleaners and so on, and has the knowledge and engineering statts that can play as leading part in such the machine design and production in the world.

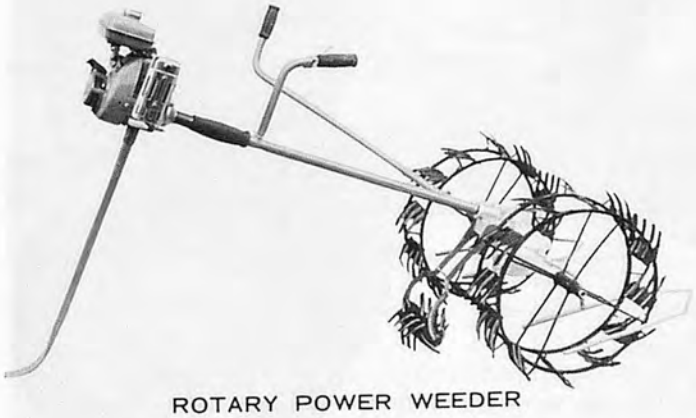
Tieing-up with an agricultural machinery factory on the every spot in the world, we want to start manufacturing suitable machines that farmers will use with pleasure.

Our company is the specialized manufacturer of agricultural machinery with 1000 employees, and has 80 strong members of designer and researcher who have the positivity to challenge new problems and rich originality to develope new machinery. We assure that KONMA will be able to help a little to promote the rice-mechanization in Asia.

TE MECHANIZATION IN EVERYWHERE



SELF-PROPELLED AUTOMATIC THRESHER



ROTARY POWER WEEDER

HAND FEEDING TYPE THRESHER

KONMA'S History of developement of main agricultural machinery

year	machinery
1928	BEEN OIL CAKE BREAKER
1930	WINNOWER
1932	RICE GRADER
1934	IMPACT HUSKER
1938	HUSKER WITH WINNOWER
1948	STROW ROPE MAKING MACHINE
1950	HAND FEEDING TYPE THRESHER
1952	AUTOMATIC RICE HULLER
1956	FORAGE CUTTER
1957	MECHANICAL FEEDING THRESHER
1958	POWER TILLER
1960	BEEN HULLER
1963	WESTERN TYPE THRESHER
1966	SELF-PROPELLED AUTOMATIC THRESHER
1968	PADDY CLEANER
1969	ROTARY POWER WEEDER
1970	HEAD FEED COMBINE HARVESTER

KONMA SEISAKUSHO CO., LTD.

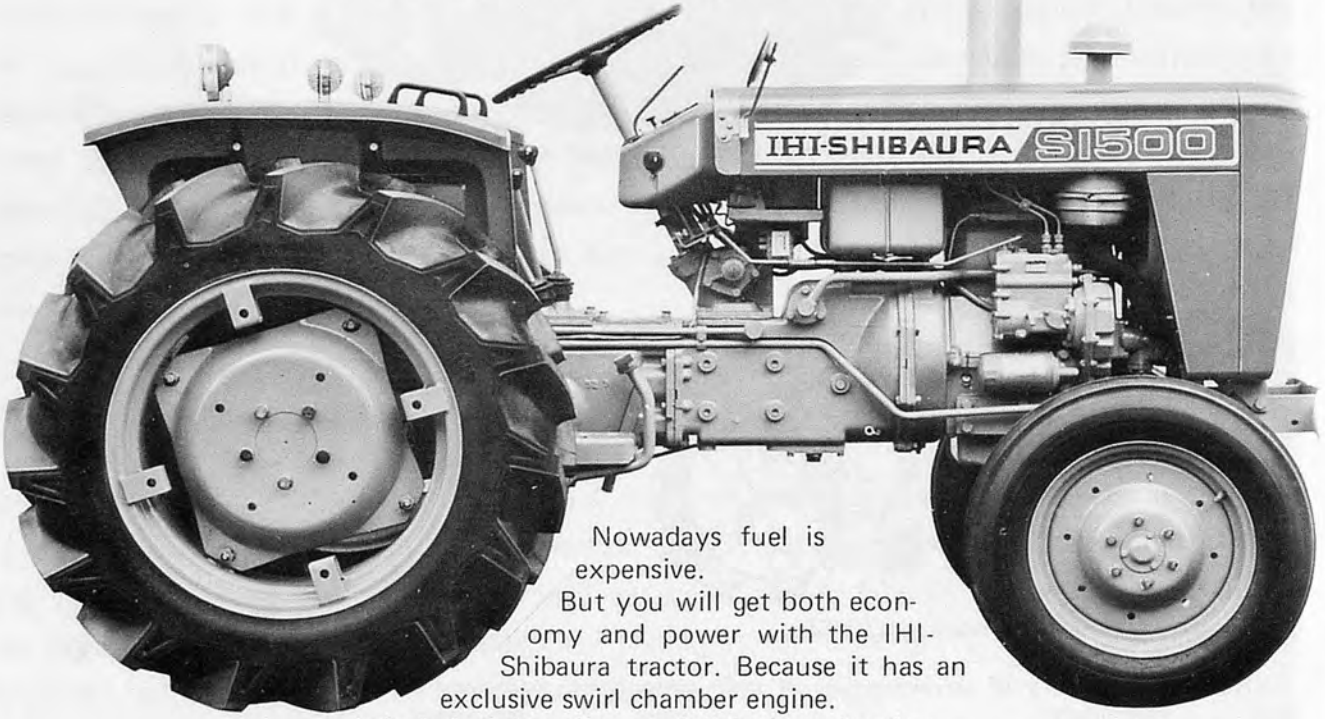
Head Office: Izumicho, Tsuruokashi, Yamagata Prefecture
Phone: ; Tsuruoka 0235(23) 1111

Tokyo Branch: 10-11-6 Okusawa, Setagayaku, Tokyo
Phone: 03(701) 3381

Osaka Branch: 3-1 cho, Omachihigashi, Sakaishi, Osaka
Phone: 0722(38) 0272

The IHI-Shibaura S1500 Tractor

Its exclusive swirl chamber engine solves the fuel problem!



Nowadays fuel is expensive.
But you will get both economy and power with the IHI-Shibaura tractor. Because it has an exclusive swirl chamber engine.
It is designed to give you full fuel combustion.

And thanks to its powerful "dynamo", the engine sparks into power everytime. In any weather.
You won't have to worry about mud, muck, rock, dirt, dust or rust, either.
Because the tough engine and mechanisms are air tight. Which makes it quiet, too.
Yet the S1500 is easy to operate. It is compact, too.
Plus, it is backed by our technology in heavy industrial equipment.
May we solve your fuel problem?
New tough compact farm machinery: Tractors and their implements/power tillers/dryers/forage cutters/air cooled gasoline and kerosene engines

Ishikawajima-Harima Heavy Industries Co., Ltd., Tokyo, Japan IHI
HEAD OFFICE: New Ohtemachi Bldg., 2-chome, 2-1, Ohtemachi, Chiyoda-ku, Tokyo 100, Japan Tel: Tokyo (270) 9111 Telex: TK 2232 (IHICO) Cable Address: "IHICO TOKYO"
NEW YORK · SAN FRANCISCO · MEXICO CITY · RIO DE JANEIRO · BUENOS AIRES · SYDNEY · LONDON · ROTTERDAM · OSLO · GREECE · DUESSELDORF · JOHANNESBURG · KARACHI · NEW DELHI · SINGAPORE · DJAKARTA · HONG KONG · TAIPEI · MANILA

