International specialized media for agricultural mechanization in Asian developing countries.

AMA

AGRICULTURAL MECHANIZATION IN ASIA

VOL.IX,NO.2,SPRING, 1978

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Pleasant Working with

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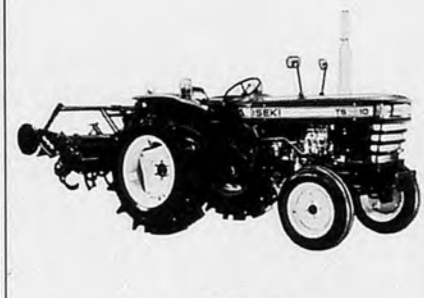
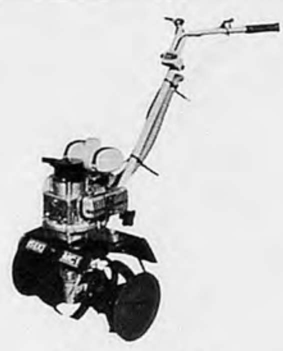


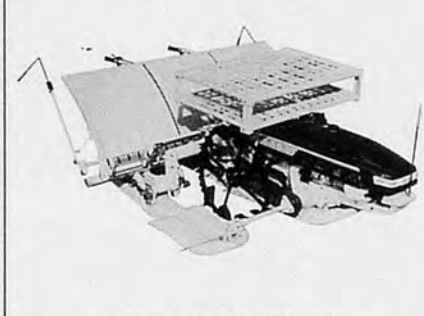
Tractor TS series

Tractor TX series

Power Tiller KS series



Mini-Tiller MC



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Tractor TS series

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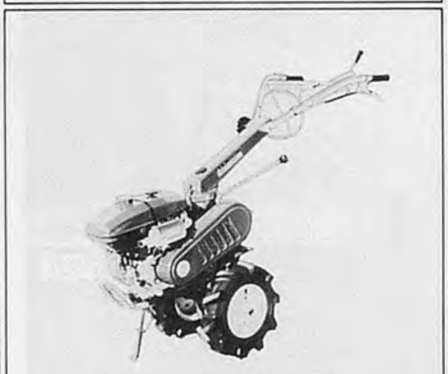

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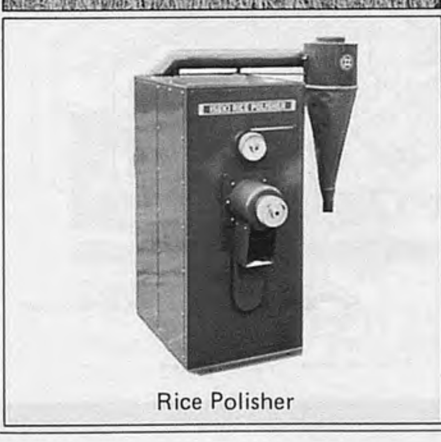

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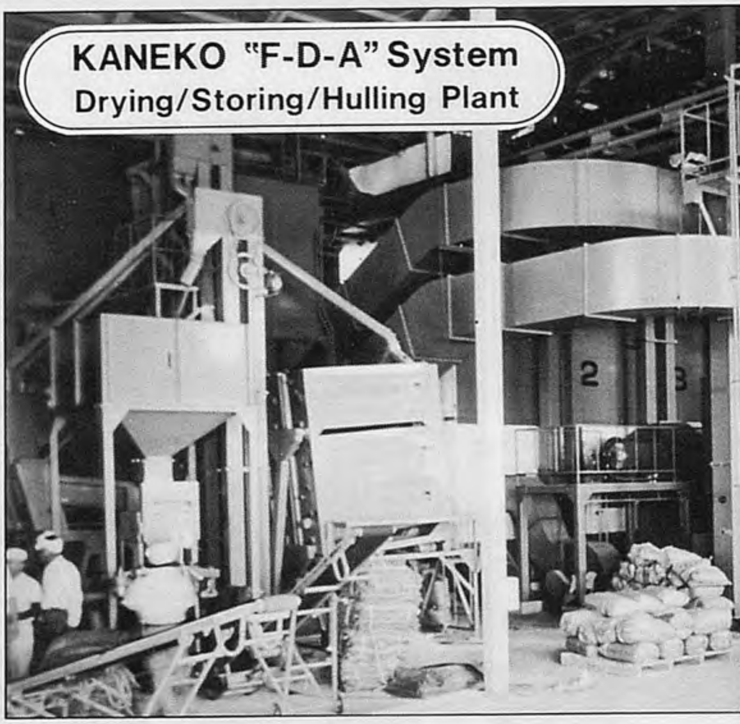

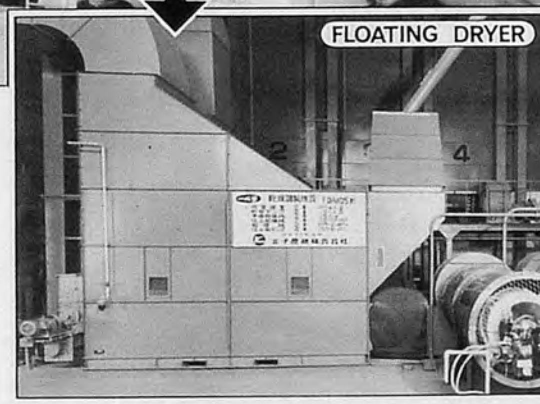

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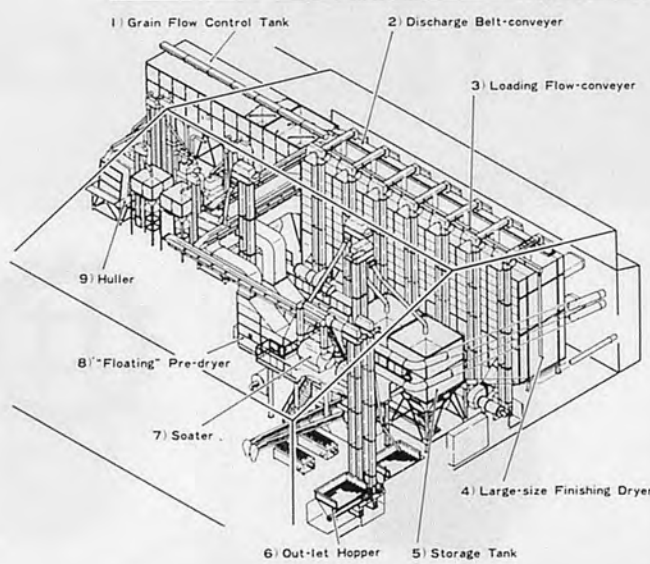

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Preface

The Japanese Government has again enforced the Policy of reduction of rice production since last year, in order to control the over-production of rice. It has occured many times during the past days such situation that, while there exist even today the condition of food shortage in many countries of all over the world, on the other hand, in Japan and the other advanced countries, the policy for control the crop production is carried out.

Even in some developing countries, there seems the great unbalance that, in some states, food lacks chronically, while in other states, they export some food to the others every year. The food problem may be considered both world-wide problem, and, at the same time, very local one. In order to dissolve such a local unbalance of the production and the consumption of food, it is necessary in many cases to improve the technical method and the social organization connected with the distribution process of food. To increase the production on a macro level is also a matter of great importance, but it is more important to spread the technique of the agricultural mechanization to make balance between the production and the consumption of food on area level.

We are planning to publish for the future in AMA the useful articles about the problem of the agricultural mechanization on area level. We would much appreciate for your useful cooperation.

We are also looking forward to receiving from the readers of AMA the news on the useful events such as the congresses, the exhibitions, etc., held in various countries, in order to make AMA the more effective means of communication.

Chief Editor

Yoshisuke Kishida

April, 1978

Tokyo

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AGRICULTURAL MECHANIZATION IN ASIA

Vol. IX, NO. 2 Spring, 1978

The Economics of Small Farm Mechanization in Asia

by
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The special problems of mechanizing small farms is generally associated with the low investment capacity in this sector and the lack of equipment which is compatible with the technical and economic requirements of small holdings. In many instances, however, it is not the lack of technology nor capital which retards use of mechanization, but the low return on investment and the lack of complementarity with other productive resources which has constrained adoption of mechanization. Schutz (1964) has noted that lack of profitable new investment possibilities is one of the major characteristics of traditional agriculture.

Data describing the social-economic and physical environments in the developing countries of Asia reveals that many types of mechanization are not profitable under prevailing condition of farm size, tenancy and output levels. In addition, in many instances there is evidence that mechanization occurred, particularly tractorization, as a result of economic policies which have distorted relative wage capital prices, exchange rates and output prices, usually to the disadvantage of small-farmers.

※Presented at ORD/ASPAC/FFTC-sponsored Lecture Workshop on the Problems of Small Farm Mechanization, Suweon, Korea. August 12-17, 1977 (Forthcoming as an ASPAC bulletin).

In this brief paper, I will attempt to answer five basic questions relating to the use of mechanization on small farms : 1) At what point in development does a country need mechanization? 2) How do we define the size, magnitude and characteristics of the small-farm mechanization issue ? 3) What types of machinery are needed on small farms ? 4) What are the alternative institutional arrangements for mechanizing small farms ? 5) What policies can be employed to ensure the optimal choice in both the technique and the sequence of adoption.

Agricultural Transformation

A fundamental question is how to properly identify and measure the effects of mechanization on output. To provide a conceptual framework within which to examine this issue, we developed a simple model which expresses output per man as the product of yield per unit of land and the land-man ratio.[1] The relationship is shown in the following identity:

$$(Y/L)_t = (Y/D)_t \times (D/L)_t$$

1) This model is a modified version of the model from Yudelman, et. al. 1971.

where Y refers to output, D is harvested acreage and L is that portion of the labor force employed in agriculture. By using this model, technological innovations are grouped into two broad areas, those which are land-augmenting (such as higher yielding varieties) and those which are labor displacing (such as tractors). In the event a labor displacing technique is introduced, its impact on average labor productivity will be felt through an increase in land-man ratio with a corresponding increase in labor productivity. Land-augmenting technologies will raise average labor productivity through increased yields per unit of land.

Unfortunately, it is nearly impossible to consider the effects of either type of technological change as completely independent. In agriculture, the nature of the relationships between labor-saving and land-augmenting technologies is not always clear; there do appear to be significant interactions. It is possible to demonstrate overall changes in average labor productivity resulting from the combined interactions from changes in the two ratios as follows:

let $x = (Y/L)$, $y = (Y/D)$, and $x = (D/L)$ or $x = y.\ z$

differentiating the expression with respect to time gives the rate of change of output per unit of labor as the sum of the relative rates of change in yield per acre and the land-man ratio:

$$\frac{\delta}{\delta_t}(Y/L)/(Y/L)$$
$$=\frac{\delta}{\delta_t}(Y/D)/(Y/D)$$
$$+\frac{\delta}{\delta_t}(D/L)/(D/L)$$

The expression then permits derivation of the possible impact of technological innovation on average labor productivity from alternative combinations of rates of changes in yield and the land-man ratio.

Examples of the inferences which can be drawn from the expression follow:

1. If the number of persons engaged in agricultural production is increasing and harvested area is constant, average labor productivity can increase only with increases in yield.
2. If the agricultural labor force is increasing and harvested area is also increasing, average labor productivity can rise if the land-man ratio increases, provided yields do not fall.
3. If the number of workers in agriculture is falling and land under cultivation is increasing, average labor productivity can increase even though there may be a decrease in yield.
4. If labor engaged in agriculture is declining and total harvested area is also declining, total agricultural production can only increase with an increase in yields.

The identity thus provides a simple means for assessing the possible implications of two types of technological change on labor productivity and total output in agriculture - - land-augmenting (yield increasing) as embodied in the improved rice varieties, fertilizer and irrigation development and labor-saving, such as found in tractors, power tillers and transplanting equipment. In general terms, we would expect use of output increasing innovations under conditions of both increasing and decreasing land-man ratios while labor-saving innovations would normally be used only when the land-man ratio is rising.

Many mechanical innovations have differential effects on yields and the land-man ratio. The net result may be an increase, decrease or no change in labor productivity and/or total agricultural output. A major difficulty in analyzing the impact of mechanization is partitioning effects into a) changes in yield (increased biological yield or reduced losses), b) changes in cultivated area, c) changes in cropping intensity, d) changes in production costs (reductions in labor and animal costs) or, e) changes in the value of the crop (improvements in quality or cropping pattern changes).

Examination of Figs. 1 and 2 indicates the transformation paths followed by Taiwan and the Philippines. There are similarities in the sequence with which these countries used available land, labor and capital resources to increase agricultural output. Initially, both used more land (increased the land/labor ratio). In recent years, however, the lack of land which can be developed at reasonable cost has forced planners in both of these countries to rely more on yield increasing innovations (Y/D) to sustain growth rates. Japan followed a similar trend during an earlier period. The degree to which a country uses innovations which augment available land or labor resources will be dependent on initial resource endowments and prevailing economic and in-

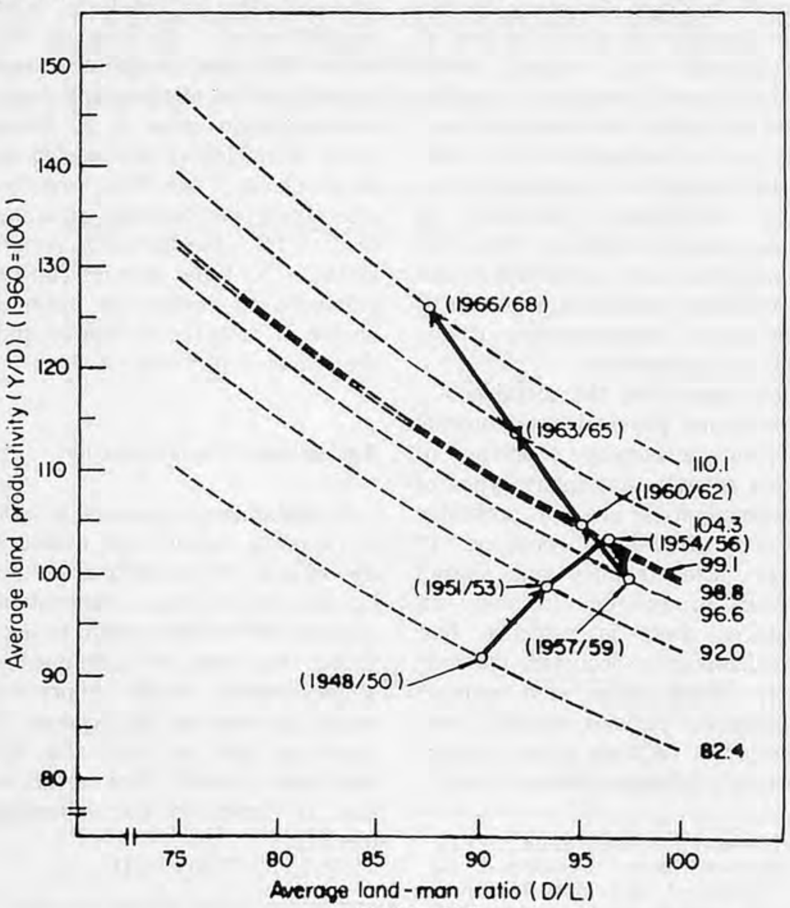

Fig.1 Historical growth path of labor productivity of agriculture in the Philippines, 1948-1968.

stitutional factors.

It is instructive to very briefly examine the historical experience of countries such as Japan and Taiwan in the use of mechanization to determine whether mechanical innovations were a necessary condition in the achievement of high and sustained rice yields.

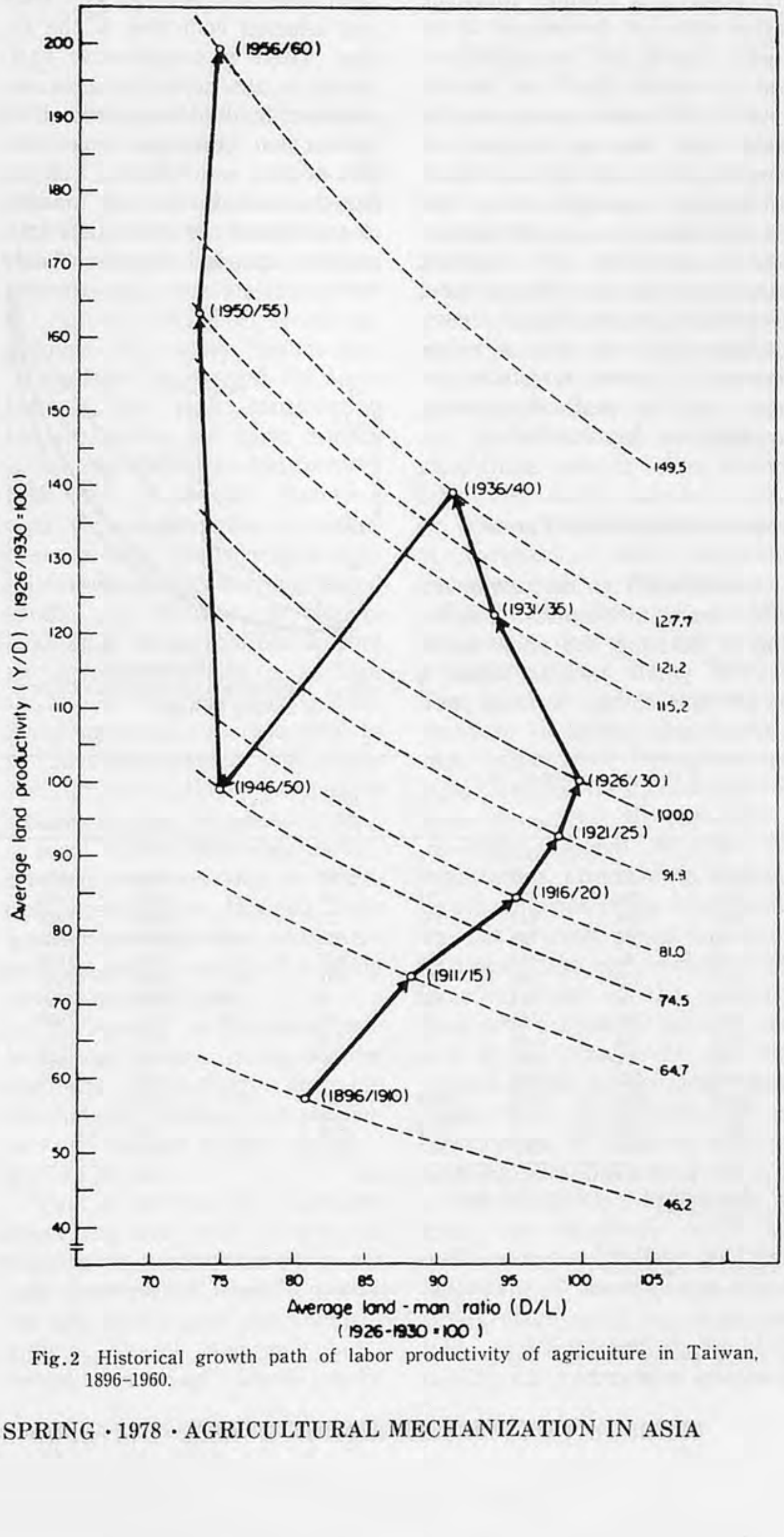

Fig.2 Historical growth path of labor productivity of agriculture in Taiwan, 1896-1960.

The widespread use of agricultural mechanization in Taiwan and Japan occurred relatively late in the structural transformation of these economies. Hayami and Ruttan (1971) and Johnston (1966) have clearly shown that major emphasis was placed on the development and extension of land-augmenting biological-chemical technologies during the early stages of growth in Japan. These technological changes, coupled with investments in irrigation facilities and the availability of a disciplined and energetic rural labor force permitted Japan to expand rice production consistently and rapidly over the period from 1880 to the present. While there were minor improvements in farm implements and tools during this period, these were primarily designed to increase the productivity of existing labor supplies and not to replace labor.

In the years following World War II, rapid industrialization was the major cause of a remarkable rapid movement of labor from the rural to urban-centered employment. The decline in the rural labor force coupled with rising wages was accompanied by the introduction of an array of agricultural machinery, initially power tillers and more recently, rice transplanters, combine harvesters, dryers and four-wheel tractors. Some would argue that Japanese farmers did not mechanize earlier because there were no suitable machinery designs available. This may be partially true, as the first power tillers, introduced into Japan from the United States in the 1950s, had to be modified to meet Japanese conditions. In historical perspective, however, there seems to have been no measurable output benefits obtainable from the use of mechanization under the prevailing economic, technical and institutional conditions. It was not until labor became scarce, wages rose and policy incentives fostering labor-saving innovations were introduced that mechanization became an important factor in maintaining agricultural output.

Taiwan, which parallels the agricultural growth of Japan (USDA, 1968 and Hsieh and Lee, 1958) shows a similar chronology in the development and adoption of modern rice technologv. Improved varieties and well-developed irrigation facilities preceded the use of machinery by many decades. Even today, with the ready availability of equimnent designed specifically for conditions in Taiwan, only slightly more than one-half of all farmers are using powered-land preparation equipment (Peng, 1976).

An important factor which has influenced the recent adoption of policies encouraging the use of farm mechanization has been the widening disparity between urban and rural income levels. Rising wages and the higher costs of modern input have made farming less attractive to younger farmers. To stem the movement from farms to cities, the government has actively promoted a wide range of farm equipment, particularly in rice production.

In contrast to Japan, the use of machines in Taiwan has permitted some crop intensification. In Japan, machines were primarily used as a replacement for labor but in Taiwan, they did contribute to a slight expansion in cropped area and output.

The varied experiences of Japan and Taiwan indicate that to achieve and sustain growth in agricultural priority, emphasis was initially placed on development of a suitable package of land-augmenting bilogical-chemical technologies. With development, changes in economic conditions have dictated the role that machines played in maintaining growth in output. Mechanization was not introduced to increase yields, but to supplement and/or replace labor and animal power. In some instances, the result has been an increase in cropping intensity, although more commonly mechanization has acted to maintain growth rates in land productivity by replacing labor draft animals. The prospect of creating technological unemployment has not been a major concern of these countries because of the high opportunity costs for the displaced labor.

Characterizing Small Farms

One difficulty in discussing the small farm mechanization question is defining the characteristics of small farms. **Table 1** shows that farms between zero and 5 hectares account for nearly 90 percent of all farms in the countries shown. The same farms, however, cultivate only slightly more than 50 percent of the area. Well over two-thirds of the farms are less then 2 hectares and more than 40 percent are less than 1 hectare in size. **Fig.3** shows the relationship between farm size and number for Asia and selected countries in the region. There is considerable variability in the degree of concentration of landholdings although it is clear that there exist large numbers of very small farms. Following the introduction of modern rice varieties, the area under irrigation expanded rapidly **(Table**

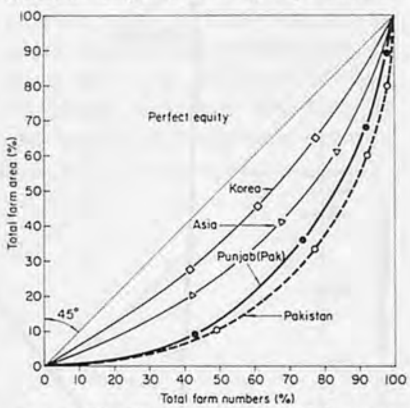

Fig.3 Distribution of farm units by area of holding in Asia.

Table 1. Distridution of farm operational holdings by size, Asian countries.

Country	.5	.5-1.0	1.1-2.0	2.1-3.0	3.1-5.0	5.1-10.0	10.0-20.0	over 20.0	Total	Year
	Farm size range, ha									
	'000 farms									
India a/ b/	9102	10783	11191	6165	7466	2958	1795	514	49874	1961
Indonesia c/	5332	3245	2223	693	431	221	69	22	12236	1963
Bangladesh a/ c	1492	1677	1615	698	442	188	27	d/	6139	1960
Pakistan a/	742	856	806	581	759	729	388	d/	4860	1960
Thailand c/ e/	na	595	945	na	884	616	163	11	3214	1963
Philippines f/	89	161	642	459	404	290	100	21	2166	1960
Nepal g/	630	300	313	na	341	492	d/	d/	2076	1965
South Vietnam c/	692	355	411	182	143	70	19	d/	1872	1960
Sri Lanka c/ h/	411	350	222	132	na	38	8	6	1167	1962
West Malaysia c/ k/	46	158	99	72	57	13	4	1	450	1960
South Korea i/	210	596	869	282	150	—	—	—	2107	1975
Total	18146	19076	19336	9264	11077	5614	2573	575	85661	
% of total units	22.0	22.0	22.0	10.7	12.9	6.6	3.1	0.7	100.0	
% of total area	2.5	7.6	12.1	10.8	19.1	18.4	15.5	14.0	100.0	

a/ Size categories are : ∠4, .4-1.01, 1.01-2.02, 2.02-3.04, 3.04-5.06, 5.06-10.12, 10.12-20.23, over 20.23.
b/ Source : Directorate of Economics and Statics, "Indian Agriculture in Brief, "11 th ed.
c/ Source : FAO report on the 1960 World Census of Agriculture.
d/ Included in previous size class.
e/ Size categories are : ∠.96, .96-2.4, 2.4-4.8, 4.8-9.6, 9.6-22.4, over 22.4.
f/ Source : Bureau of Census and Statistics, 1960 Census of Agriculture.
g/ Source : Nepal Ministry of Economic Planning, "Physical Input-Output Characteristics of Cereal Grain Production for Selected Agricultural Areas in Nepal".
Size categories are : .5, .5-1.0, 1.1-2.0, 2.1-4.0, over 4.0.
h/ Size categories are : ∠.4, .4-1.0, 1.1-2.0, 2.1-4.0, 4.1-10.0, 10.1-20.0, over 20.0.
k/ Size categories are : ∠.4, .4-1.2, 1.3-2.-, 2.1-3.0, 3.1-6.0, 6.1-10.0, 10.1-20.0, over 20.0.
i/ Source : Yearbook of Agricultural and Forestry Statistics, MAF 1975.

Table 2. Estimated percent of rice area and production by specific land type in South and Southeast Asia.

Land type	Crop area		Production	
	mid-60's	early 70's	mid-60's	early 70's
Irrigated				
Single crop	10	19	15	24
Double crop	10	14	25	24
Rainfed	50	47	42	40
Upland	20	10	10	5
Deep water	10	10	8	7
	—	—	—	—
Total	100	100	100	100

Table 3. Rice farming systems in South, Southeast and East Asia based on water control showing different levels of input intensity[a].

Item	IRRI Focus				Other			
	1 Irrigated small	2 Irrigated very small	3 Rainfed multiple crop	4 Upland multiple crop	5 Irrigated[b] East Asia	6 Rainfed single crop	7 Upland single crop	8 Deep water
Infrastracture	M	M	L	L	H	L	L	L
Cash input	M	M	M	M	H	L	L	L
Labor	M	H	M	M	M	L	L	L
Estimated % of farms	15	40	6	1	12	17	4	5
Estimated % of area	23	9	10	2	6	32	8	10

a/ For the typical farm in each system the level of infrastructure development (irrigation, roads, etc.), cash inputs, and labor use is designated as L=low, M=moderate, H=high.

b/ Japan, Taiwan, and Korea.

2). However, much of these areas still have extremely poor water control. There is considerable debate among those concerned with irrigation development as to the appropriate degree of land forming and consolidation needed to ensure adequate irrigation, drainage, and water distribution throughout the system. In some systems, the task constructing tertiary canals and farm ditches is left completely to the farmers with the result that water is used very inefficiently. In other cases, a very intensive land consolidation scheme is being tested similar to Taiwan or Japan. Nothing is left to the farmers and the development cost is so high as to be economically sound. Some intermediate steps need to be developed which will make use of appropriate mechanical technology and the existing pool of local human resources. Institutional innovations such as irrigation associations coupled with appropriate irrigation equipment such as pumps and land leveling devices are examples.

The spread of modern rice technology has changed the marginal productivity and the demand for various complementary inputs that go into the production process.

What is particularly significant about the new rice varieties in relation to mechanization is not only their yield increasing potential per se, but also their shorter growing season and non-photoperiod sensitivity which make possible a considerable shift in the cropping pattem. The introduction of modern varieties results in an increased demand for machinery to: (a) improve the timing of operations, (b) lift power constraints, and (c) make more efficient use of purchased inputs such as fertilizer and insecticides. In many instances, existing mechanical technology can be adopted or modified to meet these neds. In other instances, a new design may be required. The appropriate combination of mechanical and biological techology must be developed.

Eight rice farming systems based upon degree of water control are sketched out in **Table 3.** The level of infrastructure investment (irrigation, roads, etc.), cash inputs, and labor use are designated for the typical farm in each category (H=high, M=moderate, L=low). At IRRI, the engineering program is focused on small farms using a moderate amount of cash inputs and labor (100 man-days per hectare). This includes most of the irrigated area where modern varieties are now grown extensively, and that portion of the rainfed and upland areas where the potential for intensification of cropping systems seem to exist (Systems 1-4).

The remaining four systems include the relatively small but well irrigated farms in East Asia-Japan, Taiwan, and Korea where wage rates are rising and labor-saving technology is being rapidly adopted, and at the other extreme, the less commercialized rainfed, upland, and deepwater areas where not only capital but labor inputs are low.

The first four systems account for more than 60 percent of the farm operating units and 45 percent of the farm area. However, there is considerable variation in the number of farmers and area represented from one farming system to another. While there are pressures to serve the very small farmers who represent 40 percent of the total, it would be difficult to design machinery for this group that would have a major impact on production. It is perhaps fair to say that the machinery designs available to date have been more appropiate for farming system 1, although considerable thought has been given to the extension of services of equipment owned by farmers in this group to those in system 2 through contract operations or possible joint ownership.

Rice farms in Asia typically hire a high percentage of the labor used in rice production. With the exception of East Asia, hired labor usually makes up more than 60 percent of the total. The hired labor force includes a growing number of landless laborers who depend on this work for a major source of their income. Thus, mechanization of those tasks which use a large amount of hired labor should probably receive low priority. Major tasks in irrigated rice production together with their labor

Item	Labor Requirement[1]	
	Total labor	Hired labor
Land preparation	H	L
Transplanting	H	H
Fertilization	L	L
Plant protection	L	L
Weed	H	H-M
Water management	M	L
Harvesting	H	H
Threshing	H	H

1) There is considerable variability among countries in the degree of intensity with which labor is employed in tasks in the rice production sequence. There will also be differences by country and within countries in the division hired and family labor use for individual tasks. The above represent an aggregate estimate of a "typical" rice farm in the irrigated regions of Asia (Barker and Duff, 1975).

requirements (H=high, M=moderate, L=low) using traditional practices are listed below : From this listing, it can be seen that transplanting, harvesting, threshing, and in some cases, weeding require large amounts of hired lobor.

Mechanization Needs of Small Farmers

Generally, mechanization is employed to meet one or more objectives :

1) increase crop yields
2) increase cropping intensity
3) expand cultivated area
4) improve cropping patterns
5) improve quality and value of product
6) decrease production costs

The specific set of objectives will be conditioned by local circumstances. One or even all objectives may be consistent with overall development goals.

Mechanization requirements of small farms in Korea markedly differ from those of, for example, Java. In addition to differences in resource availabilities, dissimilarities in the rate and level of economic development in each country has created differences in the relative value of the labor and capital resources used in agriculture. Wages in Korea, particularly in industry, have increased rapidly in recent years. As a result, lack of labor has become a major constraint in operations such as harvesting and transplanting. In contrast, wage rates in Indonesia have risen only slightly in the recent past with little change in real value. For agriculture in Indonesia, a small holding continues to be the residual and major claimant of surplus labor.

Korea will use mechanization primarily to increase the productivity of available labor, generally through a process of substituting capital (in the form of machines) for labor or animal power. While the aim may also be to increase output (as was illustrated in the intensification of cropping in Taiwan), the rapidly developing counties are usually attempting to maintain agricultural growth rates while simultaneously offsetting an absolute decline in the agricultural labor force. A concomitant feature of the decline in the agricultural labor force is usually an increase in farm size. The latest statistics for Korea show the beginnings of a change in the size distribution of holdings towards larger farms (MAF, 1975).

In almost all cases involving very small farms (0-2 ha), the mechanization technologies which have been available are generally too large, too expensive and not technically compatible with the needs of small farmers. Given these limitations, what type of technology is needed?

Equipment which can be locally manufactured and maintained at low cost and which are complementary with on-farm resources of labor and power should be given priority, particularly those which improve the efficiency of purchased inputs such as water and have high social as well as private returns.

Increased yields are often cited as a major reason for mechanization. For some upland crops, such operations as deep plowing have demonstrated significant advantages in yield over traditional methods. For lowland rice, the situation appears to be less clear-cut.

To determine the effects of alternative land preparation techniques on the yield of IR20, a series of experiments and a field survey were conducted in 1974 (Orcino and Duff, and Bautista and Wickham, 1974). Replicated field plots were laid out at four sites with variable soil and water characteristics. Five tillage treatments were used **(Table 4)**. Soil depth varied from very shallow at one location to very deep at another. One rainfed site was also included to measure the effect of uncontrolled water supply on tillage requirements. The results of the experiments are summarized in **Table 5**. Grain yield data do not support the hypothesis that mechanization increases rice yields. Mean yields are not significantly different across treatments and show a minimal variation among means. Survey data from the same locality indicated farmers agreed with this finding. The irrigated farms included in the survey indicated the main reason for using tractors was ease of land prepa-

Table 4. Alternative land preparation treatments, 3 villages, Philippines, 1973 wet season.

Treatment	Land preparation method			
	Primary		Secondary[a]	
	Power source	Implement	Power source	Implement
1	65 hp tractor	rotary tiller	carabao	comb harrow
2	14 hp tiller	rotary tiller	carabao	comb harrow
3	7 hp tiller	moldboard plow	7 hp tiller	comb harrow
4	carabao	moldboard plow	7 hp tiller	comb harrow
5	carabao	moldboard plow	carabao	comb harrow

a/ Secondary tillage consists of two passes over the field repeated three times at one-week intervals.
Source : Orcino and Duff, 1974.

Table 5. Site characteristics, soil conditions and level of inputs used in land preparation trials, 3 villages, Philippines, 1973 wet season.

Site/ treatment	Labor input(hr/ha) Plow	Harrow	Total	Fuel cons (lit/ha)	Weed weight[a/] (g/0.2m2)	Means[a/] yield (t/ha)
Baluarte (shallow hardpan)						
T1	4	30	34	13	16.0	3.85
T2	6	30	36	12	12.1	3.80
T3	12	12	24	32	16.5	3.65
T4	27	11	38	17	13.5	3.88
T5	27	31	58	—	12.6	3.74
Pulo I (medium hardpan)						
T1	5	40	45	19	16.3	3.97
T2	8	41	49	16	15.0	4.00
T3	13	21	34	47	8.6	4.14
T4	34	20	54	32	10.9	4.01
T5	32	40	72	—	25.4	3.94
Pulo II (deep hardpan)						
T1	4	42	46	19	8.1	3.53
T2	7	42	49	13	9.6	3.57
T3	9	20	29	31	8.1	3.65
T4	27	21	48	27	6.6	3.57
T5	27	39	66	—	5.9	3.71
Kapalangan (rainfed)						
T1	7	47	54	28	9.8	3.08
T2	11	53	64	20	12.7	2.93
T3	—	—	—	—	—	—
T4	61	21	82	28	12.4	2.97
T5	63	66	129	—	27.7	3.01

a/ Averaged over three weeding treatments.
Source : Orcino and Duff, 1974.

Table 6. Average grain yield (t/ha) from alternative tillage and weeding trials[a/] 3 villages, Philippines.

