International specialized media for agricultural mechanization in Asian developing countries.

AMA

AGRICULTURAL MECHANIZATION IN ASIA

VOL.X,NO.1,WINTER 1979

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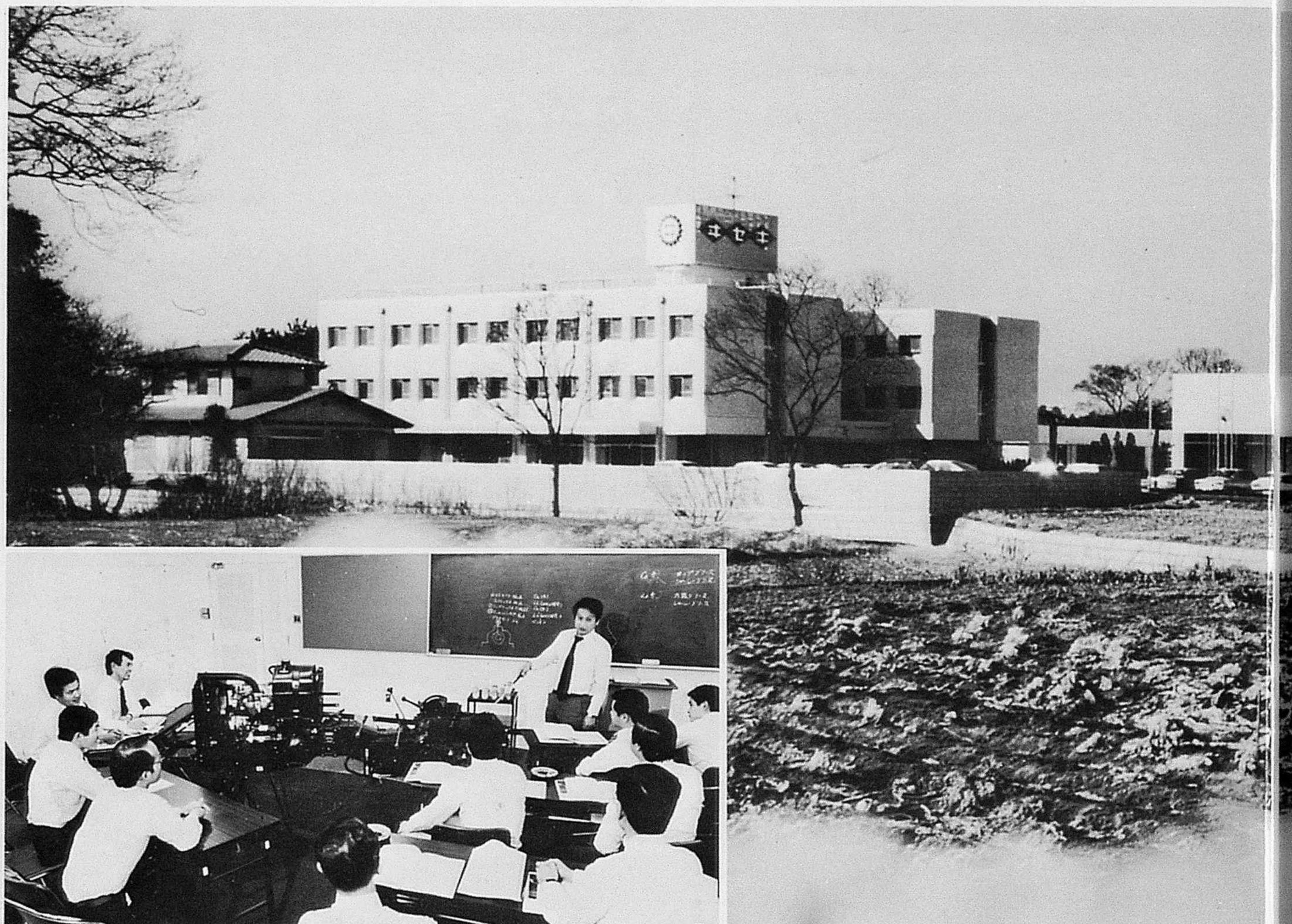

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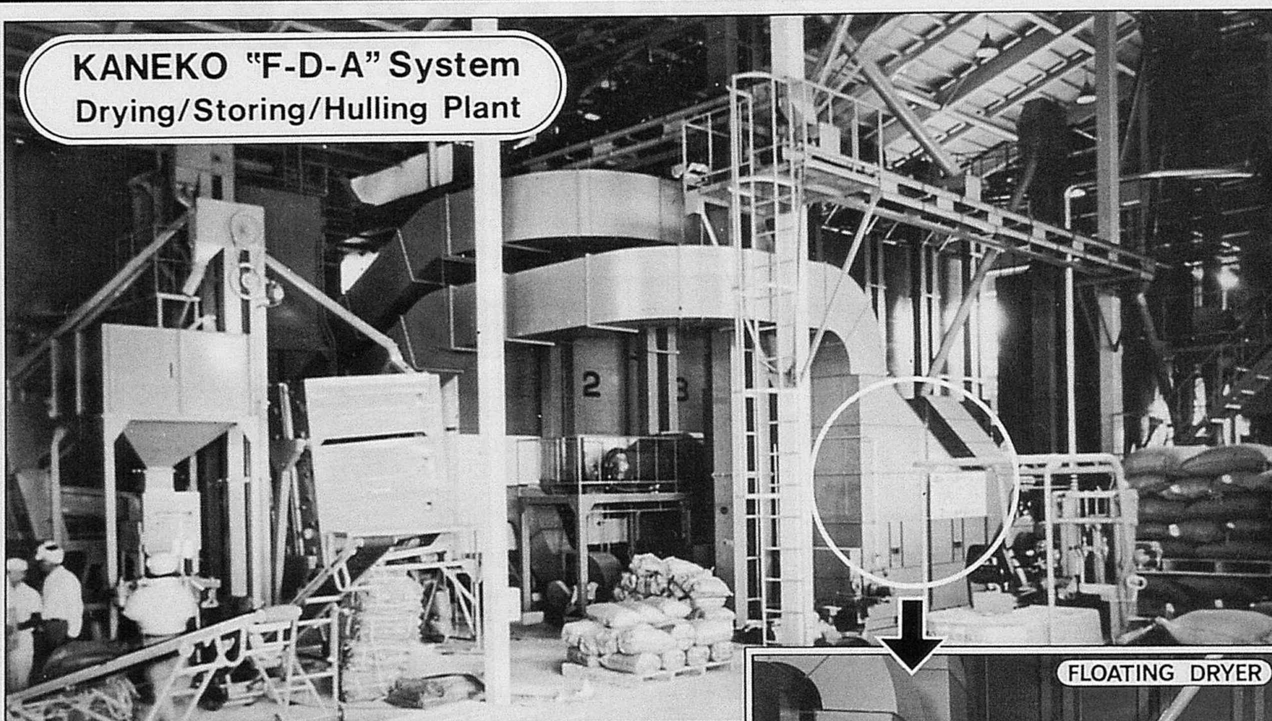

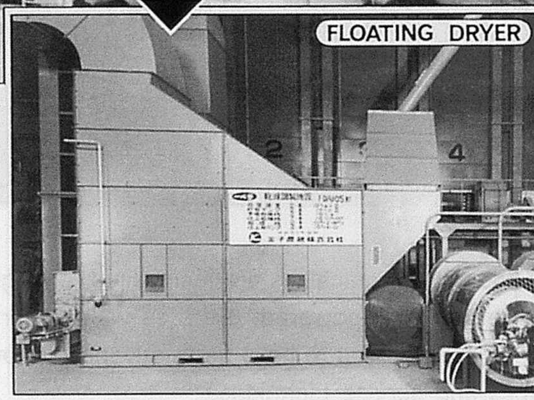

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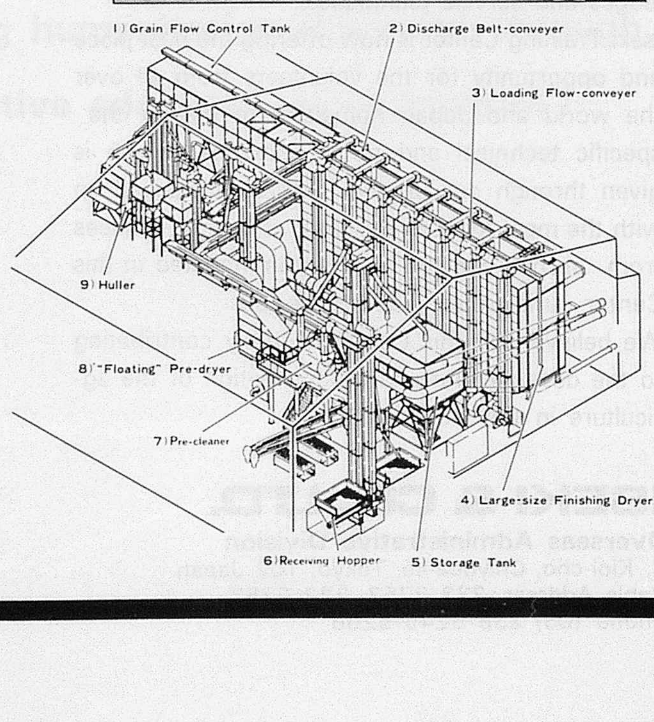