KOKUYO-KARUI PUMPS

IMPROVED FOR TROPICAL AGRICULTURAL PURPOSE

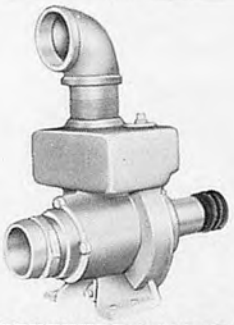
APPLICANTS

1. For pumping up water to Padi Fields and Farms
2. For Factories supplying Industrial Water and Small Scale Water Supplying
3. For Civil Engineering Water Supplying & Draining in heading Construction

SPECIFICATION

(approx)

Type No.	Nominal Bore		RPM	Total Head	Discharge Capacity	Power required		Net Weight	Cubage
	m/m	inch		Meter	M^3 / Min.	kw Moter	ps Engine	kg	CFT
KR 80	80	3	2200	11	0.75	3.7	6	38	3
KR 100	100	4	2200	11	1.5	5.5	9	60	3.5
KR 125	125	5	2200	11	3	9.1	12	85	5
KR 150	150	6	2200	11	4	14	20	110	6

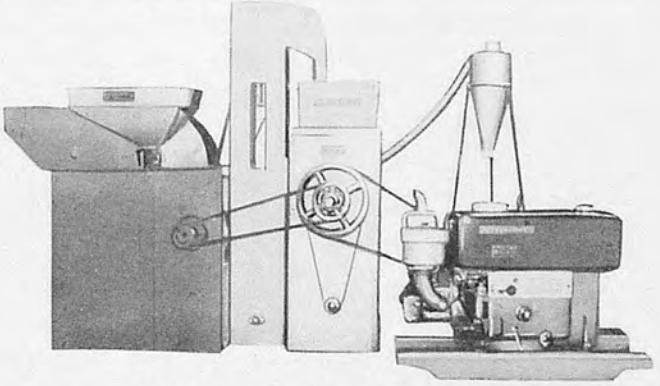


KOKUYO RICE MILLING UNIT

JUST FIT FOR TROPICAL PADI / RICE

SPECIFICATION

Unit Model	Padi Huller	Rice Polisher	Bucket Elevator	Total One set (Approximate)				
				Capacity/hr	Power Required		Net Wet	Cubage
	Type	Type	Inch	in Padi kg	Engine ps	Motor hp	kg	cft
KY-B	M F	P-10	3 1/2 "	600	12-14	10	450	90
KY-C	L F	P-15	4 1/2 "	750	16-20	15	550	150
KY-D	L F	P-20	4 1/2 "	1000	24-28	20	750	190



AS-AF CORPORATION, LTD.

4-14, MIDORI 4-CHOME, SUMIDA-KU, TOKYO, JAPAN

THE SOONER, THE BETTER!

MARUYAMA being the oldest and largest sprayer manufacturing company in Japan with the latest developments in engineering has untill today made a great contribution in making progress for Japanese plant protection.

We in MARUYAMA has been firmly determined to work together with our neighboring South East Asian Countries for increasing their food production.

Therefore we would be happy and honored to receive any inquiries you may have to ask us, and we can assure you of our full cooperation.

The sooner, the better! You should take the advantage of this opportunity so that you may have more crops.

"MARUYAMA" produces everything about SPRAYERS & DUSTERS

Products

* TRACTOR MOUNT SPRAYER
* TRAILER SPRAYER
* POWER SPRAYER
* MIST DUSTER
* HAND SPRAYER
* BUSH CUTTER

MARUYAMA MFG. CO., LTD.
4-15 San-chome, Uchi-kanda, Chiyoda-ku, Tokyo, Japan
Cable Address: MARUYAMAPCA TOKYO

TAS ENGINE GENERATOR

MODEL REG-800

The TAS Engine Generator, powered by a single-cylinder 2-cycle gasoline engine, has a wide range of applications where on-the-spot electricity is required. Examples: A primary power in areas not covered by hi-line service, such as cottages, stores, garages, gas stations, construction sites, and barns. A "must" for standby emergency insurance; one power failure might often cause financial loss to perishable foods or property damages. Also useful for family vacations, which need electricity for portable refrigerators, heaters, etc.

TYPE	OUTPUT (A.C. SINGLE PHASE)	OVERALL DIMENSIONS
A	50 c/s 100~115V 800VA	LENGTH 560 mm (22in)
B	60 c/s 100~115V 800VA	WIDTH 280 mm (11in)
C	50 c/s 220V 800VA	HEIGHT 370 mm (14.5in)
D	60 c/s 220V 800VA	
E	50 c/s 240V 800VA	WEIGHT 30 kg (66lbs)

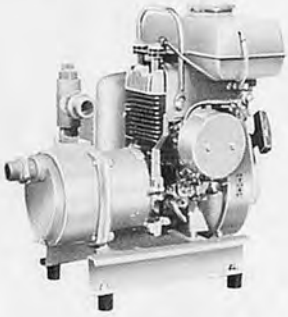
TANAKA KOGYO CO., LTD.
7-1460 Yatsu-machi, Narashino, Chiba, Japan
Phone: (0474) 72-1111 (Rep.)
Cable Address: TANAKA NARASHINO

THE FIRST PUMP OF THE JET AGE

PORTABLE CANAL PUMP

CANAL PUMP SS-25

Feather-light but most rugged and of longer life. Only 51 lbs. (23 kgrs.)
Very fast priming. Lightest and most versatile as a contractor pump. The volute and semi-open type impeller constructed of tough abrasion-resistant malleable iron treated against rusting. Most economical fire fighter, Maximum portability. Could turn 6000 rotations per minute for emergency purpose to get more volume of water at a higher pressure. 48.5 imperial gallons per minute at 55 lbs. per sq. inch.
As powerful as a big pump. Can drive a big gun sprinkler or our "Econset" for irrigation. Delivers 200 litres at 3.3 kgrs. per sq. cm.



CANAL ENGINE PUMP SSE-40

5000 ROTATIONS PARMINUTE,
GIVING MOST AMAZING
PERFORMANCES. SELF PRIMING

OREGON SPRINKLER

Complete lines for agriculture, golf courses, athletic fields, turfs, lawns, small gardens, etc. available.

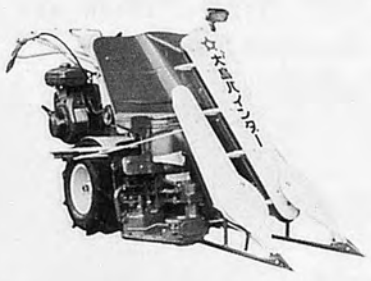
WE ARE THE PIONEER IN THE CONTROLLED IRRIGATION IN JAPAN,
KEEPING UP-TO-DATE OF THE WORLD FOREMOST STANDARDS.

OREGON FARM EQUIPMENT CO., LTD.