Site	Tillage treat-ment	Weeding hand	chemical	control	Treat-ment mean	Site Means
Marilao (shallow hardpan)	T_1	3.78	3.77	4.01	3.86 b	
	T_2	4.40	3.58	3.42	3.80 b	
	T_3	3.64	3.78	3.54	3.65 b	
	T_4	4.17	4.16	3.32	3.88 b	
	T_5	3.92	3.69	3.60	3.74 b	3.79 b
	Weeding means	3.98 a	3.80 ab	3.58 b		
Pulo I (Medium hardpan)	T_1	4.30	4.07	3.53	3.97 a	
	T_2	4.46	3.86	3.69	4.01 a	
	T_3	4.46	4.19	3.76	4.14 a	
	T_4	4.23	4.04	3.75	4.00 a	
	T_5	4.52	3.52	3.78	3.94 a	4.01 a
	Weeding means	4.39 a	3.94 b	3.70 b		
Pulo II (Deep hardpan)	T_1	3.85	3.77	2.97	3.53 b	
	T_2	4.03	3.54	3.13	3.57 b	
	T_3	4.96	3.85	3.14	3.65 b	
	T_4	3.94	3.80	3.16	3.56 b	
	T_5	3.80	3.90	3.43	3.71 b	3.61 b
	Weeding means	3.88 a	3.77 a	3.16 b		
Kapalangan (Rainfed)	T_1	3.40	3.16	2.68	3.08 c	
	T_2	3.10	2.94	2.74	2.93 c	
	T_3					
	T_4	3.28	2.98	2.66	2.97 c	
	T_5	3.36	2.93	2.66	2.98 c	2.99 c
	Weeding means	3.28 a	3.00 ab	2.68 b		

LSD. 05 (W-means at each S x T) 0.77 t/ha.
a/ Weeding means at each location followed by a common letter not significantly different at 5% level.

ration with timeliness and quality of work as secondary considerations. Rainfed farmers indicated their use of tractors was primarily to permit better timing to maximize the area of land planted following initiation of the rainy. The issue of timeliness will be discussed further in a later section.

It has also been hypothesized that land preparation may have an indirect effect on yield through more effective weed control, an issue mentioned earlier and which stems directly from the use of higher rates of fertilizer with the modern varieties.

Table 6 provides evidence from the field expariments cited above ralating to weed control. The differences in mean yields for different land preparation measures was statistically significant, but quantitavely small. In this particular study, the weed population was primarily a sedge, a weed type which research has shown to affect yields only slightly. Hence, although weed weights were affected by the land preparation techniques, with the advantage given to tractors, yields were not. These studies appear to demonstrate few field advantages from the use of mechanized land preparation compaed to traditional methods.

In the areas of crop establishment, crop protection and fertilizer application, there is no available evidence which suggests any strong interaction between choice of technique and resulting yields. Weed control has been repeatedly mentioned as an operation which provides very high returns when used in conjunction with the modern varieties. The method chosen, however, appears to reflect relative costs rather than an inherent technical advantage for one method over another. The same is true of crop

Table 7. Yields of IR34 rice and fish, *Tilapia mosambica* as affected by carbofuran root-zone and broadcast applications. Central Luzon State University, Nuera Ecija, Philippines 1976 dry season.

Item	Cost of insecticide application (US$/ha)	Rice yield (t/ha)	Fish[b] Yield (kg/ha)	Volue (US$/ha)	Income[c] (US$/ha)
Broadcast					
1 kg at 3 DT	30	4.919[bc]	141	115	673
1 kg at 3, 23, 43, & 63 DT	120	4.935[abc]	0	0	552
Root-zone					
1 kg at 3 DT	46	5.116[ab]	166	136	786
1 kg at 3 DT	92	5.613[a]	150	123	794

a : In a column, means followed by a common letter are not significantly different at the 5% level (Duncan's multiple range test).
b : Fish seeded 7 days after first insecticide application at the rate of 3000/ha.
c : Income = value of rice + fish minus insecticide and application costs. Based on price of rice at $0.82/kg.

Table 8. Control of the tungro virus vector, green leafhopper, Nephotettix virescens with a carbofuran as broadcast and root-zone applications with a liquid band injector at 1 kg a.i./ha.[a] Variety IR22. IRRI, 1976 wet season.

Treatment[b]	Applica-tions	Leafhopper/10 sweeps 47 DT	Tungro virus (%) 97 DT	Yield (t/ha)	Income[d] (US$/ha)
Broadcast	1	25[c]	68[b]	1.302[b]	147
Broadcast	4[c]	9[ab]	33[a]	2.516[a]	222
Root-zone	1	3[a]	20[a]	3.092[a]	375
No insecticide	—	212[d]	100[c]	0[c]	0

a : In a column, all means followed by the same letter are not significantly different at the 5% level (Duncan's Multiple Range Test).
b : All treatments applied 3 days after transplanting (DT).
c : The four broadcast applications were made at 20 days intervals.
d : Income = value of rice − cost of insecticide application. Cost of 1 kg granules used in broadcast = US$30/kg a.i. and flowable formulation used in root zone = US$46/kg a.i.

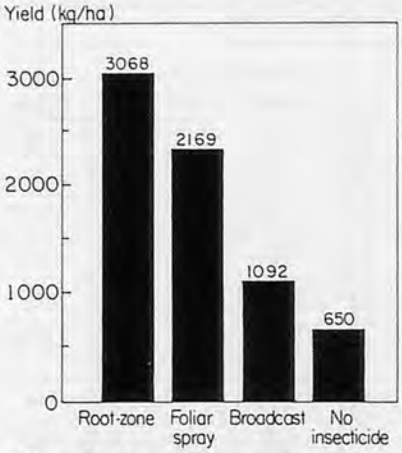

Fig.5 Yield as affected by various methods of insecticide application. Carbofuran at 1 kg a.i./ha was applied 3 days after transplanting into root zone and as a broadcast treatment. Monocrotophos was applied four times at 20-day intervals as a foliar spray at 0.75 kg a.i./ha, IRRI, 1975 wet season.

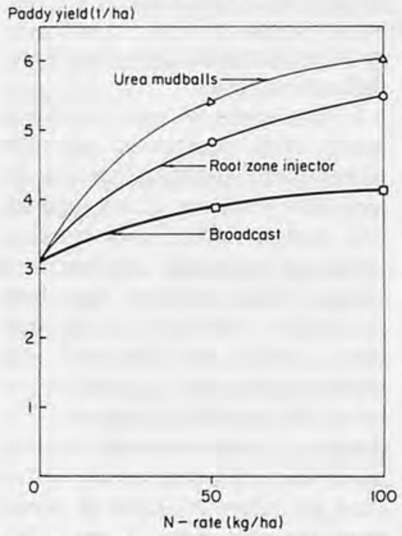

Fig.6 Yield response curves to fertilizer using three application techniques.

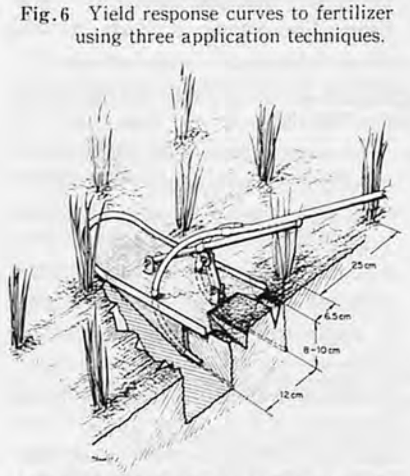

Fig.7 Liquid root-zone chemical applicator for flooded rice soils.

Table 9. Percent grain loss using four alternative post-production systems, Philippines, 1975-76.

Item	System			
	Manual threshing and solar drying	Manual threshing & mechanical drying	Mechanical threshing & solar drying	Mechanical threshing and drying
Percent grain loss				
harvesting to threshing	11.0	11.8	1.7	2.5
threshing to drying	15.3	1.2	11.4	8.2
harvesting to drying	24.6	12.9	12.9	10.5

Source : Toquero, et al 1976.

establishment. Modern rice varieties tend to be relatively insensitive to row-spacing and seedling density in respect to yield. There is, however, a strong degree of interaction between method of stand establishment and the use of mechanical weed control. Row-sown transplanted rice tends to give higher yields than higher broadcast or direct seeded rice if weed control is a limiting factor.

The farm level constraints study being undertaken at IRRI to determine why farmers are not realizing the yield potential of the modern verieties indicates ineffective use of fertilizer and the lack of profitability in the use of insectcides as the chief causes of differences between farmers' yields and optimum yields achieved under similar conditions. Contemporary work at IRRI among agronomists, entomologists and engineers to develop low-cost methods for root-zone placement of these chemicals have striking implications for yield increses on insect conqrol as shown on **Tables 7 and** 8 and **Figs. 5 and 6.** The chief limiting factor is the availability of a device **(Fig. 7)** for proper and precise placement of plant nutrients and insecticides. Reductions in application rates of 50 and 70 percent for fertilizer and insecticides respectively withont sacrifices in yields are possible.

Harvesting, threshing, drying and storage represent the terminal operations in the rice production cycle for most farmers. Efficient performance of these tasks is important if the farmer is to achieve optimum crop yields and maximize incomes. The modern rice varieties with their higher yields have tended to increase the absolute level of grain loss in post-production operations. The degree of loss which can be expected using traditional techologies in operations following harvest is appreciable. **Table 9** presents the results from the use of alternative systems of technology on yield and level of grain loss for a series of village level pilot trials conducted from 1975-77 (Toquero, et.al., 1977). Introduction of a small mechanical thresher and/or mechanical dryer significantly reduced losses and improved by up to nine precent. Laboratory analysis of paddy samples taken from the same trials showed an increase of six percent in total milled rice and 12 percent in head rice from using the mechanized systems in contrast to manual harvesting--threshing and solar drying.

Reductions in qualitative and quantitative losses in post-production operations seem particularly amenable to engineering solutions. Use of mechanized equipment is, however, sensitive to economic factors. Premiums for high quality paddy provide an added incentive for farmers to exercise care in the operations following harvest. Enactment and enforcement of grading and quality standards for paddy entering commercial markets would have a similar effect.

Introduction and use of short season varieties with non-sensitivity to day-length offers not only the prospect of higher yields but crop intensification. Undoubtedly, much of the intensification will

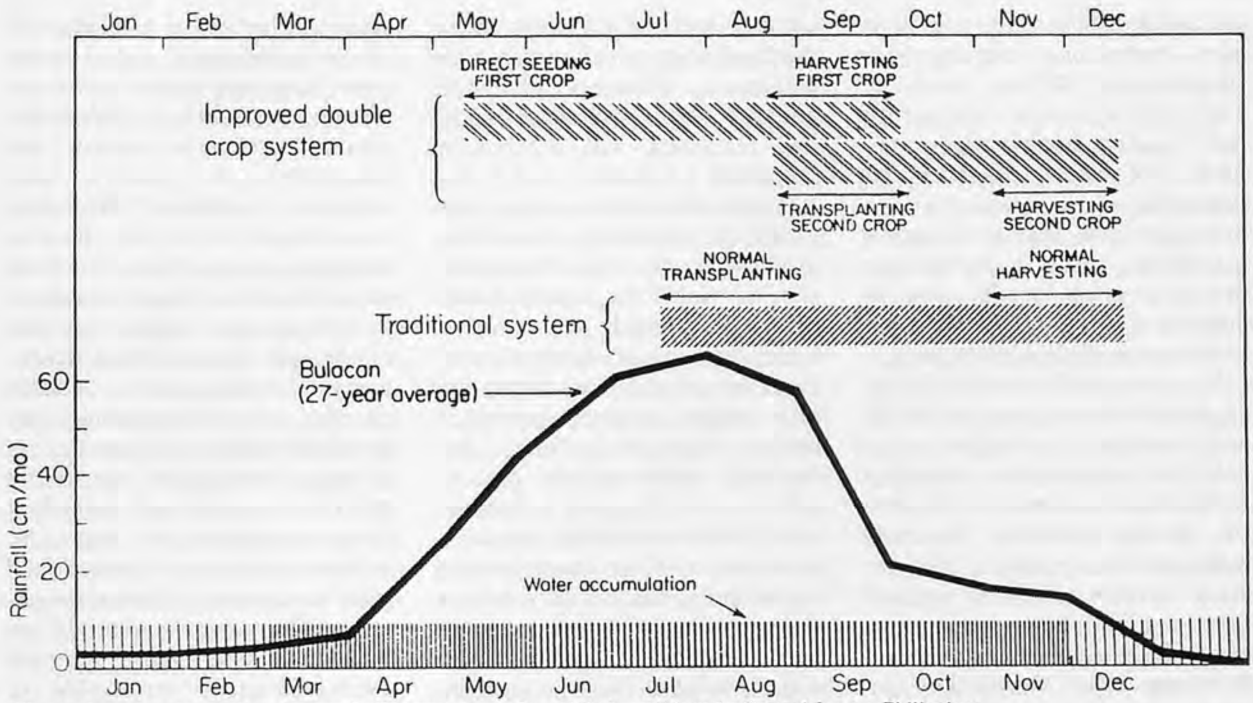

Fig.4 Actual and potential rice production systems under rainfed conditions in Central Luzon, Philippines.

take place in irrigated areas. However, the biological technology combined with techniques to permit early land preparation, crop establishment and rapid turn-around at the peak of the rainy season may permit intensification in areas with poor water control. Generally characterized as rainfed rice production, the environment represents nearly 50 percent of the current rice cropped area in Asia (Herdt and Barker, 1977).

Fig.4 contrasts the traditional rainfed cropping system with an improved double-cropped system. Under the traditional system, crops are normally planted near the peak of the rainfall distribution and harvested when rainfall is declining. Under the improved system, two crops can be planted utilizing the same moisture currently available for single crop. Under the new system, land is prepared dry at the end of the rainy season and moisture conservation practfces are employed during the dry season. The first crop is direct-seeded at the beginning of the wet season and harvested at the peak of the rainy season. A second crop is immediately transplanted. Subsequent operations for the second crop are similar to those employed for the traditional cropping system.

Effective use of this cropping system will require changes in cultural practices and the scheduling of operations. Some degree of mechanized land preparation and planting for the first crop may be necessary. Because direct seeding is employed for the first crop, weed control will become a greater problem. Threshing and drying equipment are needed for the first crop harvest. Cultural practices which maximize water use efficiency will be imperative. Timeliness is the critical element in the successful use of the rainfed double cropping system.

The importance of timeliness will be conditioned by the physical environment within which a rice crop is grown and the characteristics of the varieties themselves. Differences in topography, degree of water control, soil type and seasonality interact differently with the timing of individual operations in their impact with the output components mentioned above. For example, a single crop regime may not be affected as adversely by the degree of precision in scheduling operations as a double or triple crop pattern where the potential intensity effects of timeliness are most pronounced. An important exception is found in comparing single crop irrigated and rainfed rice production systems. An irrigated farmer's programming of land preparation and transplanting may be determined to some degree by the timing and availability of water deliveries, but he would have much greater flexibility in this regard than the rainfed rice farmer who is constrained by the availability and quantity of rainfall and must prepare his land quickly to take advantage of this moisture. In this regard, the short season varieties may reduce the urgency of early land preparation and transplanting in rainfed areas if farmers do not attempt to grow a succeeding crop. The opposite is true when rainfed farms initiate double cropping. Binswanger has also mentioned that the timeliness factor in crop establishment becomes more imperative in rainfed areas characterized by permeable soils with low moisture retention characteristics (Binswanger, 1977).

Correct timing of the harvest may interact singly or in combination with both yield and output depending again on the environment. Optimal timing of harvest maximizes yields, a precondition for high grain quality and reduces the turn-around time between crops in double cropping.

For tasks such as water delivery, weed control, crop protection and fertilizer application, it is both the timing and the frequency which ensure optimal yields from the modern varieties. Untimely water delivery subjects the rice plant to moisture stress and can cause significant yield reduction, particularly if they occur at flowering, when the modern varieties are particularly susceptible (de Datta, et. al., 1973). Mechanized pump irrigation in areas such as Pakistan and India have helped to reduce the risks associated with water deficiencies and moisture strees.

Pest control, fertilizer application and weeding have shown marked yield responses to level of application, timing and placement (Heinrichs, et. al., 1977). Equipment which can accurately measure and place chemicals under flooded conditions lowers both yield variability and the frequency of application. At a time when chemical prices continue to rise and irrigation development becomes increasingly expensive, mechanization which increase the application efficiency of water and cash inputs such as pesticides and fertilizers will become increasingly important.

Agronomists have long recognized the yield depressing effects of delays in planting. The depression in yields for upland conditions are primariy the result of water stress as available soil moisture is depleted during the later stages of plant growth. A similar, though perhaps less dramatic decrease can also be shown for lowland irrigated rice. Delays resulting in inefficient use of solar energy during formation is the primary reason, a phenomena which emerges most strikingly during the dry season when sunlight is most intense. This, in addition to the importance of timely crop establishment as the basis for obtaining more than one crop, yield may also be adversely affected by delays in planting.

In the above example, it is clear that better timing in the completion of land preparation can improve water use efficiency.

In a 1973–75 study of irrigation systems in the Philippines, Valera and Wickham presented information describing the relationships between the timing of water deliveries, land preparation and transplanting. Data for the analysis were collected from rainfed, gravity irrigation and pump irrigation sites (**Fig. 8**). Under traditional rainfed conditions, land preparation and transplanting generally follow the rainfall distribution pattern. Land preparation is delayed until sufficient moisture has been accumulated to allow plowing with the water buffalo. The total duration of these two operations is considerably longer for the rainfed site than for the irrigated areas. The long interval between plowing and transplanting may partially reflect the practice of allowing weeds to germinate between primary and secondary tillage operations. It may also indicate a lack of power and labor to carry out those two operations. From a related study, we note that only those farmers owning tractors were able to transplant earlier than before adoption of the modern varieties (Bautista and Wickham, 1974).

Both of the irrigated areas showed a close relationship between the timing of water deliveries and land preparation, although the gravity irrigation site had a longer overall interval for completion of those tasks. One conclusion was that there exists a substantial opportunity to improve water use efficiency by reducing the land preparation-transplanting interval using improved techniques for plowing and transplanting. Within the gravity irrigation system, it was estimated that a reduction of

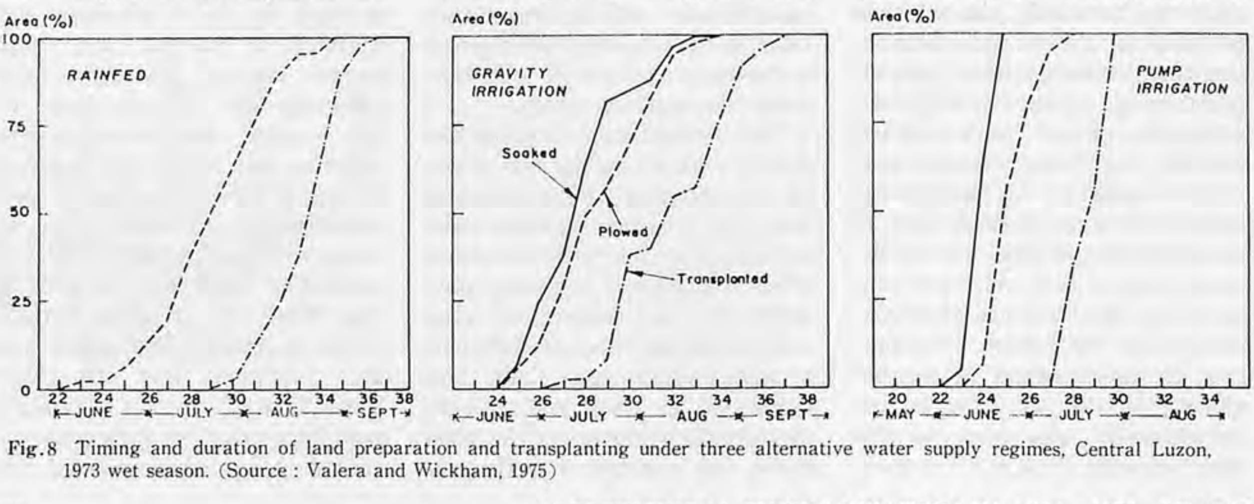

Fig.8 Timing and duration of land preparation and transplanting under three alternative water supply regimes, Central Luzon, 1973 wet season. (Source : Valera and Wickham, 1975)

3½ weeks in the land preparation- transplanting phase would save 200 to 600 mm/ha of water from that actually observed.

Choice of Technique

In the preceding section, several examples were given which illustrate the possible role which mechanization may play in fostering increased economic growth on small farms. In some instances, the machine technology tó realize these increases is available but unused. In other instances, new engineering developments are required. In all cases, a major, constraint facing

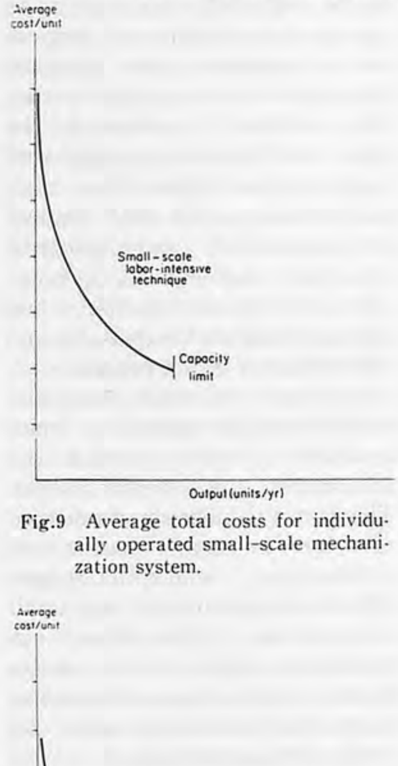

Fig.9 Average total costs for individually operated small-scale mechanization system.

small famer's use of innovation, is the lack of capital resources. The lumpy nature of investments in agricultural equlpment requires that the famer reach some minimal threshold level of use before the machines become profitable. In many cases, this threshold area is beyond the size of an average holding.

There are alternative institutional arrangements which can be employed to capture the advantages of mechanical technolgies inspite of the investment constraint. In **Figs. 9 to 12,** I have presented graphically some typi cal use patterns. **Fig. 9** illustrates the purchase and use of a single machine by an individual owner. In this case, the capacity of the machine is assumed to be closely tailored to the needs of a small holder. As long as utilization less than the capacity of the machine and average total costs are less than other alternatives, the farmer will be able to use the machine profitably. If annual use requirements exceed the size of his holdings, the farmer employs the excess capacity of the machine for contract work. In **Fig. 10,** there small machines were purchased and used under one management. Multi-machine use expands capacity and may also lower overall costs because fixed cost components such as maintenance facilities are now used for more than one machine. This arrangement also embodies the flexibility to meet a wide range of capacity needs and can provide timely service to more than one user simultaneously. To meet total investment requirements, however, the machines shown in **Fig. 10** must cover an area approximately three times greater than the single machine shown in **Fig. 9.** This arrangement also illustrates the potential embodied in joint ownership and by organizations such as irrigation associations or cooperatives.

Fig. 11 shows the total average costs for ownership and use of a single, large capacity machine. Generally, this technology would typify invesment in a large four-wheel tractor or heavy irrigation pumping unit. Fixed costs are high which means the machine must be utilized at high levels of output to achieve minimal costs. While use requirements are high, there are at least two methods by which small holders can realize the benefits from such a technology. One is through private ownership and custom hiring services. This pattern is widely used in Thailand and the Philippines for four-wheel tractors. A second pattern is through collective or cooperative pooling of investment resources to purchase the machine. The latter method is generally more complicated to im-

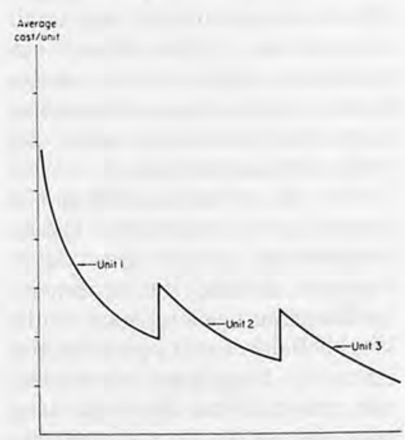

Fig.10 Average total costs for small- - scale mechanization systems replicated three times.

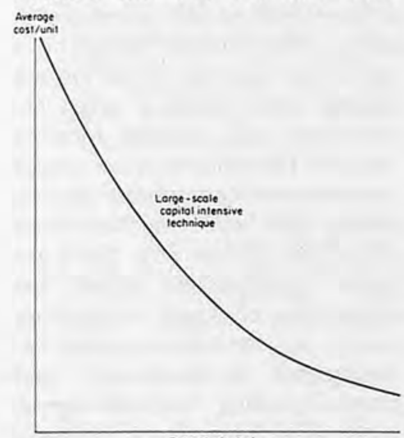

Fig.11 Average total cost for large- -scale capital intensive mechanization system.

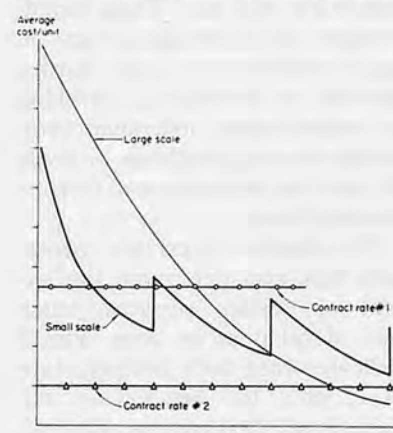

Fig.12 Compative average total costs of four alternative mechanization systems.

plement and requires a well-developed system of management to properly schedule the use of the machine. It also does not embody the timeliness and convenince features of lager numbers of small machines. At higher output levels, the large machine may, however, have lower overall costs compared to the smaller units. In some instances, it has also been shown that larger equipment is technically more efficient, using less energy and resources per unit of output than smaller units performing similar tasks.

Fig.12 compares the large and small equipment options. It is not possibie to generalize about the desirability of any of the alternatives shown in the figure. Choice will be dictated by local factor pricing, the ability of farmers to pool resources and manage investments and the importance of timeliness and convenience in ownership. Where individual ownership by small farmers is indicated, small equipment may prevail. In situations where viable community or political institutions exist to effectively consolidate and manage capital, larger equipment may be chosen. Large irrigation pumps serving adjoining holdings or village level grain drying facilities, both of which embody technical economies of size would be candidates for joint ownership and use. Where simultaneous peak loading occurs on large numbers of small farms, such as in harvesting, threshing or transplanting, individual ownership of small machines or pools of small-scale equipment may be more efficient.

The degree of private ownership will also determine the extent of custom services which may develop in an area. **Fig.12** indicates that with contract rate no. 2, only the large-scale machine is able to compete effectively and then only at high annual use levels. Using contract rate no. 1, however, only the smallest farm would find individual ownership unattractive.

The above example is only illustrative. There are many factors which affect the decision to purchase or use epuipment. The value of leisure time, the prestige factor, the degree of drudgery associated with a particular task, the amount and cost of hired as opposed to family labor used for a task and the availability of service and maintenance facilities also condition decisions to employ mechanization. In recent years, the availability of low-cost credit for acquisition of the machines has also been a decisive factor. Coupled with government controls over interest, foreign exchange rates, import restrictions and wage laws, the final choice of technique may diverge significantly from an optimal one based on social cost criteria.

Public Policies Affecting Mechanization and Research

In this paper, I have not attempted to compare the economics of alternative mechanization strategies nor develop a methodology for carrying out such an analysis. The report highlights those components of agricultural production systems (particularly for rice) which seem particularly amenable to mechanization to achieve and sustain increases in output. The actual choice of a particular machine to perform a specific task within a given environment will be very location specific. The evidence from use of the modern rice varieties demonstrates that while mechanization plays a minor role now, there are manv opportunities where the application of sound engineering design in conjunction with developments in agronomy and plant breeding embody great potential for significant increases in production.

Leadership in research and the development of public policies have a great impact on the nature and type of innovations made available to farmers. Organization of research to ensure that engineers work closely with biological scientists in the evolution of improved technology will ensure that research resources are used effectively and results are a composite of complementary technologies and not splintered fragments. Multi-disciplinary working relationships, while more difficult to affect and adminlster than others, ensure that probiems are correctiy identified and specified before development to correct them begins.

The establishment of a sound research base is highly dependent on the availability and training of scientists and engineers. Engineers in particular often bring to their jobs a preconception that designs should be judged on the basis of their complexity and sophistication rather than their performance in the field. Engineers, economists and biological scientists must embody a fuller appreciation for simplicity, low cost and ease of extension and use in their research programs.

New and innovative organizational forms are needed to make available to small farmers the advantages of mechanization. There exist inherent economies of size in some mechanical technologies which preclude efficient applications on small size farms. Until joint use mechanisms are developed to finance and manage such technologies, they will remain out of the reach of the small farmer.

The role of rural credit in the acquisition of machinery should be examined in more detail. Over the past decade, the propensity for financing agencies such as the World Bank to support capital intensive, large-scale mechanization programs has deprived many countries of the opportunity to combine development of local semi-modern industry with assistance to a wide cross-section of the rural population. Methods are needed to reduce both the risk to financing institutions and the costs in providing credit to small farmers.

Research is needed to develop public policies affecting the quality and diversity of agricultural products. Improving consumer preferences for good quality rice will have the indirect effect of inducing use of better harvesting, handling, threshing, drying, storage, milling and transport practices. Improving quality also has concomitant effect of increasing the volume of commodities reaching the consumer because of lower losses.

Further research is badly needed to clearly identify and specify the nature and magnitude of the technical relationships between the new biological technology and mechanization. In addition, the interaction of these effects with the institutional and economic factors must also be evaluated. The full impact of mechanization on output, employment and incomes may not be felt for a period of many years. Research on these consequences must embody a dynamic as well as a cross-sectional dimension. This research should be carried at both farm and regional levels to sort out the "confounding" effects of technical change and to predict their aggregate effect.

In this effort, we have not examined the effects of mechanization on changing cropping patterns or costs. Clearly, these two issues together with an evaluation of institutional structures and policies affecting the use of capital and labor on small farms would need to be incorporated into a comprehensive research effort. Lastly, the interdependencies between the level and pattern of mechanization and non-farm industrial activities are also required to fully assess the consequences of particular strategies to mechanize the rice sector.

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Plant Protection Equipment for Small and Marginal Farmers

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Agriculture in Indian Economy

India, considering the surface area, is the seventh largest country in the world with population of about 600 millions. With substantially low per capita income and consequent low rates of savings and capital formation, India is still caught in what has come to be known as the "Low Level Equilibrium Trap". The Indian economy is still predominantly agricultural with seventy per cent of population employed in agriculture, in villages, accounting for about 50 per cent of the country's Gross National Product. Agriculture is our biggest industry. In other words three out of four of the nations' population is dependent on agriculture for their livelihood. It is but natural, therefore, that in our planned journey to prosperity, agricultural development should occupy a pride of place. Planners who are behind the concept of high productivity, are concentrating their sight on the importance of Indian Villages in moulding the economy.

We have been attaching very high priority to the development of agriculture from the First Plan onwards for obvious reasons. Obviously, achievement of agricultural growth of the order envisaged in the Fifth Plan, would call for evolving appropriate strategies. Thus the over-all goal of the Fifth Plan for the country are "THE REMOVAL OF POVERTY AND THE ATTAINMENT OF ECONOMIC SELF-RELIANCE".

Land Holdings

The total geographical area of the country is 328 million hectares and the present reporting area is 306 million hectares. At present about 161 million hectares is sown under various crops every year, but there are large areas covering about 12.4 million hectares which are cultivable but not utilized.

There are 70.5 million operational holdings in the country covering an aggregate area of 161 million hectares of land. The average size of holdings is 2.30 hectares of which the net area under cultivation is 2.06 hectares. Details of land holdings are given in **Table 1.**

Irrigation

Since water (irrigation) is an essential requirement, both for high yield and for minimising risk, the adoption of new technology is easy in irrigated areas. There are 12.4 million holdings wholly irrigated covering 12.1 million hectares and 17 million holdings partly irrigated covering 46 million hectares. Over two-thirds of the total irrigated area in the country (67.6 per cent) comprise irrigated areas in small and semi-medium holdings (39.0 per cent) and medium holdings (28.6 per cent). There are 6.3 million sub-marginal holdings wholly irrigated in the country of a size less than half an hectare. Marginal and sub-marginal holdings (less than 1 hectare) on an average have only 0.3 hectare as the irrigated component of holdings. The partly irrigated area in the country comprise of small holding (1 to 2 hectares) and semi-medium holding (2 to 4 hectares). The average size of irrigation component in partly irrigated holding of medium size range from 1.3 to 3.9 hectares.

Table 1. Land Holdings

Types of Holdings	No. of Holding (out of 70 millions)	Cultivable Land (out of 161 million Ha)
1) Marginal (Below 1 Hectare)	50 % 35 millions	9 %
2) Small (1 to 2 Hectare)	19 %	12 %
3) Semi-Medium (2 to 4 Hectares)	15 %	19 %
4) Medium (4 to 10 Hectares)	11 %	29 %
5) Large (10 & above Hectares)	4 % 2.8 millions	31 % 50 millions

Crops Grown

The new agricultural technology associated with the slogan "GREEN REVOLUTION" implies the cultivation of genetic strains of crops like wheat, rice, sorghum, maize and other cereals. In India wheat and rice are the main crops.

In rice cultivation, small and semi-medium holdings (1.0 to 4.0 hectares) account for the largest part of the area under rice-cultivation both irrigated (43.6 per cent) and un-irrigated (44.1 per cent). Although marginal and sub-marginal holdings (less than 1 hectare) constitute one-half of the total number of operational holdings in the country, rice cultivation in these holdings is less than one-fifth of the total area under rice cultivation.

In wheat cultivation, small and semi-medium holdings (1.0 to 4.0 hectares) account for the largest part of the area under wheat cultivation 38.2 per cent of the irrigated area and 30.0 per cent of the unirrigated area.

Modern Technology in Agliculture for Small and Marginal Farms

The need to raise productivity for growth in agricultural production was recognized in India since long. Till mid-1960s, however, efforts to raise productivity through increasing the use of various inputs, had only limited success. There were two main difficulties. First, it was technologically impossible to use substantial quantities of some inputs such as fertilizers on existing varieties of crops. Second, because of low productivity of inputs and unfavourable product prices situation, returns on the use of various inputs were small. Consequently, cultivators' effective demand for these inputs was growing slowly. Break-through in agricultural research, beginning with the evolution of high yielding varieties, and improvement in the price situation dramatically altered the production conditions for cultivators in the second half of the 1960s. Vast expansion in the use of different inputs is now conceivable not only because it is technologically prossible, but also because of high returns on their use to the cultivators. This is clearly indicated both by data on new technologies available from various research agencies as well as unprecedented growth in the use of different inputs after mid-1960s.

Unfortunately, however, the new technology based on high yielding varieties of seeds, fertilizers, pest control and water management, has bypassed certain regions, certain crops and small and marginal farmers. With the adoption of modern technology, it is now feasible to convert small farms into economically viable units through the scientific use of inputs and diversification of activities. The need to improve the socio-economic conditions of marginal farmers and landless agricultural labourers has, therefore, assumed significant importance and attracted the attention of the government. The Fourth Plan had inter alia provided for two sets of projects comprising Small Farmers Development Agency (SFDA) and Marginal Farmers and Agricultural Labourers (MFAL) Agency.

Progress means change and change inevitably brings in its wake new problems. But these are the problems of a developing economy that have to be faced if we are to break out of the equilibrium that goes with stagnation. What is important is to ensure that we have the scientific, technical and administrative capability to take on and find a satisfactory solution to the new problems as they emerge. The high-yielding seed strains that absorb high doses of nitrogen and give increased yields, are also suceptible to attack by various pests and diseases. The answer to this difficulty is to use the new seeds, but be ready with the needed plant protection measures, to protect them from the ravages of pests by biological and chemical treatment. This is the kind of management problem that the government, farmers and industry have to face in modernizing agriculture. If this broad objective is accepted, a number of things automatically follows.