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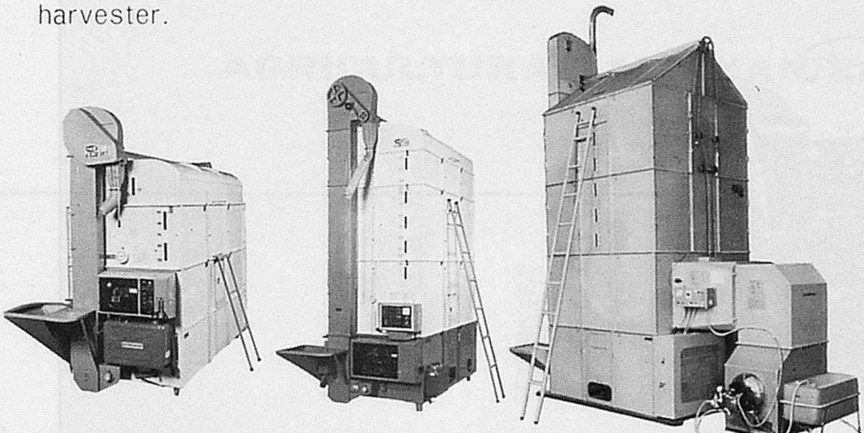

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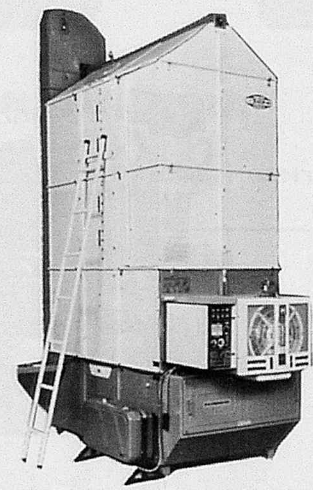

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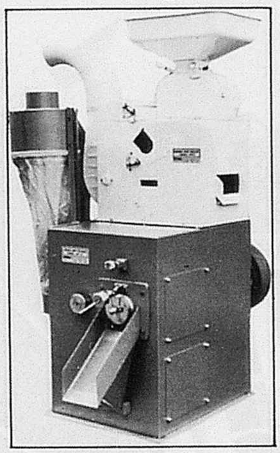

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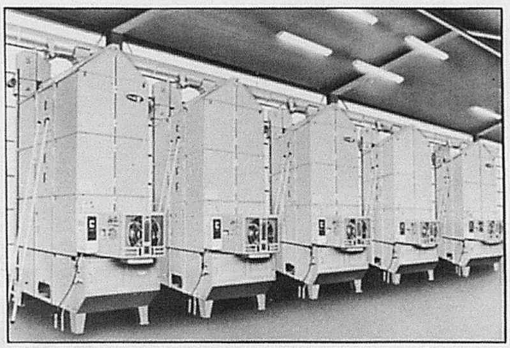

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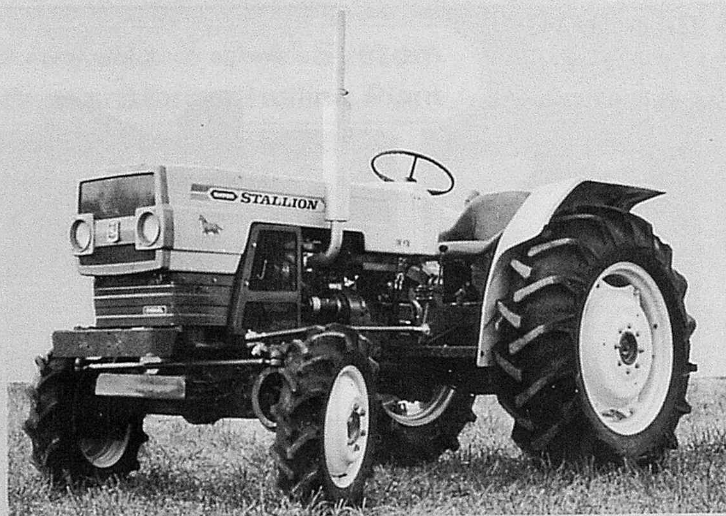

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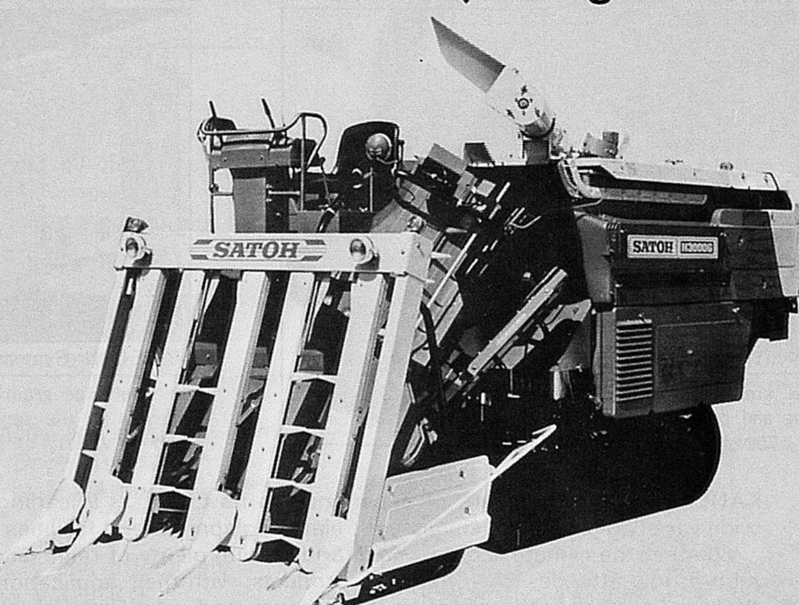

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This is the 22th issue since the issue, Spring of 1971.

Editorial

A Happy New Year !

Nine years have already passed since we started publishing AMA. In the meantime, more than three hundred thousand AMA issues have been read by the readers throughout the world. When we started publishing the AMA, there was apprehension that the promotion of agricultural mechanization in developing countries would spawn unemployment problems. In addition, economists then criticized farm mechanization severely, contending that it would produce poverty instead of prosperity for farmers.

But for the last nine years agricultural mechanization has steadily developed except for a few districts. In fact, mecanization has been adopted as the most important policy in practically all developing countries. This is because agricultural mechanization's most important mission is to develop and supply the techniques that enable farmers to engage in agriculture more profitably and efficiently. For one mechanization has solved various problems for farmers in adjusting their cropping pattern to varying regional differences such as farming dry land in large scale which was impossible prior to the advent of mechanization.

Exporting machines from developed countries has not yet completely satisfied the demands in developing countries, in the meanwhile that in the latter countries, the production trend has become intensive and that simple agricultural machines are giving way more and more to high-eficiency engines and tractors in many countries.

These observations notwithstanding, there are still many gaps in agricultural mechanization even as it continues to progress steadily in developing countries. We are impressed that this trend can be reversed.

But seeing agriculture and agricultural mechanization problems as they are in developing countries, a lot of difficulties are still discernible. So, it is necessary to invest more on innovations and put greater efforts in order to approach if not match peculiar circumstances on the part of developed countries. Not a few developing countries have been hard hit by the oil shock and are still facing difficulties. It is the expressed desire of the AMA to see continued improvement for the coming years for farm mechanization innovations through the efforts of concerned governments, firms and technical experts.

Many experts in agricultural machines have unselfishly promoted a better communication among themselves through AMA. Hereafter, the AMA managements intends to work even harder in monitoring the result of efforts of the experts so that together we shall further encourage agricultural mechanization in developing countries for greater productivity and prosperity.