Y·P·P·O·BOX. 295
HAED OFFICE : 14-15 MINAMIKARUIZAWA, NISIKU, YOKOHAMA

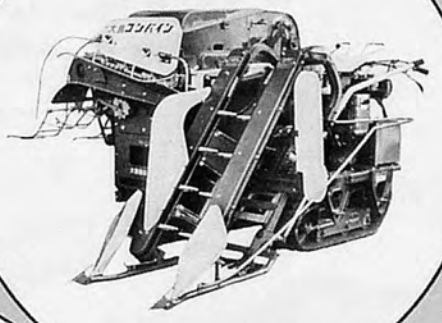
Oshima AGRICULTURAL MACHINES

BINDER



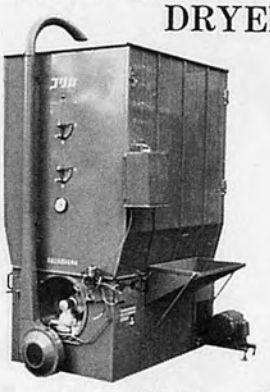
Model FB-30

COMBINE



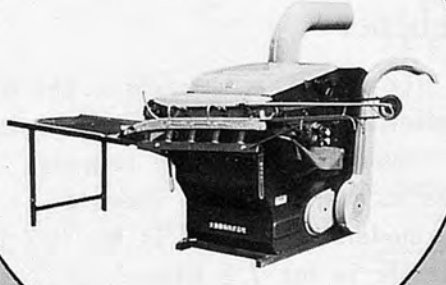
Model SC-500

RICE AUTO DRYER



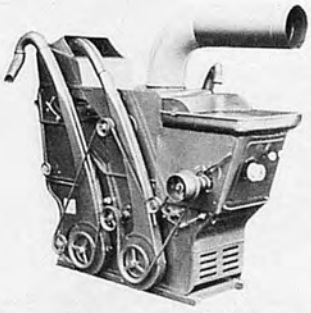
Model TV-36

POWER THRESHER



Model JD-50

RICE HULLER



Model MS-350

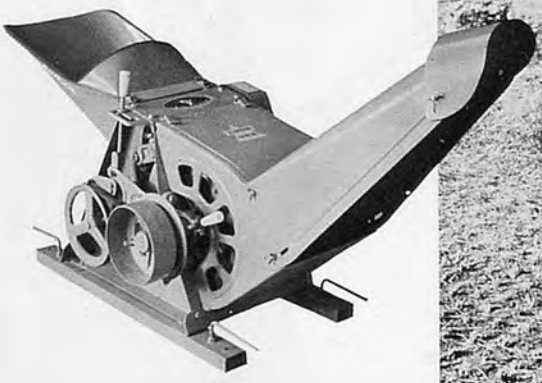
OSHIMA AGRICULTURAL MACHINRY CO., LTD.

Head Office : 3-chome, Tera-machi, Takada City, Niigata, Japan

Suitable to Forage Making for Cattle and Straw Cutting!

KOWA CUTTER

The Kowa Cutter has the longest history and is prevailing most widely in Japan. Simple design with high durability and no worry about jams. Including the latest "TORA" (tiger), there are the variety of sizes of large capacity to minimum use.



KOWA COOK-HELPER

"HURUSATO" (native country)

—Portable Rice Cake Making Machine.

As a rice cake making machine, the Kowa Cook-Helper "HURUSATO" is spreading with booming populality among city houses as well as farm houses.

* Two models : Model I is for 3.2 liter, Model II is for 7.2 liter.
* As the specially made strong-powered motor is built inside, it is used easily at anytime.

SHIN KOWA SANGYO CO., LTD.

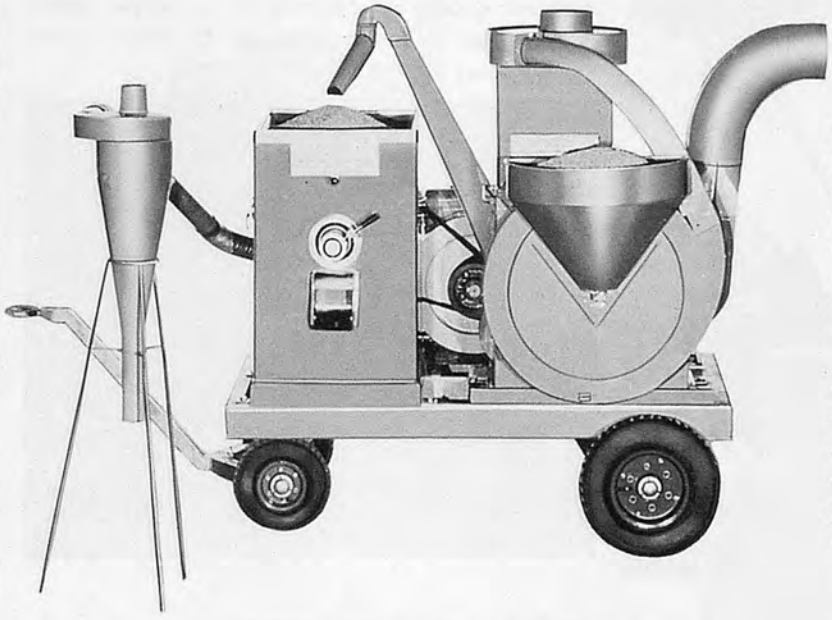
Main Office: Nagabuse, Mishima-shi, Shizuoka Pref., Japan

Tell: Mishima 0559(77) 1 8 3 0 ~ 3

Sanriku
RICE MILLING MACHINE

KAKU MARU SAN

A miracle of rice milling
An epoch-making machine patented in various countries
Now in world-wide sale



● PERFECT HULLER

Perfect Huller has been completed after the many years of study and efforts by Sanriku-noki Co., Ltd.. It is an epoch-making huller of wind pressure type. This has been patented in 18 countries in the world including the United States, Soviet Union, Viet Nam, Formosa, Korea, Thailand and Japan etc.

● JET POLISHER

This polisher produced beautiful and delicious rice by the rotation of fan with low temperature wind pressure system. The capacity is 600kg per hour white rice. Needless to say, the whiteness can be freely adjusted.

〈FEATURES〉

1. Highly efficient capacity to produce 900kg hulled rice per hour.
2. Produces polished rice 10 seconds after putting the paddy rice into the machine.
3. The husking efficiency is high and broken will be very few.
4. We are applying for patents not only in Japan, but also in eighteen other countries.
5. Compact and low in price.

〈SPECIFICATION〉

	Type	Height/Width/Length (mm)	Weight (kg)	Fan/rpm	REQ. ENGINE	CAP/HR PADDY RICE
Huller	604	1100/920/830	110	1600rpm	9−12 HP	1000 kg (approx.)
Polisher	ML50EX	790/500/850	126	800rpm		

SANRIKU NOKI CO., LTD.

NO. 11, HIROMACHI NISHIKUBO, SHIBA MINATOKU, TOKYO JAPAN.

All Mighty Cultivator Useful Both for Paddy Field and for Dry Field Work!

OHTAKE MINI-CULTIVATOR

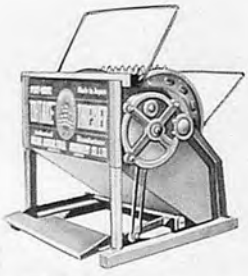
Usable for various purposes

1. Cultivating, weeding and puddling of paddy fields.
2. Cultivating, weeding, hilling in dry fields, Also useful in slope lands, orchards, greenhouses and tea fields.
3. Cutting vines of potato.

HOEING ROTOR FOR PADDY FIELD

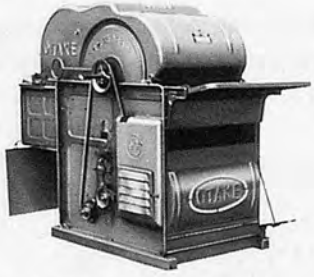
The Ohtake Mini-Cultivator is the definitive model of an extremely light portable machine for management operation which is useful both to paddy field and to dry field works. It was developed by the Ohtake engineers group by referring to a power paddy weeder which was developed by Dr. Khan of IRRI, the Philippines.

LIGHT. SIMPLE. HIGH CAPACITY



FOOT-DRIVEN THRESHER
MODEL Y-1 · MODEL Y-2

ALL OHTAKE THRESHERS are so small type, light and easy operation, produced and used most large quantities in Japan.