Pest Diseases and Losses

Though not much systematic studies have been carried out in India to estimate scientifically the losses in crops due to ravages of pests and diseases, the Pesticides Association of India estimates that on an average about 18 per cent of the production of crops is lost due to pest attack. In 1973-74, provisional estimate of Gross National Product (GNP) value for agriculture was about Rs. 26,900 crores. Therefore in terms of value the loss amounts to an alarming figure of about Rs. 5,000 crores calculated at the existing price level.

It is estimated that the maximum loss is caused due to weeds (33 per cent) followed by Plant diseases (26 per cent) and insects (20 per cent), while the storage loss could be put at 6-8 per cent. The rats are estimated to cause about 6 per cent loss to the standing crops. The average loss due to these major five categories come to little over 18 per cent. It is estimated that in 1973-74, near ly 12.5 million tonnes was subjected to avoidable loss due to pest and diseases. For rice and wheat alone Rs. 1,900 crores was lost.

It is said that 1 kg. of fertilizers can produce about 10 kgs. additional foodgrains, while on the other hand 1 kg. of pesticides saves 100 to 200 kgs. of additional grains. As against the loss of about Rs. 5,000 crores in India yearly only about Rs. 100 crores worth of pesticides are being used. The cost benefits ratio, according to National Council of Applied Economic Research is about 1 : 17 (1964). But with the present price level it will be 1 : 10. As such, we are controlling the loss of about Rs. 1,000 crores only against the avoidable loss of about Rs. 5.000 crores. Hence, the need and urgency of use of pesticides is very essential. Thus there is ample proof that in the absence of proper pest control, improved varieties often, not only, do not yield higher output, but they also act as a channel for higher wastage of costly inputs. Mr. John Hannah, Executive Director of the World Food Council said that "if we could find the means of reducing food loss to about one-third of their present day level, this could provide enough food to cover the increased needs of rising population of the developing countries for about five years".

Insects know no boundaries. The haves farmers who protect their crop, do not realize proportionate higher yields because the small and marginal farmers surrounding do not normally adopt plant protection measures. The fields of small and marginal farmers thus become the source of pests and diseases and to certain extent migrate to the nearby fields and cause damage to the crops. It is therefore all the more essential that these farmers should take plant protection measures not only to protect their own crop but also reduce the source of wider distribution of pests.

The second set of implications of a farmer-oriented approach to our development programmes in agriculture relate to the needs of proper storage, transport and processing of agricultural produce. As long as we had a subsistance agriculture, with the farmers having very limited surplus for marketing, we did not encounter serious problems of storage. The achievement of higher levels of output and greater diversification of products has thrown up the need for expanded and more scientifically organized facilities for taking adequate care of these post-harvest requirements. The farmer has a vital stake in the efficient implementation of these operations, for without them his net income is likely to be only a fraction of what it will be under a scientific system of handling the produce after it is harvested.

This is a phenominal loss. Since over 50% of total crop production in India is contributed by small and marginal farmers, who are tradition bound, the losses due to pests etc. are presumed to be greater in their crops. It is, therefore, pertinent that plant protection measures should be adopted by small and marginal farmers to obtain higher yields. The development of the small and marginal farmers, therfore, is directly related to the increase in Agricultural production.

Importance of Plant Protection Equipment

The supply of improved agricultural implements also constitutes an important part of our development strategy. The prime consideration here is how far the introduction of a particular implement will improve productivity of labour/land and what impact it will have on a more intensive use of the available land. We have to take special care to ensure that an indiscriminate introduction of machines does not cut into even the limited opportunities for productive employment that we now have in agriculture for our growing labour populaion. At the same time, it is necessary to recognize that the use of plant protection equipment can and does considerably increase land and labour productivity, without having the effect of substituting capital input for labour input.

The introduction of these machines also calls, in its turn, for the organization of various repair and maintenance services in the rural areas. This is not an easy operation to set up in the initial stages, considering the dispersed nature of these implements, lack of proper communication, and low educational level of the users.

Plant Protection Technique

In India, until about World War II, plant protection as a necessary and methodical scinece was unknown. The common Indian farmer used to practice the "catch and kill" method in his farm and only the big landlords and planters abreast of the scientific advances in agriculture abroad, were practising some sort of plant protection with the sprayers and dusters and they were privileged to import from abroad. After World War II sprayers and dusters were being gradually introduced. Initially, imported stirrup pumps came on the scene, but it was mainly for spraying for public health purposes. Hand Rotary Dusters, manufactured indigenously followed and they were being used for dusting sul phur on crops and mango trees. Since then Plant Protection has been catching up slowly. Entire range of Plant Protection Equipment is now available in our country, consisting of stirrup pums, rotary dusters, compression sprayers, knapsack spayers, foot sprayers, conventional types of power spravers, mistblowers, tractamount sprayers and gadgets for aerial application.

The importance of prophylactic treatment is being realized and it is followed on a progressive scale. We have had high volume spraying methods upto first half of sixties, low volume spraying method in the second half of sixties and now with the introduction of insecticides and pesticides of highly concentrated and toxic chemicals, ultra low volume spraying is being resorted.

We have now come to a stage where with the introduction of highly toxic chemicals, spraying is required to be done in terms of Millilitres, rather than in Litres. With this background in view, we shall have to evaluate the present day trend in plant protection equipment. With the introduction of modern chemicals which are required to be sprayed in ultra volume form, the sprayers suitable for ultra low volume spraying have come to be in great demand. Manufacturers of sprayers have been quick to grasp this and they have introduced gadgets like restrictors and micronizers, which can be fitted to mistblowers for spraying of chemical in ultra low volume form. Restrictors and Micronizers are so designed that with their help one can spray through a Mistblower as low as one wants.

Weedicide spraying has of late become a part of effective plant protection. Most of the weedicides available now are highly corrosive and not suitable for being sprayed through sprayers which are made of material prone to corrosion. High density Polythelene is corrosion resistant and, therefore, sprayers from high density Polythelene are extremely suitable for spraying of weedicides.

From the foregoing it is clear that for effective use of pesticides and weedicides, the construction of equipment, has to be changed suitably. Indian manufacturers have been quick enough to grasp this changing trend and have effected suitable changes in their equipment. Conventionally Brass has been the most popular material from which equipments have been made. In Western Countries it was long replaced by Stainless Steel, Plastic and Fibreglass. In India the need to change this material has been all the greater in view of the fact that Brass is a scarce material with us. What is true of Brass is also true of Stainless Steel in as much as it is not available indigenously. As for Fibreglass, it is still in developmental stage in India. India can rightly be stated to have entered what may be called the "Plastic-Age".

Gone are the days when sprayers were used only for spraying pesticides and insecticides. Now sprayers are also being used for foliar application of fertilizers. Solutions of nutrients are sprayed over the growing crop for intake through the leaves in contrast to conventional application on or in the soil for intake through roots. The practice is fast moving out of the realm of research into practical application, it is pertinent to ask where it fits in the crop production schemes of today.

Availability of Plant Protection Equipments

To-day in India complete range of Plant Protection Equipments known in the different parts of the world, ranging from small nursery sprayers to power operated equipments (except multi H. P. mobile equipments) are available. About 2.5 to 3 lakhs hand operated equipments are manufactured and sold by about 30 manufacturers valuing approximately Rs. 8 to 10 crores. Besides this, about 10,000-20,000 power operated Mistblowers are manufactured valuing Rs. 1 to 2 crores. The rough estimate of various types of hand operated equipments sold in Indian Market is as under :

35%	Knapsack Sprayers (continuous type)
25%	Compression Sprayers (range 9 to 18 Lit. capacity)
10%	Rocker and Foot Sprayers
15%	Stirrup Pumps and Syringe type Sliding Pumps
10%	Rotary Dusters
5 %	Small Nursery Sprayers

It is worth while to note that most of the farmers are fond of Brass Sparayers, even though they are very expensive. They prefer to use Compression Sprayer than Knapsack Sprayer (continuous type). This may be due to laziness on the part of farmers as they have to work by both hands during spraying operation with knapsack sprayer (continuous type). In fact, farmers have still not realized the economy in labour and efficiency in spraying operation which they can get by using knapsack sprayer (continuous type). Recently many farmers have started realizing this fact and they have started adopting knapsack sprayer. Even they have also started adopting plastic sprayers to a greater extent and that is why higher percentage of knapsack sprayers are sold in the market. The other note-worthy point is that still some of the farmers prefer to spray the field crop by Foot Sparayer or Rocker Sparayer or Stirrup Pump. This type of sprayer requires two persons for spraying operation. Besiders, they have to keep extra person to carry spray mixture.

Lately Indian Standards Institution has prepared standards for all the known types of manually operated Plant Protection Equipments. Few manufacturers have started manufacturing equipments with IS mark. Thus, in short, Indian farmers can get quality-product for the plant protection equipments without any difficulty.

Plant Protection-Its Cost/ Benefits

Agricultural Scientists are con-

Table 2. Cost of cultivation of 1. acre of paddy or wheat

Operations	Paddy	Wheat
	Rs.	Rs.
1. Preparation of land ploughing, harrowing, preparing of beds	80	50
2. Seed	40	80
3. Fertilizers	225 Kg −400	125 Kg −220
4. Pesticides	Mercurial 150 Lindane Dimecron Dithane Z-78	Mercurial 50 Dimecron Dithane Z-78
5. Irrigation (including labour cost)	(Kharif)	200
6. Labour :sowing, transplating, spraying, weeding, harvesting, threshing	300	125
Cost Total	970	725
Average Yield	1800 Kg.	1000 Kg.
Loss as estimated due to pest when Plant Protection Measures not taken	20 %	15 %
Loss in terms of yield	360 Kg.	150 Kg.
Loss in terms of value	Rs. 270	Rs. 150
Paddy @ Rs. 75 per quintal Wheat @ Rs. 100 per quintal		

Table 3. Data of Plant Protection EquipMents Owned by Small & Marginal Farmers

Sr. No. State & District	No. of villages	Area acre	No. of farmers	No. of Equipments	Remarks
West Bengal					
1. 24-paragnas	8	140	105	105	1. Most of these farmers operate the equipments by themselves.
Karnataka					
2. Bangalore	10	297	128	58	
Gujarat					
3. Surat	20	695	295	37	
4. Bhavnagar	10	560	150	14	
5. Vadodra	8	227	116	15	2. Very few hire labour for operating the equipments.
6. Kaira	5	113	44	7	
Maharashtra					
7. Thana	7	607	87	3	
8. Poona	1	1215	284	15	
9. Sangali	1	172	14	12	
Total	73	3856	1223	278	

ducting a large number of demonstrations in farmers fields in order to introduce to farmers the new crop varieties and multicropping systems. In such demonstrations sponsored by the ASPEE Agricultural Research and Development Foundation at Kosbad Hill, Dist. Thana (for paddy) and at Rajwad, Dist. Surat (for wheat), inputs such as seeds, fertilizers, pesticides were provided to the farmers in time and entire cultivation was done by the farmer (adivasi) himself, following the technical suggestions given by the scientists. The data collected for these two crops are shown in **Table 2.**

The statistical analysis of the data showed that the new agricultural technology introduced in adivasi area proved equally good in terms of production compared with big modern farmers. This would imply that the new technology could be successfully adopted by small and marginal farmers, if they are provided with the needed inputs. But the economic benefits from high yield varieties of rice and wheat, can be fully realized only with good water and pest management.

If the farmers had not adopted plant protection measures to protect the crops, then they would have probably lost more than the estimates made in the **Table 2.** In fact, the incidence of pest and diseases are quite severe. The cost of pesticides should be considered as a premium against the insurance of good crop. This alone is of greater advantage than higher earning itself.

Even if all the needed inputs are provided, experience has shown that the new technology is of two kinds with regard to its requirements of individual and group efforts, under conditions where the average size of a holding is 1 to 2 hectares. One kind of technology, as for example, in wheat, is capable of successful individual adoption, success being measured in terms of return from the investment made. The other kind is rice grown in south west monsoon season where pest and water management problems are many, and where the maximum economic benefit accrues to the community only if some degree of group endeavour, can be achieved in certain areas of crop management. Otherwise, the risk element becomes high.

In view of the magnitude of the problems facing plant protection and increased crop production, it was necessary to determine to what extent the small and marginal farmers are cautious about taking measures to protect their crops. A survey was made by ASPEE Agricultural Research & Development Foundation to find out the vast potentiality of increasing crop production by small and marginal farmers by adopting plant protection measures, data for which is given in **Table 3.**

The survey undertaken in 4 states reveals that 1223 small marginal farmers holding 3,426 acres of land, are having only 278 equipments. Most of them grow paddy, wheat, jowar, bajra and ragi. Some have started using high yielding seeds. If all the farmers start using high yielding seeds and follow modern farm practices with required inputs, then the problem of pest and disease control, will be enormous. They will not be able to control pest & disease with meagre quantity of plant protection equipments owned by them. The advantages of modern farm practices could be achieved by these farmers if they take proper plant protection measures. In fact, they have to adopt prophylactic measures for plant protection and not to wait for the pest and disease to come. This, in turn, requires that all the farmers should be equipped with plant protection

Table 4. Future Annual Investment In Important Farm Equipment

	Estimated annual requirements (Qty.)	Unit investment	Estimated annual investment (Rs. crores)
1. Wheel tractors and equipment	50,000	40,000	200
2. Crawler tractors and equipment	1,500	200,000	30
3. Power tillers & equipment	10,000	12,000	12
4. Engine driven pumpsets	100,000	3,000	30
5. Electric Pumpsets	200,000	2,000	40
6. Plant protection equipment			6
7. Power threshers	50,000	2,000	10
8. Combines	200	150,000	3
9. Water-well drills	100	600,000	6
10. Replacement spare parts			15
11. Bullock carts, pneumatic tyred	250,000	1,000	25
12. Improved bullock drawn implements			20
13. Fuels & lubricants for farm prime-movers	2 m. tonnes		203

equipments and preferably his own equipments either small or big, depending on his land holding.

Telescopic Lance (or Slide Pump) Sprayer will cost Rs. 100/-approx. and a Plastic Knapsack Sprayer will cost in the range of Rs. 200/-to Rs. 300/-approx. The normal life of an equipment, if well maintained, will be minimum 5 years. The equipnent could be used for two or more crops (i. e. kharif and rabby) in a year. The depreciation cost of the equipment, will be hardly 20% per year, in which he can take care for two or more crops. He can also make use of the plant protection equipments for spraying weedicides or for application of fertilizers and micro-nutrients. The advantage accruing by the plant protection measures, referred above, are only for cereal crops. The gain will be phenomenal, where cash crops such as cotton, groundnut and vegetables are grown.

Although the availability of plant protection equipment plays a very important role in adopting plant protection measures but the successful cultivation of a crop and the realization of their prices are major factors for adopting Plant Protection Measures. A very interesting example could be cited here that Gujarat was a State where these equipments were used for plant protection measures in negligible quantity, even though the farmers were rich and capable of adopting such measures. When Hybrid-4 cotton was introduced in Gujarat about 4 years back, the returns in growing cotton were remunerative and hence they realized the value of plant protection measures and started using the equipment to such an extent that the use of plant protection equipments and pesticides was the highest in Gujarat compared to the other states in the country. In 1974-75, in growing cotton, cost of inputs increased and the return was minimum with the use of equipment reduced once again in Gujarat and is once again lowest in the country.

Farmers in India invest nearly Rs. 600 crores in major equipments every year, according to the Indian Society of Agricultural Engineers. Now farmers are aware of farm mechanization and have started purchasing the farm equipments. As a result, the demand for the farm equipments have increased. The estimated requirements of different agricultural machineries needed by the farmers is given in **Table 4.**

Conclusion

As stated earlier, there are about 29 millions holdings in the country having irrigation facility and hence they are in a position to grow more than one crop. There will be a need for equal number of Plant Protection Equipment, if all these farmers start using high yielding variety and adopt modern technology in agriculture. Considering that 15 million farmers would be well equipped with plant protection equipment, the need for equal number of such equipment will arise. If the purchase for these farmers is spread over a period of 5 to 7 years, yearly requirement of plant protection equipment will be approximately 25/30 lakhs. If this comes true, the requirement of plant protection equipment will be more than the estimate shown in the **Table 4.**

In any case to feed the future generation, adoption of modern farm tehnology and high yielding strain in a must even if we adopt plant protection or not.

Telescopic Lance (or Slide Pump Sprayer)

The sprayer consists of a telescopic positive plunger type pump which serves as part of the discharge system, a fixed or adjustable nozzle, a supply hose with strainer and plastic container fitted with shoulder strap. The sprayer is worked with a two-handed telescopic plunger action. The adventege of the sprayer is that it is relatively cheap and simple to use and maintain. It can be used successfully by unskilled personnel with very little instruction. Spare parts are inexpensive and easy to replace. The sprayer can be dismantled and repaired without tools. The sprayer is most suitable for marginal farmers where more expensive equipment may not be justified, as his spraying work is small. The only disadvantage is that both hands are required for operation.

Knapsack Sprayer

Knapsack sprayer, as the name implies, is carried on the back in knapsack fashion, supported by straps passing over the shoulders. The container is shaped to fit confortably on the shoulders. A skirt or frame is usually fitted on the bottom of the container to prevent its direct contact with ground and to provide a steady base on which it can stand.

Conventional plunger pump

(Hydraulic) are either mounted inside or outside the container. The pump is operated by hand lever positioned under the arms so that it can be moved up and down by hand. Sometimes provision is made for changing the operating lever from one side of the sprayer to the other side, so that it can be actuated with either right or left hand, An air vessel is provided to even out pulsations of the pump and to maintain spraying pressure between strokes. Many of these sprayers have a mechanical agitator which is moved up and down inside the container with the hand lever. The outlet side of the pump is connected to cut off velve lance, and nozzle by means of plastic hose. The pump is operated with one hand and the lance is held and directed by the other hand, so both the hahds are needed. The working pressure of 40 to 50 psi can be maintained without undue effort. This type of sprayer can be used by unskilled operators. The maintenance is usually simple.

The knapsack sprayerck have slightly larger field of use than the hand operated compression (air) sprayer, Foot Rocker or Stirrup Pump. The knapsack sprayer is cheaper compared to these types of sprayers. Only one person is required for spraying operation. It can be used to spray all types of field crop and small fruit trees. The outstanding adventage of this type of sprayer over the air compression sprayer is that a fairly uniform pressure may be maintained by keeping the pump mechanism in continuous action. This type of sprayer is most ideal for small farmers.

Power Operated Equipment

These equipements are not recommended for small and marginal farmers as they are expensive and quantum of spraying work with them is much less compared to the capacity of the sprayer.

These equipments are precision make which require proper maintenance and care. Small and marginal farmers are not so much conversant with them and they lack technical background and hance they cannot be in a better position to make good use of such costly equipment. More so the facilities for repairs and maintenance of such equipment are not available at their level. Besides, we have got more manpower in rural areas which also require employment.

Community Spraying

The idea of community spraying has gained more grounds recently, but it has not made much headway, although it is an ideal and beteer way of fighting with pest and disease. In this system mostly the equipments are owned by the Government Agencies or Co-operative Institutions and are used for plant protection work when needed. The equipments are given on rent to the farmers. The equipments are mostly power operated equipments because the work has to be carried out on a larger scale. The other point which has been observed here that the user is not the owner of the equipments and as such he does not take proper care for operation and maintenance of the same. The system has been introduced at various places, but the results are not much encouraging. The most obvious reason is that the system can not cope up with the needs in time of epidemics. It may work to a certain extent for prophylactic treatment. Looking to the present situation and need for employment of the farm labour, it is recommended that a cheaper equipment, should be owned by a farmer which will enable him to take care for prophylactic treatment as well as in case of epidemics. This will help in timely application of pesticides which is very essential for effective control of pest.

If modernized agricultural practice for small and marginal holdings is adopted, additional employment may be generated to millions of man-days, which in turn will help for additional employment of agricultural labour. It is found that cultivation of one additional crop would require 70 man-days of work per acre. This would be a significant achievement so far as frontal attack on rural poverty is concerned, apart from the considerable increase in agricultural production.

Aerial Spraying

Aerial spraying has recently been adopted for pest control on a larger scale. This system is very much in operation where the area under cultivations is continuous and large. In a country like ours, where there are small holdings and farmers grow crops of various types and also they stay on the farm with their cattle, it is difficult to adopt Aerial Spraying. At present, under existing conditions aerial spraying is not much practicable at all places.. Besides this, the capital expenditure in establishment of fleet of aircrafts, will be enormous in a country like ours. Not only this, but much amount had to be spent in preparing air strips and other facilities which are required for aerial spraying.

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Prospects of Farm Mechanization on Small Holdings in U.A.R

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Introduction

One of the most urgent problems facing Egypt today is the production of adequate amounts of food for an ever increasing population, living on a limited cultivated land.

This serious situation is vividly magnified by the fact that the share per capita-that was in 1895, 0.52 feddans* has gradually droped to 0.15 feddan in 1975 (**Table 1**).

Many projects have been undertaken to remedy this situation without any appreciable results.

In spite of extensive efforts, the average yield/feddan-from 1952 to 1973-has not reached the level that could meet with the increase in population during that period. Moreover, addition of more land by land reclamation has not, for the last twenty years achieved any significant contribution.

How can the country achieve rapid economic growth in the face of these problems? It has become a general fact that the Egyptian agricultural land has not been receiving either adequate care or enough inputs to produce its very best.

Table 1. Population and land share per capita, 1897–1975

Year	Population ('000)		Cultivated area ('000 feddan)	Share per Capita	
		Index number		feddan	Index number
1897	9715	100	5088	0.52	100.0
1907	11278	116	5402	0.47	90.4
1917	12751	131	5268	0.41	78.8
1927	14218	147	5544	6.38	73.1
1937	15933	164	5281	0.33	63.5
1947	19022	196	5761	0.30	57.7
1957	34179	239	5831	0.23	44.2
1967	30907	318	6106	0.20	38.4
1975	38300	410	5700	0.15	26.9

※1897=100

Egyptian agricultural technology, especially in small holding, is traditional, even ancient, without being primitive.

It is man and animal intensive farming that require constant meticulous care. In spite of its intensive type of production, there is still considerable scope for more intensification through :

i) improved irrigation and drainage
ii) improved seeding and fertilizing
iii) Appropriate farm mechanization.

This paper is concerned with farm mechanization possibilities on small holdings, as a factor contributing to more food production.

Land Fragmentation and Mechanization

Before dealing with actual problems, it is desirable that a definition is given of what is to be classified as a small holding.

According to Egyptian Standards, we define as a small holding a farm of an acreage of arable land of less than 5 feddans. We are quite aware of the subjective and relative charactor of such a definition, but it serves well enough for our purpose.

One of the problems which has always hampered the application of modern techniques and mass

※one feddan=1.038acre=0.42hectare=4.200m² production practices in Egyptian agriculture, has been the predominance of small holdings, each divided into a number of dispersed parcels of lands.

This land fragmentation with numerous canals and drainage ditches and narrow access roads to individual plots seriously restricts the use of mechanized equipement.

In 1965, there were 3.3 million holdings with an average size of 2 feddans: 95% of the holdings occupying 49% of the cultivated land, measured less that 5 feddans. Only 31900 farms (29.5% of cultivated land) were above 20 feddans. The land ceiling is presently set at 50 feddans for individuals and 100 feddans for a family of three.

Although the farm structure would have undergone some change due to the prosess of farm subdivision during the last decade, it may be assumed that about two-thirds of the operating farms are in the range of 3-4 feddans. **(Table 2)**

Mechanization of the small holding is a difficult but also a vital problem. Difficult for reasons that will be discussed later and vital because Egypt cannot afford to have more than half of its arable area deprived of the benefit from appropriate mechanization.

Table 2. Agricultural land distribution in Egypt (1969) (Private Ownership)

Size of Holding (feddan※)	Property Area		Number of Ownership	
	1000 fed dan.	Persent	('000)	Persent
Less than 1	911.4	16.59	2326.5	70.08
1 to less than 2	567.0	10.32	425.7	12.82
2 〃 〃 〃 3	461.4	8.40	200.4	6.64
3 〃 〃 〃 4	389.2	7.08	118.2	3.56
4 〃 〃 〃 5	351.3	6.39	80.8	2.43
5 〃 〃 〃 10	607.3	12.06	91.1	2.74
10 〃 〃 〃 20	584.2	10.63	44.5	1.34
20 〃 〃 〃 50	661.2	12.04	23.1	0.69
50 〃 〃 〃 100	550.7	10.02	7.3	0.21
100 and more	407.2	7.41	1.5	0.05
Total	5490.7	100%	3319.1	100.00

※1 feddan=1.038 acre=4200 m²

Table 3. Percentage land distribution before and Subsequent land reform

Size of Holding (feddan)	Before Issue of Land Reform Law 1952	After Issue of Land Reform 1952	After land Reform Law 1961	Land Distribution 1965
Less than 5	35.4	46.5	52.1	57.1
5 to less than 10	8.8	8.8	8.6	9.5
Total less than 10.	44.2	55.3	60.7	

Source: Central Agency for Puplic Mobilisation and Statistics October 1974.

With acreage, the impossibillty of extending the arable land, for instance, by reclamation, ranks as the greatest obstacle . The acreage available cannot be varied by the individual farmer unless in a declining sense due to the current law of inheritance. **(Table 3)** With regard to labour, the fact that the vast majority of the smallholdings are family-operated, means that all work, or at least the major part of it, is carried out by the farmer and his family **(Table 4)**.

Table 4. Percent of hired labour to total labour in different holding sizes.

Size of Holding (feddan)	% of Hired Labour
0.5 to 2	24
2 to 5	36
5 to 10	13
10 and more	85

Concerning capital, i.e., farm machinery, though engineering has indeed done much to design implements with lower capacities, this applies more to horticulture than to small agricultural entreprises ; and the variations of the implement cost are by no means propotional with capacity so that the smaller acreage is at all events at a disadvatage. The small farms are forced to use considerably more horsepower per feddan.

Moreover, many implements would show such an under employement on the small holding that their purchase is not justified. This underemployment on the small holding is further increased because most of the small holdings are mixed entreprises.

Why it is difficult to mechanize small holdings

Factors which hamper mechanization on the smallholding will be discussed briefly as follows :

A. Unfavourable quantitative combination of the factors of production ; namely, acreage, labour and capital.

It is evident that an optimum combination of production factors frequently cannot be accomplished on the small holding.

B. Unfavourable land fragmentation.

Small holdings in Egypt have quite an unfavourable land fragmentation. The acreage is frequently divided in many and widely scattered, badly shaped, small parcels which renders machine operation all the more difficult by the longer transport distances, the relatively long setting times and the unfavourable shape of the parcel. Furthermore, these small land parcels are subdivided by checks or border of 2 x 3 meters to suit the present practice of irrigation.

These high soil boundaries offer serious obstacles to the traffic of cultivating or harvesting machines.

C. The present rent system

It is estimated that despite

fairly strict rent control 50% of all cultivated land in Egypt is still rented.

Owners of 1 to 5 feddans and of 10 to 50 feddans tend to rent their land because they have too little our too much to warrant their direct cultivation.

Renters are less liable to possess machinery than land owners.

D. **Financing**

Financing of mechanization on the small holdings is confronted with great difficulteies. The income of the small Egyptian farmer is not sufficiently high and stable to finance machine investments, evpecially after the sudden high increase in tractors and machinery price since 1973.

Credit could not be given easily to farmers who possess less than 10 feddans.

E. **Educational level of the farmer**

The technical knowledge required to select appropriate machinery for the farm and for the technical operation, maintenance and front line repair is generally not available, especially in small Egyptian holdings.

F. **High yield per feddan**

Due to the fact that the land area factor is in minimum position while the labor factor is often in a maximum position in small holdings, farmers aim at the highest possible yield per unit of land.

In fact the yield/feddan in small plots has been generally higher than the yield/feddan in bigger plots. Therefore, a machine which cannot help produce a higher yield or reduce production cost and cause a justifiable increase in milk or meat production will be at a disadvantage and not fit for use in small holdings.

Some Means of Promoting Small Mechanization

Mechanization in Egypt is primarily a social problem, firstly to find alternative employment for the majority of its rural population and, secondly, to amalgamate into larger units many of the peasant holdings.

For generations Egyptian agriculture has been regarded as a way of life and not in any sense as a business concern as it must be today.

Perhaps the stimulus towards improvement will come from both the actual food crisis and the industrial development of the country.

For the succesful application of farm mechanization in small holdings, the following procedures should be promoted :

i) Consolidation of fragmented parcels with a mandatory crop rotation ;

ii) Collective use of farm machinery ; and

iii) Subsidizing the tractor or import tax relief.

A. **Consolidation of small holdings**

Consolidation of small holdings without affecting private ownership has been a successful experiment in the land reform areas since 1960/1961.

As the country follows a 2--year or 3-year rotation, consolidation is being effected by means of grouping neighbouring parcels owned by various holders into either 2 or 3 big plots, each being put to one single crop according to the rotation to be followed. The size set for the consolidated plots ranges between 20 and 300 feddans.

Since its introduction, it has facilitated plowing and pest control work, the adoption of proper irrigation and drainage practices and the timely provision and utilization of various agriculture maohines.

To succeed, mechanization would require the generalization of midget holdings not only reform areas but also in most areas where mechanization would be applied.

B. **Collective use of machinery**

The various difficulties in the mechanization of small farms can partly be overcome by the use of farm machinery on a collective basis by means of co-operation or contract services.

Unlike mechanization in industry, mechanization in agriculture stands a poor chance of being realized on an individual basis. Because of the seasonal growing process, the farmer can use his machinery only during a relatively short period. As a result the overhead charges incidental to individual ownership will be relatively high.

In addition, the farmer is not usually in a position to make full use his machine. By using the machinery on various farms, he productivity of the machines will be raised to a considerable extent.

From the viewpoint of both the private farm economy and the notional economy relative to the searcity of capital, it is desirable to intensify the use of machinery by having it operated by groups, co-operatives and contractors.

These forms of exploitation offer great opporunities for agricultural mechanization.

Apart from greater profitability in comparison with individual ownership, they remove a considerable part of the financial burden from the shoulders of the individual farmer.

C. **Subsidy and tax relief**

Mechanization has to be stimulated as far as possible by the state by means of reduced tax rates.

Since the government buys the

the from farmer his products (wheat, cotton, sugarcane etc...) at a much lower price than the world export price, the least the government can do, in return, is to have this farm tractor procured to him at a subsidized price.

Susidies will have to be accompanied by sufficent warrants for competent management, based on economic principles, if these subsidies are to induce mechanization in a rational way. A first essential is therefore good work organization of cooperation.

Conclusion and Recommendations

Midget size land holdings in Egypt representing more than half the cultivated ares, offer the biggest obstacle towards an agriculture run on an economical and business enterprise basis. As 70% of the national animal wealth is concentrated in holdings of less than 5 feddans, the expected increase in milk and meat production would compensate largely the machinery investment, let alone the other great benefits the appropriate machanization will eventually provide after its successful introduction in the smal holdings.

In order that the farms of less than 5 feddans can benefit from mechanization it is suggested that the following be undertaken by the relevent authorities.

1 —Land consolidation as a means to convert agriculture from a family to a business enterprise.
2 —Better managed farm machinery cooperative societies or farm machinery stations (either government or private).
3 —Subsidees and tax relief on machinery.
4 —Research, expermient and development projects to find the best system and machines for such small holdings.
5 —Rural industries to absorb extra labour ana improve rural life. ■■

Mechanized v/s Bullock Cultivation —— Consumptive Water Use

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Introduction

Much of the world is still hungry and ill-clad. Population is increasing at an alarming rate and food and fibre supply is not keeping pace with it. Land is also limited and seems that we have almost reached the physical bounds of an increase in the cultivated area. Moreover, land is not elastic and we cannot expand it, but the population, and hence agricultural needs expand. This could only be achieved through the increase in productivity per unit area per unit time. This is possible by intensive use of land through an efficient use of irrigation water, fertilizers, high yielding varieties, pesticides and better agronomic technology. Above all shortage of irrigation water is of great concern.

The climate and soils of Pakistan are suitable for agriculture but precipitation is inadequate and untimely. The rainfall not only fluctuates as to quantity and distribution within one season but also from year to year. Without supplemental irrigation crop production is quite impossible. Thus, irrigation is very necessary for productive agriculture.

There are about 40 thousand miles of canals discharging about 80 million acre feet of water commanding over 33 million acres of land. About 25 million acres receive canal water and 8 million acres are irrigated from more than 80 thousand tubewells. The yearly average intensity of irrigation is below 100 percent. It is estimated that about 52 million acre feet of water reaches the field after conveyance losses, which is further subjected to field losses due to non-uniform application of water to irrigate uneven lands to possibly attain about 50 percent irrigation efficiency when almost all important crops are grown using irrigation water.

There are considerable differences which demonstrate the tremendous gap in unit production achieved in Pakistan as compared to production acquired in modernized countries of the world with like resources. Some of the reasons of low yields may be inadequate water supply, improper land levelling, want of irrigation water checks, insufficient salinity control, lack of water management practice, use of outdated cropping patterns and cultivation with traditional implements. The greatest contribution relates to the saving of water and cultivation of more land.

The soils of Pakistan are not mostly salty and can be expected to produce many times more output than presently being achieved with meticulous use of tillage machines and scientific techniques. To acquire this, various tillage techniques need to be adopted. The crop yield is directly dependent upon improved farming conditions.

It has been reported that it is possible to fetch increased yields with less of the irrigation water than currently being applied in Pakistan. It is, therefore, evident that more land could be brought under irrigated agriculture. Introduction of new technology in irrigation and soil management practices and scientific knowledge of water movement in soil relative to crop requirements can improve the water supply conditions.

The accumulated irrigation water requirement differs from consumptive water requirement, because the total water applied includes not only the water required for plant growth but also the likely losses from canal and field itself. Water is lost through evaporation and deep percolation and the usual field irrigation efficiency is less. Nothing has been accomplished relative to the improvement of irrigation practices which in fact are still ancient and traditional and need to be considered part of the entire irrigation system.

Looking in to the phenomenal

facts of hydrologic cycle, water is lost by surface run-off, through evaporation, by excessive infiltration beyond root-zone and through transpiration by plants of economic importance or otherwise. Infiltration is activated by keeping the soil surface rough through tillage means by reducing the chances of crust formation. Mulch tillage improves moisture conservation by reducing the rates of evaporation and run-off. Tillage requirements also need thorough knowledge of soil and crop environments. Repeated tillage operations resulting in over-stiring of soil may not prove beneficial from the stand point of soil structure and soil-water-plant relationships in addition to being costly. Very fine tilth affects both water penetration as well as evaporation either by compaction of soil or due to over-pulverization. Considerable emphasis should therefore be directed towards optimizing tillage operations. Its success depends on the type of soil, climatic conditions and cultural requirements. The production potentials to standarzation of operations under a particular local condition require intensive research studies. The favourable results of tillage practices should ensure improved soil physical conditions for optimum rate of infiltration, less soil resistance to root effects and higher friability. Of the tillage practices, the first in importance to economize water use is land forming. The main objective of this operation is to make certain efficient and uniform field drainage to prevent water logging and to facilitate machine use. Steep slopes need to be reduced by proper grading to slow down the flow of water and to prevent erosion, and ensure uniform absorption of water.

The irrigation system practiced in Pakistan suggests even topography, but actually there is no other system due to technical and socio-economic constraints in which water be applied precisely according to desired infiltration rate. The low infiltration rate capacities of harder soils do not permit sufficient water into soil profile during one irrigation turn. Water is supposed to be stored on the soil surface during irrigation and allowed to stand for some time to infiltrate into required soil depth.