January, 1979
Tokyo

Chief Editor
Yoshisuke Kishida

CONTENTS

AGRICULTURAL MECHANIZATION IN ASIA

Vol. X, No. 1, Winter, 1979

Effect of Supplemental Irrigation by Sprinkler on Wheat Yields in Northern Iraq

by

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Abstract

The northern part of Iraq forms the major wheat producing area of the country. Its climatic conditions are not favourable for carry-over of moisture from the harvest of one crop to the planting of another. The dryland farming is mainly dependant on rain (250—500mm) which does not follow any definite pattern with respect to its occurence and distribution. Under such conditions, supplemental irrigation can help avoid crop failures or poor yields in the annual cropping system followed here. Even partial irrigation is sufficient in most cases.

This study was carried out to see whether supplemental irrigation would be useful or not. A number of plots were planted under rainfed and irrigation conditions, keeping all the cultural practices the same, and the yields obtained. It was found that the average yield has increased considerably (58% and 110%). It shows that supplemental irrigation to dryland farming is extremely beneficial and results in better economic returns.

Introduction

The cereal crops (wheat and barley) are grown mainly in the northern part of Iraq under dryland conditions and about 75-parcent of the total crop produced comes from this area (Tamimi, S.A. and Al—Fakhry, A.K.). The climate of this area is semi—arid in nature. The rainy season starts in November and continues though May. Although the rain ranges from 250 to 500 mm, it does not follow any definite pattern as to timing of incidence and amount (3). The rainy season is followed by a period of 6 months, including summer, when there is no rainfall whatsoever. These conditions are not favourable for carry—over of moisture from the harvest of one crop to the planting of another. If the rains do not come, the planting has to be delayed.

The soils of the area are reddish brown and calcareous clays with a zone of carbonate accumulation at depth of from 30 to 50 cms (Buringh, P. 1). Good agricultural output can be had from such soils.

High production results only when combinations of water, soil, and crop management are adopted to local conditions ; and proper fertilizers, correct varieties and other appropriate cultural practices, including pesticide, etc. are used (2).

In some parts of the world as in Iraq, supplemental irrigation to dryland farming can be carried out. The vagaries of rainfall can be surmounted by carrying out even only partial irrigation. It has been reported that usually supplemental irrigation results in good economic returns (2).

The objective of this study was to find out the extra yield that can be obtained by the use of supplementary irrigation with sprinklers, hence determine the feasibility of sprinkler irrigation for supplementing the rainfall winter crops.

Material and Methods

The experiment was carried out by dividing the field into 20 strips, 200 sq meter each in area. Based on machine width, the width of strips was chosen as 3.75 m, hence the length of strips was about 53 m. Twenty such strips were formed and were numbered from 1 to 20. The strips, 1 to 10, were chossn for irrigation while the remaining (11 to 20) were left out to receive rainfall. Fertilizer superphosphate was applied to all the strips in equal amounts.

The operations were carried out in the following sequence :

Year 1975—76 :

i . Seedbed preparation consisted of disc harrowing and floating.

ii . Planting and fertilization were carried out with John Deere combine drill.

iii . Irrigation :

Table 1. 1975—76

Irrigation by Sprinkler		Rain Fed	
Yield (kg) X_1	X_1^2	Yield (kg) X_2	X_2^2
36.62	1,341.024	38.09	1,450.848
41.79	1,746.404	22.41	502.208
43.99	1,935.120	34.39	1,182.672
43.97	1,933.360	38.47	1,479.941
39.55	1,564.202	25.42	646.176
72.11	5,199.852	24.95	622.502
53.44	2,855.833	36.19	1,309.716
38.82	1,506.992	18.41	338.928
42.88	1,838.694	15.42	237.776
43.47	1,889.640	34.56	1,194.393
456.640	21,811.121	288.31	8,965.160

Average : 45.66   28.83
At estimate of the combined $S^2 = 89.555$
$s = 9.463$ degree of freedom (df) = 18
standard deviation of the mean = 4.232
$t = 3.977$ against $T_{5\%}$ (df = 18) = 2.101
This shows that statistically the difference is significant at 5 percent level.
Also comparing the averages, it is seen that the average yield per plot is 58 percent more in the case of sprinkler irrigation than the rainfed conditions.

Table 2. 1976—77

Irrigation		Rain Fed	
Yield (kg) X_1	X_1^2	Yield (kg) X_2	X_2^2
38.295	1,466.507	13.020	169.520
40.005	1,600.400	13.635	185.913
53.550	2,867.602	21.615	467.208
57.885	3,350.673	16.875	284.765
29.130	848.556	16.200	266.440
21.870	478.296	17.760	315.417
13.320	177.422	11.205	125.552
13.080	171.086	8.445	71.064
14.655	214.769	—	—
281.790	11,175.311	118.755	1,881.879

Average = 31.310   Ave. = 14.844
Estimate of the combined $s^2 = 164.716$
$s = 12.834$
df = 15
standard deviation of the mean = 6.235
$t = 2.64$ $t_{5\%}$ (df_{15}) = 2.131
This t-test shows that there is significant difference between the two.
Also the average yield in case of sprinkler system is 110 percent more than under rainfed conditions.

1st irrigation on 12th December.
Water applied = 12 mm.
2nd supplemental irrigation on 30th and 31st Dec.
water applied = 30 mm.
3rd and final irrigation on 11th and 12th May, 1976.
Water applied = 10 mm.

Year 1976—77 :

The same practices were adopted in seedbed preparation and planting.

Irrigation :

1st irrigation on 28th March, 1977.
2nd irrigation on 10th May, 1977.
Water applied in both the casss = 15 mm.

The crop was harvested as soon as it was ready and the yields for the various plots were determined.

Results and Discussions

Supplemental irrigation results in considerably higher yields as compared to the rainfed conditions alone. During the first year of experiment, the rains started in the beginning of January and continued with almost uniform distribution till the end of April. Because of the delay in rainfall, planting was likewise delayed. Hence, the irrigated plots gained a headstart over the rainfed plots. Subsequently, there was no distinctly visible difference between the stand of crops in both cases, but the yield under irrigated conditions was much higher. The following year, i.e., 1976—77, the rainy season started earlier and timely operations of tillage and planting were possible. However, during that year, the rainfall was lower than the yealy average and the distribution uneven. Irrigation were carried out as planned. The resulting yields were 110 percent higher under irrigation conditions than under mere rainfed conditions. Hence, under conditions of lower rainfall supplemental irrigation proved to be extremely beneficial. The non-irrigated fields demonstrated a poor performance, and the resulting yields dropped below that obtained the preceding year.

Hence it can be concluded that supplemental irrigation results in good returns under conditions of both delayed and low rainfall. Whenever there is an opportunity for such irrigation, it should be carried out in order to boost agricultural production.

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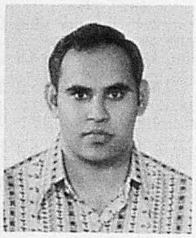
Field Study of Agricultural Mechanization in Central Mindanao, Philippines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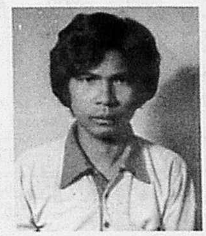
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Many nations are engaged in organized effort to increase agricultural productiviy through the use of modern technology. One of the aspects of this technology is agricultural mechanization. These nations face major decisions on the type and pace of mechanization for which information on the input requirements as well as on the effects (in terms of production, employment and costs) of various forms of mechanization is needed. Findings from previous works related to the effects of mechanization on yield and employment have been reviewed by SINGH and CHANCELLOR (1974) and YADAO (1977).

A study was undertaken in 1976–77 to suggest an appropriate system of mechanization for the rice and maize crops based on farm size, cropping intensity, production and net income per unit area. For this study a six-month long survey was conducted of inputs and outputs on 80 farms in three municipalities-(Maramag, Valencia and Malaybalay in Bukidnon province in Mindanao, Philippines. Farms surveyed included 33 rice farms, 39 maize farms, 7 farms in which both rice and maize were grown and one very large farm. Other crops that farmers grew were considered for their contributions to the income. Other factrs which directly influenced the income of the farmer, like off-farm jobs and raising poultry and livestock, were also considered.

The farmers using various levels of mechanization were grouped in three categories as follows :

Category 1—Farm using animal power mainly and referred to as animal farm.

Category 2—Farm using owned or hired power tiller as well as animal power and referred to as tiller farm.

Category 3—Farm using owned or hired four-wheel tractor as well as animal power and referred to as tractor farm.

No distinction was made between a farmer owning a power tiller and a farmer custom-renting it for field operations. Similar was the case with tractor farms.

The study included the relationship of the level of mechanization, mainly in tillage, to the productivity of the farm. Machines used in operations other than land preparation like water pumps and threshers were also considered. Other factors like fertilizer application rate, area planted with high yielding varieties and irrigated area on various farms ware considered for their influence on the yield.