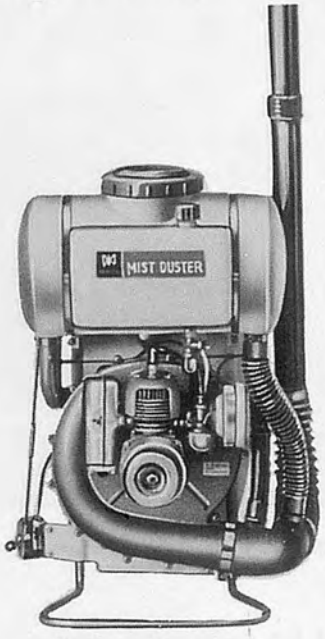
POWER THRESHER
MODEL KS-20

OHTAKE AGRICULTURAL MACHINERY CO., LTD.
NO. 265, NAKAJIMA, ŌHARU-MURA, AMA-GUN, AICHI, JAPAN

Arimitsu power does the hard jobs efficiently !

ARIMITSU MIST DUSTER AND POWER SPRAYER

**Introducing two powerful, portable labor savers.
Reasonably priced, they save you time and money
by quickly and easily eliminating pests.**



Features of MIST DUSTER MD 35B
Engine capacity: 35cc 2.8HP/7500 RPM
Tank capacity: 10ℓ
Air velocity: 90 m/sec.
Air Volume: 15 m³/min.
Weight: 8 kg

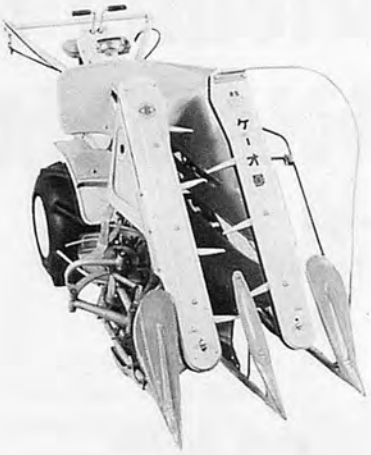
Features of POWER SPRAYER US-34
Weight: 15.0 kg
Maximum Pressure: 35 kg/cm²
Suction capacity: 34 ℓ/1000RPM

For further information, write to:

ARIMITSU INDUSTRY CO., LTD.

No. 3-21, 2-chome, Fukaekita, Higashinari-ku, Osaka, Japan
Cable Address: "ARIMITIND OSAKA"

K-O Agricultural Machines

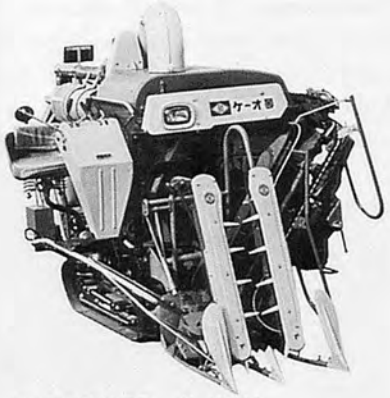


BINDER BS60A

The plants are binded at the central part and discharged from the right side. Full cutting width enables medium reaping and right angle reaping, no need for head-land reaping.

simple mechanism and easy to handle.

The unique pick-up mechanism enables to reap even the inclined stalks.



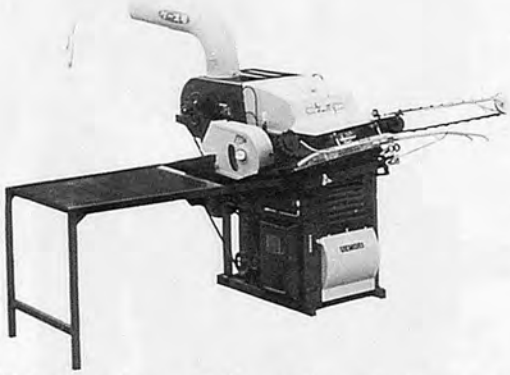
COMBINE HARVESTER CH60C

Efficiency is fifteen times to the traditional way.

Even the inclined stalks can be harvested.

Usable for both long and short stalks.

Needless for much head-land reaping.

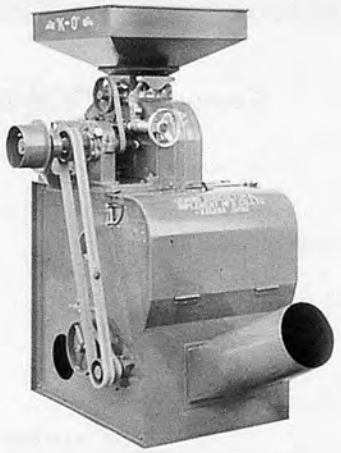


AUTOMATIC THRESHER JL55K

Double separating system assures beautiful separation.

Ceaseless-operation is possible owing to the smooth shaker system.

Simple method for exchanging concave, no need to detach the drum.



This type has a huller and a winnower combined in it, chaffs can be separated from hulled rice.

Another new feature is a suction fan which collects chaff. Therefore you need not worry about dusts and chaffs from operation.