The farmer usually forms his land on a dead level basis with antiquated implements and prefers a small tolerance in elevation necessary for such field design. For example, a one inch difference in elevations between two ends of the field means the difference of more than two inches of water stored in root-zone and this can be as much as 50 percent of the water needed for proper plant consumptive use. The farmers adopt conventional and levelling methods and procedures. Water itself is utilized to provide a measure of level and the land is continually relevelled with wooden planks (sohaga) till workable field is maintained. All the field is covered with water, including high spots thereby resulting in over-application and waste of water during each irrigation. The amount of water to be applied during irrigation depends on soil characteristics to preserve moisture and growing stages of plants for actual evapotranspiration. Also, leaching of salts, depth to ground water, providing moisture for seed germination and minimum depth application to cover all the field are important factors. Small fields are considered to be the most efficient system of irrigation. Under conditions of improperly levelled land and limited water checks, small basins are convenient, but not efficient.

Obviously, due to inefficient water use, some areas are idle during peak cosumptive season and mostly the irrigation interval is extended resulting in drought conditions between two subsequent irrigations. Delayed application of large amounts of water result in plant-water stress during the peak consumptive use periods. Water is stored in the soil for plant growth and must be replenished throughout the growing season.

As a matter of fact, water applied to a field initially to moisten soil for tillage to prepare the seed bed. After tillage the surface is very loose causing higher infiltration rates. Soaking the field just before sowing is excessive because of the high infiltration rate of the soil and small amount of the moisture needed. Also, the first irrigation after the crop is planted is often excessive because of the relatively high infiltration at the limited soil layer depletion. Over irrigations is also supposed to leach excessive amount of nutrients from the soil futher reducing the potential yield of the crop. Hypothetically, water applied to a field for growing a particular crop should not be more than the consumptive use. The consumptive use or evapo-transpiration is dependent on soil-plant-cilmate relationships. But there is considerable effect of cultural practices on consumptive water use which balances climatic and soil conditions providing water to plants for longer periods.

This article is confined to comparative analysis of consumptive use of water for cotton cultivation under mechanized versus traditional tillage considering total water applied at times of crops needs to be consumptive water use ignoring percolation losses if any. The results are based on frequency of irrigation, amount of water for various irrigations and retention of moisture in the soil at different stages of plant growth.

Plate.1 Use of disc plow

Plate.3 Tractor plowing and bullock plowing

Plate.2 Use of leveller

Plate.4 Tractor plowing and bullock levelling

Abstract

An experiment to evaluate the role of agricultural machinery in better use of irrigation water, was conducted in randomized block design on cotton crop in Hyderabad district of Sind Province with eight replications and two treatments : Bullock farming and mechanized farming on 8 acres of land of which 4 acres were mechanized and the other 4 acres cultivated by bullocks. Tillage operations and time of irrigation and amount of water for each irrigation were the variable factors and other inputs were kept constant. The study was confined to i) time for applying irrigation ; ii) acre inches of water applied ; iii) interval of irrigation ; iv) loss of water through evapo-transpiration ; v) consumptive use of water and its coefficients ; and vi) physical differences of soil and plant growth.

Methods

The tillage operations, including interculturing were carried out with tractor drawn implements in treatments of mechanized farming and entirely bullock drawn implements in bullock farming treatments. Disc plow, tandem disc harrow, tractor blade and cultivator were the tractor drawn machines, and local plows and wooden planks were the bullock operated implements. The sowing operations in both treatments were done through bullock drawn bamboo drill attached to local plow. The rod readings were taken with dumpy level before and after cultivating experimental fields to ascertain elevations and evenness of plots in both treatments. Soil physico-chemical properties were noted through by soil sampling at three depths of 0-6 inches, 6-12 inches and 12-18 inches immediately before each irrigation. Irrigations was applied as and when required on the basis of signs of wilting at the hotest time of the day. The amount of water for each irrigation was measured to ascertain the average depth of 3 acre inches.

The physico-chemical properties obtained through analysis were compared with the results of Israelsen and Hansen **(Table 1)**. The experimental area of loam soil was found to be at field capacity of 27% and permanent wilting at 8%. Thus, the amount of available water in acre inches consumed by cotton crop was calculated by applying the follwing formula.

$$A_w = Bd \times \frac{M_c - P_w}{100} \times D_p$$

Where : A_w=Available water, B_d=Bulk density being 1.2, P_w=water conduct immediately before irrigation being an average of 12.22 in mechanized tillage and 11.79 in bullock treatments, D_p=Depth of profile in inches, and M_c=Moisture content after two days of irrigation (field capacity) being 27 percent.

The amount of water applied and frequency of irrigation were maintained through necessary calculations by tank method :

$$\text{Discharge} = \frac{\text{Volume of tank in cu. ft.}}{\text{Time in seconds}} = \text{Cusecs.}$$

Consumptive use of water was calculated by using Blaney-Crid-

Table 1. Representative Physical Properties of Soil

Soil Texture	Infiltration and Permeability (inches/hour)	Total Pore Space (percent)	Apparent Specific Gravity	Field Capacity	Permanent Wilting	Dry Weight percent	Volume (Percent)	Inches per Foot
Sandy	2 (1–10)	38 (32–42)	1.65 (1.55–1.80)	9 (6–12)	4 (2–6)	5 (4–6)	8 (6–10)	1.0 (0.8–1.2)
Sandy Loam	1 (0.5–3)	43 (40–47)	1.5 (1.4–1.6)	14 (10–18)	6 (4–8)	8 (6–10)	12 (9–15)	1.4 (1.1–1.8)
Loam	0.5 (0.3–0.8)	47 (43–49)	1.4 (1.35–1.5)	22 (18–26)	10 (8–12)	12 (10–14)	17 (14–20)	2.0 (1.7–2.3)
Clay Loam	0.3 (0.1–0.6)	49 (47–51)	1.35 (1.3–1.4)	27 (23–31)	13 (11–16)	14 (12–16)	19 (16–22)	2.3 (2.0–2.6)
Silty Clay	0.1 (0.01–0.2)	51 (49–53)	1.30 (1.25–1.35)	31 (27–35)	15 (13–17)	16 (14–18)	21 (18–23)	2.5 (2.2–2.28)
Clay	0.2 (0.05–0.4)	53 (51.55)	1.25 (1.2–1.3)	35 (31–39)	17 (15–19)	18 (16–20)	23 (20–25)	2.7 (2.4–3.0)

Source : Israelsen 1962.

Table 2. Accumulated Use of Water From Planting to Maturity of Crop

Growing Period (Percentage)	Days Since Planting	Total Growing Period (6 Months) Accumulated water use
10	18	0.9
20	36	2.0
30	54	3.5
40	72	5.1
50	90	6.8
60	108	8.7
70	126	10.6
80	144	12.4
90	162	13.9
100	180	14.7

Source : Israelsen and Hansen 1962

Table 3. Potential Evapo-transpiration for Summer crops, Hyderabad

Ifem	April	May	June	July	Aug.	Sept	Oct	Total
Kohler (H.W.W.)	8.97	10.71	9.50	7.70	7.30	7.67	7.11	58.96
Kohler (Brunt)	7.95	9.86	8.32	6.56	6.21	6.83	6.53	52.26
Penman	6.32	9.42	8.95	7.56	7.07	6.17	5.06	50.55
Rohwer	11.84	16.51	15.59	12.21	10.23	9.14	8.20	83.72
Recommended	7.60	9.30	8.40	7.00	6.50	6.50	5.60	50.90

Source : Revelle Report 1964.

Table 4. Consumptive Water Use of Cotton Crop in Mechanized v/s Bullock Farming

Month	El Inches	Revelle Et	Revelle Et/E	Mechanized Farming Et	Mechanized Farming Et/E	Bullock Farming Et	Bullock Farming Et/E
		inches		inches		inches	
April 20	0.4	2.5	6.25	1.0	2.50	3.50	8.75
May	0.5	9.3	18.60	3.0	6.00	4.70	9.40
June	0.45	8.4	17.56	6.0	13.33	8.50	18.89
July	0.4	7.4	17.5"	6.3	15.75	6.20	15.50
August	0.3	6.5	21.67	8.0	26.67	8.00	26.67
September	0.3	6.5	21.67	5.0	16.67	5.20	17.33
October 15	0.3	5.6	18.67	3.0	1".00	3.90	13.00

dle method (u=kf) of the entire cotton growing season by using mean air temperature and light hours for both treatments. To compare the experimental results, the findings of various scientists were reviewed. The accumulated use of water from planting to maturity of crop **(Table 2)** and potential evapo-transpiration for summer crops in Hyderabad **(Table 3)** were also reviewed.

Results

The consumptive use, evaporation, and ratio of evapo-transpiration over evaporation (E_t/E) for the entire cotton growing season were computed **(Table 4)**. The results indicated that E_t/E in mechanized farming was generally less than that of bullock farming. The maximum E_t value occured in June for bullock operated plots, but in mechanized plots it reached the peak in August.

The consumptive use coefficients (E_t/E) were calculated for different cotton growing periods **(Fig.1)**. Bullock tilled plots had higher consumptive use coefficients than tractor operator plots.

The consumptive water use or accumulated evapo-transpiration, from April 20 to October 15, was 32.8 acre inches in mechanized plots and 40 acre inches in bullock operated plots **(Table 5)**.

The consumptive use coefficient was highest during the month of August for treatments and lowest at the time of seeding. However, there were conspicuous differences between tractor and bullock farmed plots for the months of April, May, June and October. The tractor operated area had less consumptive use coefficient than bullock operated area. The yield of cotton crop also increased in mechanized farming.

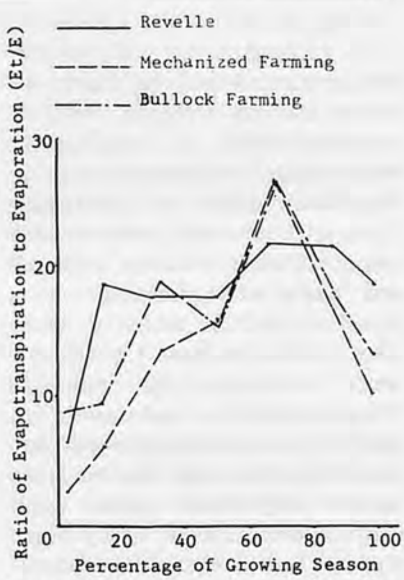

Fig.1 Comparative Consumptive Use Coefficient

Conclusion

The consumptive use water and its coefficients were higher in bullock farmed plots than machine-cultivated fields. The interval of irrigation was more in mechanized farming and less in bullock tilled plots due perhaps to non-beneficial evaporation of irrigation water from the partially bare land during the early stages of crop growth due to less infiltration. In mechanized plots, the water absorption was comparatively quick and thus there were less chances of water evaporation. Conclusion could therefore be made that better tillage through machine use as compared to bullock operations saves water

Table 5. Consumptive Water Use of Cotton Crop in Machanized v/s Bullock Farming

Period	Mid-point	Days to Mid-point	% age of Growing Season	Mean Air Tempeiature (t)	% age of Day light Hours (p)	Consumptive Use Facter (f)	Consumptive coeff: (k)	Consumptive Use inches (u) =kf.
Mechanized farming								
April 20–30	25	5	3	90	8.58	7.72	0.13	1.0
May	15	20	15	91	9.25	8.42	0.36	3.0
June	15	31	33	93	9.20	8.60	0.70	6.0
July	15	30	51	90	9.00	8.10	0.78	6.3
August	15	31	69	87	8.80	7.66	1.04	9.0
September	15	31	87	86	8.31	7.15	0.70	5.0
October 1–15	7	22	100	82	8.12	6.66	0.45	3.0
Total		170						32.3
Bullock farming								
April 20–30	25	5	3	90	8.58	7.72	0.45	3.50
May	15	20	15	91	9.25	8.42	0.56	4.70
June	15	31	33	93	9.20	8.60	0.99	8.50
July	15	30	51	90	9.00	8.10	0.77	6.20
August	15	31	69	87	8.80	7.66	1.05	8.00
September	15	31	87	86	8.31	7.15	0.73	5.20
October 1–15	7	22	100	82	8.12	6.66	0.59	3.90
Total		170						40.00

by reduced consumptive water use.

Suggestions

The inherent capacities of farmers to observe the laws of Nature and successfully follow these observations can be increased by technical training to improve the understanding of scientific realities and inventions attached to agriculture. The greatest inroads against inefficient irrigation water application are dependent upon the successful training of the farmer. The farmers need to be taught through experimental approach to optimize field operations and water use.

The farmer's belief that machines and labour use to accomplish field operations at a desired depth and precision are costly may not be true. Enhanced unit production results in higher labour productivity, and improved technology substitutes labour and increases output. To be sure, the overhead labour costs on land, tillage, irrigation, weed control, seeding, interculturing and harvesting will not vary whether one produces 10 maunds per acre or 30 maunds per acre by using approximately the same amount of labour. Surely, the efforts directed towards the development of land and improvement of cultural practices lead to less consumptive water use.

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Status of the Rice Milling Sector

by
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Introduction

To begin with I should like to express my gratitude to the officers and members of the Rice Millers Association for this opportunity to particpate in your 78th Annual Convention here in Honolulu. It is indeed an honor and privilege for me to speak on the rice milling sector of the various countries throughout the world.

Before proceeding further, I would like to express my admiration for the very high standard the U. S. rice industry has achieved and wish to compliment all of you here today who have contributed in making the U. S. rice industry the world's leader in this field.

In order to give you a clear picture of the status of the rice milling sector, it may be worthwhile to first briefly outline conditions of the rice industry throughout the world. One only needs to be reminded that practically half the population of the world is wholly dependent upon rice as its staple food to comprehend the importance of this grain.

This paper was presented at the 78th Annual Convention of The Rice Millers' Association of the U.S.A. held in Honolulu, Hawaii on June 17, 1977.

Production and Consumption of Rice in the World.

Last year's world production of paddy is estimated to be 345 million tons of which 90% was grown in Asia. China is by far the largest producer of rice in the world. This country produced 118.6 million tons which is equivalent to 34% of the world's production. Ranking second is India, producing 69 million tons or 20% of the worlds total amount and then followed by Indonesia at 23 million tons or 6% of the world's production. These three countries together produced practically 60% of the rice in the world. The U.S. ranks in 11th place after the Philippines at approximately 5 milion tons or 1.4% of the world's total production.

The largest annual consumers of rice in the world are the people of Laos who eat an average of 377 lbs. (171kg.) per person. They are followed by the Cambodians, Vietnamese, Thais, Malaysians and Burmese all of whom consume over 220 lbs. (100kg.). The smallest consumers are the Ethiopians and Tunisians both at 0.44 lbs. (0.2kg.). The annual consumption in the U. S. is approximately 7.7 lbs. (3.5kg) which is about 1/14 of the world's average of 106.3 lbs. (48.2kg.).

It is interesting to note that in comparing planting area economy of rice, maize, and wheat, rice is the most economical grain. Rice requires only about 20% of the total area in the world utilized for cultivation by these grains even though it feeds half the population in the world. The high food value of rice has been demonstrated throughout history by the high population density per unit area in the countries eating rice as compared to those consuming wheat products.

Recent trends reveal that the large rice producing and consuming countries such as China, India, Indonesia and Bangladesh are not the only ones who are diligently trying to increase their rice production. Countries which have been dependent on maize and root plants for their diet are gradually turning to rice for their staple food. Last year, I had the occasion to meet a high government official from a West African country, who made this statement. "I have observed the economic growth of Japan after the Second World War and want my country to develop as quickly and to become as strong as yours. Rice is your staple food.

This must have been a factor in making possible your progress. To follow in your footsteps, we are embarking on a large scheme to grow and consume more rice in our country." This gentleman's theory may or may not be correct, but it is true that Japanese are rice eaters. However, the important fact here, is that an increasing number or countries and their peoples are wanting to consume more rice.

Post-harvest Processing Operations.

In order to cope with this world demand for additional rice, contributions are being made by International Agencies as represented by the FAO, World Bank, Asian Development Bank and such national organizations as the United States Agency for International Development. These agencies have indicated that to facilitate the development of plans for increasing the production of rice, the rice industry may be divided into two major sectors.

The first sector involves the planting and growing of the rice itself. During the past decade considerable advancement had been achieved internationally as exemplified by the work done by the International Rice Research Institute. The quantity of paddy has been increased by the introduction of better and higher yielding varieties, more efficient production techniques, use of proper fertilizers and improved plant protection.

The second sector is the post harvest processing operations. This is the area we are primarily interested in. The major operations involved are threshing, drying, storing and milling. In the past, this sector has not made as much progress as the first sector. The degree of modernization achieved in post harvest operations varies throughout the world, but generally speaking most countries including the major rice producing nations are still far from being mechanized. Post harvest operations are important, because the quantity and quality of the milled rice ultimately produced is not determined solely by the amount of paddy harvested in the first sector, but is influenced greatly by the efficiency of the operations in the second sector. Even if the world were able to grow a sufficient amount of rice, there would still be a shortage if post harvest operations were not modernized.

To give you an idea of the post harvest losses for all grains including rice, FAO has estimated that 80 million tons of food is lost annually. In the developing countries, agriculture production going to waste is anywhere from 20% to 40% of the total output. Losses for rice alone may be over 40 million tons. In most countries, the role of proper machines and other factors in reducing post harvest losses is recognized. However, the lack of necessary capital means prevents progress in this area.

The Peoples Republic of China with a population of about 850 million is the largest single producer of rice. The yearly production of paddy is approximately 118.6 million tons. In China 80% of the population is engaged in farming. In parts of this country, three crops are harvested during the year. The total area under rice cultivation is estimated at 30 to 35 million hectares which is about 24% of the total farm area. As a nation, the Chinese are also the largest consumers of rice. The average annual consumption per person is about 187 lbs. (85 kg.), which is 81 lbs. (37 kg.) more than the world average, but considerably less than the 377 lbs. (171 kg.) consumed by the people of Laos.

Information and data on post harvest conditions are limited, however, according to representatives of my firm visiting China for an exchange of technical information on rice milling several years ago, the Chinese are considerably behind the developed nations.

The need for mechanization of the agriculture sector was recently described in an editorial of the Peking Peoples' Daily. The newspaper called for the nation to race against time to mechanize agriculture by 1980. Actually this is a very difficult task even by normal standards, but the paper stressed "It is not an impossible goal".

Last month, the former U. S. Ambassador to Ghana and now U. S. Chief of Protocol, Mrs. Shirley Temple Black visited China and learned that the Chinese have abandoned their quest for self-reliance. On her return to the U. S. Mrs. Black announced that through expanded world trade, China would be able to obtain much needed technical aid and modern machinery. This policy change will enable that country to facilitate the modernization of their industries including the rice milling sector. Losses in post harvest operations in China are estimated to be over 15%.

India, the second largest producer of rice, harvested about 69 million tons last year. This is slightly more than half of what the Chinese produce. However, the Indian population at 620 million is about 72% of the Chinese population. Thus, in terms of rice supply the Indians have less to consume than the Chinese. Consumption per person in 1971 was 138.5 lbs. (62.8 kg.) which indicates that for a rice eating country this commodity is certainly not in abundance.

Approximately ten years ago, the Indian Government with the assistance of the Ford Foundation decided to compare all the rice milling equipment manufactured in the world to determine the best overall performing mills. Manufacturers from West Germany, East Germany, and Japan participated in this Olympics of Rice Milling Machinery. After a comprehensive study by the Indian Government, the results proved that the Japanese type of machines were far superior to the others. As a consequence, an order for 24 modern rice mills was placed with the firm I represent.

However, overall conditions are such that there continues to be urgent need for further improvements. Although some simple threshing machines are available at the village level, paddy is still being threshed manually by beating the stalks on the ground or by spreading paddy on paved public roads for cars to run over to do the threshing. Losses are large in this type of operation and one can easily assume that over 15% to 20% is lost. Harvested paddy is dried in the fields with very little mechanical drying practised. Approximately, 20% of the rice is still milled by hand pounding. In 1971, there were a total of 84,000 rice mills of which the Engelberg type accounted for 90% and the remaining 10 % mostly underrunner type mills. All total, at least 30 % of the harvest is probably lost.

In view of these conditions, the Indian Government in 1968 amended their Rice Milling Industry Act of 1958 to provide for progressive replacement of the traditional huller and sheller mills with the modern type paddy cleaners, rubber roll huskers, paddy separators, and whiteners. In further recognition of the need for improvement, the government is providing technical assistance to millers who desire to modernize their mills.

Another developing country in dire need of assistance is Bangladesh, whose population of 70 million also poses a big food problem. Modernization of their post harvest operations is imperative, but the purchasing power of the millers and farmers is very low. The annual income of people is about $100.00 per person making this country one of the poorest in the world. Ninety percent of the people live in the rural districts with about 80 % estimated to be working on the farms. Rice is, of course, their staple food and 80 % of the farm land is utilized for growing rice. Their total rice production is about 17 million tons which still leaves a deficit of 1.7 million tons. Their post harvest operations are still primitive. A small number of foot operated threshers are in operation, but most of the threshing is accomplished manually. Manual threshing is done by grasping a bundle of rice stalks and either beating it on the ground or against a drum can. Approximately 80 % of the rice consumed in Bangladesh is parboiled.

Mechanical dryers are very limited in number and drying of paddy after parboiling is accomplished by spreading the paddy on concrete slabs out in the open for several days at a time. There is a large loss to birds and rodents during this drying process. Rice milling on the village level accounts for about 80 % of the total rice milled and this is done either by hand or foot pounding The remaining 20% is milled mostly on Engelberg type mills. Although a few modern type mills are found in Bangladesh their number is small. Losses in post harvesting operations may be as high as 30% to 35% of the paddy harvested.

In the Philippines, the yearly production of rice is approximately 5 million tons which is about the same as that of the United States. The annual consumption per person is 187 lbs. (86 kg.) which is equal to that of the Chinese and some 50 lbs. (24 kg.) more than the Indians. The average yearly income in the Philippines is about $ 380 per person indicating they are much better off than the peoples of China, India and Bangladesh. The population is about 40 million with 70 % occupied in agriculture.

Recently their Agriculture Secretary Arturo Tanco announced that the Philippines rice reserve of 954 thousand tons will be boosted by a surplus of another 100 thousand tons at the end of the crops in June. The country will then haye a stock equivalent to about 97 days consumption.Mr. Tanco also stated that the rice production increased by about 5.4% and that this will be the second consecutive year that the Philippines will not be importing rice.

In this country, the government agency supervising post harvest operations is the National Grain Authority which has been remarkably effective. However, there still remains much to be accomplished. 80 % of the threshing is done manually by the farmers who also sun dry their crops in the fields. Mechanical drying is still limited at the village level although it is beginning to be used during the rainy seasons. The Engelberg type mills are most commonly seen and it is estimated that there are about 10,300 mills of this type throughout the country. The stone type mills account for another 2,700 mills making a total of 13,000 units. Unfortunately, most of these mills give very low yields and to prevent further losses, they must be reslaced by modern ones at the earliest possible time. Although, there are a few modern rice mills in the Philippines these are still limited and similar to other countries, losses in the post harvest operations can be presumed to be fairly large. Recent information reveals that in the rice milling sector, many projects are being planned. For an example, the National Grain Authority reports that a modern storage and milling complex is being built in Leyte near the

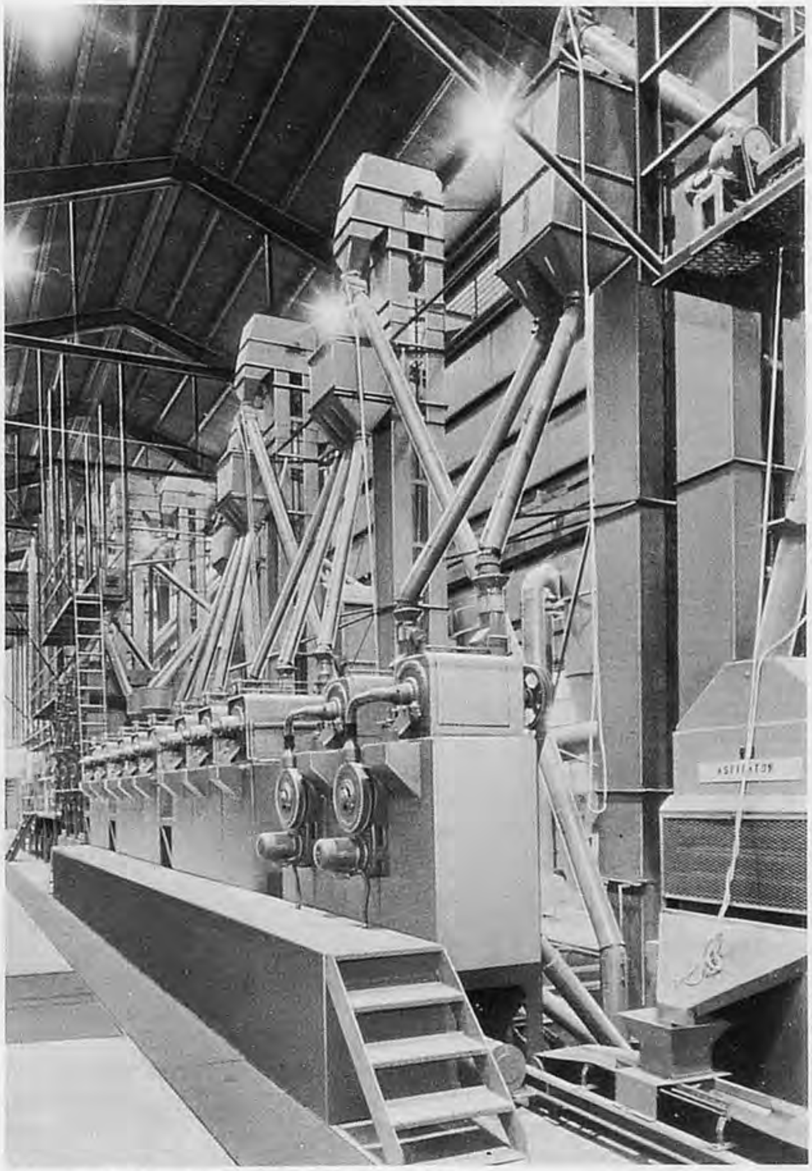

Fig. Satake rice mill operating in the Philippines

home town of Mrs. Marcos. This is expected to serve as a model plant for that region as well as for the whole of Southeast Asia. Completion of the plant is expected by the fall of this year.

I have given you a brief summary of conditions in China, India, Bangladesh and the Philippines. These conditions will hold true for most of the other developing rice producing nations in the world.

I should like now to touch upon the subject of rice milling machinery and modern rice mills. There has been tremendous technical advancement in the field of rice milling machinery during the past decade. This is substantiated by the rice millers in the U. S., who have replaced their Engelberg hullers with whiteners and pearlers. Also rubber roll huskers have taken the place of the stones shellers. As a result, U.S. rice mills have been able to attain a high degree of efficiency.

As mentioned in the section on India, complete modern rice mills are finding their way into Central and South America, Southeast Asia, Africa and other parts of the world.

These modern rice mills and all the component machines including whiteners, pearlers, and rubber roll huskers were developed in Japan. Other machines such as paddy separators and graders of higher precision and efficiency are becoming increasingly available. Recently a machine capable of producing a brilliantly finished non-coated white rice product which has not been obtainable before has been perfected and is now coming out on the market. It is predicted that there will be other major technical breakthrough in rice milling machines and equipment in the near future.

Next, I should like to acquaint you with the environment and conditions in Japan that have lead to the development of rice milling machinery and equipment superior to those available in the past.

To begin with, as you are all aware, rice has been a staple food for the Japanese since the very beginning. In the olden times, tenant farmers paid for the use of the land they cultivated with the rice they produced. Usually after payment to the landlords, very little rice remained. This had to be stretched over a period of maybe a year until the next harvest. It was only natural that rice was considered a precious commodity which was not to be over eaten or left on the table to be thrown away. There is still a saying in Japan, "One will lose his eyesight if he is wasteful with his rice". In the past, children were brought up by being constantly cautioned that they should not leave a single grain of rice in their bowls. They were taught to be thankful because the farmers had labored very hard to grow the rice. This type of thinking is still prevalent in Japan and it is under these conditions requiring the highest concern for the rice that Japanese rice milling machines are being developed and manufactured.

The second factor involved in the development of Japanese rice milling machines is that the Japanese government controls the entire rice industry. The government has registered rice millers who mill at pre-determined commission rates according to strict government standards. These standards designate the degree of milling and yield to which the miller must conform. If the miller is using inferior or poorly maintained equipment he may lose money, because even the smallest amount of brokens will decrease his yield. It is interesting to note that in a year when an inferior quality crop is harvested, rice whiteners and pearlers are readily sold, because the miller realizes that he must have the best machine to make any profit. Due to these circumstances, where the milling yield and commission is fixed, it is understandable that the millers have always urged the manufacturers to develop machines which will produce the highest yields.

Because rice is served at practically every meal, everyone in Japan claims to be a connoisseur of rice. Undoubtedly, this is the result of our having placed a high value on rice and on the way in which it is prepared. Unlike most countries where rice is seasoned or served with highly spiced curries, normally we eat plain boiled rice. Japanese believe the true taste of cooked rice can only be experienced in this manner. This also has affected the development of rice whitening machines, because it is known that high temperatures during the milling process deteriorate the taste of rice. As a consequence, low temperature pearlers presently used in many countries including the U. S. were developed.

In the past, the income of the rice millers was estimated not by what their books might have shown, but by the readings on their electric meters. The Internal Revenue people knew that by checking these meters, the rice millers would be properly taxed. This in turn also brought pressure on manufacturers to develop efficient rice milling machines that utilized the least amount of energy. Lately, in the United States, President Jimmy Carter has been stressing the need for conservation of energy, but, in out field, we have developed many machines which are energy conserving and therefore feel that we have already accomplished much of what President Carter is calling for.

I hope this has given you some insight on why we have strived to build rice mills and machinery that are compact, energy saving, efficient, high yielding and producers of high quality rice.

I am sure most of you are wondering what the future rice mill will look like and how it will operate. The rice mill of the future will be a very compact unit and completely computerized. All the machines and equipment will be fully automated. The total operations and maintenance of the mill will be handled by no more than about three persons with eventually a one man operation becoming possible. Data from samples of paddy and brown rice will be fed into a computer which in turn will direct the dryers, rice milling machines, huskers, paddy separators and other components to operate at optimum conditions. Huskers will have rubber rolls lasting many more hours than their present life. New rice milling machines will not break rice during milling. Energy requirements for all the machines will be minimal. Wearing parts will not require replacement for a full season. New continuous reading moisture meters and milling degree meters will become an integrated part of the plant. Paddy husks will be used as a source of energy with a new type of burner eliminating any pollution of the environment. Many other innovations are being considered, but the ones I have mentioned are in various stages of development and I am confident that this rice mill of the future will become a reality very soon.

Conclusion.

In conclusion, I should like to stress again that in the developing countries post harvest operations must be modernized to alleviate existing food shortages as well as defer if not prevent any future serious deficits such as the one recently predicted for the mid 1980's by the Asian Development Bank. I will add that this modernization can only be accomplished by the governments of the developing countries taking an active leading role with the assistance of the developed countries which must provide sufficient financial and moral support for this important undertaking. ■■

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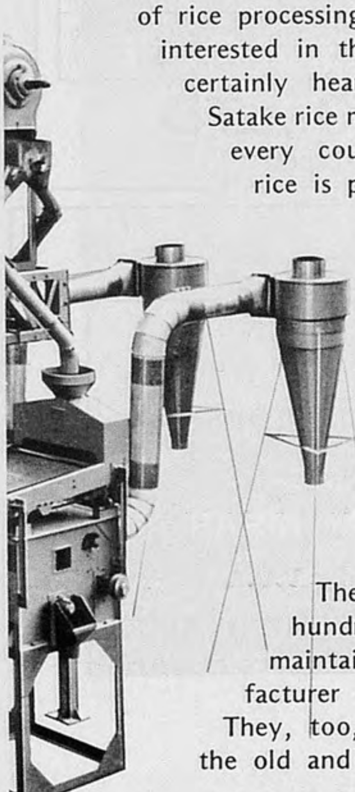

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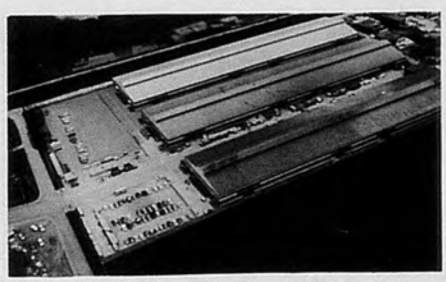

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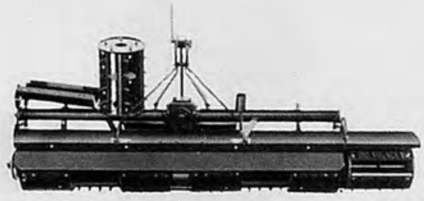
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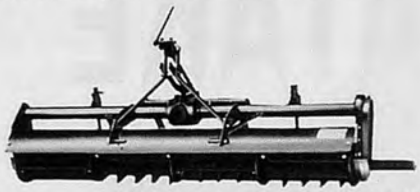
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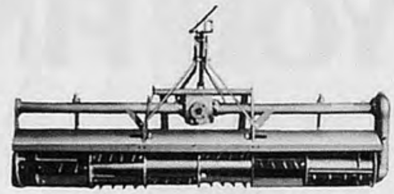
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Impact of Tractorzation on Production Pattern, Cropping Intensity and Farm Income in India

by
A.C.Sharma
Farm Economist
Department of Economics & Sociology
Punjab Agricultural University
Ludhiana, India

A large number of surveys* have been conducted in India with a view to ascertaining the impact of tractorization on cropping intensity, yields, timeliness and returns. There is, however, lack of convincing evidence to show any positive relationship between tractorization and these variables. This paper presents the results of a study which furnishes some evidence to indicate that tractorization does influence the production pattern, intensity of cropping and farm income.

* For example, Chopra, Kusum, Tractorization and change in factor inputs : A case study of Punjab, Economic and Political Weekly IX(52), 1974 ; Govt. of Punjab, Economics of tractor cultivation and economics of production and cultivation practices of high yielding varieties of wheat, maize and paddy Punjab, 1969-70 to 1971-72, Combined Report ; Johl, S. S., Mechanization, labour use, and productivity in agriculture, Aaril. Situation in India, 28(1) : 3-15 ; Kahlon, A. S., Impact of mechanization on Punjab agriculture with special reference to tractorization, Indian Jorn. Agril. Econs. 31(4) 1976 ; Misra S. P. Impact of tractorization : A Study in a tehsil of Madhya Pradesh, Indian John. Agricl. Econs. 31(3), 1976 ; and Singh, Roshan and B. B. Singh, Farm mechanisation in Western U. P., in Problems of Farm Mechanization, Indian Soc. Agril. Econ. Seminar Series No.9, 1972.

The Study Design

The study was undertaken in Ludhiana district which represents the overall conditions of farm size in the Punjab State (India). This district comprises two heterogeneous tracts, viz. the non-bet and bet. The non-bet area includes uplands on the southern side of the bet with a comparatively low water table, a plan surface and not liable to damage by floods while the bet area covers the low-lying riverine area between Budha Nala and Sutlei including an area to the south of Budha Nala with a high water table and subject to frequent flooding by swollen rivers. The non-bet area comprising 87.11 per cent of the total cultivated area of the district with almost homogeneous soil-cimate-crop complex and with little or no variations in the performance rates of farm machinery was selected for this investigation.

The sampling design used was the multi stage random sampling technique. Villages formed the primary and operational holdings, the ultimate units of sampling.

The inquiry was taken up in those non-bet villages where a large number of diesel engines, electric motors and a minimum of three* tractors and allied equipment were in use. The 89 villages, where three or more diesel tractors operated in the study zone**, constituted the population for this investigation. Nine villages comprising about 10 per cent of the population, were randomly selected for this study with a probability proportional to the number of tractors and without replacement.