Rice Farms

The 33 rice farms consisted of 12 animal, 14 tiller and 7 tractor farms. The characteristics of the rice farms surveyed are given in **Table 1**. The average holdings of the animal, tiller and tractor farms were 2.50 ha, 4.16 ha and 13.14 ha, respectively. Large farms used higher levels of mechanization. The tiller farms had the highest cropping intensity of 177 percent followed by animal with 159 percent and the tractor farms with 143 percent. The cropping intensity on animal and tractor farms was low mainly due to the lack of irrigation

Table 1. Characteristics of Rice Farms

Item	Farm Category		
	Animal	Tiller	Tractor
Number of farms surveyed	12	14	7
Farm size (ha)	2.50	4.16	13.14
(standard deviation)	(1.36)	(2.13)	(7.59
Average number of family laborers	1.75	2.07	2.29
Average number of draft animals	1.50	1.36	3.43
Average cropping intensity	159	177	143
Number of paddy thresher users	1	2	3
Percent of farms irrigated	58	79	57
Percent of farms planted with HYV	100	86	100

Table 2. Average Energy Input per Hectare from Various Sources and Yields on Rice Farms

Item	Farm Category					
	Animal		Tiller		Tractor	
	I Crop	II Crop	I Crop	II Crop	I Crop	II Crop
Family labor (man-days)	42.2	39.8	20.8	17.0	8.2	4.3
Hired labor (man-days)	43.3	43.8	55.4	56.4	54.0	62.3
Total labor (man-days)	85.5	83.6	76.2	73.4	62.2	66.6
Human power* (HP Hrs)	68.4	66.9	61.0	58.7	49.8	53.3
Animal power** (HP Hrs)	43.5	58.1	27.4	28.9	26.4	15.4
Mechanical power*** (HP Hrs)	0.0	0.0	133.2	210.8	461.6	635.8
Total power (HP Hrs)	111.9	125.0	221.6	298.4	538.0	704.5
Yield (kg/ha)	3450	2350	3690	3295	3805	3145

*Based on 0.1 hp per worker and 8-hr work day.
**Based on 0.5 hp per animal.
***Based on 50 percent of BHP utilization.

Table 3. Mean Labor Utilization in Man-Days per Hectare per Year

Farm Operation	Rice Farms					
	Animal		Tiller		Tractor	
	F	H	F	H	F	H
Plowing	8.0	0.8	2.0	0.4	0.5	0.2
Harrowing	0.5	–	0.4	–	–	–
Rotavating	–	–	0.6	1.9	0.8	1.1
Puddling	9.0	0.9	2.3	3.6	1.2	3.9
Leveling	0.5	0.1	0.3	0.2	0.3	0.1
Seed. prep. & sowing	1.4	0.2	0.7	0.6	0.1	0.3
Pulling seedlings	4.5	5.4	1.1	8.9	–	4.5
Cleaning dikes	4.0	2.3	3.6	6.9	2.6	3.1
Planting/ Transplanting	8.4	10.2	1.6	18.6	0.4	15.4
Fertilizing	1.7	0.2	1.8	1.3	1.0	2.0
Irrigating	4.0	–	3.0	1.8	0.4	2.8
Spraying	4.4	0.5	3.1	2.6	0.9	4.2
Weeding	2.6	0.5	2.5	2.6	0.2	6.0
Harvesting	3.6	17.0	2.7	16.6	0.2	20.4
Threshing	4.4	24.1	3.8	20.4	–	11.8
Hauling	0.4	3.7	0.7	3.3	0.6	4.8
Drying & storing	1.5	0.1	0.8	1.0	0.8	2.4
Sub-Total	59	66	31	91	10	83
Total	125		122		93	

Note: F–Farmer and family labor
H–Hired labor

Table 4. Annual Production, Income and Mechanical Power Use on Rice Farms, by Category

Item	Animal	Tiller	Tractor
Production (kg/ha)	4875	6175	5585
Gross income* (P**/ha)	5360	6785	6145
Expenses:			
Cash (P/ha)	1080	2045	1945
In kind (P/ha)	970	1135	1860
Net income (P/ha)	3310	3605	2340
Income other than rice farm (P/farm)	1495	3835	16700
Tiller/tractor use:			
Own farm (hr)	–	215	165
Custom work (hr)	–	332	607
Total (hr)		547	772

*Average paddy rice price ₱1.10/kg
**1 US$=7.32 P (Peso)

water as only 56–57 percent of these farms were irrigated compared to 79 percent of tiller farms being irrigated. Also, the large tractors, mostly equipped with harrow-plough, often bogged down in saturated fields and in many cases could not be used for wet cultivation required for the paddy crop. Cropping intensity on the tiller farms was due to the availability of irrigation water and faster land preparation.

Energy input from human, animal and mechanical sources on the rice farms is given in **Table 2**. Tractor farms used maximum level of total energy with reduced amount of total human labor as well as animal energy per unit of crop land area. Animal farms used maximum amounts of animal energy. Tractor and tiller farms employed more casual labor compared to animal farms on per ha basis. Total annual labor utilization per ha on animal and tiller farms was about equal **(Table 3)**.

The yields on tiller and tractor farms were higher than on the animal farms **(Table 2)**. This was probably due to better land preparation, timely planting and greater use of fertilizers. On a per ha basis both annual production and net income were highest on the tiller farms **(Table 4)**. Although the annual production on animal farms was lower than that on tractor farms, the net income on per ha basis on the former farms was higher than on the latter farms. This was due to less expenses incurred on animal farms. But the tiller and, especially tractor owners, earned significant income by custon-renting their tractors and tillers to cultivate the fields of other farmers.

Maize Farms

The 39 maize farms consisted of 16 animal, 1 tiller and 22 tractor farms. The tiller farm being the only one was excluded from the analysis. The characteristics of the maize farms surveyed are given in **Table 5**.

The average holdings on the animal and tractor farms were 3.94 ha and 6.25 ha, respectively, indicating that tractors were used on comparatively larger farms. However, the use of tractor also depended upon the topography and accessibility of the farm. The number of family workers and animals on the farms of both categories was about the same. The tractor farms had higher cropping intensity than animal farms. Most of the tractor farms grew high yielding varieties (HYV) while only about one-third of the animal farms grew HYV maize.

Energy input on the maize farms from human, animal and

Table 5. Characteristics of Maize Farms by Category

Item	Animal	Tractor
Number of farms surveyed	16	22
Farm size (ha)	3.94	6.25
(standard deviation)	(2.11)	(5.74)
Average no. of family laborers	2.5	2.5
Average no. of draft animals	1.8	1.7
Average cropping intensity	213	231
Percent of farms planted with HYV	38	91

Table 6. Average Energy Input per Hectare and Yields on Maize Farms, by Category

Item	Animal			Tractor		
	I Crop	II Crop	III Crop	I Crop	II Crop	III Crop
Family labor (man-days)	28.0	26.0	25.0	12.8	12.6	11.0
Hired labor (man-days)	16.5	16.3	17.1	25.7	22.9	13.4
Total labor (man-days)	44.5	42.3	42.6	38.5	35.5	34.4
Human power* (HP Hrs)	35.6	33.8	34.1	30.1	28.4	27.5
Animal power** (HP Hrs)	60.9	56.3	42.8	28.4	26.1	19.7
Mechanical power***(HP Hrs)	0.0	0.0	0.0	122.9	122.9	71.8
Total power (HP Hrs)	96.5	90.1	76.9	181.4	177.4	119.0
Yield (kg/ha)	1240	935	920	2025	1595	1370

*Based on 0.1 hp per worker and 8-hr work per day.
**Based on 0.5 hp per animal.
***Based on 50 percent of BHP utilization.