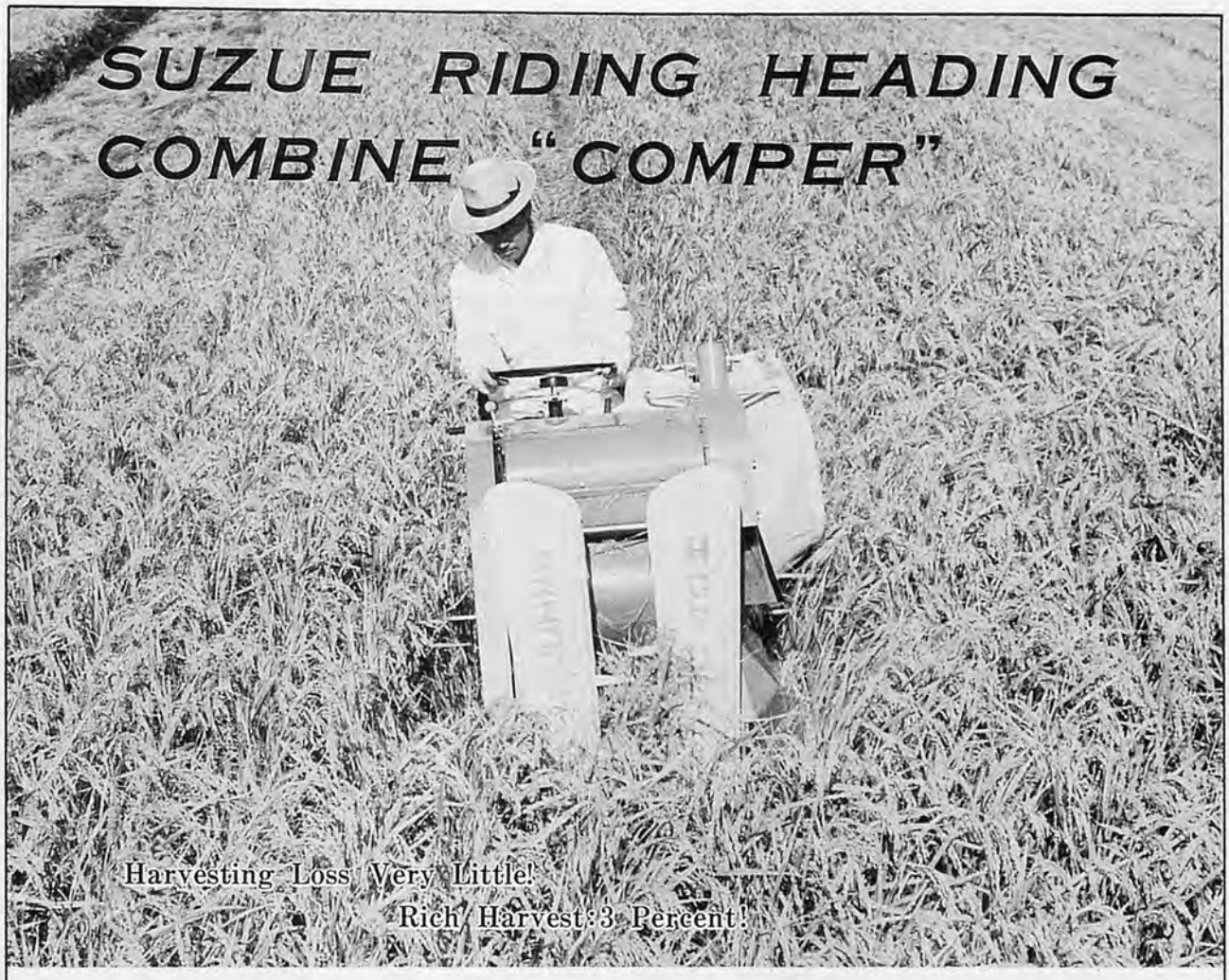
COMBINATION HULLER MRT60

UEMORI Agricultural Implemement Mfg. Co., Ltd.

Head Office:Kan-onji-cho, Kan-onji City, Kagawa, Japan

Tokyo Branch :1-1, Izumi-cho, Kanda, Chiyoda-ku, Tokyo

SUZUE RIDING HEADING COMBINE "COMPER"



Harvesting Loss Very Little!

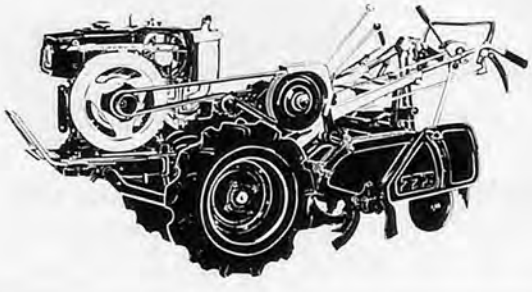
Rich Harvest: 3 Percent!

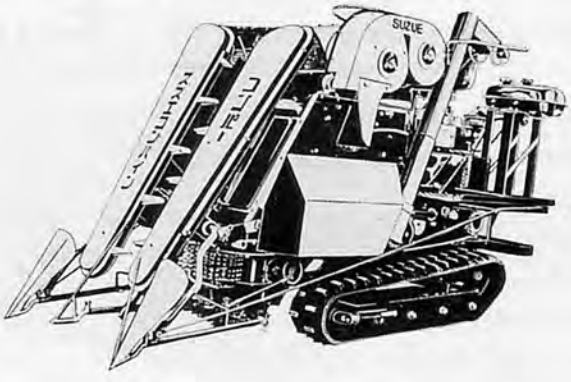
This machine is the ear-cutting type for rice and wheat family and is an exclusive mechanism one in the world. Remaining stalks are cut and scattered with a special device.

POWER TILLER MODEL "C"

Easy Operation!

Durable Life!





SUZUE

SUZUE AGRICULTURAL MACHINERY CO., LTD.
144-2, Gomen-cho, Nankoku-shi,
Kochi-ken, Japan

BEAVER
PATENTED POWER MOWING MACHINE

Light · Low-cost · Easy to use.

- Angle of blades can be freely changed during operation, a feature patented in 19 countries.
- Engine is supported at only two points and can be rotated 360°.
- Special device is built in to prevent low lever and shoulder vibration.
- Anyone can use BEAVER and its TEA-PICKER, CHAINSAW, DIBBLER PUMP and LAWN-MOWER attachments to a wide range of jobs very well.

YAMADA MACHINERY INDUSTRIAL CO., LTD.

No. 10, 2-CHOME, ASHIHARA-DORI, HYOGO-KU,
KOBE, JAPAN.

CABLE ADDRESS "BEAVER YAMADA" KOBE

PHONE 078(68)KOBE 2175

KAAZ REAPER

Use: Mowing of weed, pasture, lawn
· Weeding in a forest
· Reaping of rice & barley

Features

- Using erosion-, shock-proof aluminum
- Applying ultra hi-efficient lubricant & molybdenum disulfide
- Uniform performance and quality of all examined products processed by exclusive machines.
- Using the best materials

Main Products

KAAZ Reaper
KAAZ Arrow Pump
KAAZ Lawn Mower
KAAZ Tohi Engine
KAAZ Grinder
KAAZ Rotor

Specifications

Type	HA	HB	HC
Engine	G3C-32cc	G4C-37cc	G5C-52cc
Moderation	Bevel gear	Bevel gear	Bevel gear
Clutch	Centrifugal clutch	Centrifugal clutch	Centrifugal clutch
Weight (kg)	7.1	8.1	10.1

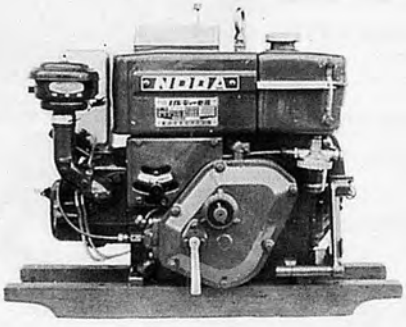
KAAZ MACHINERY CO.

388, Higashi-Furumatsu, Okayama City, Japan
Tel. Okayama (0862) 24−4561

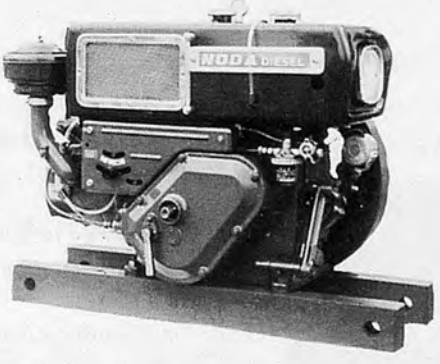
The Farmer's Best Friend

NODA DIESEL ENGINE

High Reliability and Economy !!



HOPPER TYPE DH57
DE 3~4PS
D45H 4~5PS
D57H 5~7PS
D68H 6~8PS
D79H 7~9PS



RADIATOR TYPE DC112

DC57 5 ~ 7 PS
DC68 6 ~ 8 PS
DC79 7 ~ 9 PS
DC81 8 ~ 10PS
DC112 10~13PS

NODA INDUSTRIAL CO., LTD.

Head office : 5-3-41, Asahi-machi, Takamatsu, Japan
TEL. 0878-21-8161
Factory : Takamatsu · Sakaide
Liaison Office : Sendai · Koonosu · Takamatsu · Kurume

UCHIDA POWER TEA PICKER

■ CUTTEALOR BABY with the Hair-Trimmer Type Blades which does not damage tea leaves has the plucking ability of 90 times to hand plucking, 8 times to a hand tea-leaf shear. It is siutable to a small sized tea field.

■ The KIRISHIMA is the large type shearing machine designed for earge scale tea field. It takes 1.5~2 hours to shear 10 ares. And this can pick about 1,300 kg a day.

UCHDA'S POWER TEA PICKERPAT.
■ CUTTEALOR BABY

AUTO. TEA-LEAF PIKING & TEA-FELD SUPERVISING MACHINE.
■ UCHIDA'S "KIRISHIMA" PAT.