All the operational holdings in the nine sample villages were pooled and arranged according to the size of the cultivated area in an ascending order. These holdings were then divided into three categories so that each stratum covered almost the same extent of cultivated land. Operational holdings in the selected villages were categorised and gathered to show the distribution of small, medium and large holdings as

* This number was arbitrarily fixed to ensure a minimum number of observations necessary for the development of technical coefficients after having allowed for the contingency of a few tractors being out of commission at any point of time.

** Information collected from the District Agriculture Office, Ludhiana.

lying below 5.07 hectares, between 5.07 and 8.90 hectares, and 8.90 hectares and above, respectively.

This study was designed to provide (i) a sample of farms, irrespective of size, for developing technical cofficients in respect of selected power-machine combinations ; and (ii) another sample of farms representing the large holdings size-group to examine the impact of tractorization on production pattern, intensity of cropping, and farm income.

For selecting the first sample of farms, the holdings in the selected villages were stratified by the type of power unit held by them. Fifteen holdings were randomly selected for each type of power plant to develop the technical coefficients for various power-machine combinations. The coefficients thus generated, were rationalized in conference with the agricultural engineers*.

The second sample of farms was obtained by stratifying the holdings in the selected villages into size-groups of small, medium and large farms and randomly selecting 10 per cent of those in the last stratum. This yielded, for the study, a sample of 22 large holdings.

The impact of tractorization was examined by developing a synthetic farm situation representing the farming characteristics of unmechanized large holdings and working out optimum production plans for this situation using (i) bullocks and their equipment for field operations and a 5-h.p. diesel engine and allied machinery for stationary farm jobs ; (ii) a 14.0-h.p. tractor and its associated machinery systems for both field and stationary farm operations ; and (iii) a 14-h.p. tractor and the equipment that goes with it for field work and a 5-h.p. diesel engine and its equipment for stationary jobs on the farm. These plans were developed on the basis of the input-output data for kharif and rabi crop enterprises comprising the package of recommended practices, following the system analysis approach, through linear programming technique using the model :

Objective function :

$Z_0 = P_1X_1 + \cdots\cdots\cdots + P_nX_n$ to be maximized

subject to

$a_{11}X_1 + \text{———} + a_{1n}X_n = C_1$
$a_{21}X_1 + \text{———} + a_{2n}X_n = C_2$

$a_{m1}X_1 + \text{———} + a_{mn}X_n = C_n$
$X_{11} = 0;$ ——— $; X_n = 0$

Where Z_0 represents returns over variable farm expenses and fixed costs* of power unit and equipment. $P_1, \cdots, P_n$ are returns from crop activitiesX_1 ; ···········; X_n respectively, and a_{11} ; ··········· ; a_{1n} ; ··········· ; a_{m1} ··········· ; a_{mn} are inputs for X_1 ; X_2 ; ··········· ; X_n activities with resources C_1 ; ——— ; C_n.

This profit maximization model provided for appropriate land use capability classification and included kharif (summer) and rabi (winter) capital borrowing and labour hiring activities for the peak periods at the prevalent market rates.

For developing the normative production plans, different plots of available land resource were classified according to their use capabilities as below : —

1. Kharif land suitable for desi (local) maize, hybrid maize, desi cotton, American cotton and kharif fodder.
2. Kharif land suitable for sugarcane. This category of land was not mutually exclusive of land in category 1. Sugarcane, therefore, competed with the crops grown in land in category 1.
3. Kharif land suitable for groundnut. The upper layer of this land was lighter in texture whereas the lower layer was relatively heavy. This category of land was mutually exclusive of lands in categories 1 and 2 and other kharif crops were not planted in this area.
4. Rabi land suitabie for desi wheat and Mexican wheat.
5. Rabi land suitable for sugarcane and rabi fodders. This category of land overlapped with that in category 4. Sugarcane and rabi fodders, therefore, also competed with crops grown in the land in category 4.
6. Rabi land suitable for gram and barley. This area was mutually exclusive of the area in category 5, but was not so from that in category 4. Gram and barley, therefore, competed with desi and Mexican wheats grown on in category 4.

The Kharif and rabi fodders were considered as fixed farm activities.

Impact on Production Pattern

The normative production plans for the synthetic large farm oranization operated at the improved level of technology, using the selected power-machine combinations, are shown in **Table 1**.

It is apparent from **Table 1.** that despite the similarity in the enterprise-mixes of all the farm situations under consideration which included American cotton, sugarcane, groundnut during kharif and Mexican wheat during rabi, besides fixed activities relating to kharif and rabi fodders for farm animals, there was perceptible difference in the percent distribution of total cropped

* The help extended by Dr. S. R. Verma, Professor and Head, Department of Farm Power and Machinery, Punjab Agricultural University, Ludhiana, is gratefully acknowledged.

** The fixed cost of power units and their equipment were included because the purchase of costly machines involved long term management decisions.

Table 1. Optimum Production Patterns for Synthetic Large Farm Operated at the Improved Level of Technology with Various Power-Machine Combinations, Study Area, 1969–70

Enterprise	Operated with Bullocks and a 5-h.p.Diesel Engine	Operated with a 14-h.p. Tractor	Operated with a 14-h.p. Tractor and a 5-h.p. Diesel Engine
(i) Kharif Crops			
1. American cotton	3.40(19.18)	4.44(23.67)	4.44(23.67)
2. Sugarcane	1.48(8.35)	1.48(7.89)	1.48(3.89)
3. Groundnut	3.24(18.28)	3.24(17.27)	3.24(17.27)
4. Kharif fodders	0.96(5.42)	0.96(5.12)	0.96(5.12)
5. Sub-total	7.08(51.24)	10.12(53.94)	10.12(53.94)
(ii) Rabi Crops			
6. Mexican wheat	8.00(45.15)	8.00(42.64)	8.00(42.64)
7. Rabi fodders	0.64(3.61)	0.64(3.41)	0.64(3.41)
8. Sub-total	8.64(48.76)	8.64(46.06)	8.64(46.06)
(iii) Total Cropped Area	17.72(100.00)	18.76(100.00)	18.76(100.00)
(iv) Total Cultivated Area:	10.12	10.12	10.12

Figures in the Parentheses indicate percentages of the total cropped area.

area of various enterprises. It was noticed that whereas the bullocks and engine operated organization planted 9.08 hectares during kharif the tractor situations were able to plant the netire cultivated area measuring 10.12 hectares during the same season. This showed that the bullocks and engine operated organisation left 1.04 (10.12−9.08−=1.04) hectares of cultivated land as fallow during the kharif season. The reasons for this were located through the analysis of the results obtained in the various iterations of the simplex solutions of the linear programming problem matrices.

The returns from sugarcane, an annual crop, were the highest even when compared with the total returns from any one kharif crop and any one rabi crop in an annral rotation on all the situations. The sugarcane land had mutually inclusive classification with maize and cotton land during kharif and wheat land during rabi. Being the highest paying enterprise, sugarcane entered the final solutions of all the situations for the entire ares (1.48 hectares) in which this crop could be raised during both kharif and seasons,

The next best paying enterprise of the kharif season was American cotton. The whole land available for maize and cotton after sugarcane (5.92−1.48=4.44 hectares) was ear-marked for this crop (American cotton) on the tractorised organisations, whereas the bullocks and engine situation included this entersrise only on 3.40 hectares. This was because sugarcane, the most paying crop, entailed 7.41 bullock-pair hours per hectare and 10.97 bullock-pair hours for 1.48 hectares (7.41×1.48=10.97), leaving a balance of 229.03 out of a total of 240 bullock-pair hours availabie from 15th to 30th April, for American cotton. This crop required 67.38 bullock-pari hours per hectare during this period for preparatory tillage. The bullock-pair resource became the most limiting factor on this (bullocks-and-engine operated) situation after including 3.40 hectares of American cotton in the normative plan.

Next to American cotton, groundnut was the most paying enterprise and the balance of the available resources on all the situations was directed to its production. The classification of kharif land for groundnut being mutually exclusive, the whole of this land (3024 hectares) was set aside for groundnut cultivation in all the cases (including the bullocks-and-engine operated organisation).

Hybrid maize was the crop paying next to groundnut. The balance of the kharif land suitable for cotton and maize (1.04 hectares) on the bullocks-and-engine operated situation should have been earmarked for this enterprise. But it did not happen and this land was left fallow. The reasons for this practice were traced by examining the position of limiting resources. The bullock-and-engine operated situation at this stage, faced resource limitations in respect of permanent human labour durind peak periods, 15th to 30th April and Ist to 31st May, bullock power from 15th to 30th April and working kharif capital. The crop enterprises in order of their retums competing for this kharif land, apart from American cotton, were hybrid maize, desi maize and desi cotton. Hybrid maize and desi cotton required human labour resource during lst to 31st May to the extent of 311.32 man hours per hectare each and kharif cash of the order of Rs. 921.43 and Rs. 493.07 per hectare, respectivelv. But the human labour resource during tnis period had already been completely utilized in the productfon of the better paying sugarcane, American cotton and Mexican wheat (for post-harvest operations) enterprises and kharif cash for raising sugarcane, American cotton and groundnut. These resources had therefore, to be acquired for producing hybrid maize and desi maize enterprises. But the low MVRs marginal value productivities of the limiting resources (human labour and kharif capital) did not warrant their acquisition for these activities. Again, desi cotton needed 59.19 bullock-pair hours from lst to 30th April for preparatory tillage. But this resource had already been fully exploited and there was no balance left for desi cotton. This crop also could not, therefore, be planted on the remaining kharif land suitable for maize and cotton (1.04 hectares) which was ultimately left fallow on the bullocks-and-engine operated organisation.

This analysis of the normative cropping pattems on various farm situations indicates that there was little difference in the optimum production pattems on the synthetic large tractorized farm situations operated at the improved level of technology. These production pattems were based on the use capability, classification of available land resource and the economic criterion of relative profitability. These patterns, however, differed from that on the situation operated with the bullocks and the engine and their allied equipment. The normative cropping pattern in the latter case clearly brought out that the relatively more paying American cotton was restricted by the paucity of bullock-pair resource (farm-power resource for field operations) from 15th to 30th April. The low MVP of borrowed kharif cash and hired human labour resource during 1st to 31st May, inhibited the cultivation of hybrid maize and desi maize crops on 1.04 hectares of kharif land on this organisation. Again, this land could not be utilized even for the relatively less paying desi cotton because of the bullock-pair-restriction from 15th to 30th April.

Impact on Cropping Intensity

The variations in the cropping intensity brought about by tractorization are set out in **Table 2.**

It is clear from **Table 2** that the cropping intensity on the synthetic large farm organisation operated at the improved level of technology with bullocks and the engine worked out to be 175.09 per cent as against 185.38 per cent on tractorized situations. This showed that there was a possibility of increasing the intensity of cropping by 5.86 per cent through tractorization of large holdings.

Impact on Farm Income

The impact of tractorization on returns over variable expenses and fixed cost of power and equipment was studied by examining the optimal returns on bullocks-and-engine operated situation vis-a-vis the tractorized organisation as in **Table 3.**

It is apparent from **Table 3** that the situation operated with tractor and its associated machinery systems for both field and stationary operations was the most paying (Rs.40, 260.63). The organisation operated with the tractor and the engine was next in order of returns (Rs.39,231.18). The farm operated with the bullocks and the engine and their equipment earned the lowest returns (Rs.37,652.55). This analysis indicates that when tractor was used as a versatile machine for mechanising both field and stationary jobs on the farm the returns increased by 6.93 per cent over those when the farm was operated with the bullocks and the engine. This increase was however, reduced to 4.19 per cent when tractor and the engine were employed to mechanise the farming operations.

Conclusions

The study indicates that tractorization had a positive influence on the production patterns, cropping intensity and levels of income on large farms. Whereas the bullocks and the engine operated situation experienced production constraints imposed by bullock-pair resource, permanent human labour and kharif cash, the tractorized organisations did not suffer from any such constraints and consequently their optimum cropping patterns were based on the use-capability classification of the available land and the economic criterion of relative profitability. The bullock-pair resource restriction on the bullocks-and-engine operated situation from 15th to 30th Aprill limited the area under such profitable enterprises as American cotton. Again, the resource limitations prescribed by the shortage of kharif cash and permanent human labour from 1st to 31st May on the bullocks-and-engine operated organisation did not permit the utilization of a part of the land suitable for maize and cotton (1.04 hectares) for even hybrid maize and desi maize. Further, the restrictions imposed by the bullock-pair resource from 15th to 30th April inhibited the cultivation of even the less paying desi cotton and this area had to be ultimately, left fallow on this farm situation.

Tractrization of the large synthetic farms contributed to the cropping intensity by 5.86 per cent over the situation operated with the bullocks and the engine. Similarly, the income levels increased up to 6.93 per cent when the large synthetic farm was tractorized. ■■

Table 2. Optimum Cropping Intensity on Synthetic Large Farm Operated at the Improved Level of Technology with Various Power-Machine Combinations, Study Area, 1969–70

Farm Power Combination	Optimum Cropping Intensity	Per Cent Increase Over the Situation Operated with Bullocks and a 5-hp Diesel Engine
1. Operated with Bullocks and a 5-hp Diesel Engine	175.09	–
2. Operated with a 14-hp tractor	185.38	5.86
3. Operated with a 14 hp tractor and a 5-hp Diesel engine	185.38	5.86

Table 3. Optimum Returns Over Variable Expenses and Fixed Costs of Power and Equipment on Synthetic Large Farm Operated at the Improved Level of Technology with Various Power-machine Combinations, Study Area, 1969–70

Farm Power Combination	Cptimum Returns in Rupees	Per Cent Increase Over the Situation Operated with Bullocks and a 5 hp Diesel Engine
1. Operated with Bullocks and a 5-hp Diesel engine	37,652.55	–
2. Operated with a 14-hp tractor	40,260.63	6.93
3. Operated with a 14 hp tractor and 5-hp Diesel engine	39,231.18	4.19

Solar Pond and Storage of Solar Energy

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Introduction

The solar pond is an artificial black bottom pond one or two meters deep in which convection is suppressed by having a strong density gradient from the bottom to the top. The gradient is obtained by having a high concentration of salts at the bottom of the pond and a negligible concentration at the top. These ponds absorb solar energy (radiation) and achieve reasonably high temperatures.

The world population of about 3,500 million is increasing at the rate of about 2% per year and will double by the end of the century. As a result, the need for enrgy will also increase. This increasing energy demand can not be met by fossil fuels. "Coal will not last more than 150 years, and known resources of oil will be used up by the end of the century (1)".

The sun is the ultimate source of all energy in this universe. Solar energy is free at the point of arrival. We can utilize it in many practical ways-cooling, heating, distilling water, producing electricity and so on. Utilization of solar energy is becoming more and more significant as we use up other sources of energy and are obliged to develop new fuels for future, those that have served up to the present time are fast diminishing.

Appliances that put solar radiation to use immediately will work only when the sun is shining. At other times they will be idle. For efficient use of the solar energy some sort of storage system is required because the input of solar radiation is intermittent.

Nuclear power has limitations, regarding cost, efficiency, and safety. Solar energy is a source that is inexhaustible as far as human life is concerned. The problem of storage of solar energy is the principal barrier to its full-scale utilization.

The present situation of shortage of fuel and electrical energy threatens to lead us back to the use of the oldest subsistence methods for agriculture. It is high time to think of some alternative sources of energy. Solar ponds offer a cheap method of collecting and storing solar energy. The purpose of this work is to investigate the potential use of solar ponds for supplying energy to operate the polar powered equipment.

Previous Work on Solar Ponds

Historically (8), the first scientific exploration of lake temperature was supposed to have been made by de Sassure (3) using an alcohol thermometer in a wood casing. The first series of vertical temperature profiles in some Scottish lakes were recorded by Jardine in 1812-1814. The first published reports on thermal stratification, however, were made by la Beche (3) on the lakes of the Swiss Alps. The late nineteenth century studies by Buchanan (2), Ritcher (1892) and Fitzgerald (7) established the generality of thermal stratification of deep lakes in temperate climates.

According to Farrington Daniels, "large shallow ponds of water with black bottoms can be used for storing heat from solar radiation for long periods of time. Small ponds are not effective because of large heat losses at the edge, but in very large ponds these losses become relatively less important. Several days of solar heating are required to bring the pond up to temperature. Evaporation of water at the surface of an ardinary pond prevents high temperatures. A film of oil on the surface of water reduces the rate of evaporation and increases the temperature." Daniels (5) pointed out that the solar radiation can be used for producing power day and night. He further noticed that one of the difficulties may be the accumulation of dust settling through the water and resting on the brine solution, decreasing the radiation that reaches the black bottom of the pond.

According to B. J. Brinkworth(1), "Solar ponds have a number of advantages over other collectors. They are by far the cheapest devices for collection of solar energy on a large scale and they possess a large inherent energy storage capacity because of the high specific heat of water. Heat losses to the surrounding and underlying soil are more important in small ponds than in the large ones, so that the most effective ponds are more than 50 square meters".

In a density stratified pond the convective motions and circulation patterns are restricted as has been established experimentally by various researchers such as Yih(1954, 1958, 1965), Each (1952), Debler (1959), Harleman, et al. (1959), and Skverer and Elata (1963). Heat may, therefore, continue to accumulate in the lower layer as long as the total density due to temperature and dissolved minerals continues to increase with depth. The stable upper layer insulates the lower layer and heat is lost only by conduction through the ground and in the upper layer. In those ponds salt concentration near the bottom are maintained by salt deposits and the concentration gradient is maintained by fresh water streams flowing across the top of the lakes. Toward the end of the summer, temperatures of the order of 160°F have been observed at a depth of four feet. Under controlled conditions higher temperatures rises are obtained and the possibility of utilizing solar energy collected in the form of heat at the bottom of an artificial pond becomes attractive.

An experimental pond (9), "one meter deep and 25x25 meters in plan was constructed in Israel. The pond had a blackened bottom and a vertical salt concentration gradient was created artificially. In the period of operation before the pond was destroyed by leakage, a temperature of 200°F was attained in the bottom layer". A general description of the use of solar ponds for power production (11) indicates that they are potentially competitive with power production by commercial fuels in tropical regions. "Feist (6) also describes several schemes for utilization of energy from solar ponds both for primary power production and as a by-product of solar distillation". An investigation of some of the hydraulic problems concerning the stability of the vertical concentration gradient in a solar pond has been reported by Elata and Levin (4).

Stability and energy balance have been analysed mathematically by Weinberger. He has shown that density gradient readily obtainable by practice by using concentrate salt solution. He has also indicated that the collection efficiency of the pond which of course, depends upon the depth, the cleanliness and the temperature of withdrawal.

Theory on solar pond :

Energy absorbed in the pond during a particular time : Heat capacity of any volume of pond's water is given by

$$dQ_1 = M_w C_w dT$$

Where dQ_1 = heat flow rate, kj.
M_w = Mass of water, kg.
C_w = Specific heat capacity of pond water (4.185kj/kg(k)) for fresh water.
dT = rate of temperature change (O_c)

$$\therefore \; Q_1 = M_W C_W \int_{T_o(x)}^{T_f(x)} dT$$

or, $Q_1 M_w C_w (T_f(X) - T_o(X)) \cdots\cdots\cdots (1)$

Where $T_o(X)$ = initial temperature of water at a depth x from surface of water (O_c).
$T_f(X)$ = final temperature of water at a depth x from the surface after time t hours (O_c).

$\therefore$ Energy absorbed/unit time $= \frac{Q_1}{t}$ (Wm^{-2}) or MJ/M^2(day).

Energy losses from the top of the pond :

Energy loss from the top of the pond will be in three ways, such as conduction, convection and radiation. From the concept of longwave radiation and the knowledge of conduction and connection theory, one can tell the total energy loss from the top of the pond. Therefore, the total energy loss from the top of the pond is :

$$Q_{1c} = h \quad (T_p - T_a) + E_p(T_p4 - T_a4) \cdots\cdots\cdots\cdots (2)$$

The first term represents convection and conduction and the second term represents radiation losses.

Where h = the convection coefficient ($Wm^{-2}(O_c)^{-1}$).

It varies with the velocity of air at a place.

T_p = the temperature of the plastic film cover (O_c).
T_a = the ambient air temperature surrounding the pond (O_c).
E_p = Emissivity of plastic film cover.

Q=Stefan Boltzman constant ($5.672\times10^{-8}Wm^{-2}(K)^{-4}$).

Q_{lc}=Total energy losses from the top cover.

Energy losses from the sides of the pond :

Energy loss from the sides of the pond is

$$\phi_m=\phi_c+\phi_r+K_c(T_s-T_a)+E_s6(T_s^4-T_a^4)\cdots\cdots\cdots\cdots(3)$$

ϕ_c=Energy losses by conduction & ϕ_r=energy losses by radiation.

Where K_c=Conduction co-efficient for air $=0.000066\ Wm^{-2}(O_c)^{-1}$

E_s=Emissivity of surface=1.00 for brick wall

T_s=Temperature of the outside surface of the pond's wall.

T_a=The ambient air temperature.

ϕ_m=Total energy losses from the surface of the pond.

Energy losses through the bottom of the pond :

The expression for the total energy loss into the soil, the ground, is given by (10).

$$Q_g=\Delta T\sqrt{4K_s\vartheta_sC_{Ps}/xt}\cdots(4)$$

Where Qg is the energy loss from the bottom of the pond into the ground KJ/m^2 (day).

ΔT=The change in temperature at the soil surface (O_c)

K_s=The thermal conductivity of the soil MJ/m℃ (second).

S_s=The density of the soil (gm/cc).

C_{ps}=The specific heat of the soil (KJ/Kg°c)

t=The period of collector operation (hours).

Efficiency of the pond for a short period of time :

$$\eta_P=\frac{\text{Total rate of energy incoming to the pond : }-\text{ all energy losses from the pond over that period.}}{\text{Total rate of energy incoming over the pond.}}=\frac{\text{Total rate of energy accumulation in the pond.}}{\text{Total rate of energy incoming over that period.}}\cdots\cdots\cdots\cdots(5)$$

Where N_p=efficiency of the pond for a short period of time.

ΔE=total rate of energy accumulation in the pond.

ΔS=total rate of energy incoming to pond over that period.

Solar Pond at Asian Institute of Technology

Experimental design :

Ponds of dimensions 2x2xo.4, 2x2xo.6, 2x2x1, and 2x2x1 meters namely, P_1, P_2, P_3 and P_4 were constructed on the flat ground at the forecourt of AIT research centre. All the ponds were dyke type. The detail design is shown in **Fig.1.** The bottom of the ponds were blackened with asphalt in pond P_1 and with cement and charcoal in other three ponds. Plastic film covers were provided on the top of the pond to protect it from dust particles and wind disturbances and also to prevent evaporation losses. No insulations were provided in the bottom and sides of the pond. Galvanized steel pipes of 1'-6"x1/4" were installed in the sides of the ponds with inside ends closed and outside ends open to permit temperature measurement of water.

Table 1. The Concentrations and Densities of salt solutions at 25°C.

Conc. (Factor)	Density (gm/CC)	Turbidity (after 10 min. of solution prepared) (J.T.U.)	Wt. of solt required (gm).
0.22	1.0993	200	22
0.18	1.0807	154	18
0.15	1.0664	60	15
0.12	1.0554	35	12
0.08	1.0429	30	8
0.04	1.0063	13	4
0.02	0.9997	5	2
Tap water	0.9980	0.24	0

Method of charging the pond :

The densities for different concentrations of salt solution were determined. **Table 1** shows the concentration and density of salt solutions.

The desired salt solution was kept in the tank as shown in **Fig.2** It was easy to fill the bottom layer with salt solution. After filling the bottom layer, the rest of the layers were filled as follows :

A piece of plywood 0.5x0.5 meter was placed on the water surface in the pond **(Fig.2).** Salt solution was dropped into the wooden piece from the tank by means of siphonic action. The wooden piece and plastic tube were nailed together. The velocity of salt solution approached to zero as soon as the salt solution was dropped on the wooden piece. Then the solution was dropped into the previously filled layer from the wooden piece without causing any disturbances. In this way desired layers of salt solution were obtained in the pond.

When the filling was completed the density steps had disappeared and substantially smooth linear gradient was obtained. The density thus obtained was checked at an interval of 15 days.

The temperature of water in the pond was recorded with ordinary alcohol thermometers. The temperature was recorded in the pond at an interval of two hours at different depths.

In a seperate experiment the temperature rise in a thin water-filled plastic bag resting on a black surface was observed.

Initially, the following concentrations and densities were maintained in the ponds.

The charging of the ponds was completed on 22-3-1977. The experiment was started on 25-3-77 and continued up to 22-5-77. The temperatures at the bottom of ponds were recorded at an interval of two hours every day. The reading taken on

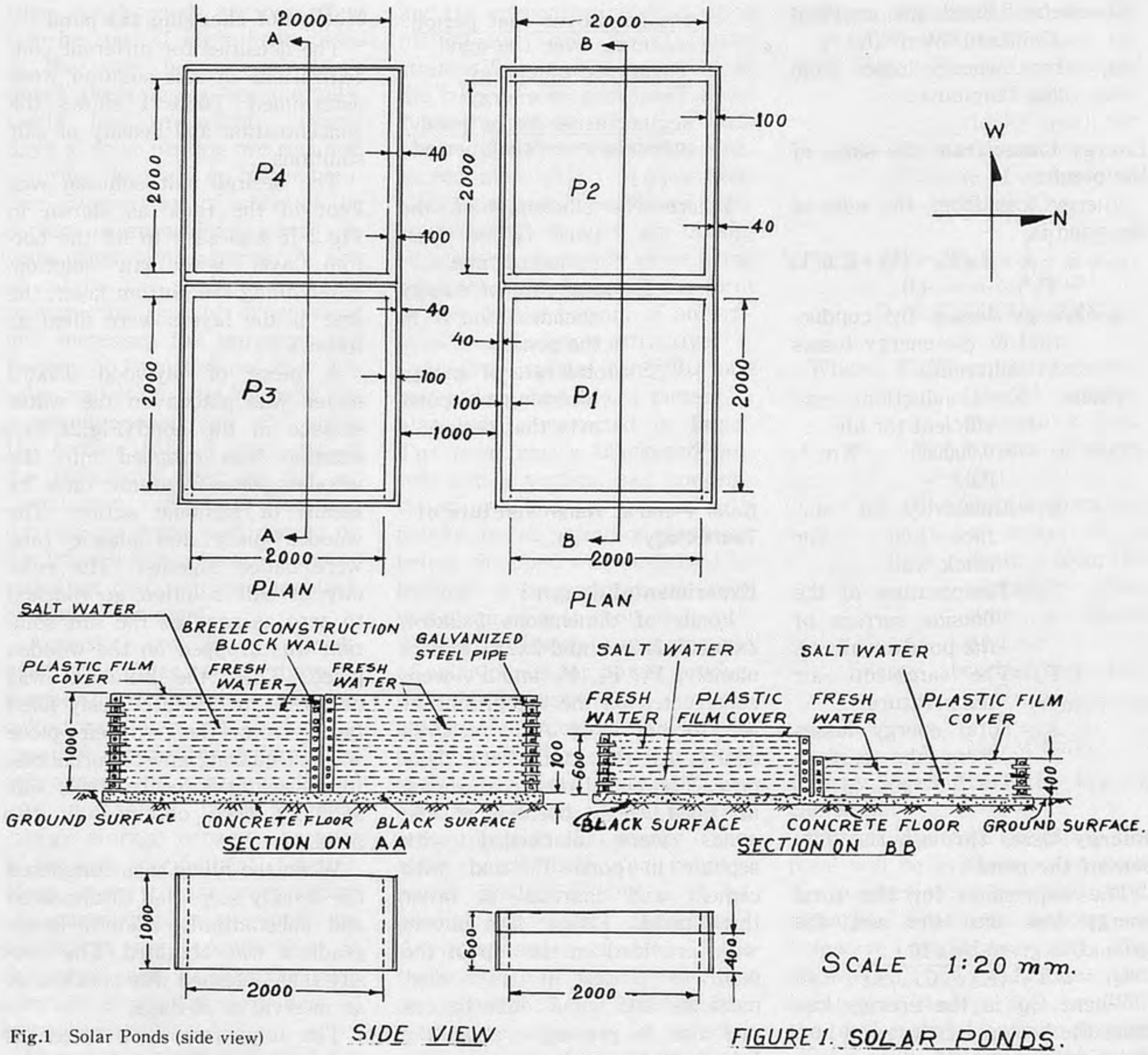

Fig.1 Solar Ponds (side view)

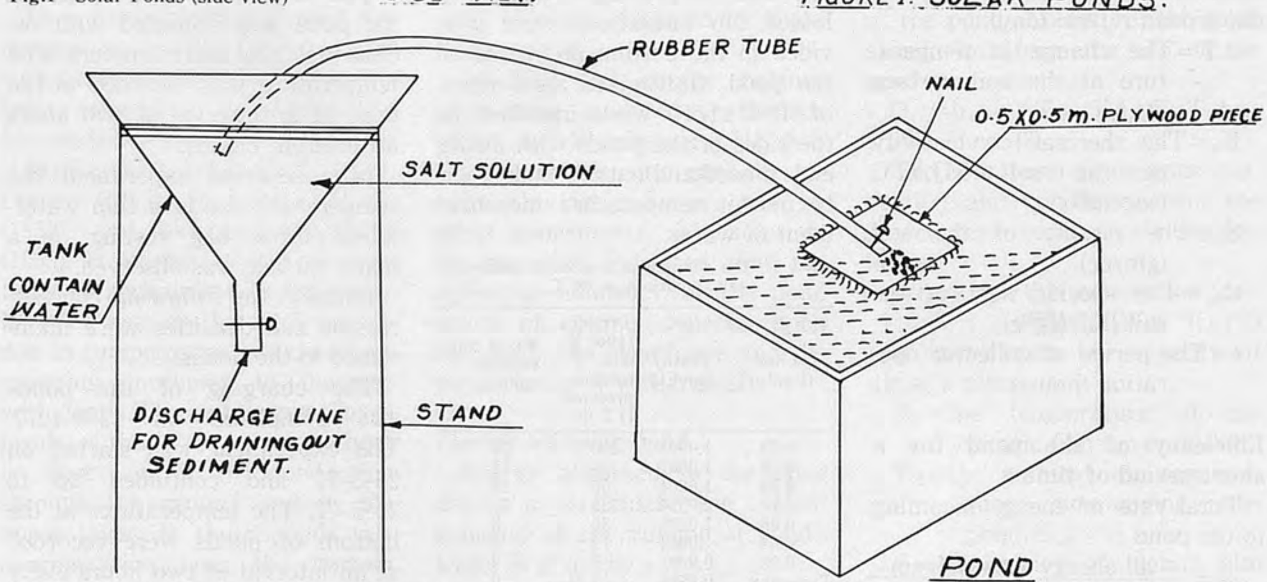

Fig.2 Pond is being charged with salt solution from the sedimentation tank by siphonic action

Table 2. Pond P_1 (400 cm deep)

Depth layer from surface (cm.)	Concentration (factor)	Density gm/cc.	Qty. of alt required (Kg.)	Sp. ht · Kj/KgoC.
30–40	0.22	1.0993	88	3.368
20–30	0.18	1.0807	72	3.486
10–20	0.02	0.9997	8	4.059
00–10	0.00	0.9980	0	4.143

Table 3. Pond P_2 (60 cm deep)

Depth layer from surface (cm.)	Concentration (factor)	Density gm/cc.	Qty. of salt required (Kg.)	Sp. ht · Kj/KgoC.
50–60	0.22	1.0993	88	3.368
40–50	0.18	1.0807	72	3.486
30–40	0.15	1.0663	60	3.575
20–30	0.02	0.997	8	4.059
10–20	0.00	0.998	0	4.143
00–10	0.00	0.998	0	4.143

*Obtained from Ashrake Handbpok of Fundamentals. The values are extrapolated from the properties of brine chart.

Table 4. Pond P_3 (100 cm deep)

Depth layer from surface (cm.)	Concentration (factor)	Density gm/cc.	Qty. of salt required (Kg.)	Sp. ht · Kj/KgoC.
90–100	0.22	1.0993	88	3.368
80–90	0.18	1.0807	72	3.486
70–80	0.15	1.0663	60	3.578
60–70	0.12	1.0554	48	3.695
50–60	0.08	1.0429	32	3.929
40–50	0.04	1.0063	16	3.975
30–40	0.02	0.997	8	4.059
20–30	0.00	0.998	0	4.143
10–20	0.00	0.998	0	4.143
00–10	0.00	0.998	0	4.143

Table 5. Pond P_4 (100 cm deep)

Depth layer from surface (Cm.)	Concentration (factor)	Density gm/cc.	Cut of salt required (Kg.)	Sp. ht · Kj/KgoC.
0–100	0.00	.998	0	4.143

*Obtained from Ashrake handbook of foundamentals. The values are extrapolated from the properties of brine chart.

15-4-1977, was chosen for analysis because that day was almost a cloudless day.

Results and Conclusion

Temperatures at the bottom of the ponds were found up to 56°C, 54°C, 46°C and 34.5°C corresponding to the ponds P_1, P_2, P_3 and P_4, respectively. The variation in temperatures at the bottom of the ponds during the day on 15th April, 1977 are shown in **Fig.3**. Although the system worked, the rate of rise in temperature was very slow. This may in part be due to the low absorptivity of solar radiation by the black bottom of the pond. During the experiment the bottom was covered with particles from the suspended solids of the solt solution. At the time of charging the pond the turbidity of salt solution was very high being about 200 JTU (**Table 1**) at the bottom of the pond. To obtain good results turbidity should be as low as possible.

It was observed that the density at the bottom layer of the pond decreased due to the diffusion of salt over the 50 day-period after charging the pond with salt solution. As a result the temperature at the bottom started to fall slowly.

During the investigation it was found that wind action also reduced the rate of increase in temperature in the pond. A wind break should be provided for obtaining an improved result. Side and bottom losses could be reduced by providing good insulation.

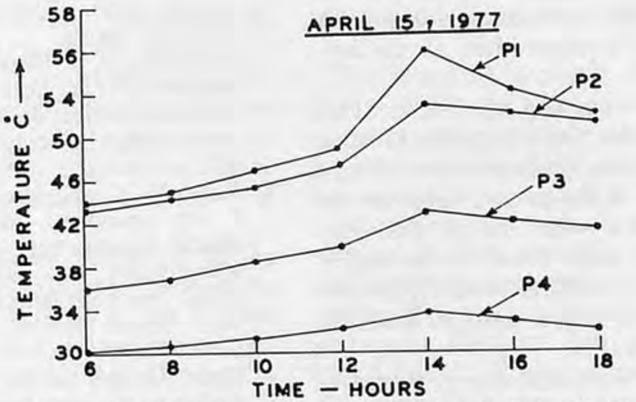

Fig.3 Variation of temperature at the bottom of ponds during the day

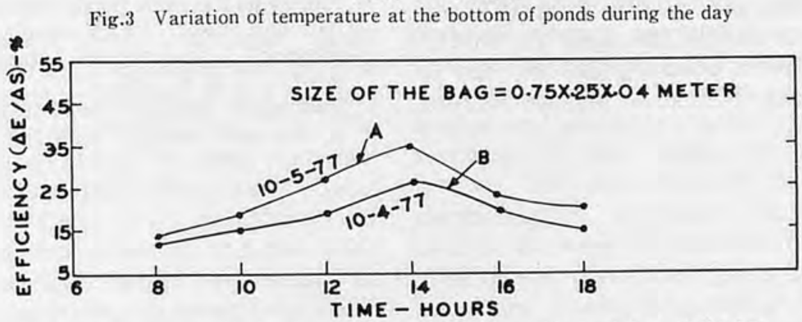

Fig.4 Efficiency of energy accummulation in the bag with insulation at the bottom of the bag 'A' and without insulation at the bottom of the bag 'B'

The maximum temperature recorded in the plastic bag was 70°C with insulation and 61°C without insulation at the bottom of the bag. The observed efficiency (**Fig.4**) of the bag between 12 noon and 2 p.m. was found to be approximately 35% with insulation and 22% without insulation, respectively, at the bottom of the bag.