Table 7. Mean Labor Utilization in Maize Farms (Unit : Man-day/ha/yr)

Farm Operation	Animal		Tiller		Tractor	
	F	H	F	H	F	H
Plowing	16.6	1.4	–	1.0	1.4	0.6
Harrowing	2.8	0.1	1.1	1.5	1.3	0.1
Furrowing	3.5	0.1	1.2	4.9	1.2	1.4
Cultivating	8.6	0.4	7.0	6.3	5.5	4.8
Planting	3.8	3.1	1.5	7.8	1.8	5.3
Fertilizing	1.7	0.4	0.9	3.0	2.2	1.3
Spraying	0.2	–	–	–	0.2	0.1
Weeding	18.6	8.0	–	30.1	13.0	12.0
Harvesting	0.5	22.0	–	38.0	0.5	24.3
Hauling	0.6	1.1	–	–	0.2	0.7
Shelling	1.7	0.1	–	0.5	0.5	0.3
Drying & storing	1.0	0.6	–	1.2	0.6	0.8
Sub-Total	59.6	37.3	11.7	94.3	28.4	51.7
Total	96.9		106.0		80.1	

Table 8. Annual Production, Income and Mechanical Power Use on Maize Farms

Item	Animal	Tractor
Production (kg/ha)	2325	4060
Gross income*(P/ha)	1975	3450
Expenses:		
Cash (P/ha)	325	975
In kind (P/ha)	320	635
Net income (P/ha)	1330	1840
Income other than maize farm (P/farm)	1330	4380
Tractor use:		
Own farm (hr)	–	475
Custom work (hr)	–	780
Total (hr)		1255

*Average price ₱0.85/kg of shelled maize.

mechanical sources is given in **Table 6**. The tractor farms used almost twice the total energy used on the animal farms. Though the tractor farms provided slightly less labor than on the animal farms, the employment of hired labor on a per-ha basis was significantly higher on the tractor farms. The annual distribution of both family and hired labor utilization on the maize farms on a per-ha basis is shown in **Table 7**.

The yields for all the three crops on tractor farms were higher than yields on animal farms **(Table 6)** due to better land preparation, timely planting and greater use of fertilizer. The annual production per ha on the tractor farms was significantly higher than on the animal farms. The expenses incurred were also very high on tractor farms but the annual income per ha was also high. Tractor farmers earned significant income by custom-renting their tractor to cultivate the fields of other farms.

The analysis of the seven mixed farms growing both rice and maize crops was not included because of limited sample size. These consisted of two head of animal, four tiller and one tractor farms when classified according to power sources used in rice crop. According to the power sources used in the prodution of maize crop on these farms, there were one animal, two tiller and four tractor farms. The large farm (ARFI Farm, 680 ha) was also excluded in the analysis.

Summary

This study analyses the data of 33 rice farmers and 38 maize farmers who raised these crops. The data was collected through personal interviews of the farmers from December, 1976 to April, 1977. The crop year 1976 was considered and, for some farmers, the crop year 1975.

The aim of the study was to suggest an appropriate system of mechanization for each crop based on farm size, cropping intensity, production and net income per unit area. For rice farms, it was found that the power tiller users (both owners and those who hired) had the highest cropping intensity and highest annual production per hactare resulting in the highest gross as net income per ha. Tiller and tractor farms used more hired labor than animal farms. The use of family labor, hence total labor were highest on animal farms.

In maize farming, the farmers who used four-wheel tractor (both owned and hired) in land preparation had higher cropping intensity and higher annual production per ha giving higher gross, hence net income per ha compared to animal farms. With the exception of a third crop, which is grown in very few plots, the tractor farms used more hired labor than the animal farms. The use of family labor, hence total labor was higher on the animal farms compared to tractor farms.

ACKNOWLEDGEMENT

The authors wish to acknowlege the financial assistance provided by the Ford Foundation for the study.

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Efficiency of Machines in Sugarcane Production: Progressive vs. Traditional Farming

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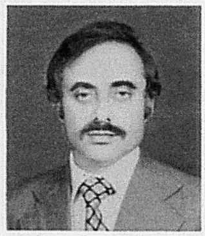

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Introduction

Sugarcane is the only source of sugar production in Pakistan. It plays an important role in the economy of the country. It is grown on almost all types of soil. The popular variety grown in PR-1000, although COL-54, BL-4 and CO-997 are also grown. Sugarcane is an annual as well as perennial crop. It gives one main crop and 1—2 ratoon crops. Ratoon crop gives less yield year to year, but almost competes with the main crop in terms of net returns.

Sugarcane has fibrous roots that penetrate down to vertical depths of 24 inches. It also requires good quality tilth conditions. It is planted in rows of 2.5 to 3 feet apart. Sugarcane production is mechanized only in preplanting operations with the exception of a very few planters used. The efficient production of sugarcane is dependent on many factors which include edaphological and environmental conditions coupled with the use of bio-hydro-chemical technologies. The good variety seed free of insect attack, plant population with desired distances, proper fertilizer applications, plant protection, effective irrigation at recommended interval and dose, and harvesting at appropriate time at maximum recovery percentage contribute towards increased production.

The government of Pakistan emphasizes the importance of sugarcane production. New sugar mills have been established in the recent past. More than eight sugar mills are functioning in Sind Province alone. Since sugarcane production requires heavy capital outlays, the sugar mills and other government agencies advance loans to producers to enhance cane production. But still the average per acre yield of sugarcane is low compared to other sugarcane growing countries. The main reason for low yield may be defective cultural practices which could only be improved by mechanization of operations. The acreage under sugarcane, total production and per acre yield in Pakistan have been fluctuating from year to year though there is increasing trend **(Table 1)**.

The province of Sind produced 3.115 million tons of sugarcáne from 0.211 million acres of land being the average from 1971-72 to 1973-74 and contribrted 14.88 percent of the total production in Pakistan.

Abstract

This report is based on the result of a 3—year study research (1971-76) on sugarcane production in Sind by the Agricultural University The study was conducted in over to determine the efficacy of various machines towards increased agricultural production for an initial period of five years (extended further for 3 1/2 years more to complete by June 30, 1982) through the financial assistance of USDA,

Specifically, the study aims to determine the suitability of farm machinery under varying types of soil, and effects, functions and eficiency of machines on various field operations and to appraise the economic efficiency in crop production.

Methodology

The area of study covered tractor farms and traditional

Table 1. Area and Production of Sugarcane 1947–75

Years	Area in 000' Acres			Production in 000' Tons		
	Actual	Index Number	Percent Change	Actual	Index Number	Percent Change
1947–48	464	35.37	–64.63	5442	29.99	–70.01
1948–49	487	37.12	–62.88	6837	37.67	–62.33
1949–50	543	41.31	–58.69	7725	42.57	–57.43
1950–51	465	35.44	–64.56	5419	29.86	–70.14
1951–52	469	35.75	–64.25	5314	29.28	–70.42
1952–53	626	47.71	–52.29	7151	39.40	–60.60
1953–54	722	55.03	–44.97	8815	48.57	–51.43
1954–55	752	57.32	–42.68	8696	47.92	–52.08
1955–56	708	53.96	–46.04	8070	44.47	–55.53
1956–57	788	60.06	–39.94	8806	48.52	–51.48
1957–58	982	74.85	–25.15	11116	61.25	–38.75
1958–59	1057	80.56	–19.44	12292	67.73	–32.27
1959–60	980	74.70	–25.30	10494	57.82	–42.18
1960–61	959	73.09	–26.91	11457	63.13	–36.87
1961–62	1095	83.46	–16.54	15130	83.37	–16.63
Average:	739.74	56.38	–43.62	8850.93	48.77	–51.23
1962–63	1312	100	–	18148	100	
1963–64	1180	89.94	–10.06	15885	87.53	–12.47
1964–65	1243	94.74	– 5.26	18373	104.24	– 4.24
1965–66	1476	112.50	+12.50	21957	120.99	+20.99
1966–67	1605	122.33	+22.33	21635	119.21	+19.21
1967–68	1245	94.89	– 5.11	18365	101.20	+ 1.20
1968–69	1336	101.83	+ 1.83	21624	119.15	+19.15
1969–70	1532	116.77	+16.77	25952	143.00	+43.00
1970–71	1572	119.82	+19.82	22801	125.64	+25.64
1971–72	1365	104.04	+ 4.04	19648	108.27	+ 8.27
1972–73	1318	100.46	+ 0.46	19632	108.18	+ 8.18
1973–74	1564	119.21	+19.21	23533	129.67	+29.67
1974–75	1655	126.14	+26.14	21000	115.72	+15.72
Average:	1424.25	108.56	+ 8.56	20867.08	114.98	+14.98

Source: 1. Government of Pakistan, Twenty Five Years of Pakistan in Statistics 1947–72, (Karachi: Central Statistical Office, Economic Affairs Division, Ministry of Finance, Planning and Development, 1972) pp-112-113.
2. Government of Pakistan, Crop Statistics of Pakistan, (Islamabud: Ministry of Agriculture and Works, Agriculture Wing, Planning Unit) pp-31-32.

farms in Sind disticts growing sugarcane on commercial scale. A sample of 50 progressive and 25 traditional farms was selected through purposive sampling. The districts are Tharparkar, Sanghar, Hyderabad, Nawabshah and Sukkur. The sample was further drawn from three sub-districts of each selected district on the basis of variation in machines and tractors available on different farms, types of soil, and ability of operator to respond and cooperate in providing data. The selection of traditional farms was based on the criteria that they are under Similar farm conditions except the use of farm machinery.