UCHIDA HAMONO KOGYO CO., LTD.
KIKUKAWA SHIZUOKA-PREF JAPAN.
P.O.BOX. NO.3 TEL. KIKUGAWA 05373-5-2261~3.

ORIONMILKER

Milk more cows by Orion Milker.

Orion Liquid Power Milker makes it possible to milk more cows by saving both time and money. This most modern milker is endurable, milks fast and safely.

Milking machine(bucket type)

Orion boasts the largest market share of Unit Cooler in Japan.

You must cool milk rapidly after milking, or milk will soon be spoilt.
Orion Unit Cooler cools water in tank efficiently, in which you preserve filled milk cans. And best milk quality is maintained. Of course, it's designed highly efficient and compact.

ORION MACHINE MFG.CO., LTD.
HEAD OFFICE & FACTORY
NO.246, KOTAKA, SUZAKA-SHI, NAGANO-KEN, JAPAN 382
TEL. (02624) 5-1230
ORION SALES DEPARTMENT
NO.1-37-20, YOYOGI, SHIBUYA-KU, TOKYO, JAPAN 151
TEL. (03) 379-4156

IFM NewsLetter

INTERNATIONAL FARM MECHANIZATION RESEARCH SERVICE
c/o SHINNORIN-SHA 2—7 KANDA NISHIKI-CHO CHIYODA-KU,
TOKYO, JAPAN., TEL. 03—291—5718, 3674

Dear friends

International Farm Mechanization Research Service was established in 1968 with the pourpose of promoting efective communications and researches on agricultural mechanization especially in developing countries.

We will gladly welcome everybody to join us who want to promote free and vital communications on agricultural mechanization over many barriers like sectionalism.

Our body is really independent one supported by every member's free and active mind to make better world.

Whenever you need more informations, pleas write me!

Yours Sincerely
Yoshikuni Kishida
Head of Directors

MARUBENI -IIDA... ...a beginning

All developing countries have to start somewhere. And most wise countries usually do by calling on Marubeni-Iida. Just like this Power Tiller which meant a start towards higher productivity, less labor and more income. It and thousands of others just like it were supplied by us because we're the biggest exporter to Southeast Asia.

Maintaining the latest technology, and extending a helping hand are two very basic features of our corporate structure. Supplying both to Asian countries has kept us very busy. Because Southeast Asia was also a beginning for us... the beginning of our worldwide network which now includes some 99 offices.

Marubeni-Iida Co., Ltd.
Tokyo: C.P.O. Box 595, Tokyo 100-91, Japan Cable: MARUBENI TOKYO
Osaka: C.P.O. Box 1000, Osaka 530-91, Japan Cable: MARUBENI OSAKA
Transportation & Construction Machinery Export Dept.
Agricultural Machinery Export Sec.

Here, a power tiller helps develop Malaysia's Agriculuture.

KUBOTA
AGRICULTURAL MACHINERY

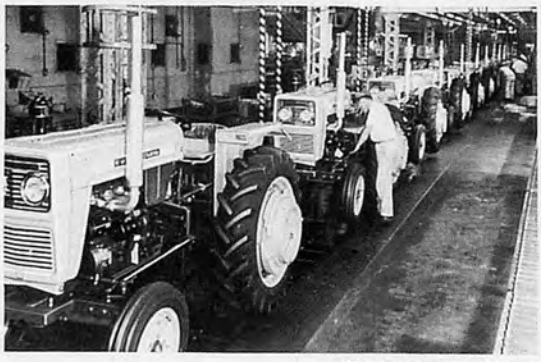
Just about any machine that can be conceived for use on farms is made by Kubota. And made with a degree of perfection rarely found anywhere. From planting to harvesting, they are helping to raise both the quantity and quality of food in many parts of the world.

Asia's largest manufacturer of agricultural machinery, Kubota makes each part of its machines. Kubota engines, powered by diesel, gasoline or kerosene, are noted for dependable service. Two factories, at Sakai and Utsunomiya, are devoted exclusively to the manufacture of agricultural machinery. Kubota not only makes the machines, but trains personnel from around the world in their proper care and use.

Intensive and thorough research, with the highest level of technological skill, have resulted in many innovations in Kubota products, making them easier to use and more effective. Presented here is only a part of the long list of fine machinery manufactured by Kubota.

Head Office

Sakai Plant



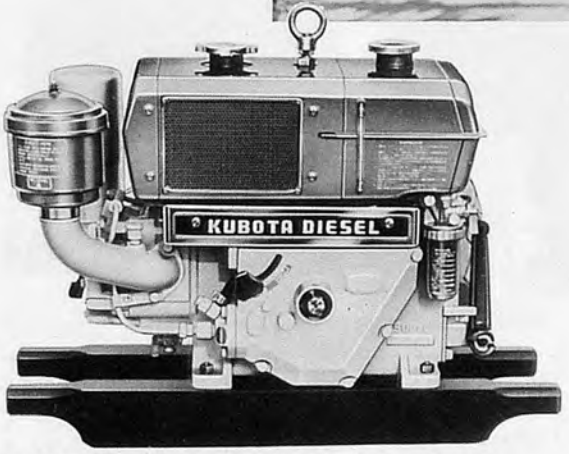
Tractor assembly line

Utsunomiya Plant

KUBOTA Kubota, Ltd. 22, Funade-cho 2-chome, Naniwa-ku, Osaka, Japan

DIESEL ENGINES

With pumps for irrigation, disposal, etc.

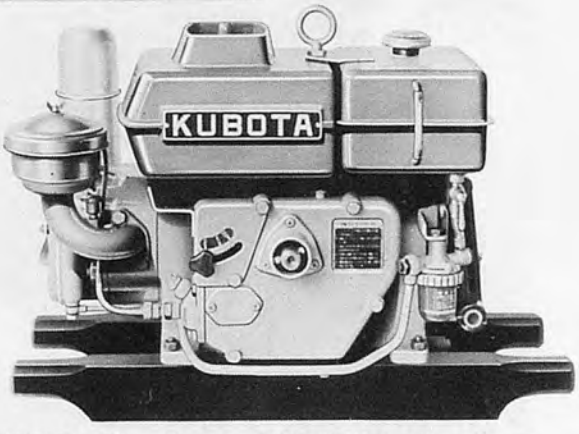


ER Series, ERN Series

(without head light)

* Unique radiator cooling for continuous operation without adding water.
* Spherical combustion chamber and double accelerating handle for fast starts.
* Perfect balance eliminates vibration.
* Completely sealed to keep out dust and water.
* Magnetic oil filter for clean lubricating oil.