The rate of energy accumulation between 6 a.m. and 10 a.m. was very low in the ponds P_2, P_3, P_4 because solar radiation in the morning could not reach the bottom of the ponds due to the vertical walls.

Therefore, the capacity for absorbing solar radiation could be considerably improved by providing clean salt solution in the pond, a dull black surface at the

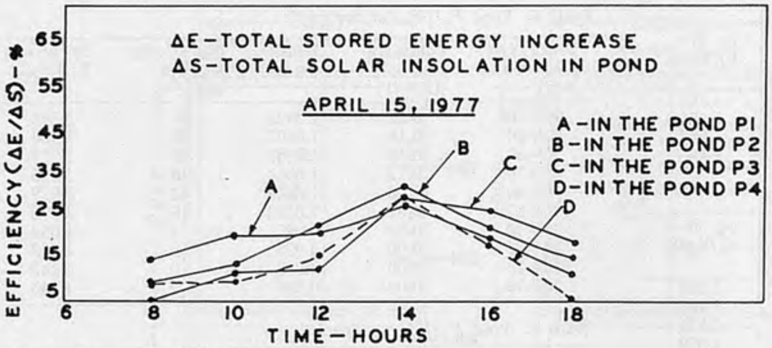

Fig.5 Observed efficiences of the ponds

bottom of the pond, and a wind break. Pond P_4 contained water only with no salt added. An appreciable higher temperature was found at the water surface of this pond P_4 rather than at the bottom.

The observed efficiencies (Fig. 5) of the ponds between 12 noon and 2 p.m. (increament of energy stored in the pond divided by the incoming solar energy over that period) were found to be approximately 23% in pond P_1, 30% in pond P_2, 29% in pond P_3 and 28% in pond P_4.

The estimated energy stored in the ponds on 15th April, 1977 was MJ/day in the pond P_1, 33MJ/-day in pond P_2, 32.8 MJ/day in pond P_3 and 30 MJ/day in pond P_4.

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The Development of the IRRI Portable Thresher A Product of Rational Planning

by
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Introduction

Engineers in the industrially advanced contries are developing sophisticated new agricutural machinery systems with automatic controls in order to minimize farm labor inputs and optimize the use of available resources (1). Farmers are buying entire systems to mechanize their operations, instead of individual pieces of equipments. In the not too distant future, it is likely that field machines will be controlled by computer tapes, and one operator can monitor the automated movements of a fleet of field machines from a control tower. Indeed, engineering developments in the industrialized countries are moving further away from the needs of Asian farmers than they are now.

The Agricultural Engineering Department of IRRI is currently engaged in the development of appropriate mechanization for the farm and village level needs of Asian rice farmers. This work is based on the assumption that mechanization of agriculture is hastened by working simultaneously with small farmers and local manufacturers. The application of this new agricultural technology increases the farmers' income and provides them the means to afford some degree of mechanization. Most developing countries of Asia have small metal fabricating shops capable of productng simple agricultural equipment. Local production conserves foreign exchange, gives opportunities for employment in rural based industries, and enhances equitable distribution of wealth.

A significant change is taking place in world rice production. About 20 percent of the world's riceland now grows new high yielding rice varieties (2). The adoption of these varieties is taking place throught Asia, where it is estimated that over 90 percent of the world rice production is concentrated (3). The advancement in seed fertilizer technology, liberalized credit facilities, and installation of modern irrigation systems offer the Asian farmer the potential of substantially incresing crop yields beyond the subsistence level. However, realizing the full im pact of this new technology requires prompt execution of the production steps between crops. Rice production techniques, especially in harvesting and threshing, have remained unchanged for centuries in this region. Traditional rice threshing methods limit turn-around time and present a demand for low-cost and efficient mechanical threshers suited to rice farming conditions in tropical Asia. IRRI has responded to that demand by developing a portable thresher.

Product Development at IRRI

The portable thresher developed at IRRI is a product of rational planning. Product planning at IRRI is viewed as effort to coordinate major activities in the development of new products, such as, market research, design and development analysis, and testing. The product development system at IRRI is illustrated in **Figs.1 and 2.** Potential projects are carefully screened for their potential impact on production, incomes, acceptability and range and size of market. Trends are studied and customer's needs investigated by the mechanization systems and mechanization research section of IRRI's Agricultural Engineering Department. With overall department goals in mind they develop proposed product specifications, rough cost estimate, justification statement and an economic analysis (**Table 1.** and **Fig.4**). The proposal is submitted for review and if it receive favorable acceptance, it goes of the machinery design section for conceptual evaluation. In practice, the product usually evolves from numerous concepts that are molded by the designer into his "ideal design."

The design concept is proven by building a prototype which is tested. Field testing takes place both locally, i. e., at the Institute and in farmer's field in an enviro-

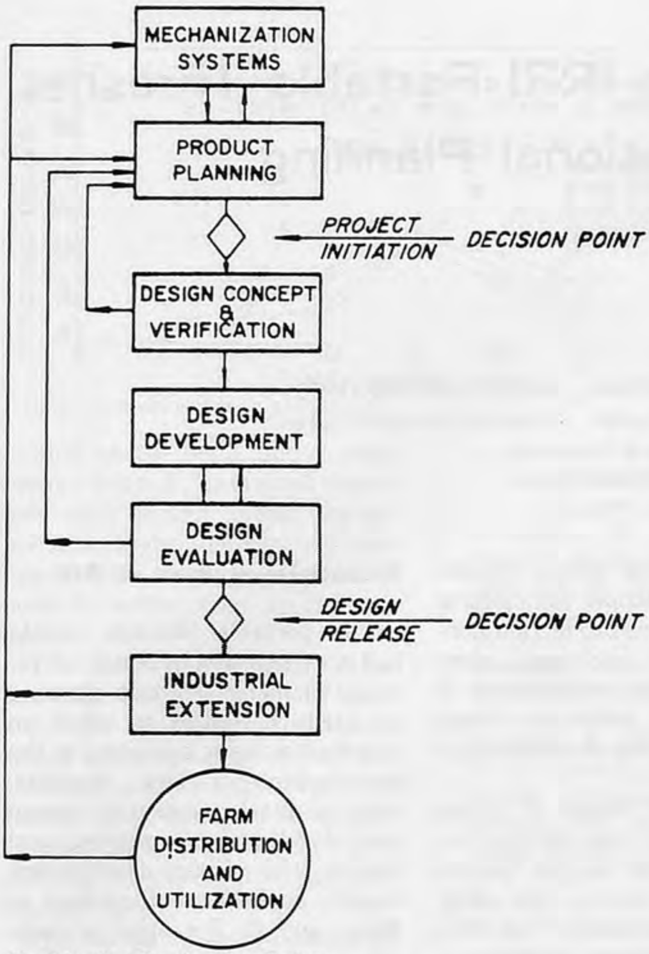


Fig.1 Product Development System

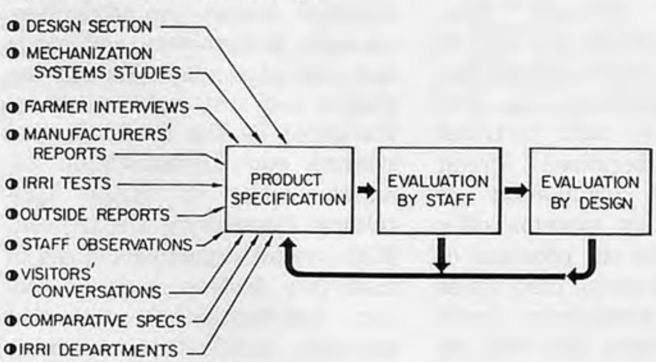


Fig.2 Product Planning Cycle

Table 1. Cost Analysis, IRRI Portable Thresher

Initial cost (pesos)	₱5,500.00
Machine life (years)	6
Thresher capacity (kg/hr)	400
Field capacity (hr/ha)	
Assume 4,000 kg/ha output, 4000/400=10 (hr/ha)	10
Fixed cost (annual)	
1. Depreciation	
$D=\frac{\text{Purchase price}-\text{Salvage value}}{\text{No. of years}}$	
Assume : Salvage value =10%	
$D=\frac{3{,}500-350}{6}=P\,525.00$	525.00
2. Repairs & maintenance	
$R\ \&\ M=\frac{\text{Purchase price}\times K}{\text{No. of years}}1$	
Assume : Value of constant K1−45%	
$R\ \&\ M=\frac{3{,}500\times 45\%}{6}=P\,262.50$	262.50
3. Interest	
$I=\frac{(\text{Purchase Price}+\text{Salvage value K}}{2}2$	
Assume value of constant K2=12%	
$I=\frac{(3{,}500+350)\ 12\%}{2}=P\,189.00$	231.00
4. Tax & insurance	
$T\ \&\ I=\frac{\text{Purchase Price}\times K}{\text{No. of years}}3$	
Assume value of constant K3=12%	
$T\ \&\ I=\frac{3{,}500\times 12\%}{6}=P\,70.00$	70.00
	₱1,088.50
Variable cost (P /hr)	
1. Fuel	
Gasoline consumption=0.75 liter/hr	
Cost of gasoline=P 1.66	
$F=0.75\times 1.66=P\,1.25/hr$	₱1.25
2. Lubrication	
Lubrication consumption=1 liter/20 hours	
Cost of lub-oil=P 6.50/liter	
$L=\frac{6.50}{20}=P\,0.33/hr$	0.33
3. Labor (3 men at P 1.00/hr)	
L−3×P 1.00=P 3.00/hr)	3.00
TOTAL	₱4.58/hr or ₱0.01/kg at 400 kg/hr
Cost to thresh/kg of paddy (manual method)	
At 6% share from total volume threshed at the rate of 50 kg/hr, P 1.00/kg =6%×P 1.00/kg=P 0.06/kg	
Breakeven Point	
$\frac{\text{Fixed cost (P)}+\text{Variable cost (P)}\times\text{Annual use(kg)}}{\text{annual use(kg)}}$	
$\frac{1088.50+0.01(x)}{x}=0.06$	
x=21,770 kg/yr. =21,770/400=54 hours.	say, 22 tons/year

ment in which the machines will eventually be distributed and used. The mechanization research group perfoms the durability and reliability tests and farmers trials. In most cases, the prototype goes back to the designer, for further improvements and refinements.

When an acceptable level of performance is attained, the product is released to cooperating manufacturers. They are required to submit a pre-production prototype for evaluation by IRRI before being given permission to use the design on a commercial basis. The industrial extension setion, which works closely with the local manufacturers promotes and distributes the designs.

Different Types of Mechanical Threshers

In 1974, IRRI's agricultural engineers conducted a performance tests on the various kinds of throw-in type threshers popular in the Philippines (**Fig.4 and 5, Table 2.**). The tests were done under common conditions found in the major rice producing areas of the country. The studies was initiated to evaluate machine performance, establish design criteria for local manufacturers, and to help farmers select the kind of threshers suited to their requirements.

Type I–Bicol type–in the southern part of Luzon, the most popular type of thresher is a single drum

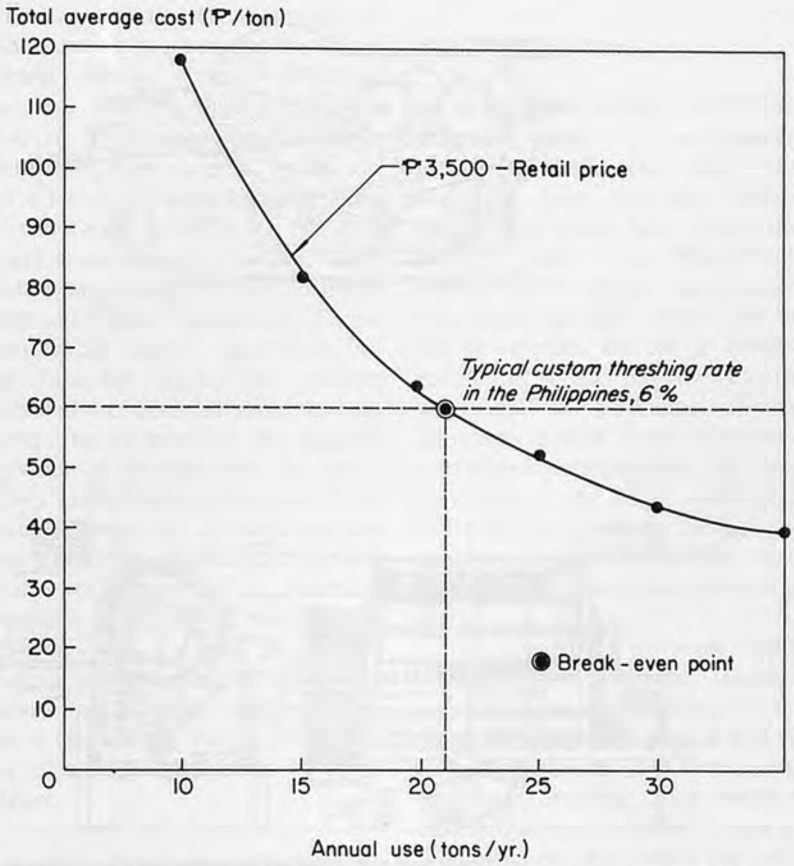


Fig.3 Relationship Between Threshing Cost and Annual Use of IRRI Portable Thresher

Table 2. Mechanical Thresher Results (November, 1974) *

Item	Thresher**				
	I	II	III	IV	V
Operating speed, rpm-	1200	900			
Threshing drum 1	–	1200	900	520	750
Threshing drum 2	– –	1400	1200	–	–
Blower	– –	1200	1400	1000	700
Auger	0 –	250	1200	270	400
Separator	3 0	8	250	17	200
Horsepower rating, HP	3	8	11	7	65.80
Crop condition :					
Grain M.C., %	23	23	21.3	20	20
Material length, cm	35	35	35	38	40
Grain-straw ratio	0.65	0.49	0.53	0.53	0.49
Labor requirement	4	6	7	4	8
Men feeding	1	1	1	1	3
Men handling	3	5	6	3	2
Others (tractor operator, collector, checker)	–	–	–	–	3
Test duration, min	3.75	3.75	3.50	6.25	3
Output, kg/test (total)	44	60.58	68.52	97.53	122.50
kg/hr	704	969.28	1148.38	936.29	2450
Labor output, kg/man-hr	176	161.55	164	234.07	306.25
Capacity, kg/hp-hr	234.6	121.16	104.40	133.76	37.69
Unthreshed loss, percent	17	1.3	3.3	0.2	0.98
Separation loss, percent	56	15.27	4.0	2.67	3.14
Blower loss, percent	–	23	38	1.54	–
Purity, percent	92.1	98.1	98.3	97.4	99.5

*Average of 3 tests.
**Threshers tested were were all throw-in feeding.

machine with no blower or separator. It is a flow-thru type with paddy fed the top of the threshing drum. The material makes a three-quarter turn before ejecting below the feed tray. Separation of the grain from the straw is done manually. This type has the lowest separation efficiency because it has no separation system and the smallest concave area. Output per horsepower hour is highest of the types tested.

Type II–Kyowa type (Japanese)–this double drum thresher has a blower but no separator. The two threshing drums are placed parallel to each other. The threshing drums can rotate at different speeds and can have different diameters. Paddy is fed into the first drum and moves axially to the feed opening of the second drum. A centrifugal blower winnows the threshed grain as it falls from the concaves. The winnowed grain is conveyed out by an auger. Six men are required to operate the machine, and it has a very low output per man hour. It requires an 8 hp engine.

Type III–Cotabato type–this flow-thru thresher is widely used in the Southern Philippines. It has two threshing cylinders, blower and separator. Paddy is fed along the whole width of the thresher's first drum. Final threshing occurs as the material goes to the second cylinder which runs faster than the first. The threshed gran falling from the concave passes through an airstream for winnowing. The cleaned grain is conveyed by an auger to a bagging system. Seven men operate the machine and the labor output is about 165kg per man hour. An 11 hp engine is used to power the unit.

Type IV–IRRI Axial-Flow Thresher–this thresher is described in the next section of this paper. It has a high labor output of 235kg per man hour and capacity of 105kg per hp hour. Total grain loss is about the same as the McCormick type at 4%.

Type V–McCormick type (**Fig.-5**)–this thresher is popular in the Central Luzon area for use in custom threshing operations. It is a high capacity, high horsepower type. This thresher design precedes that of the present rice

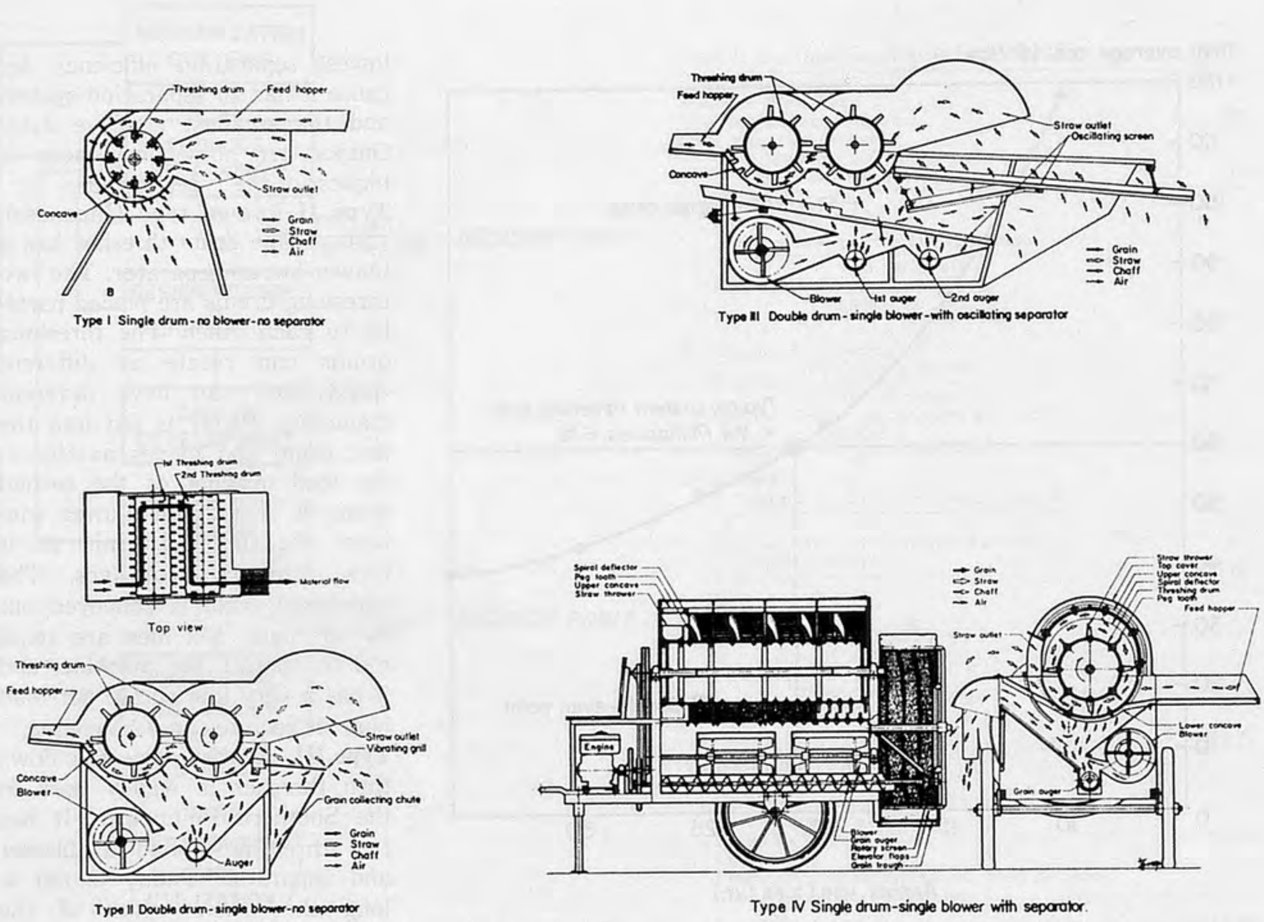


Fig.4 Types I to IV-Different Types of Mechanical Threshers.

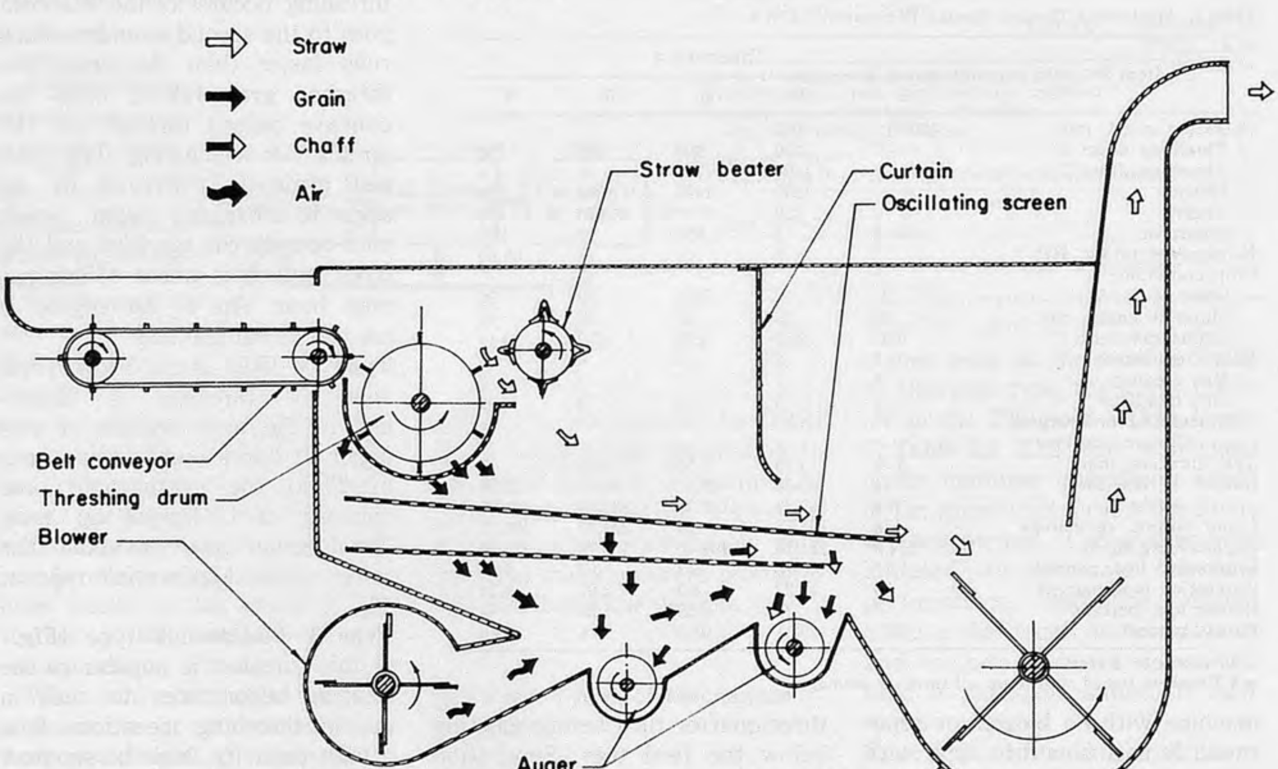


Fig.5 Type V-Different Types of Mechanical Threshers

combines in the U. S. Its major components are a single threshing drum, blower, two oscillating screens and an auger. Paddy is fed to a floating belt conveyor which delivers material to the top of a full-width pegtooth threshing drum. Grain falling from the concave is screened by the first oscillating sieve with air-stream blowing out lighter impurities. Straw and other heavy impurities fall on another sieve for further separation. Cleaned grain is conveyed by an auger to the bagging portion of the machine. An auxilliary auger delivers grain and tail ings, blown by the air stream, back to the threshing chamber for recycling. This thresher requires a 65-80 hp tractor for power and 8 men to operte. Labor output is high at 306 kg per hour and total grain loss is low at 4.12 percent. Purity of output is also high compared to other types.

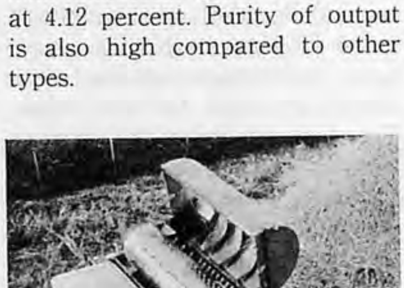


Fig.6 The IRRI Axial-Flow Thresher

IRRI Portable Thresher

Comparative studies at IRRI of different types of mechanical threshers indicated that the throw-in type provides higher output per man hour than the hold-on type. The McCormick type is costly, heavy, complicated and requires high power (30-60 hp) to operate. Its use is limited to the dry season harvest because of mobility problems. While Japanese double drum threshers performed satisfactorily in most conditions, its high cost and difficulty in manufacturing the machine in Asian countries have limited their adoption in tropical Asia.

The need for a low-cost, light-weight, throw-in type thresher prompted the development of the axial flow thresher (**Figs.6 and 7**). The thresher has a 122 cm. long pegtooth threshing drum inside a full-length oval shaped concave. The concave has round bar grill type construction. Spiral baffles placed inside the upper concave move material axially from the inlet side and to the discharge end. A centrifugal blower winnows the threshed grain as it falls from the concave. The winnowed grain is conveyed by an auger to a rotary screen which removes residual pieces of straws that cannot be separated by winnowing. The thresher is mounted on wheels to provide mobility. It is usually powered by a 7 hp air-cooled gasoline engine.

Several versions of the thresher based on the original design have been developed by IRRI cooperating manufacturers in efforts to improve performance and suit their manufacturing facilities. One company installed a full-width oscillating screen under the concave with the blower located above the oscillating screen. The rotary screen was retained, thus forming a dual cleaning system. Another firm replaced the rotary screen with a full-length oscillating screen with the blower located under the screen. Another, added a detachable oscillating screen grain cleaner with blower at the grain spout of the original design. A simple arrangement to recycle tailings and other unthreshed materials from the rotary screen back to the threshing chamber was also added. A company in India, modified the threshing drum and other components of the machine for wheat threshing.

Attempts were also made to improve the original design at the Institute. Different versions of the cleaning system were tried to select the least cost design could be used under varying conditions. As a result of these trials, a new thresher, (**Fig. 8**) which is simpler

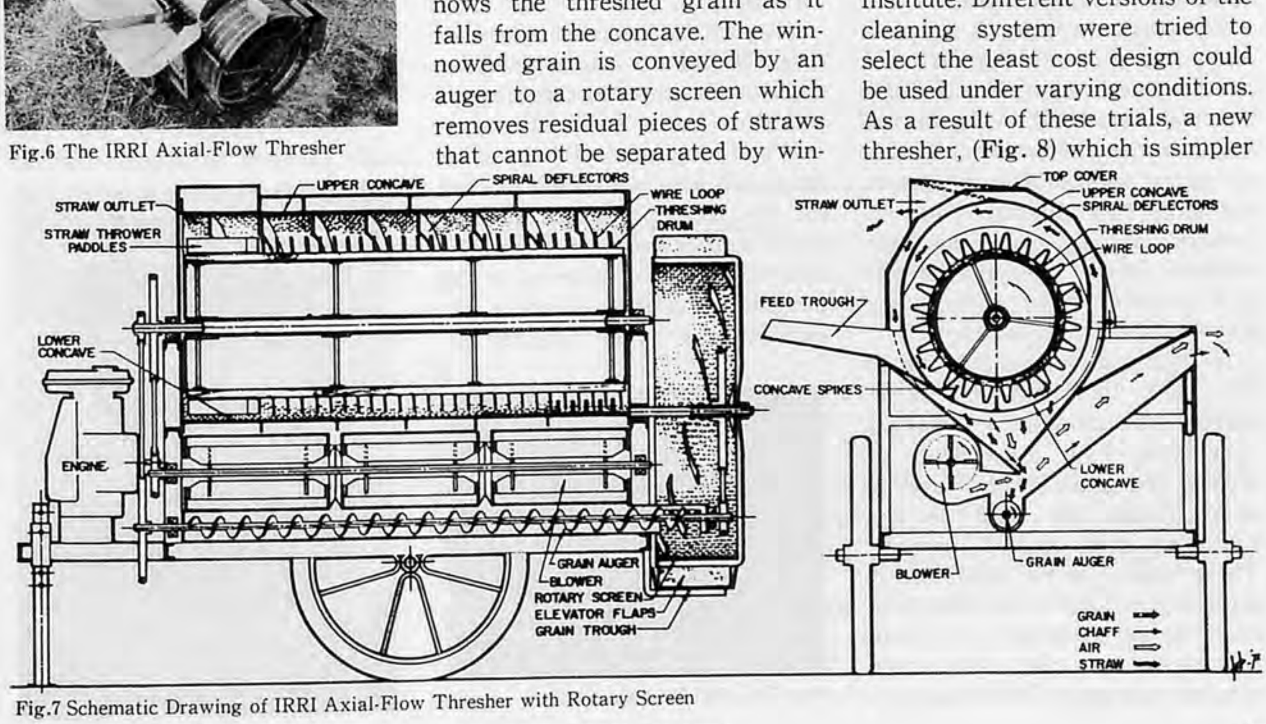


Fig.7 Schematic Drawing of IRRI Axial-Flow Thresher with Rotary Screen

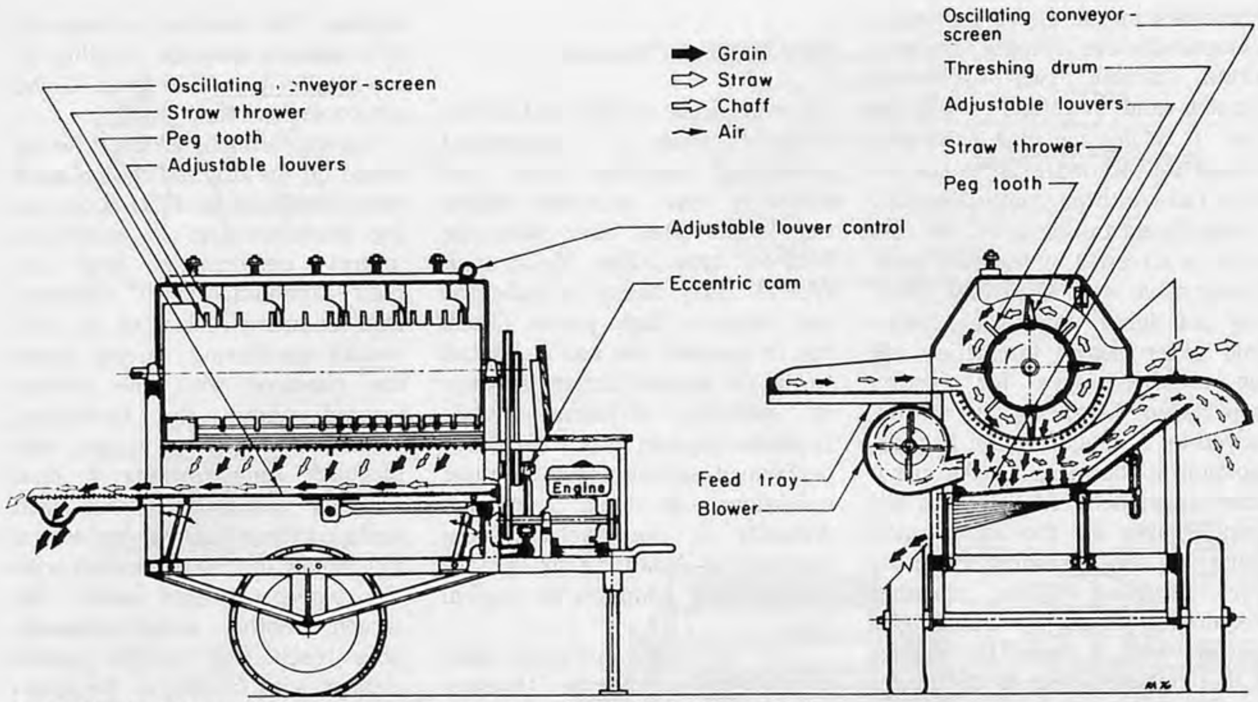


Fig.8 Schematic Drawing of the IRRI Axial-Flow Thresher with Oscillating Screen

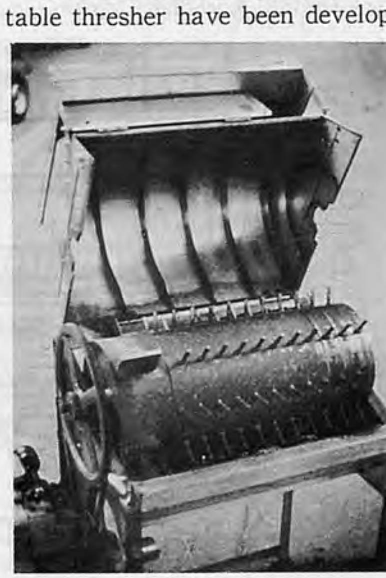
than the earlier design, was developed. It has a full-length, flat oscillating conveyor tray installed directly under the concave. Threshed material onto the plain tray is then conveyed to a 60×60 perforated screen, which removes the chaff and other impurities. A centrifugal blower is mounted above the oscillating tray to winnow the threshed grain. The whole oscillating tray is supported by four a bar linkage mounted on the base frame. The oscillating tray assembly replaces the auger, rotary clearner, and side collecting boards. This version of the axial-flow thresher costs 15 percent less to build than the original design. This machine is now commercially produced by 18 companies in 5 countries.

In 1972, a study was initiated to determine the field losses incurred in harvesting-threshing operations (4). According to studies, the grain loss in handling paddy from the field to the threshing area is 2-7 percent. These losses can be minimized if threshing is done in the field. The encouraging response of manufacturers to the axial-flow thresher prompted IRRI engineers to look into the possibilities of developing a lighter version of the thresher which could be carried into the field. Presently available portable threshers require at least four men to carry them to the field. Since rice field levees are only wide enough for one man to walk, four people have difficulty in carrying these threshers.

The IRRI portable thresher (**Figs. 9 and 10**) can be used for hold-on or throw-in threshing of paddy. It has a 30 cm. diameter-×17 cm long pegtooth threshing drum. Woven wire mesh is used for the concave to increase the effective concave open area. The retention time of material in the threshing chamber is about the same in the larger thresher because it has the same number of spiral louvers on the top cover. Light gauge angle iron and G. I. sheets are used for the frame. The legs supporting the thresher fold to provide handles during transport. The thresher weighs about 100 kg., including a 5 hp air-cooled gasoline engine. It has an average output of 500 kg per hour with a grain separation loss of less than 2 percent. Two men are required to operate and carry the thresher.

Several versions of the portable thresher have been develop-

Fig.9 The IRRI Portable Thresher



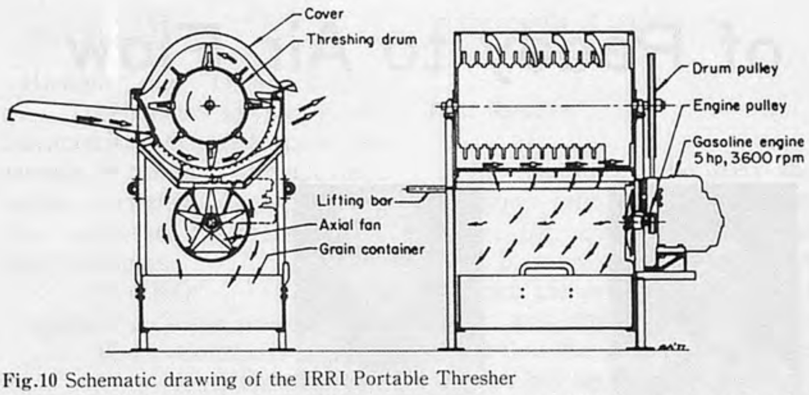


Fig.10 Schematic drawing of the IRRI Portable Thresher

ed. An automotive fan blade was attached directly to the engine output shaft to serve as a winnowing blower. A converging bellmouth shroud around the fan improves its air-moving performance.