The farms were visited frequently to collect desired information. The growers were interviewed to record data on pretested questionnaires prepared for the purpose. The reliability of data was tested from time to time through multiple question series. Experimental methods of investigation were also adopted to collect date for computing field efficiency and performance of machines. The farms were stratified into small, medium and large according to the acreages for sugarcane. For analysing the production function the farms were grouped as follows : small, farms, growing below 100 acres ; medium farms, 101 and 200 acres ; and large farms, above 200 acres.

Plate 1 Use of bullock drawn local made plow (traditional farm)

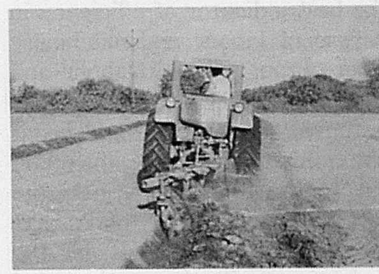

Plate 2 Use of disc plow (modern farm)

Plate 3 Harvesting of sugarcane by manual labour

Plate 4 Use of tandem disc harrow for crushing and burying sugarcane refuse after harvest crop

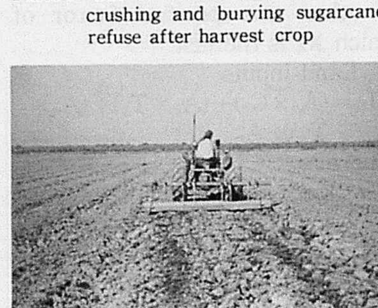

Plate 5 Covering of cane sets after planting by attaching wooden plank behind cultivator

Analytical Approaches

The objectives of farm mechanization are empirically tied up with the performance of farm power, farm machinery and farm labour derived from machine use. In order to determine the efficacy of various machines towards increased production, numerous efficiency standards were used. The best indicator of efficiency in the use of labour and machinery is net output per unit labour and machine expenses. Net output from resources used would be at a maximum when the marginal cost of the resources equals the marginal productivity of resources. Thus, the analysis of the production function included measurement of land inputs, labour inputs and capital inputs. The suitability of machines was analysed through a comparative study of progressive and traditional farms on time-cost pattern and production pattern.

Production Function

The production function was analysed through the formula, $Y=f(X_1, X_2, X_3 \cdots\cdots X_n)$ (Heady). Y refers to the single commodity which is being produced, whereas, X refers to specific factor of production. In this equation X_1 stands for land, X_2 for labour, X_3 for capital including machinery, and X_n indicate that production is a result not only of specified inputs but also of other non-specified factor of which X_n is the last.

1. Land Inputs

$L_i=(A_c \times C_r)+(A_c \times T_1)+(A_c \times T_w) \div A_c$

Where :

L_i=per acre land inputs for sugarcane crop :

A_c=cropped area under sugarcane enterprise :

C_r=contract rate of land (rent) :

T_l=per acre land tax ; and

T_w=per acre water tax.

2. Labour Inputs

$L_i=(M_d \times W_r)+(B_d \times W_r) \div A_c$

Where :

L_i=Labour inputs per acre for specific operation ;

M_d=Man work days involved for specific operation ;

B_d=Bullock work days involved for specific operation ;

W_r=Wage rate per man or pair bullocks for a particular operation ; and

A_c=Cropped area under sugarcane enterprise.

3. Capital Inputs

$C_i=(Q_r X P_c) \div A_c$

Where :

C_i=Capital inputs per acre on specific capital component ;

Q_r=Quantity of specific capital component used ;

P_c=Price per unit of a particular item ; and

A_c=Cropped area under sugarcane enterprise.

4. Cost of Machine Use

The amount of capital in the form of farm power and machinery depends largely on its availability and dependability. Annual costs of ownership are relatively fixed and vary a little with the amount of use each year. Such costs can easily be determined by dividing annual ownership cost with the hourly ownership costs. The break-even point in hours of operations per year can be found. And decision could be made as to hire or own a machine.

Tractors and machinery were operated under a wide range of conditions. The power costs were calculated on the basis of the specific conditions for specific operations and for tractor. The power cost of similar type of tractor was not same under all circumstances. The cost of tractors and machinery was classified into basic costs and operating costs, where basic costs included interest on capital and depreciation. The interest was calculated on yearly basis whether or not the tractor was used. Depreciation and repair costs were calculated on hourly basis for which the tractor was operating for sugarcane crop. The costs of tractor shed were calculated on annual basis. The interest was determined on half of the replacement costs of tractor plus 10 percent for the trade-in value. The actual repair costs of tractors and machinery were investigated from sample growers. One percent of the replacement cost of a tractor was estimated for Tractor sheds.

Interest Cost of Power and Machinery

$$I_{py} = \frac{R_i}{100} \times \frac{1}{2} \left(R_c + \frac{1}{10} T_v \right)$$

Where :

I_{py}=Interest per year ;

R_i=Rate of interest ;

R_c=Replacement cost ; and

T_v=Trade-in value.

Depreciation

$$D_{ch} = \frac{R_c}{S_l}$$

Where :

D_{ch}=Depreciation cost per hour ;

R_c=Replacement cost ;

S_l=Span of life in work hours.

Repair Cost

$R_{cy}=Y_{wh} \times R_{ch}$

Where :

R_{cy}=Repair cost per year shared by an acre of sugarcane ;

Y_{wh}=Yearly working hours shared by sugarcane ; and

R_{ch}=Repair cost per hour use for an acre of sugarcane.

Housing Cost

$$H_{ch} = \frac{H_{cy}}{Y_{wh}}$$

Where :

H_{ch}=Housing cost per hour ;

H_{cy}=Housing cost per year ; and

Y_{wh}=Estimated yearly work hours.

Fuel Cost

$F_{ch} D_{rh} \times R$

Where :

F_{ch}=Fuel cost per hour :

D_{rh}=Diesel required per hour in gallon ; and

R=Rate per gallon of diesel in rupees.

Therefore,

$F_{cc}=S_{wh}\times F_{ch}$

Where :

F_{cc}=Fuel cost for an acre of sugarcane ;

S_{wh}=Work hours for an acre of sugarcane ; and

F_{ch}=Fuel cost per hour.

Oil Cost

$O_{ch}=O\ ph\times R$

Where :

O_{ch}=Oil cost per hour ;

O_{ph}=Oil consumed per hour in gallon ; and

R=Rate per gallon in rupees.

Filter Cost

$F_{ch}=F_c/W_h$

Where :

F_{ch}=Filter cost per hour ;

F_c=Cost of filter ; and

W_h=Estimated work hours per filter.

Grease Cost

$G_{ch}=Q_y\times R$

Where :

G_{ch}=Grease cost per hour ;

Q_y=Quantity required in lbs. ; and

R=Rate per lb. in rupees.

Labour cost per Hour

$L_{ch}=M_p/M_{wh}$

Where

L_{ch}=Labour cost per hour ;

M_p=Monthly pay ; and

M_{wh}=Monthly work hours.

Returns and Economic Efficiency

Returns are received as payment for use of inputs. Production function is said to be efficient when it yields maximum output for every unit of input. For measuring returns, the physical productivity and revenue productivity per acre were calculated as follows :

$A_{pp}=(T_{yp}\div A_s)+(T_{yp}\div A_s)$

Where :

A_{pp}=Average per acre physical productivity ;

T_{yp}=Total yield of principal crop ;

A_s=Area sown under sugarcane ; and

T_{yp}=Total yield of by-product.

$V_p=(T_{yc}\ x\ P_r)+T_{yp}\ x\ P_r)\div A_s$

Where :

V_p=Value productivity per acre ;

T_{yc}=Total yield of principal crop ;

T_{yp}=Total yield of by-product ;

P_r=Price per unit ; and

A_s=Area sown under sugarcane crop.

The economic efficiency of machine use was calculated in terms of input-output relationship, elasticity of production and time-cost analysis :

Input-output ratio$=Y\div(x_1+x_2+x_3)$

Where :

Y=Average per acre revenue productivity ;

X_1=Land input ;

X_2=Labour input ; and

X_3=Capital input, including cost of machines and management.

Elasticity of Production

$$E_p=\frac{\dfrac{(V_{pp}-V_{pt})}{V_{pt}}\times 100}{\dfrac{I_{pp}-I_{pt}}{I_{pt}}\times 100}$$

Where :

V_{pp}=Value productivity for progressive farms ;

V_{pt}=Value productivity for traditional farms ;

I_{pp}=Average per acre for sugarcane inputs on progressive farms ; and

I_{pt}=Average inputs on traditional farms.