Model	Output	r.p.m.	Net Weight
ER30	3 ~ 3.5HP	2,000	55kg/121lbs
ER40	4 ~ 5 HP	2,000	60kg/132lbs
ER50(N)	5 ~ 6.5HP	2,200	65kg/143lbs
ER65(N)	6.5 ~ 8 HP	2,200	75kg/165lbs
ER75(N)	7.5 ~ 9 HP	1,800	108kg/238lbs
ER90(N)	9 ~ 12 HP	2,000	145kg/319lbs
ER100(N)	10 ~ 13 HP	1,800	153kg/337lbs
ER150N	15 ~ 18 HP	1,800	247kg/543lbs



KND Series, KNDR Series

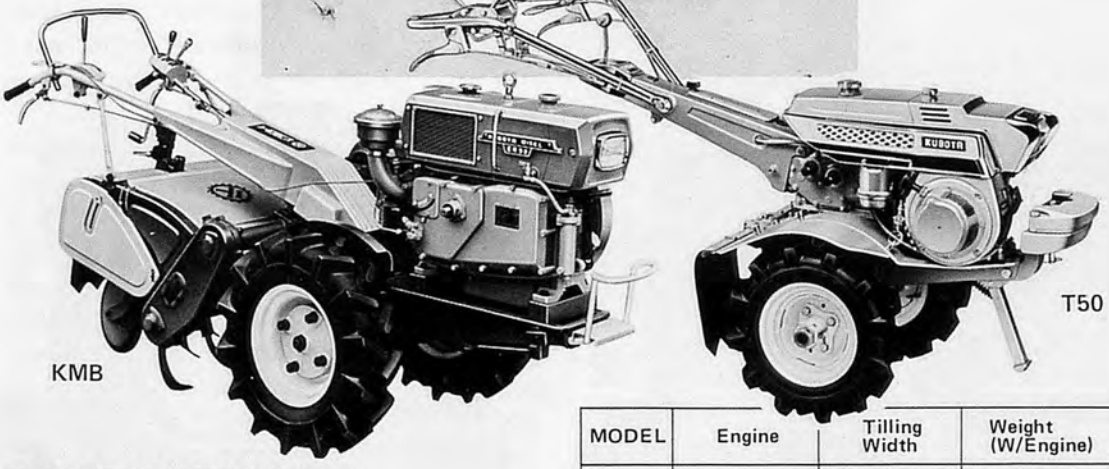
* Lightweight for many industrial and farm uses.
* Automatic feeding of lubricating oil for fast starts.
* Convenient hopper cooling.
* Magnetic filter in lubricating oil system keeps out dust and foreign matter.
* Totally enclosed engine.

Model	Ouptut	r.p.m.	Net Weight
KND3	3 ~ 4 HP	2,000	60kg/132lbs
KND40	4 ~ 5 HP	2,000	65kg/143lbs
KND5B	5 ~ 6.5HP	2,200	75kg/165lbs
KND70	7 ~ 9 HP	1,600	112kg/246lbs
KND90	9 ~ 12 HP	2,000	135kg/297lbs
KNDR70L	7 ~ 9 HP	1,600	100kg/219lbs
KNDR90	9 ~ 12 HP	2,000	145kg/318lbs

KUBOTA

Kubota, Ltd. 22, Funade-cho 2-chome, Naniwa-ku, Osaka, Japan

Kubota power tiller in paddy field



KMB

T50

POWER TILLERS

* Highly efficient Kubota radiator cooled diesel engine.
* Weight of tiller and engine well blanced for easy operation.
* Wide selection of models for many types of work and conditions.
* Works efficiently in wet paddy fields as well as dry land.
* Many attachments for all kinds of work.

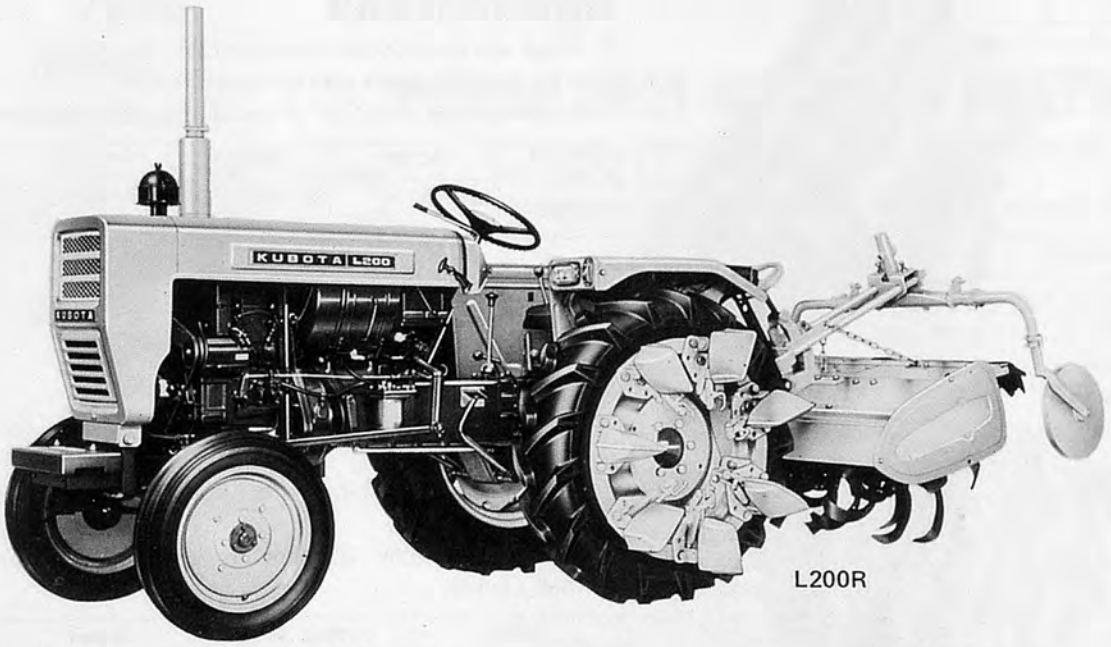
MODEL	Engine	Tilling Width	Weight (W/Engine)
KR850	ER65	48 - 60cm (19"-23.6")	286kg/630lbs
MP2	ER75/ER80	54 - 75cm (21.3"-29.5")	330kg/725lbs
KME	ER90/ER100	60 - 66cm (23.6"-26")	480kg/1055lbs
KMB	ER90	60cm (23.6")	395kg/869lbs
KMF	ER100	60 - 66cm (23.6"-26")	465kg/1023lbs
K500	ER50-2	48 - 60cm (19"-23.6")	264kg/581lbs
K700	ER65-2	48 - 60cm (19"-23.6")	324kg/714lbs

TWO WHEEL TRACTORS

* Highly efficient air cooled Kubota gasoline engine.
* Ruggedly built for long, effective use.
* Simple to operate for everyone.
* Compact for work in small areas.
* Lightweight for easy transporting anywhere.

MODEL	Engine Output	Speed Changes	Weight (W/Engine)
PC	1.8 ~ 2.5PH	F1 R1	43kg/951lbs
T50	3.5 ~ 5.0HP	F6 R2	120kg/264lbs
T40	3.0 ~ 5.0HP	F4 R2	90kg/198lbs
T410	2.2 ~ 3.5HP	F2 R1	49kg/107lbs
T510	3.0 ~ 4.5HP	F4 R2	96kg/211lbs
T710	3.5 ~ 5.0HP	F6 R2	126kg/277lbs

KUBOTA Kubota, Ltd. 22, Funade-cho 2-chome, Naniwa-ku, Osaka, Japan



L200R

FARM TRACTORS

* Highly efficient Kubota water cooled diesel engine.
* Rotary tilling implement available for simultaneous plowing, harrowing, weeding.
* Complete hydraulic system for handling many implements.
* 3-point hitch system in DIN Categories.
* Adjustable wheel tread for versatility.
* Wet paddy field or dry field work.