The portable thresher is currently being adapted for threshing other crops like sorghum, soybeans, mongo and peanuts. The portable thresher's performance look promising in these crops and development is under way to further improve its performance. IRRI engineers are working closely with other IRRI departments in an effort to come up with a truly multicrop thresher.

Eight Philippine manufacturers are commercially producing this thresher and seven others are in various stages of prototype fabrication and testing. The portable thresher is being evaluated by IRRI cooperators in India, Korea, Pakistan, Sri Lanka and Thailand.

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INDEX TO ADVERTIZERS

Resistance of Paddy to Air Flow



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Introduction

Rice is staple food in South-East Asia and Bangladesh. This commodity is now showing fluctuations in production and price with shortages to meet the requirements in some Asia countries. Agricultural engineers must be involved in production, handling, processing, strong and marketing of this product. High yielding varieties have been developed to cope with food crises. During rainy season some high yielding varieties ripen. Once grown, whatever season it may be, it must be harvested, processed, stored, transported and marketed with minimum loss and the quality of the produce must be improved for best economic returns. The minimization of loss and wastage could increase the total production and hence the farmer will be able to feed more peopie. Agricultural engineers must take the major role in production and processing for the following specific objectives.

i) Minimize the losses associated with the product.
ii) Develop improved methods for handling and processing.
iii) Improve the well being of the farmers and the society in general.

Crop drying using either heated or natural forced air gives the farmers greater independence from Natures whim. Forcing air through paddy using heated or unheated air in drying machines as well as for storage stuctures or bins are widely used in developed countires. From time immemorial sun drying has been practiced in Bangladesh and in some Asian countries. More recently mechanisation of drying and storing of paddy is getting due importance in developing countries. The relationship among volume the of air moved through the product, static pressure developed and the depth of the product is important for mechanization. An attempt has been made to obtain data on the resistance to the passage of air flow through three varieties of paddy namely Nazirsail, BR-3 and Chandina. These data would be useful to the designers of natural and mechanical ventilation systems.

Literature Review

Stirniman, Bodnar and Bates[3]. conducted tests on resistance to the passage of air through rough rice in a deep bin and found that the relationship between the air flow rate per unit cross sectional area of the bin and the depth of the rough rice is a straight line when plotted on log paper at different static pressures. The relationssship between Y and X for static pressure of 4.0 inch W. G. was expressed as

$$Y = 78.0\ X^{-0.52}$$

where Y = air flow rate of rough rice, $ft^3\ min^{-1}\ ft^{-2}$

X = Depth of rough rice, ft.

It was further reported by this group of researchers that the relationship between the static pressure and depth of rice for any bed depth can be expressed accurately by equation of the above form.

Henderson[1] developed the following relationship between the rate of air flow per unit cross-sectional area (Q) and the pressure (P) for shelled maize and bin walls to air flow for a given depth.

$$Q = \frac{59\ P^{0.63}}{D^{0.66}}$$

where, Q = air flow rate, $ft^3\ min^{-1}\ ft^{-2}$

P = pressure.

D = Depth.

Shedd[4] carried out research on ear corn (M. C. 20%) for depth varying from 2 to 12 ft and proposed the following approximate equation

$$Q = 300\sqrt{\frac{P}{D}}$$

Hussain and Ojha[2] carried out experiments to study the characteristic of resistance to the passage of air flow through three Indian varieties of paddy rice. They expressed the pressure flow relationship as

$$P_s = KQ^N$$

where, P_s = Static pressure
K, N = Constants and are functions of depth.

They found the following equations for the three varieties of rice paddy.

$P_s = (0.032d - 1.32)Q^{2.14-0.0089d}$ (Dulor)

$P_s = (0.045d - 1.22)Q^{1.52-0.0035d}$ (Taichungnative—1)

$P_s = (0.045d - 1.99)Q^{2.11-0.0076d}$ (Patnai—23)

The pressure distribution along the column of paddy was found to be linear and the rate increased as the pressure under the bed was increased.

Laboratory Equipment

A cylinrical bin of capacity 4.62 cft was constructed for this test. A false floor that is a perforated floor was located 13 inches above the bottom of the bin and the plenum chamber was established under the product used. The air was moved through the product by a blower powered by a ½ hp. electric motor. The static pressures were recorded by inclined manometer for the range up to 8 inches of distilled water. The quantity of air moved through the product was controlled by throttled lever. The quantity of air moved through the system was measured by a venturi-type flow meter designed according to B. S. 1042, Part I, 1964 by Ziauddin, A.M.M. and Hossain, Md. Mosharaf[5] and was constructed in the workshops under the department of Farm Power & Machinery, Bangladesh Agricultural University, Mymensingh. The tests were performed on three lots of paddy.

Test Results

The relationship between the air flow rate (Q) cu. ft. per minute per square foot and the static pressure drop (ΔP) per foot of depth the product in inches of water was investigated. It was found that the graph showing the relationship between (Q) and (ΔP) provided the best means for analysing and interpreting the data. It was found that the plot Q versus ΔP on logarithmic paper showed a straight line. The resulting curves can represented by the following equation :

$$Q = a\,(\Delta P)^b$$

where, Q = cu.ft/min/sq.ft.
a = constant
b = constant
ΔP = static pressure drop per foot depth, inches of water.

The test results are shown in **Tables 1, 2 and 3** and the corresponding values of a and b are shown in **Table 4. Fig.1** shows the straight line relationship for paddy of Naizarsail, Chandina and BR-3 varieties. **Fig.2** shows the computed curves and the experimental points for each variety.

Conclusions

The relationship between the

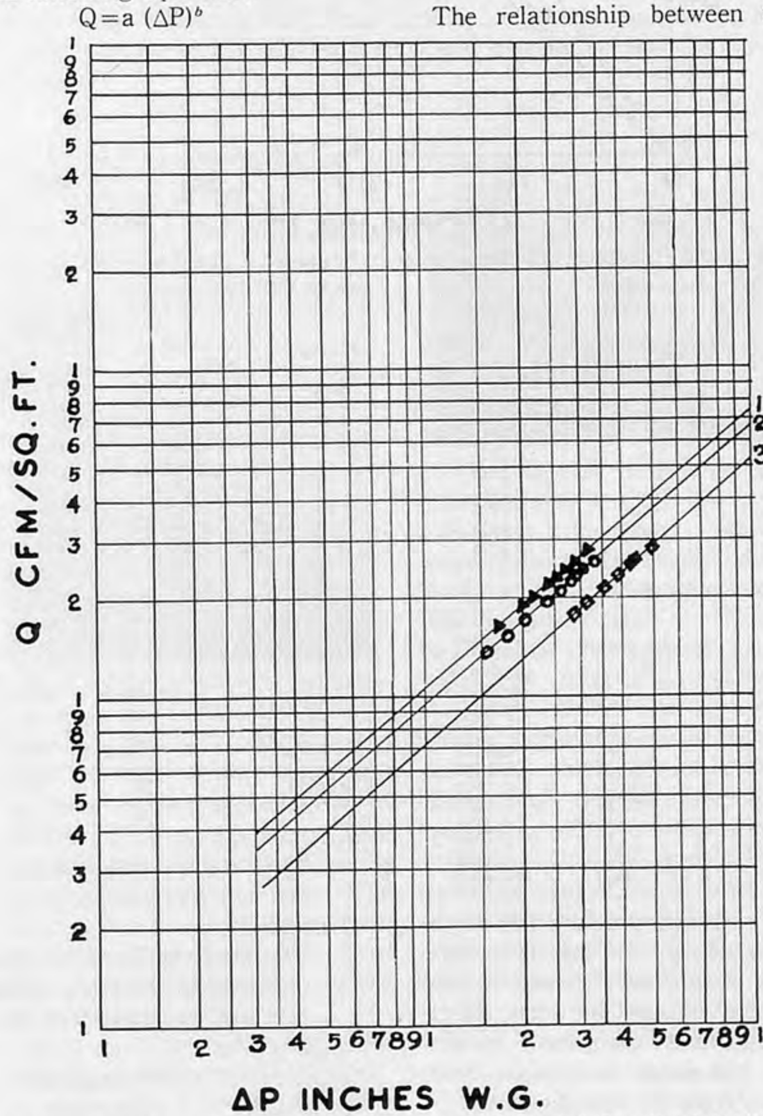

Fig.1 Resistance to airflow of three varities (1. Naizarsail, 2. Chandina 3. BR-3)

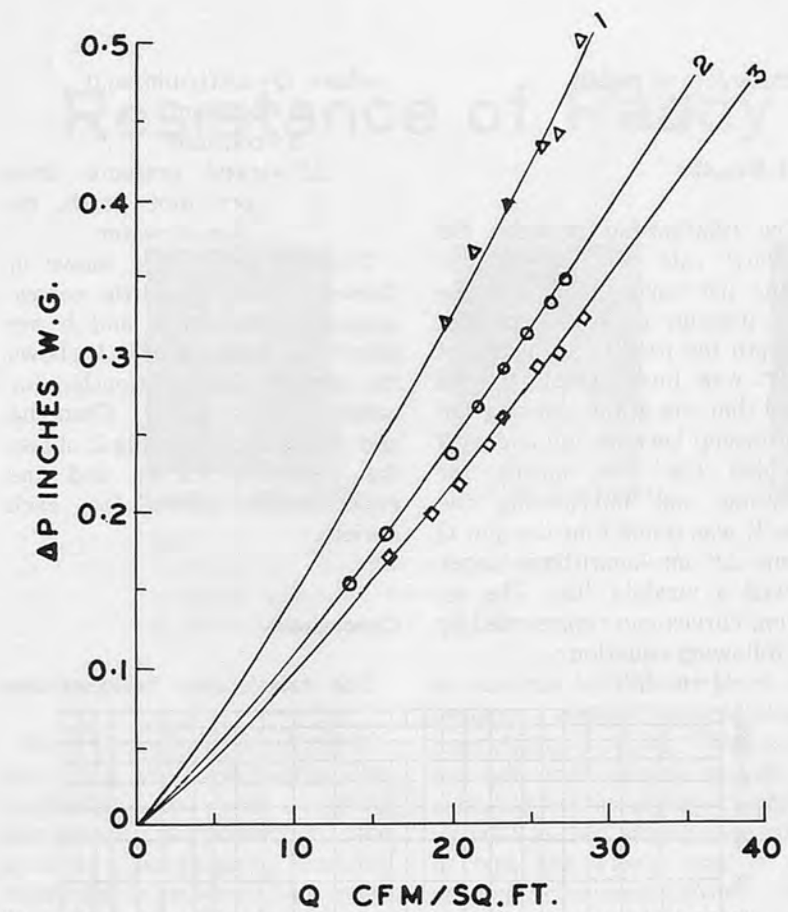

Fig.2 Comparison of theory and experiment (1. Naizarsail, 2. Chandina 3. BR-3)

Table 1. Naizarsail Paddy Variety

No. of Observation	Air Flow Rate (at 80°F) Q, c.f.m./ft2	Average Pressure Drop, △P inches of water/ft. depth of grain
1	18.10	0.2895
2	19.68	0.3190
3	21.40	0.3656
4	23.48	0.3973
5	26.00	0.4327
6	27.00	0.4408
7	28.15	0.5000

Table 2. Chandina Paddy Variety

No. of Observations	Air Flow Rate (at 80°F) Q, c.f.m/ft2	Average Pressure Drop, Δ P inches of water/ft. depth of grain
1	13.46	0.1566
2	15.98	0.1840
3	20.08	0.2354
4	21.79	0.2662
5	23.36	0.2920
6	24.88	0.3121
7	26.34	0.3309
8	27.65	0.3412

Table 3. BR-3 Paddy Variety

No. of Odservations	Air Flow Rate (at 80°F) Q, c.f.m/ft2	Average Pressure Drop, Δ P inches of water/ft. depth of grain
1	16.80	0.1700
2	18.94	0.2000
3	20.70	0.2166
4	22.40	0.2420
5	23.18	0.2590
6	25.42	0.2920
7	26.85	0.3036
8	28.13	0.3200

Table 4. Values of Constants, a & b, three varieties of paddy, Bangladesh.

Variety	Constant a	Constant b
Naizarsail	52	0.86
Chandina	67	0.86
BR-3	74	0.86

flow rate and pressure resistance to air of each of the three varieties were studied. Postive relationship existed between experimental and computed results. The following conclusions were drawn from the investigation.

1) The relationship between flow rate and pressure arop can be expressed as

$Q=a(\Delta P)^b$

2) The final equations for the relationship between flow rate and pressure drop are given by

$Q=52(\Delta P)^{0.86}$ (Naizarsail)

$Q=67(\Delta P)^{0.86}$ (Chandina)

$Q=74(\Delta P)^{0.86}$ (BR-3)

Finally, it was concluded that the horsepower required to force a known quantity of air for each variety of paddy can be readily calculated from the static pressure drop, volume of air flow and horse power relationship as shown below.

$$HP=\frac{VxP}{6356} \text{ x Efficiency}$$

where, HP = Fan horse power

V = Volume of air, o.f.m.

P = Pressure drop, inches of water.

If the efficiency of the fan is known, the actual horse power required can be easily determined.

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Report from Overseass Shows

Royal Smithfield Show

The 166th Royal Smithfield Show was held to the public at Earls Court, London from 5th to 9th of December, 1977.

From spanners to spud harvesters, the Royal Smithfield Show offers the would's most comprehensive display of farm equipment-under one roof. Around 200 new products were being introduced, and among the more unusual machines on display were a revolutionary tractory; a pea harvester which can pick and shell 77 tons of peas in a working day (enough for about 1¼ million meals) and electronic equipment for the selection of potatoes.

Tractor

The County 1174 Forward Control···with an 84 kW (112h.p.) engine and the unique County Drive System is designed as an agricultural tractor capable of outstanding performance, and handling large implements with ease. The forward mounted cab imposes sufficient weight on the front axle to balance the unit for maximun traction during heavy draught operations without the use of additional front weight. Large windows with tinted glass give the driver an unobstructed view of his work and the implements are clearly visible. The tractor is fitted with twin assistor rams, double spool valves and an optional hydraulic levelling ram may be fitted enabling implements to be simply operated from the control module. The two mid-mounted fuel tanks have a total capacity of 227 litres (50 gals.). Sufficinet for many hours of work.

(County Commercial Cars Ltd, Fleet, Hants)

Tractor

Fiat 680 ··· available in two-wheel and four-Wheel-drive versions, the Fiat 680 tractor has a fully enclosed, 68 hp four-cylinder diesel engine the capacity of which is 3,456cc maximum r.p.m. is 2,500 and maximum torque is produced at 1,400 r.p.m. The tractor has a twin 279.4 mm diameter plate clutch with live p.t.o., and a 12-forward, three-reverse speed gearbox.

(Fiat-Agricultural Tractor Division, London)

Tractor Cab

DB Q-Cab ··· designed and manufactured by the DBT company, this new cab will become progressively available as basic bquipment on all standard DB tractor models.

Principal characteristics of the new DB cab are: extra-wide lockable doors giving easier access to the more spacious, fully insulated interior; heater / ventilator with 2-speed fan; multi-purpose control console incorporating a linkage levelling lever operated from inside the cab; solid metal / glass rear panel with sliding windows; sun visor; and screen washers.

The new comply with NIAE/ OECD requirements ralative to safety and noise levels.

(David Brown Tractors Ltd., Meltham Huddersfield)

NEW PRODUCTS

Tractor Cab

Low-Profile Removable Q cab··· designed in co-operation with Ford Tractor Operations, these cabs are now available as an option to the standard Ford Q cab for farmers who want to operate in low buildings. The overall height of the new Lambourn cab on the 4100 model is 91" and on the 4600 model 93.5". This puts these cabs amongst the lowest available on the U. K. market and allows entry to many previously inaccessible areas with the cab still fitted. However, the cab can be easily detached at fender level simply by unplugging the wiper wiring socket, lifting off the doors and removing eight bolts. The removal of the top half of the cab does not affect the use of the Ford agricultural loader, all the controls remaining in position.

Main features include :

1. Two wide lockable doors
2. Toughened glass all round, set in heavy rubber surround
3. Quickly detachable upper cab structure (8 bolt fixing)
4. Two lifting rings on cab roof
5. Hinged side windows for extra ventilation
6. Hinged upper rear window opened by gas struts. The lower rear window hinges separately to allow access to controls
7. Black polyurethane covering on bulkhead and transmission housing
8. Non-slip urethane floor mats
9. Undersealed fenders
10. Seven pin trailer socket
11. Side and rear lights, flashing turn indicators and licence plate illumination
12. Two external rear view mirrors

(Lambourn Engineering Ltd, Lambourn, Newbury, Berkshire)

Plough

Carnfield heavy-duty subsoiler/chisel plough···a feature of the implement is its comparitively low power requirement. This is achieved by the chisel plough tines loosening the topsoil which reduces the drag on the following subsoiling legs. The subsoiling legs can be adjusted to two different depth settings, giving a difference of 10 inches and 13 inches between the front and rear tines.

The robust welded frame carries four chisel plough tines on the front 100mm square, 2.5m-wide front beam, and two subsoiling legs fitted with detachable wings on the 250mm square rear beam. This enables chisel ploughing and subsoiling to be carried out simultaneously.

(Carnfield Engineering & Construction Ltd., Alfreton, Derbyshire)

Plough

Askan reversible plough···available in 3- or 4- furrow models, is a further extension of the proven Krone setional system for use with high hp tractors.

The range is fitted with a sheer pin safety device on each body (adjustable from 14–16 inch width) and as an added protection a fully hydraulic stone safety release can be fitted as an extra.

Design featrues include a robust headstock with separate angle control ; fully-automatic turning mechanism with no dead-point for a high standard of operating control ; and a support wheel that can easily be adjusted to serve as a transport wheel. This removes the strain on the tractor-headstock-hydraulics section and ensures safe, rapid road transport.

(Bernard Krone (U. K.) Ltd., Hadleigh, Ipswich)

Cultivator Drill

The Nordsten Cultivator Drill···the drill has a working width of 4.00m (13ft 2in) and a hopper capacity (for barley) of 420kg (8.2cwt). Sowing width between the 27 rows is 14cm (5½in).

Like the 3.00m cultivator drill it is intended for sowing on the heavier clay lands and has flat spring tines coupled to the sowing tubes. The angle of the point and stiffness of the spring tines are designed to avoid bunching the seed or bringing the cold subsoil layer to the surface.

This featrue is desirable in heavy clodding soils and has a particular application in the sowing of peas and beans, where it is important to get down to the moisture level for satisfactory germination.

(Ransomes Sims & Jefferies Ltd., Ipswich, Suffolk)

Potato Planter

Howard Super Rotaplanter··· the new machine is the Supper Rotaplanter-an improved version of the well-established Rotaplanter with a high working speed of 4½ to 7½ mph and requiring only one operator.

Hopper capacity has been increased to 11cwt and 6.00x 9 10 ply tyres have an improved profile.

Special features include a deluxe seat and better protection for the operator and the machine from dust and trash thrown up by the tractor wheels.

(Howard Rotavator Co., Ltd., Edmunds, Suffolk)

Forage Harvester

Sperry New Holland 1895 ··· the new Model 1895 is a higher horse power version which can utilize the harvester's capacity to the fullest extent. The 1895 is designed for heavy duty operation by contractors, dehydrators and large scale farming enterprizes.

The engine fitted is the Caterpillar 3306T straight six cylinder diesel producing 250 HP at 2,200 RPM. The harvesting unit is fed by four feed rollers which can be instantly reversed in the case of blockage. The reversing gearbox has a planetory gear and brake band design which permits "inching" of the material into or out of the feed rolls.

(Sperry New Holland, Division of Sperry Rand Ltd., Aylesburg, Bucks.)

Forage Harvester

Taarup Trident-501 ··· following upon the success over the past two seasons of the Trident -502, offering a dual capability of fine chopping from both pick-up or direct cut, Taarup have now added a slimmer version — the TRIDENT-501 — with a reduced overall transport width of 9ft. 2in., compared with 10ft. 2in. for it's larger stable mate. The cutting width is 5ft. for this new machine.

The introduction of the '501' follows considerable demand for a narrower version of this design, which has proved extremely popular with both contractors and farmers. It will have special appeal to operators with narrow lanes and gates to contend with.

The success of the TRIDENT has been due largely to the incorporation of Taarup's exclusive fine chopping cylinder, together with the very generously dimensioned auger around an uncommonly large centre tube. These factors have contributed to its excellent performance with consistent fine chopping, especially in wilted grass.

The new '501' inherits all these features ... including a built-in knife sharpener, unique to this class of machine.

(Western Machinery & Equipment Co., Ltd., Ivybridge, Devon)

Drum Tedder

Flying Pheasant ... now incorporated into the Flying Pheasant drum tedder are 'teaser tines' to remove lumps and loosen the crop. Now available 'big baler' windrowing doors.

A 3 point linkage mounted machine the Flying Pheasant has P.T.O. drive to heavy duty gearbox with chain drive to rotor. Solid three sided drum with three banks of trailing tines. Fully castoring wheels. Built-in rust proof jack. Hayridges, spreads, swath turns, night swaths and windrows for conventional or big balers.

(British Lely Ltd., Wootton Bassett, Wiltshire)

Round Baler

The John Deere 410 ... six upper forming belts encompass the bale during the entire process and the bale rides on the rear gate. Advanced features of the new baler include an open-end pickup, enclosed oil gearbox-hydraulic wrapping and bale ejection. The new machine also features the unique starter roll process available in the larger 510 machine which takes material and tucks it into the bale core for better compaction.

The bale size indicator, visible from the tractor seat, allows the operator to start the wrapping process when a "Stop" appears automatically after the desired size has been reached.

The 410 round baler can be operated with a 40 hp tractor with two dual hydraulic outlets. Twine wrapping is done hydraulically from the tractor seat, there are no cranks to turn or ropes to pull.

(John Deere Ltd., Langar, Nottingham)

Mower

The Class WM25···with a cutting width of 2.24m (7ft. 4in.), the mower has three cutting drums and is mounted on the tractor 3-point linkage. As with the large WM 30 3-drum system, a tractor with wide wheel track or larger tyres can be used without running over the crop.

Minimum tractor power requirement is 35 h.p. A feature is the dual spring linkage suspension which makes it possible to cut over undulating ground at high speed.

Capable of cutting at angles of +22 deg. to −19 deg., the mower weighs 420 kg (9241bs.) and can be easily swung into the transport position to give a width of only 1.77m (5ft. 9in).

(J. Mann & Son Ltd., Edmunds, Suffolk)

Mower Crimper

Olympus KM 165 ... a 3-point linkage mounted unit with a working width of 5ft 3in (1.65m).

Designed for the medium sized dairy farmer, the 165 is a smaller version of the trailed KM 240 introduced last year.

The KM 165 incorporates the same 4-disc cutter bar as the Discus mower and Doublet mower-conditioner, a fact which simplifies servicing and parts availability. Above the cutter bar is mounted a pair of profiled rubber rolls.

The conditioning effect on the grass can be varied by increasing or decreasing the pressure between the rolls, whilst a heavy duty plastic cover guards against the danger of stones flying up from the discs.

(Vicon Ltd., Ipswich, Suffolk)

Onion Harvester

The Wilder Onion Topper··· the tractor mounted Flail Onion Topper enables growers to top and clear onion beds prior to harvesting. The implement is fitted with long and short flails, the pattern of which can be varied to accommodate the many different bed sizes and row widths in current use.

In operation the long flails rotate between the onion rows, lifting up the dead and fallen haulms in order that the material can next be chopped by the shorter flails. The pulverised haulm is then discharged out of the rear of the machine.

The Wilder Onion Topper has a cutting width of 1.8m (72").

Wheel positions are adjustable. Two models are available, a Standard model and a Spinner model complete with discs and hydraulic motors.

(John Wilder (Engineering) Ltd., Wallingford, Oxon).

Fertilizer-Spreader

Eurospand Series-S . . . our fertilizer-spreader EUROSPAND offers some unique features that really set it appart from any other make.

The hopper, conical in shape, is made according to the latest known techniques, deep, drawn, no welding, of the highest quality steel with the smoothes surface where it counts : on the inside of the hopper !

The manufacturing characteristics, specified elsewhere in this brochure, guarantee a constant and continous flow of the materi al being spread, eliminating any clogging and assuring a uniform

spreading pattern even with pulverized materials.
(Mil Ltd., Wolverhampton)

Slurry Tanker

MF100 . . . the MF 100 slurry tanker range is of the vacuum fill, pressure discharge type, in four models from 3640 litres to 9100 litres (800 to 2000 gallons). The design emphasises built-safety features and exceptionally strong axle equipment, including dual axles on the two largest models.

The pump is direct-driven and gives a spread width up to 15.2m (50ft) and a fill-time of 11½ to 3¾minutes, according to model. It can be equipped with hydraulic operation of the gate valve to provide full control of spreading from the driving seat of modern closed-cab tractors.

(Massey-Ferguson (UK) Ltd., Banner Lane, Coventry)

Slurry Injector

Bauer Slurry Injector . . . with this equipment between 40 to 100 m_3 slurry can be injected into the ground at a depth of 10–20cm without offensive odours.

The unit can be employed on freshly harvested ground or on plowed fields but may also be used on hoed crops in-between plant rows and even on maize up to a height of 60cm.

Distribution between plant rows provides valuable top manuring.

The equipment can, furthermore, be used also on pastures without doing damage to the turf.

During dry weather the manure can be distributed without loss of nitrogen for the injected manure and the volatile nitrogen is instantly absorbed by the ground, resp. covered by earth.

On using the tandem system–tractor with injector and tractor with slurry tanker–it is sufficient having tractors with 40–50 HP. if several slurry tankers are employed the injector can be in continuous operation.

The slurry tanker, whether empty or full, always travels on unmanured ground which avoids slurry-dirtied wheels on the roads.

(British & General Tube Co., Ltd., Slough, Berks.)

Salon International de La Machine Agricole (SIMA)

The 49 International Agricultural Machinery Show (SIMA) was held in Paris of France for a week during 5–12 of March, 1978.

The mission of the COMMITTEE TO ENCOURAGE TECHNICAL RESEARCH is to show to advantage the technical achievement of French and foreign manufacturers which are exhibited at the SIMA, when they offer a character of novelty or original improvement which can be considered as progress in the field of agricultural mechanization.

The personalities of this Committe, resolving themselves into a Board, after examining the literature or machines take into consideration the achievements meeting the following criteria :

a) be of an interesting and distinctly agricultural nature ;

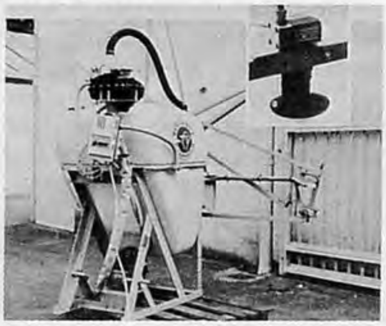
b) offer a character of novelty or original improvement as compared to equipment already built or to patents lodged, either by their general principle, or by certain important elements in the design or construction ;

c) provide progress in at least one of the following fields :

- operation (quality of work, gain in productivity) ;
- use (facility of use, comfort, safety, reduction in the user's fatigue) ;
- technical design ;
- economy (price and amortization conditions).

The selected machines in the committee of the 49th SIMA are as follows :

ULV Sprayer



The rate of application is only 20 to 40 litres/ha and immediately applies to any treatments and circumstances. The liquid (regulated by a Bermatic for a constant volume/ha) is sprayed by swirl plates rotating at high speed in "centrifugal nozzles". A 12 volt motor controlled by electrovalves ensures the swivel plate rotation. The speed of rotation of the swivel plates is varied by a rheostat (up to 10,000 rpm) thus giving a precise control of dropled diameter and impact "density". Three "centrifugal nozzles" treat a swath 9 metres wide.

(Berthoud : Rue Victor Hugo, 69220 Belleville sur Saone)

A Cutter of Suckers of Strawberries Cultivated on a Plastic Mulch

Suckers reduce the yield of strawberries. Soft and thick brushes lift the suckers and present them to a blade which cuts them away. These brushes mounted by two revolve in opposite directions. This machine "la stolinière", "self-tracted" (5hp) easily replaces ten people (output 1ha/day).

At the same time the beds are cleaned. A special auger removes dead leaves, or with a longer support, cuts the strawberry plants.

(Bigot : Zone Industrielle de Boulazac, 24000 Périgueux)

Universal Cutting Table

Gram harvesting losses are reduced and the travelling speed is increased.

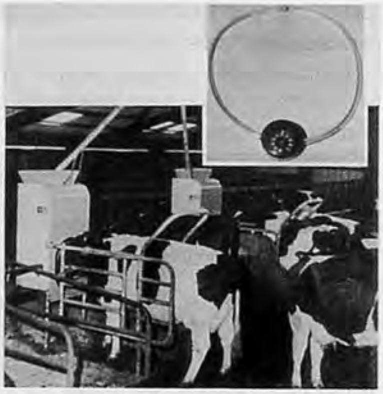
A slatted rubber elevator is placed between the cutter bar and the feed auger running with a relatively high speed (70–80 m/min). The crops fall on this elevator and roll under the auger, ears first and stems in a parallel direction. The auger diameter is larger with a bigger and more elevated pitch.

The threshing drum ensures a better shelling and does not clog. The ears slip. Prethreshing is reduced, the reels are not so useful and can be set "softer" with less adjustments in laid crops. without "crop wall" in long strawed cereals or rape.

(Massey-Ferguson : 22, avenue Galilée B.P.25, 92350 Le Plessis Robinson)

Programmed Distribution System of Concentrated Feed

High milk yielding cows have to be fed with a great deal of



concentrates but they have not enough time to eat their ration during the two milkings. The high nutritional rations have to be distributed preferably at several times.

A distribution programme takes into account the requirements of the animal and its deglutition and rumination speeds. A timed electronic medal fixed on a collar round the neck of the cow is fitted with a pro-set dial allowing the animal to have its fair ration. When the cow approaches the manager's antenna, it is identified. A programmer sets the flow of the feed auger. The number and the hour of the meals are decided by the cow itself, within the limit of the scheduled ration.

(Alfa-Lavel : 62–70, rue Yvan Tourgueneff, 78380 Bougival)

The 〈AR 80〉 Self-Regulating Device for Mounted or Trailed Sprayer

A servo control device adapted to mounted sprayers and fixed on a regulator affects the spraying pressure (varying as the square of the foward speed) and ensures an application rate proportional to forward speed.

In the regulator, the spring has been replaced by an actuator which is operated on one side by the spraying pressure, on the other by the hydrostatic circuit pressure. The position of this actuator adjusts the quantity of liquid to be returned to the tank.

A feeler wheel runs, without slipping on the wheel of the tractor or sprayer and drives a mini pump. The latter applies to a hydrostatic circuit a pressure proportional to forward speed by means of an output monitor with the same application rate) pressure relation as the spraying nozzles selected.

The regulator, instead of being at constant pressure, is modulated as the forward speed.

The output monitor is adjusted from the tractor cab, for a hnown speed, to the required volume/ha.

(Tecnoma : B.P.195, 51321 Epernay)

A Versatile Harvesting Header on the Uni-System New-Idea

Mounted on a self propelled forage harverster, the harvesting header can :

—ensile with direct cut
—cut, condition and swath
—collect and chop the swaths or crap residues.

The flails (with a peripheral speed reduced by 30%) cut the base of the stem without chopping it and ensure conditioning of the fodder by repetition of a gentle contact with the flails.

This fodder is, either laid down in swaths, or conveyed towards a high capacity cutting picked up rotor, or from the swaths.

The change in operation is obtained by opening or closing outlet doors under the delivery chute.

(Bara : 26, rue A. Joly, 78004 Versailles)

Flex Baler

On the HESSTON ROUNDER pick-up baler, new devices enable flax to be collected, stems being maintained parallelly, without the crop being rolled over, and, rolls thus shaped, can be swingled mechanically by a special unwinding system at the factory.

The flax raised by a knife then gripped between a wheel and a belt is turned over and compressed into a thicker parallel sheet. This sheet is centred by adjustable flanges, and two strings are inserted during winding to isolate the turns which are easily separated in swingling.

(Deporteere : 5, rue du Cardinal Mercier, 75009 Paris)

Feed Distributor Container

This equipment discharges feedstuffs to points which are difficult of access or of small dimensions such as mobile hutches housing poultry in the open air.

A three ton capacity trailer is fitted with an extractor to feed evenly a flexible worm 6-m long.

The tractor's power take-off drives a pump which actuates two motors :

—one for the strip extractor which stirs and ensures a regualar output at 50RPM
—one for the worm rotating at 750 RPM and delivering at 6T/h.

Two electrically controlled distributors make these two movements either simultaneous or individual.

(Gentil : Urzy, 58130 Guérigny)

A Plastic Film Transplanting Laying Perforating Machine

A plastic mulch laying device and a perforator are mounted on a commercial transplanter : all three operations are carried out in a once over pass. Four operators with the two row model can transplant 2,000 to 3,000 plants per hour.

The synchronization of the operations ensured by a can fixed on the planting wheel and by a thermal perforator at the place where seedlings are planted is the original feature. A solenoid valve (electric model) or an actuator (pneumatic model) triggers off the gas heated perforaing device.

A timing system schedules the contact duration of the perforating device on the film and a more or less wide opening is thus bored.

(Isle : Le Capiol, 24250 Domme)

Pneumatic Fertilizer Distributor 〈Tive 1000〉

The application rate of the pneumatic fertilizer distributor is proportional to forward speed. The spreding width is 6 to 12 metres, the hopper capacity is 1,000 litres and granular fertilizers can be used.

The accurate running of the speed variator fixed on the distribution toothed roller is ensured by balls and bearing races and adjusted by a micrometric screw.

This ground wheel-driven fertilizer distributor has adjustable springs and an application rate proportional to forward speed.

An areameter mounted on the distributor checks the adjustments. Static and dynamic tests with a view to using new types of fertilizers can be easily carried out.

(Kongskilde, B.P.57, Zone Industrielle 45800 Saint-Jean-De-Braye)

Liquid Feed Mixer-Distributor

This equipment consisting of two superposed tanks can prepare a fully balanced and homogeneous feed from liquid, solid or wet ingredients (specially for pigs).

— Proportionning is obtained by accumulative and programmed electronic weighing : the control cabinet can be remotely controlled or by radio and displays the

global quantity of mixture weighed, via a potentiometer. The upper tank is suspended to a dynamometer.

— The more or less continuous distribution is obtained by transfer into the lower tank, stirring by an auger, and distribution to the animals. The cycle recommences via electrovalves, pumps, augers, automatic vibrating distributors.

(Law : 5, avenue du Géneral de Gaulle, 60304 Senlis)

Pneumatic Market Garden Sowing Machine

The seeds are held by suction via a fan in contact with a drilled plate at a rate of one seed per hole. At the tile of dropping, the plate runs in front of a blower which ejects the seed.

The rotates driven by an electric motor at 8000 RPM. Shutter adjust the distribution of air according to the weight of the seeds ; the spacing is provided by a belt variator.

This principle, well known and appreciated for its accuracy was not yet adapted to small size (single row) market garden year.

(S.N.E.I.A. : 88bis, rue de la Convention, B.P.728, 44100 Nantes Cedex)

Modular Swathing Mower

This mower follows the uneveness of the ground and can be used at high speed (up to 18 km/h).

The cutter bar features a number of modules adapted to the farm requirements.

Each cutting disc is fitted with free knives and mounted on a mobile, interchangeable module. If need be, dampers are fixed on the modules, thus avoiding ther springing-back.

Behind the dics, a steel fingered rotary rake, mounted on rubber blocks, conditions the crop, and projects it against adjustable shutters to form a swath.