For making time cost analysis, the time required and cost incurred on various operations under both semi-mechanized as well as bullock operated farms was calculated by the following formula :

$M_{oc}=(M_{lc}+T_{wc})\leqq B_{oc}=(M_{lc}+B_{wc})$

Where :

M_{oc}=Cost of mechanized operation ;

M_{lc}=Cost of manual labour ;

T_{wc}=Cost of tractor work ;

B_{oc}=Cost of bullock operation ; and

B_{wc}=Cost of bullock work.

Table 2. Cultivation Standard of Sugarcane Progressive, Farms, Sind, 1974－75 and 1975－76

Implements Used	Large Farms (3216 acres)		Medium Farms (1040 acres)		Small Farms (646 acres)	
	Area operated	Passes	Area operated	Passes	Area operated	Passes
	Acre	No	Acre	No	Acre	No
Dry Plowing						
Disc plows	3216	1	1040	1	606	1
Mould board plows	1300	1	–	–	75	1
Tandem harrows	3216	2	1040	2	476	2
Disc harrows	400	2	–	–	98	2
Cultivators	1480	2	980	2	554	2
Rotavators	–	–	150	2	–	–
Clod Crushing						
Rollers/planks	–	–	170	2	8	2
Levelling						
Levellers	3216	1	890	1	646	1
Bund Making						
Bund makers/border discs	2436	1	520	1	196	1
Channel Making						
Ditchers/trenchers	1630	1	200	1	–	–
Planting						
Riders	1506	1	170	1	273	1
Cane planters	700	1	–	–	–	–
Post Planting						
Fertilizer application	3216	3	1040	2	646	2
Hilling up	3216	2	1040	2	646	2
Irrigation application	3216	15	1040	14	646	13
Harvesting and de-leafing	3216	1	1040	1	646	1

Table 3. Average Per Acre Operating Cost of Machines and Implement Use

(Unit : Rupees)

Farms Size	Basic-Cost 1974–75	Basic-Cost 1975–76	Basic-Cost Average	Operating-Cost 1974–75	Operating-Cost 1975–76	Operating-Cost Average	Interest on Capital 1974–75	Interest on Capital 1975–76	Interest on Capital Average	Total
Progressive Farms										
Large	33.68	44.29	38,97	63.20	106.47	84.84	2.19	2.88	2.54	126.36
Medium	66.85	45.09	55.97	114.95	97.38	106.17	4.35	2.93	3.64	165.78
Small	64.57	53.90	59.24	117.34	118.11	117.73	4.20	3.50	3.85	180.82
Average	55.03	47.76	51.39	98.50	107.32	102.91	3.58	3.10	3.34	157.65
Traditional Farms	0.95	0.33	0.70	0.68	0.40	0.54	0.06	0.03	0.04	1.28

Table 4. Average Per Acre Cost of Sugarcane Production

Item	Land Input	Labour Input	Capital Input	Total	Change Actual	Change Percent
Progressive						
Large Farms						
1974–75	222.03	311.95	889.63	1423.61		
1975–76	137.97	329.63	861.13	1328.73		
Average	180.00	320.79	875.38	1376.17	− 64.40	− 4.47
Medium Farms						
1974–75	216.65	367.55	906.08	1490.28		
1975–76	259.40	380.32	968.32	1608.24		
Average	238.05	373.94	937.30	1549.26	+108.69	+ 7.54
Small Farms						
1974–75	206.02	424.68	1008.26	1638.97		
1975–76	239.55	427.52	964.09	1631.16		
Average	222.79	426.10	986.19	1635.07	+194.50	+13.50
Overall Average	213.61	373.61	932.95	1520.17	79.60	+ 5.53
Traditional Farms						
1974–75	198.55	692.66	542.70	1433.91		
1975–76	222.36	573.80	651.06	1447.22		
Average	210.47	633.23	596.88	1440.57	–	–

Result

Sind, Hyderabad, Tharparkar, Nawabshah and Badin districts are the main sugarcane growing areas. In the recent past through the introduction of farm machines on progressive farms., a change in cultivation standard has taken place **(Table 2).**

The analysis of sugarcane production function indicates that it involved average inputs of Rs. 1520.17 per acre on progressive farms as against Rs. 1440.57 on traditional farms. The cost of production on progressive farms included Rs. 213.61 on land inputs, Rs. 373.61 on labour inputs and Rs. 932.95 on capital inputs as against Rs. 210.47 on land inputs, Rs. 633.23 on labour inputs and Rs. 596.88 on capital inputs employed on traditional farms. The average cost of production on tractor farms was higher than bullock farms by 5.53 percent involving more volume of capital and less labour input. The increase in capital inputs was due to machine use. Comparative analysis of machine use and local

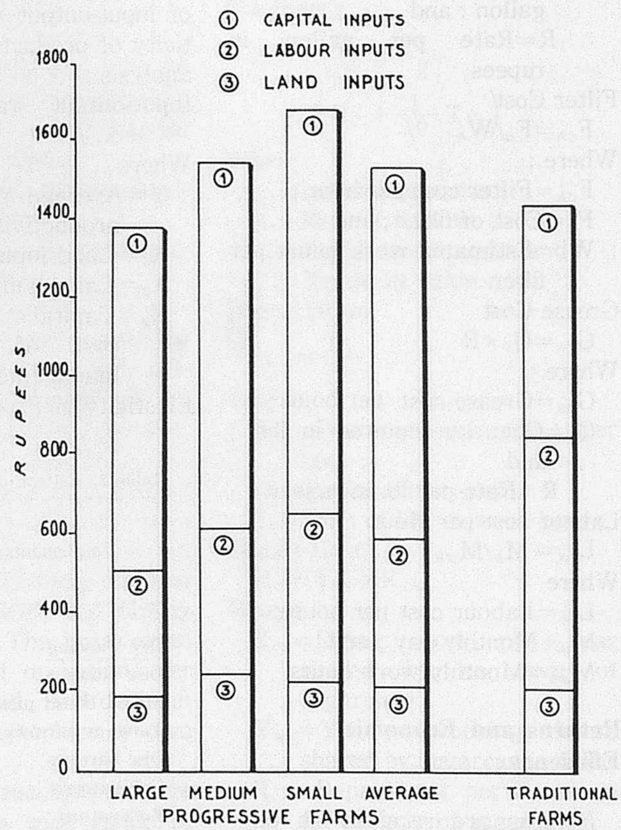

Fig. 1 Average per acre cost of production on sugarcane farms in Sind during 1974—76

Table 5. Productivity Per Acre of Sugarcane

Farms Group	1974–75 Physical Productivity	1974–75 Change Actual	1974–75 Change Percent	1975–76 Physical Productivity	1975–76 Change Actual	1975–76 Change Percent
	Maund	Maund		Maund	Maund	
Traditional	621.08	–	–	110.66	–	–
Progressive						
Large	794.71	173.63	27.96	128.41	+17.75	+16.04
Medium	828.99	207.91	33.48	145.48	+34.82	+31.47
Small	868.74	247.66	39.88	141.69	+31.03	+28.04
	830.81	209.73	33.77	138.53	+27.87	+25.19

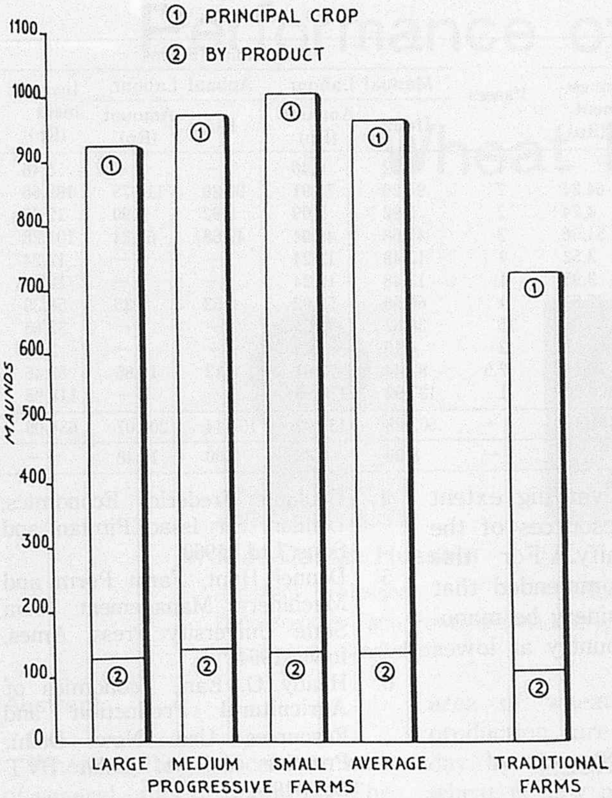

Fig. 2 Average per acre physical productivity accrued on sugarcane farms in Sind during 1974—76