Kubota tractor leveling in paddy field

MODEL	Engine Output	Ground Clearance	PTO r.p.m.	Weight
L140R	14 HP	33cm	694/1,253	700kg/1,543lbs
L170R	17 HP	33cm	642/1,252	790kg/1,741lbs
L200R	21 HP	34cm	650/990	910kg/2,006lbs
L120	12 HP	28cm	400/606/864	600kg/1,323lbs
L260	26 HP	37cm	172/222/313/404	1,000kg/2,205lbs
L270	27 HP	49cm	505/728/1,136	1,320kg/2,910lbs
L350	35 HP	48cm	560/1,062	1,440kg/3,175lbs
ST22	23 HP	47cm	663	1,050kg/2,315lbs

KUBOTA Kubota, Ltd. 22, Funade-cho 2-chome, Naniwa-ku, Osaka, Japan

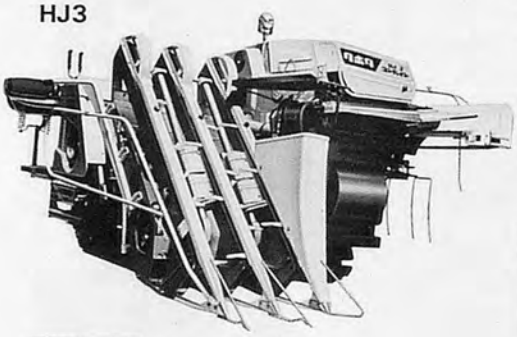
HC500

HARVESTERS

* Reaps and binds in one simple process.
* Wide ground contact with low pressure tires.
* Plants leaning up to 75° or wet plants easily harvested.

MODEL	HC75F	HC500	HC302
Efficiency	50~70min/ 10ares	60~90min/ 10ares	90~120min/ 10ares

HJ3

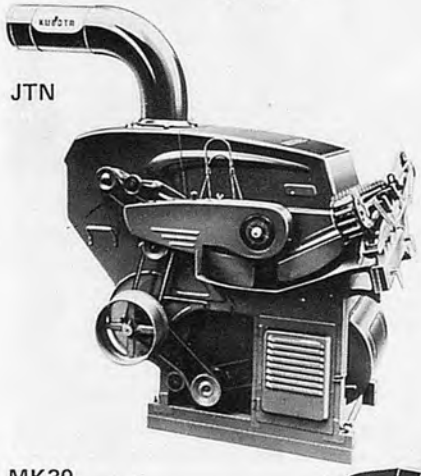


COMBINE

* Reel and cutter table operate precisely for complete harvesting of leaning plants.
* Almost no threshing and screening loss or damaged rice.
* Crawler is highly efficient in wet paddies or small fields.

MODEL	Cutting Width	Speed
HJ3	50cm20"	31m/min
HT125	125cm50"	72m/min
M200R	230cm92"	2~3km/h

JTN

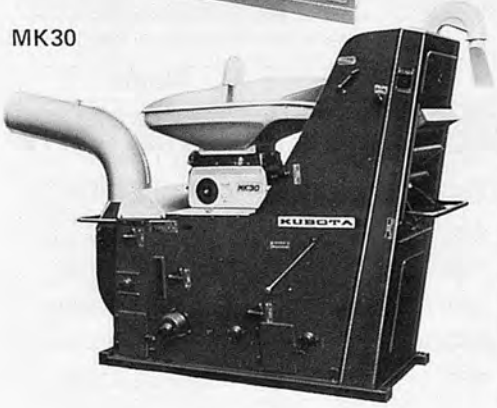


POWER THRESHERS

* Light weight and easy to carry.
* Efficient screening.
* Easy to operate.

MODEL	Threshing Width	Required HP
ATA54	540mm/21.3"	1.0 HP
LT42	420mm/16.6"	1.0 HP
JR3	460mm/18.1"	3.0 HP
JR4	540mm/21.3"	4.0 HP
JTN480	480mm/19"	3.0 HP
JTN540	540mm/21.3"	4.0 HP

MK30

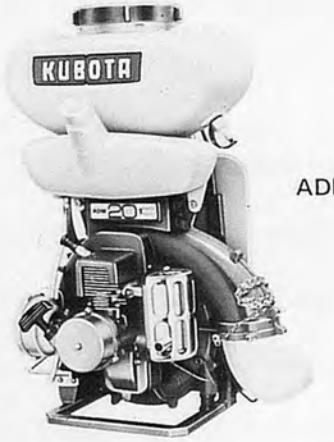


HULLERS

* Rubber rolls protect rice from damage.
* Automatic grain screen makes screening very simple.
* Equipped with precise tachometer.

MODEL	Capacity	Required HP
MK30	780kg/h	1.5 HP
MK40	1,400kg/h	3.0 HP

KUBOTA **Kubota, Ltd.** 22, Funada-cho 2-chome, Naniwa-ku, Osaka, Japan



ADM20

POWER MIST BLOWER & DUSTER

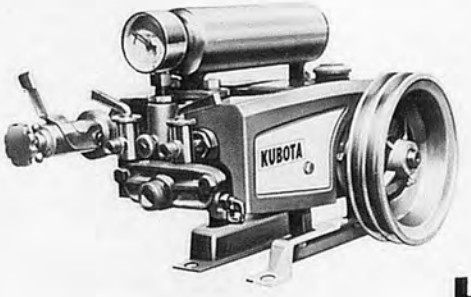
* Various attachments let them be used for liquid, powder, flame throwing.
* Strong engine for high speed and large air quantity.

MODEL	Net dry Weight	Max. discharge capacity			Engine
		Powder	Mist	Granules	Max. output
ADM20	7.5kg	4.5kg/min	3.2ℓ/min	7kg/min	2.0 HP
ADM30	9.3kg	6.5kg/min	3.6ℓ/min	6kg/min	3.2 HP

SA2

POWER SPRAYER

* Light and compact for easy installation and portability.
* Complete draining of tank very simple.
* The corrosion proof special alloy used in various parts and a perfectly sealed oil bath type lubrication system assure out-standing durability.



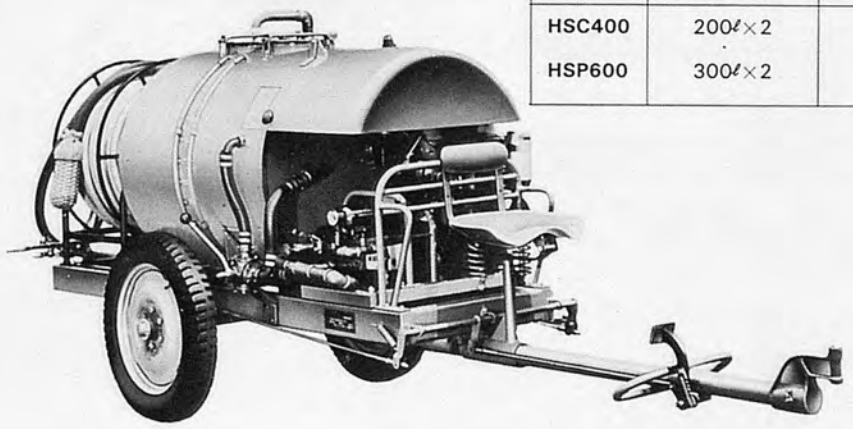
MODEL	Discharge Capacity (Standard)	r.p.m.	Max. Pressure	Net Weight
SA2	29ℓ/min	1300	35kg/cm²	10kg/ 22Lbs
SB	29ℓ/min	1200	35kg/cm²	17kg/ 37.4Lbs
SC	49ℓ/min	1050	40kg/cm²	22kg/ 48.4Lbs
SE	94ℓ/min	800	50kg/cm²	54kg/ 118.8Lbs

HI-PERFORMANCE SPRAYER

* Spraying can be done from the levee.
* Divided tank for simultaneous supply and spraying.
* Self-priming pump for faster supply.

HSC400

MODEL	Tank Capacity	Spraying Distance	Engine
HSC400	200ℓ×2	15m	LG250
HSP600	300ℓ×2	25m	Tractor P.T.O.



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Yoshisuke Kishida

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