A set of rotary flails can be aded whose work is similar to that of a forage harvester, and a rear discharger for very damp crop.

(S.N.E.T. Garnier : 12, quai Jean Bart, 35600 Redon) ■■

The World Agricultural Situation

by U.S.Department of Agriculture
(Economic Research Service
WAS-15, December 1977)

World agricultural production (excluding China) may have increased a little more than 1 percent in 1977, despite a 2-percent drop in global grain output (**table 1**). The People's Republic of China appears to have about matched the world performance.

Agricultural output in the developed countries (including the centrally planned economies) rose about 1 percent, held back largely by a big decline in the USSR and also by declines in Canada and Oceania. The most notable gains resulted from the recovery in Western Europe and a substantial increase in U.S. output.

In the developing countries, a sharp increase in Latin American agricultural production and moderate gains in South and East Asia more than offset reduced production in Africa and West Asia, resulting in an overall increase in agricultural output of about 2 percent.

Total world food production (excluding China) also increased about 1 percent, with developed and developing countries both about matching the overall gain. Per capita food production was unchanged in 1977 or may even have declined a little, since population growth likely meant slightly lower per capita output in developing countries. The trend rate of growth in per capita output for the developing countries has been about 0.4 percent since 1960. The rate of increase in food production in 1977 about matched that for population growth in heavily populated South Asia and in Latin America, fell sharply below in Africa and West Asia, and was moderately below in East Asia.

Economic growth in developed countries in 1978 is expected to be about the same as in 1977, adding little stimulus to foreign import demand, and, with 1977/78 world food supplies generally above yearearlier levels, U.S. export prices are likely to average lower. Consequently, U.S. agricultural exports may drop around $2 billion from fiscal 1977's $24-billion record, although export volume is expected to increase.

The world grain outlook continues much as reported early in the season—except for a substantial increase in the estimate of rice output—with overall production down and consumption up in 1977/78. Coarse grain stocks are still expected to build, although not as much as forecast earlier, but wheat stocks should fall somewhat.

World production of oilmeal is forecast to recover aharply in calendar 1978 because of good oilseed crops in most major producing regions. The resulting lower prices, especially when compared with those for feed grains, are expected to bring increased use of oilmeals in feed rations, particularly the United States, the European Community (EC), and Japan. World production of edible vegetable oils is also expected to increase in 1978,

Table 1 Selected Indices of World Agricultural and Food Production (excl. China), 1961−65=100

	Total agricultural production						Total food production						Per capita food production					
	1972	1973	1974	1975	1976	1977*	1972	1973	1974	1975	1976	1977*	1972	1973	1974	1975	1976	1977*
Developed countries	123	131	129	128	134	136	125	133	131	130	137	138	115	121	118	116	121	121
United States	120	122	117	126	129	132	126	128	122	134	136	139	114	115	109	119	120	121
Canada	120	123	112	127	140	134	122	123	112	128	143	135	106	106	95	106	117	110
Western Europe	121	123	128	125	123	129	121	123	128	125	123	129	113	115	119	115	113	118
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* Preliminary.

and larger consumption should follow as vegetable oil prices retreat from their 1977 highs. Stocks of both meals and oils (most in seed form) are expected to increase.

The overall levels of meat production, consumption, and trade in the world's two largest meat consuming regions—the United States and the EC—were little changed in 1977 from 1976 and are likely to continue relatively steady into 1978.

World milk production increased an estimated 2 percent in 1977, with the largest gains in the USSR, the EC, and the United States. World butter and nonfat dry milk stocks remain in surplus, and more growth in stocks is expected, while cheese supplies and consumption should be in relative balance.

World sugar consumption is not expected to increase as sharply as the forecast 4-percent increase in production, and a sizable increase in stocks is expected. Implementation of the new International Sugar Agreement may lead to some recovery in sugar prices in 1978.

Coffee production is bouncing back from 1976/77's low level largely because of a substantial recovery in Brazilian output, but a return to more customary levels of output is not expected until at least 1979. Prices have weakened substantially in recent months but remain well above those of a few years ago. World cocoa production is also likely to greatly improve over 1976/77's short crop, and prices have moderate considerably.

World cotton production is forecast to increase sharply in 1977/78 because of excellent weather in most major producing countries, but demand may be relatively sluggish, resulting in a rise in cotton stocks. World tobacco output declined in 1977 from the 1976 record high. Consumption should increase a little in 1978, so a stock drawdown is expected for the third year in a row.

IDA assists agricultural extension and research in India

by World Bank (IDA News Release No.78/31 December 29, 1977)

The International Association (IDA), an affiliate of the World Bank, today announced the approval of a credit of $8 million to help finance a project designed to reorganize and strengthen agricultural extension services and upgrade and develop adaptive research in the State of Bihar in India. The main objective of the project is to achieve early and sustained improvements in agricultural production, particularly of foodgrains.

Recent agricultural reviews in India have stressed the potential for achieving a significant and broadly distributed increase in production by improving basic cultural practices through regular and systematic training and visits to large numbers of farmers by village level extension workers. This system has the capacity to transmit appropriate recommendations from research to the village level quickly and at no extra cost. The new extension service was first tried in canal command areas of three World Bank/IDA-assisted projects in the States of Rajasthan and Madhya Pradesh and has resulted in dramatic production increases. This approach has been introduced in India through a series of five projects being assisted by IDA. Under these projects, nearly 15 million farm families in the States of Orissa, West Bengal, Assam, Rajasthan and Madhya Pradesh are expected to benefit.

The present credit of $8 million will help extend the improved system in the State of Bihar. The main result from the project will be an increase in foodgrain production benefiting an estimated 7.8 million farm families in Bihar. Small farmers with limited financial resources, but excess labor will be the primary beneficiaries. The IDA credit to India is for term of 50 years, including 10 years of grace. It is interest-free, except for a service charge of 3/4 of 1% to meet IDA's administrative costs.

Tobacco transplanter being develop

by Research and Farming (Vol.36: Nos.1-2, Summer-Autumn 1977)

RESEARCH is continuing at N.C. State Univarsity on the "missing link" in mechanized tobacco production–the growing and setting of tobacco plants.

Engineers with NCSU's Agricultural Experiment Station are working on an automatic transplanter that has the potential for setting an acre per hour.

Dr. B. K. Huang, head of the project, says this is the first automatic transplanter of any kind in the United States. As a consequence, producers of tomatoes, celery and other transplanted crops are already showing an

interest in the machine.

The experimental transplanter is actually only one element in a revolutionary new system of growing and setting tobacco plants. Plants for the machine are grown in a greenhouse rather that in outdoor plantbeds. The greenhouse later doubles as a solar-heated curing barn.

Each plant is grown in a plastic cube of peatmoss which measures one and three-quarters by one and three quarters inches. This means that the plants have a compact, well preserved root system at the time of transplanting. Such plants live better and grow more uniformly than bare rooted plants pulled from a conventional plantbed.

Eighty cubes are linked together in a flat or tray for speedier handling. These trays can be used over and over.

Tobacco seeds are among the tiniest seeds in the world, and putting one seed in each cube of peatmoss would be a tedious process. But Dr. Huang has solved this problem with another of his inventions–a tobacco seeder. He uses seed which have been coated with a clay mix. This makes them almost as large as BB shots and much easier to handle.

The coated seed are poured into a hopper on the automatic seeder. An operator presses a handle which isolates 80 seed by matching the holes in two feeder plates. Each seed then tumbles down a separate plastic tube to a waiting cube of peatmoss.

Seeded cubes of peatmoss are then placed on perforated metal racks in the greenhouse. The metal prevents the plant roots from matting.

Dr. Huang grows three racks of plants in his greenhouse-solar barn and he could grow four. "You need only about a fifth as much space to grow plants in a greenhouse as you do outside," he said.

After seeding, the tobacco plants are grown much like tomatoes, petunias or other bedding plants. They are watered, fertilized and given extra light when necessary. They are ready for transplanting in about seven weeks, which is about half the time required to grow than outdoors.

Dr. Huang's automatic transplanter is a two-row, tractor drawn machine. One person drives the tractor. Two other people are needed to keep the transplanter supplied with plants and water. As a comparison, about 13 people are needed to operate and service present two-row mechanical transplanters.

The transplanter holds six trays or 480 plants. The trays are placed on a platform which moves or indexes over an opening through which a vacuum sucks the plants from the plastic cube in which they were grown. The plant falls to the ground, receives a squirt of water, and is then firmed into place by a press wheel.

The entire operation takes less than two seconds per plant. Thus, the two-row planter can average more than one plant per second under ideal conditions. Of course, the time needed to turn the machine and to load ti with plants and water cuts into the average.

Huang believes the advantages of his new system, once the machine is in production, will be threefold, It will save labor and provide farmers with a more uniform crop, which is important in mechanical harvesting. It will also enable a farmer to get double duty out of his greenhouse-solar heated curing barn. This facility has cut energy costs by a third in two years of testing.

1 st INTECSOL (International Exhibition of Solar Technology and Equipment)

October 19–22, 1978, Verona/ Italy.

The International Verona Fair, in collaboration with the Verona C.R.A.I.E.S. (Research Center for Industrial Use of Solar Energy), proposes a new initiave to update public and professionals on the present state of research and development on the solar systems and equipment being manufactured in Italy and abroad. The Exhibition aims at spreading the word about the reality of these new technological systems, helping to increase their use, and giving information on future prospects for use in various sectors of the economy.

An International Conference on the Use of Solar Energy will be held simultaneously with the International Exhibition of Solar Technology and Equipment. Front ranking Italian and international experts in the field of sun research will take part in this Conference.

Categories of exhibits : flat solar collectors-Linear and point solar concentrators-photo-voltaic solar cells-solar and weather instrument–equipment for recording and elaborating solar and climate date-sea and salt-water desalination equipment-thermohydraulic building heating, cooling and conditioning equipment-heat exchangers-heat pumps-heat storage systems-automated devices and control systems-equipment for using solar energy in farming–process for the bio-chemical conversion of solar energy-process for the photo-chemical conversion of solar energy-exhibiting of technical publications.

GENERAL INFORMATION

Date : International Exhibition 19th-22th October 1978.

International Conference 19th-20th October 1978.

Location : Verona Fair Grounds, Viale del Lavoro, Verona.

Hours of opening : daily from 9.00 to 18.00 hrs.

Services and facilities : information office-overseas visitors reception and interpreters services-press and public relations office-post, telephone and telex services-bank and exchange office-international forwarding agent-travel agency-conference and meeting rooms with simultaneous translating services in italian/english/french/german-parking facilities.

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IX CIGR Congress

July 8–13, 1979, Michigan, USA.

In May 1977 the CIGR announced its IXth International Congress of Agricultural Engineering to be held at East Lansing, Michigan, USA on July 8-13, 1979.

One of the scientific program matters in Section 3 of the Congress will be on Appropriate and Effective Mechanization Systems for Agriculture in the Developing Countries.

In order to take care of this task properly, Mr. Adrian Moens, general reporter, is asking your cooperation in preparing a paper on this subject.

In following notes, we prepared an introduction of the subject as well as an identification of a number of major topics. It may be helpful to definie the type of contributions you like to make.

We would appreciate to receive your reaction, and in the case you intend to prepare a paper, a brief indication will be covered.

If you intend to make any type of contribution, please send all correspondences to following address.

Adrian Moens
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Wageningen
The Netherlands

Introduction.

The Management Committee of CIGR in cooperation with the Oraganizing Committee of the American Society of Agricultural Engineering of the United States-the host country for Congress-has selected as one of the themes of this Congress : Appropriate and Effective Mechanization Systems for Agriculture in the Developing Countries.

The main considerations for this selection are that it is getting better recognized throughout the world that adequate supply of power and equipment of the agricultural sector is a prerequisite for the security of future world food supply and an indispensable tool to fullfil the basic needs of the mass of the population in the Third World.

In planning future agricultural and industrial development there is a growing demand for more reliable information on the role that agricultural mechanization and the farm machinery industry can play ; particularly its impact on the increase of plant and animal production and the reduction of product losses during harvesting and post harvesting stages. And in addition other important features are : the impact of mechanization on the employment level both in primary agricultural sector and in other sectors of the society ; reduction of hard work and drudgery ; reduction of work by women and children.

Other related subjects are the estimation of future requirements of farm power units and farm equipment in the Third World ; what investment levels have to be met and how the farm machinery industry should be developed.

Handling this theme at the forthcoming Congress should enrich our supply of information and assist us to develop improved and new strategies for selecting the most appropriate technology in agriculture.

Out of the many aspects to consider, the following major topics have been formulated :

1) Strategy of agricultural mechanization planning ;
2) Design, development, testing and evaluation of tractors and equipment for agriculture ;
3) Development and application of mechanization and farming systems ; Multifarm use of tractors and equipment ;
4) Development of the agricultural tractor and equipment industry ;
5) Education, training and advisory services.

For each of these topics it is evident that the one universal solution of the problem does not exist. The conditions in the Third World are not only different from those in the industrialized countries but also different for Asia, Africa and Latin America as well as from one country to the other. Under the term "conditions" we think of : ecologlcal, climatic, geographic, agronomic, economic, social and cultural conditions.

However, as agriculture in the Third World is predominantly carrid out on a small scale and under other unfavourable conditions for mechanization it is evident that it is most adequate to concentrate our attention on this situation.

In this content mechanization of large scale farming is of particular interest if it is beneficial to surrounding groups of small farmers. Otherwise the mechanization of large scale farms either as family or as industrial enterprises will be dealt with in a separate section of the report.

In the next part of this note a number of key words have been given to indicate the subjects to be covered :

1 Strategy of Agricultural Mechanization

Principles and techniques in planning future requirements of farm power and equipment on national and regional levels : specifics of techniques ; available and required data information ; results of practical experiences.

It is evident that there is an urgent need for information, both in the public and the private sector, on the required amount of power units and farm equipment in the Third World.

11 Design, development, testing and evaluation of tractors and equipment

Information on engines, tractors, machinery including hand tools and animal drawn equipment for use in agriculture in the developing countries with emphasis on applicability on small farms either for individual use or for various systems of multifarm use.

In these activities that are carried out both in the industrialized countries as well as in the developing countries the following institutions are involved :

International research institutes, national agricultural engineering institutes, university department and engineering departments of industrial companies.

It is desirable to receive contributions for the Congress from all these sectors.

The contributions themselves may be of a general nature or deal with specific problems and solutions.

III Developmefft and application of mechanization and farming systems

Characteristics of the change of traditional farming systems to systems with higher levels of resource utilization, capital investments, income levels etc.

Results of systems research and practical experiences. Under this topic also the various systems of multifarm use of tractors and equipment will be covered.

IV Development of the agricultural equipment industry

The development of an agricultural equipment industry is a complementary part of agricultural mechanization.

Included in this topic are problems on marketing, after sales services and industrial managment.

The appropriate level of technology and scale of operations are fundamental aspects and related to these can be mentioned experiences with joint ventures. Specific attention might be focused on experiences with training courses on various levels ; spare part supply and other after sales services, marketing, crediting, government policies (taxes) etc.

Reports may be dealing with general policies or specific cases.

V Education, training and advisory services

Illiteracy is considered as the highest priority problem for development, ranking even higher in urgency than energy or capital requirements as it is basically dependent of the capacity and the attitude of the man in the Third World himself.

What are the minimum requirements on general and specific knowledge and skills to develop agricultural mechanization and a farm machinery industry successfully? How to arrive at this level? What experiences are available we can learn from? Although lastly mentioned in this list of topics it is certainly the most important one.

With reference to this it can be noticed that throughout the Third World plans and investments are made for strengthening the fysical, scinetific and manpower facilities for research, training and advisory work in the area of agricultural mechanization and related agricultural engineering fields, both on national and internatinal levels.

It is most important to be informed on what should be the goals to achieve, what results have already been obtained and to what extent a more close cooperation and coordination could be beneficial. ■■

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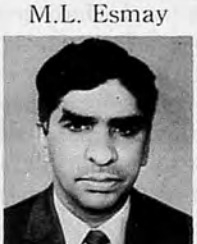
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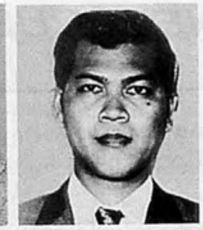

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NEW PUBLICATIONS

—1978 Edition—
The Green Book
(U. K)

Each year the face of farming is changed by new equipment and different products as a result of energetic developments by our manufactures.

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The Green Book contains 30 Sections and the information it contains runs to over 600 pages. Main sections are as follows : –

Multi-Lingual Glossary : To assist the many overseas readers of the book the main items of the range of equipment shown is translated into four chief languages.

Tractors : Each tractor is given a page to itself, the photograph is accompanied by a full description of the vehicle to include all the specifications.

Farm Equipment : Seventeen Sections are given over to the manifold types and vaieties of equipment used in farming. Each Machine or piece of apparatus is illustrated and described.

Maunfacturers Names & Address : Are listed under Section 2. It contains 1400 names and addresses with telephone and telex numbers where avaiable.

Price per copy : £10.50+86p (small order charge) ; USA $ 23.00+$2 (postage and packing) by Surfacemail-$12 (postage and packing) by Airmail

To : Thomas Reed Industrial Press Limited,
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London, EC1A9BY, England.

Supporting Papers :
World Food and Nutrition Study
(U.S.A.)

The study was begun in June 1975 by a Steering Committee appointed by the President of the Academy. It produced two reports for the President : an Interim Report, published by the Academy in November 1975, and a final report, World Food and Nutrition Study : The Potential Contributions of Research, published in June 1977. The Steering Committee was assisted by 14 study teams appointed by the Academy to analyze and make recommendations to the Committee on various portions of the study.

This publication is one of five volumes containing the reports of Study Team 1-10, 12, and 14. Study Team 11's report overlapped the other reports and has been integrated with them. Study Team 13's report of its ranking of research priorities was an integral part of the work of the Steering Committee. Consequently, it is not published here.

This is Volume I of Supporting Papers, World Food and Nutrition Study. The other Volumes are :

Volume II
- Study Team 4 Recources for Agriculture
- Study Team 5 Weather and Climate

Volume III
- Study Team 6 Food Availability to Consumers
- Study Team 7 Rural Institutions, Policies, and Social Science Research
- Study Team 8 Information Systems
- Study Team 10 Interdependencies

Volume IV
- Study Team 9 Nutrition
- Study Team 12 New Approaches to the Alleviation of Nunger

Volume V
- Study Team 14 Apricultural Research Organization

Size : 22.7×15.0 cm
Page : 318 pages
Available from : Printing and Publishing Office, National Academy of Sciences 2101 Constitution Avenue, N. W. Washington, D. C. 20418. USA

Farm Water Management for Rice Cultivation
(Japan)

Water stands out as one of the most important farm inputs that influence agricultural productivity. On irrigation depend the effective application of fertilizers, increased yields of rice varieties and the maximum use of farm resources such as labor and land. In this context, proper management and efficient use of irrigation water is no less important than the construction of new irrigation facilities. In an effort to assess the actual status and to discuss institutional, engineering, agronomic and socio-economic problems of farm level water management in paddy fields in member countries, the APO conducted a regional survey on water management at the terminal level for rice cultivation and, subsequently, organized a symposium on farm water management in Tokyo in September, 1976.

The present volume reports on the highlights of this symposium. Included in this volume are papers of resource persons from various disciplines, Summay of the regional survey and country reports of participants preseted at the symposium.

The main contents are as following :

Part 1 Summary of Findings
Part 2 Symosium Papers
Part 3 Report of APO Survey on Farm Water Management for Rice Cultivation
Part 4 Country Reports
Part 5 Appendices

Size : 13.7 × 21.4 cm

Page : 333 pages

Published by Asian Productivity Organization Aoyama Dai-ichi Mansions, 4-14 Akasaka 8-chome, Minato-ku, Tokyo 107, Japan.

Technical Bulletin No. 1557
Annotated Checklist of New World Insects Associated with Prosopis (Mesquite)
(U.S.A.)

Mesquite, *Prosopis glandulosa* Torr., and its relatives are widely distributed in both the New and Old World, but until recently the complex of insects associated with these plants had been almost completely ignored. Now, however, many people in North and South America have become interested in mesquite and other species of *Prosopis* for a variety of reasons. For those studying the possibilities of controlling mesquite by biological means, this list provides access to as much information as possible about insects found on *Prosopis*.

The insects that have been collected on or reared from *Prosopis* in the New World are listed alphabetically by orders and families. Specific host records, ecological notes, alternate hosts, synonyms, distribution data, and information sources are given. The insects are indexed by host plant and insect species name.

Size : 26.0 × 19.5cm, Page : 115-pages,

Address communications to D. E. Foster, Entomology Department, Texas, Texas Tech. University, Lubbock, Tex, 70409, USA

Published by Agricultural Research Service, U. S. Department of Agricuture, Hyattsville, Maryland 20782, USA

Technical Bullelin No. 1563
The Hydrology and Hydrogeology of Ahoskie Creek Water shed, North Carolina: Data and Analysis
(U.S.A.)

The research upon which this bulletin is based was a cooperative effort of USDA Agricultural Research Service, the USDA Soil Conservation Service, the U. S. Geological Survey, the North Carolina Department of Natural and Economic Resources, and the North Carolina Agricultural Experiment Station. The purpose of the research was to collect, analyze, and interpret hydrologic data in order to determine the hydrologic characteristics of Ahoskie Creek watershed in the Coastal Plain of North Carolima.

The bulletin is divided into six main sections. The "Introduction" describes the formulation of the project and outlines the study. "Watershed Physical Characteristics" contains the information provided by onetime or survey-type date. "Channel Characteristics" treats stability and conveyance. "Basic Data and Representativeness" describes the data available, data summaries in the appendix, and considerations of precipitation normalcy of record periods. "Data Summarization" gives the first level of information from the time-dependent data. "Analyses and Interpretations" includes information on hydrologic component interrelations and hydrologic and geohydrologic inferences.

Because of the comprehensive nature of the report, a brief summation of the most significant findings is presented, rather than a full summary. Users are cautioned to exercise care in taking excerpts out of context, lest misuse and misinterpretations result. Developments and findings are appropriately referenced.

Size : 26.0 × 19.5cm, Page : 163-pages,

Penalty for private use : $300

Published by Agricultural Research Service, U. S. Departmant of Agriculture, Hyattsville, Maryland 20782, USA

Approaches to National Economic & Industrial Planning for the Developing Countries with Special Reference to the Development Process of Japan.
(Japan)

This is an Elaborate account of Japan's economic, industrial and agricultural evolution, tactics & strategy and their applicability to the developing countries — an invaluable document and reference for learned individuals, Govt. agencies, international organizations, companies, researchers, and experts interested in Japanese economic activities or in international aid, trade or technology transfer with the developing nations.

NEW PUBLICATIONS

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Section 2 Driving Force Behind Japan's Economy

Section 3 Theoretical Concept of Economic Development
— economic take-off etc. etc.

Section 4 Analysis of Japan's Economic Take-off, and Sustained Growth Pattern and Their Applicability to the Developing Naqions
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or (2) Farm Machinery Industrial Research Corp., 7-2 chome, Kanda-Nishikicho, Chiyoda-ku, Tokyo 101, Japan Tel : (03) 291 3671

Published by Farm Machinery Industrial Research Corp., Tokyo, Japan, 1978

Unused Resources in Agriculture (1977)

(Japan)

This bulletin is a brief summary of the Minor Special Issues on "the Agriculutural Machinery and Facilities for the Utilization of Unused Resources" published on the Journal of Agricultural Machinery Japan, Vol. 38, No. 4 and Vol. 39, No. 1, 1977, and is published in english for the purpose to offer some materials from Japan for the preparation to the US-Japan Energy Seminor planned to be held in 1979 at the Michigan State University in USA.

The aim of this issue to introduce the various research works on unused resources in agriculture in Japan to all over the world. We hope this issue will be of good help for the people those who are interested in the same fields as ours.

Those who have further interest in these topics are strongly recommended to contact the author directry and individrally.

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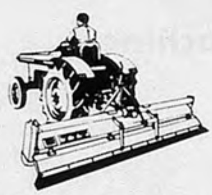

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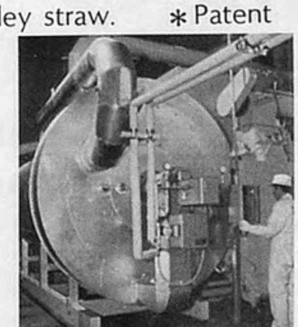

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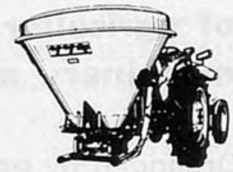

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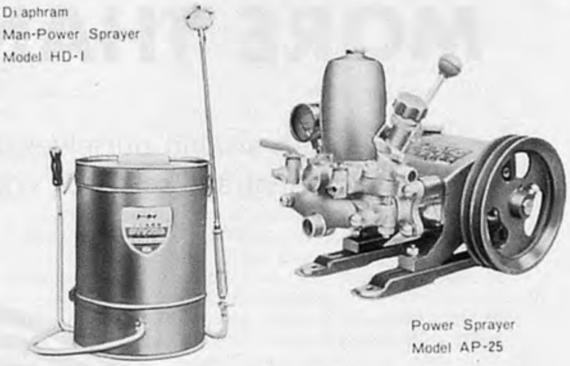

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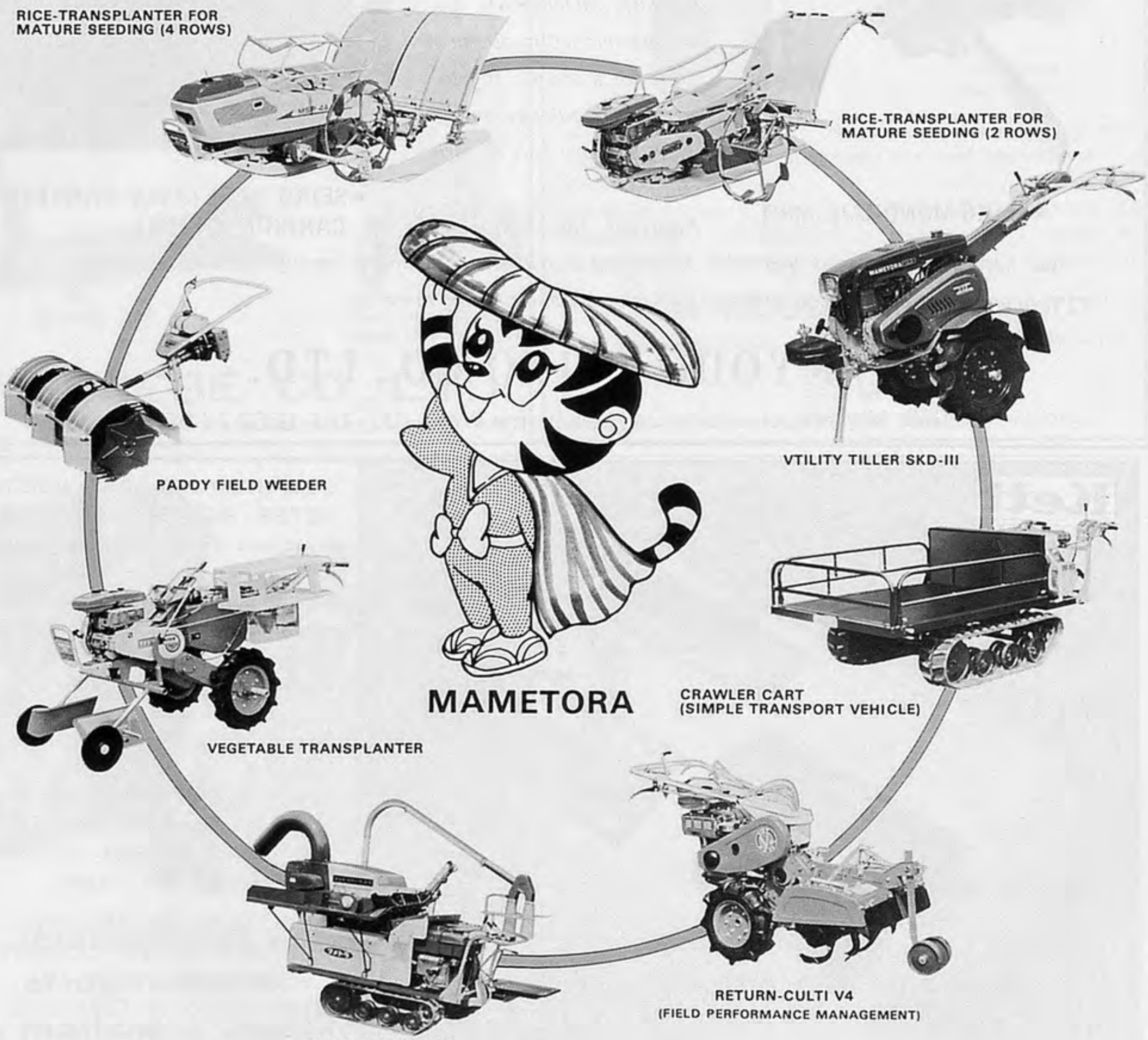

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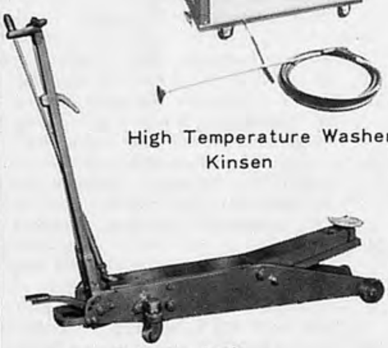

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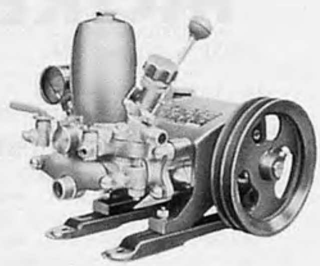

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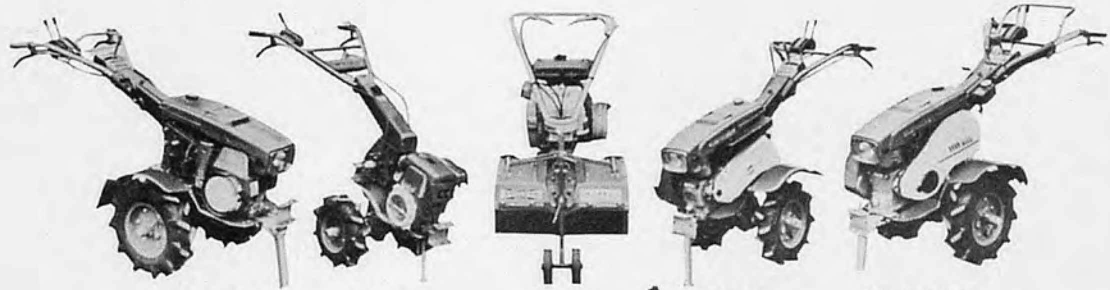

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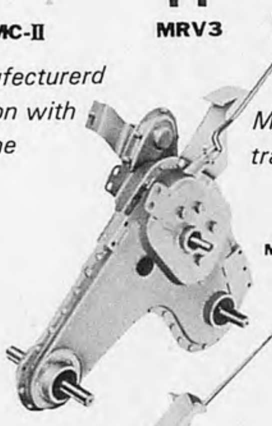
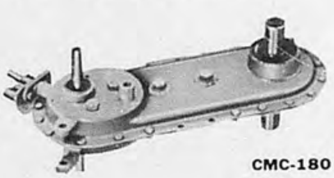
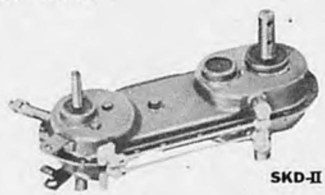


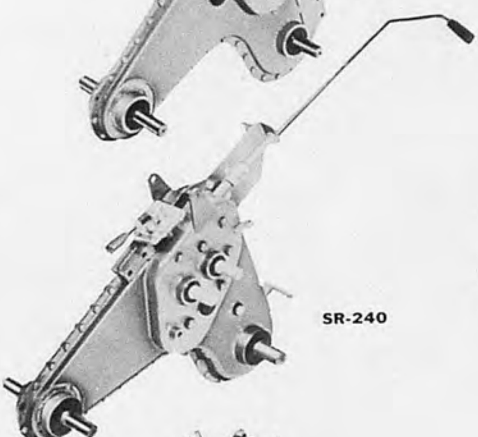
MRV3



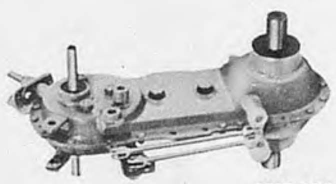
CMC-180



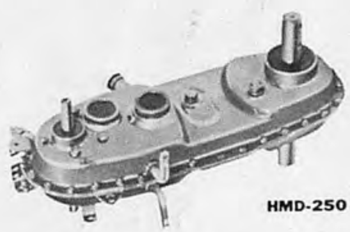
SKD-II



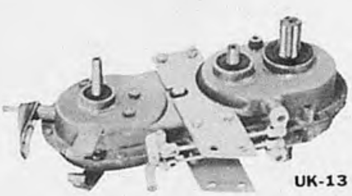
SR-240



DMC-180

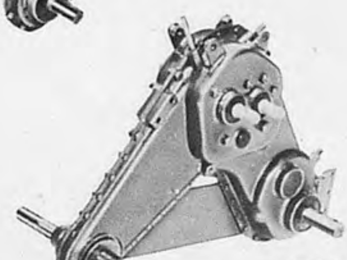


HMD-250



UK-13

PM-350



JAN-800

Model		MC-80	MCF-130K	CMC-180	DMC-180	DMC-II	SKD-18	SKD-II	SKD-III	HMD-250	PM-350	UK-13	MH-750	MT-40
Applications (PS)		1·8~2·5	2·0~3·5	3·0~4·5	3·0~4·5	3·0~4·5	3·0~4·5	4·5~6·0	4·5~6·0	5·0~7·0	6·0~8·0	3·0~4·5	3·0~4·5	3·0~4·5
Shifiting Stages		F1	F1, R1	F2, R1	F2, R1	F3, R1	F2, R1	F2, R1	F3, R1	F4, R2	F6, R2	F2, R1	F1, R2	F1, R2
Sidecluch		—	—	—	—	○	○	○	○	○	○	○	○	○ with Lock
Gear Ratios		F_1=1:21·71	F_1=1:18·16	F_1=1:25·41	F_1=1:25·41	F_1=1:41·31	F_1=1:21·21	F_1=1:31·06	F_1=1:66·07	F_1=1:70·03	F_1=1:53·97	F_1=1:32·13	F_1=1:25·54	F_1=1:37·62
			R_1=1:27·24	F_2=1:15·38	F_2=1:15·38	F_2=1:19·40	F_2=1:10·28	F_2=1:11·34	F_2=1:18·96	F_2=1:38·73	F_2=1:37·41	F_2=1:16·92	R_2=1:29·37	R_1=1:32·83
				R_1=1:35·58	R_1=1:35·58	F_3=1: 9·35	R_1=1:21·33	F_1=1:44·52	F_3=1:11·43	F_3=1:15·81	F_3=1:18·50	R_1=1:32·77	R_1=1:20·22	R_2=1:10·69
						R_1=1:49·91			R_1=1:81·09	F_4=1: 8·74	F_4=1:19·42			
										R_1 1:105·04	F_5=1:13·47			
										R_2 1:23·71	F_6=1: 6·66			
										:	R_1=1:66·67			
											R_2=1:24·0			
Dimensions	A	170	170	170	170	202	192	192	224	234	243·5	192	192	192
	B	434	434	434	435·5	532	492	492	545	578·5	603 3	467	467	467
	C	289·5	289·5	289·5	289·5	344·7	336·75	336·75	336·75	319·7	402·5	409·9	287	287
	D	15	15	15	15	16	16	17	19	19	19	16	16	16
	E	31	31	31	31	31	31	31	31	34·5	34·5	31	31	31