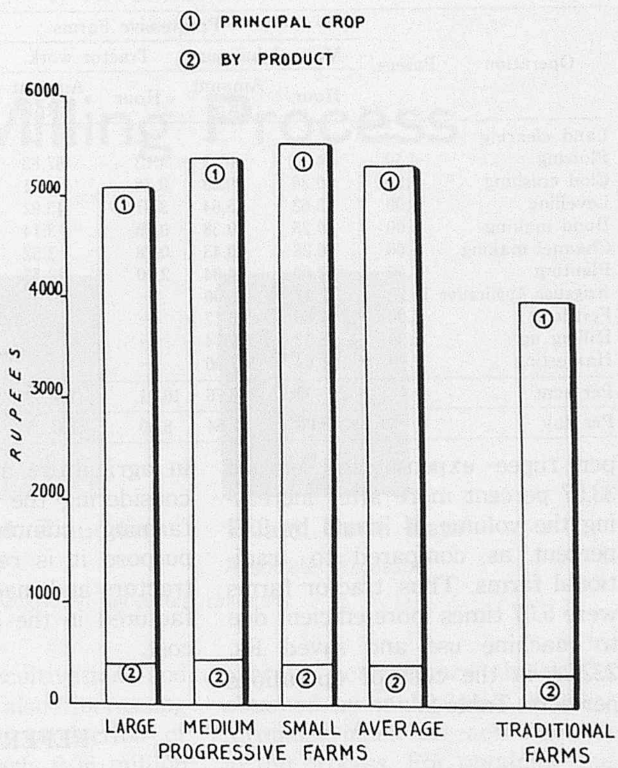

Fig. 3 Average per acre revenue productivity accrued on sugarcane farms in Sind during 1974—76

implemets in sugarcane is given in **Table** 3 and differential in cost of production is shown in **Table** 4, and **Fig.** 1. An acre of sugarcane crop earned Rs. 4933.48 on tractor farms and Rs. 3693.56 on traditional farms, **Table 5**, and **Fig.** 2. For 830.81 maunds of cane and 138.53 maunds of leaves and tops, considering opportunity cost of by-product on tractor farms, and 621.08 maunds of cane and 110.66 maunds of leaves and tops per acre on traditional farms, respectively. The yield of cane on progressive farms was 33.77 percent higher in respect of cane production and 25.19 percent in by-product as compared to traditional farms, **Table 6** and **Fig. 3**.

The input-output ratio on tractor farms was 1 : 3.25 as against 1 : 2.57 on traditional farms. The machine contribution in sugarcane production in varying sets and combinations is shown in **Table** 7 which was highly significant. Thus, progressive growers earned high income of Rs. 0.68 on

Table 6. Average Revenue on Per Acre of Sugarcane Production

Farm Group	Principal Product: Revenue Productivity	Change: Actual	Change: Percent	By-Product: Revenue Productivity	Change: Actual	Change: Percent
	Rs.	Rs.		Rs.	Rs.	
Traditonal Farms	3380.10	—	—	313.49	—	—
Progressive						
Large	4329.96	+ 949.86	28.10	378.71	+ 65.22	20.80
Medium	4514.62	+1134.52	33.56	439.75	+126.26	40.28
Small	4732.14	+1352.04	40.00	405.30	+ 91.81	29.29
Mean	4525.57	+1145.47	33.89	407.92	+ 94.43	30.12

Table 7. Machine Contribution in the Production of Sugarcane, Selected Progressive Farms. 1975—76

Machine Sets Used	Farms No	Area Acres	Production Total Maund	Production Per acre Maund
Tandem harrow+cultivator+blade	3	12	7800	650
Disc plow+cultivator+roller+blade	4	16	12832	802
Disc plow+tandem harrow+cultivator+leveller	3	12	9876	823
Disc plow+disc harrow+cultivator+roller	8	32	23200	725
Disc plow+cultivator+blade	2	8	5408	676
Disc plow+tandem harrow+rotavator+Cultivator+blade	5	20	16300	815
Disc plow+tandem harrow+leveller	4	16	12656	791
Mould board plow+disc plow+disc harrow+cultivator+blade	2	8	7640	955
Tandem harrow+cultivator+leveller	2	8	5600	700
Total	33	132	101312	768

Table 8. Per Acre Time-Cost on Sugarcane Production, 1974−76

Operation	Pasees	Progressive Farms: Manual Labour Hour	Progressive Farms: Manual Labour Amount (Rp)	Progressive Farms: Tractor work Hour	Progressive Farms: Tractor work Amount (Rp)	Progressive Farms: Investment (Rp)	Pasees	Traditional Farms: Manual Labour Hour	Traditional Farms: Manual Labour Amount (Rp)	Traditional Farms: Animal Labour Hour	Traditional Farms: Animal Labour Amount (Rp)	Traditional Farms: Investment (Rp)
Land clearing	−	−	−	−	−	−	1	8.12	6.46	−	−	6.46
Plowing	4.50	4.13	6.41	4.13	57.83	64.24	7	90.20	71.91	90.20	116.75	189.66
Clod crushing	1.50	0.38	0.53	0.38	4.21	4.74	2	5.92	5.09	5.92	7.90	12.99
Levelling	1.00	3.62	5.64	3.87	45.92	51.56	2	47.68	40.04	47.68	63.24	103.28
Bund making	1.00	0.25	0.38	0.25	3.14	3.52	1	13.48	12.24	−	−	12.24
Channel making	1.00	0.28	0.43	0.28	3.52	3.95	1	13.48	12.24	−	−	12.24
Planting	1.00	2.00	4.04	2.00	23.47	27.51	1	60.56	55.02	2.52	3.33	58.35
Irrigation Application	15.00	40.12	35.06	−	−	33.06	15	38.32	32.65	−	−	32.65
Fertilizer	3.00	7.06	6.17	−	−	6.17	2	4.16	3.78	−	−	3.78
Hilling up	2.50	88.52	75.14	−	−	75.14	2.5	82.44	72.61	8.12	10.85	83.46
Harvesting	1.00	152.64	129.96	−	−	129.96	1	137.92	118.98	−	−	118.98
Per acre	−	299.00	263.76	10.91	138.09	401.85	−	502.28	432.02	154.44	202.07	634.09
Per day	−	8.00	7.64	8.00	101.28	−	−	8.00	6.88	8.00	10.48	−

per rupee expense and earned 33.57 percent more after increasing the volume of inputs by 9.62 percent as compared to traditional farms. Thus, tractor farms were 5.07 times more efficient due to machine use and saved Rs. 232.24 in the cost of operations per acre, **Table 8.**

Conclusion and Suggestions

Mechanized cultivation though expensive in terms of initial cost is more efficient than conventional farming. Thus, various field operations should be standarized through experimentation and machines be introduced in phase program after working out the feasibility of machine adoption in agriculture at varying extent considering the resources of the farming community. For this purpose it is recommended that tractors and machinery be manufactured in the country at lower cost.

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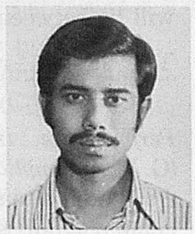
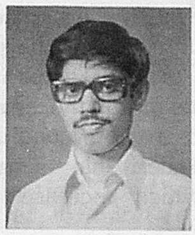
Performance of Wheat Milling Process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Abstract

Wheat milling process consists of several units of operation. The efficiency of milling is a function of individual performance of operations throughout the milling process. The overall performance may be obtained by multiplying the performance index of each operations.

Introduction

Bangladesh is now a serious food-deficit country. Rice is the principal staple and its production is not sufficient to feed all the people. Wheat is the second largest cereal product in Bangladesh. The people are gradually dependent upon wheat. Farmers are trying to grow more and more wheat in their farms. The area of wheat cultivation and production are also increasing day by day. The production of wheat is now nearly 0.36 million tons per year (**Table 1**).

Table 1. Wheat Production, 1973–78

Year	Production in million tons per year
73–74	0.11
74–75	0.12
75–76	0.22
76–77	0.26
77–78	0.36

Source: Evaluation of the First Five-Year Plan. Published in The Bangladesh Observer, May 26, 1978.

The utilization of cereals should be economical. Milling with high efficiency will be one of the methods of economic use of wheat utilization. This paper reports on the performance of the wheat milling systems and the factors affecting the mill performance.

A wheat milling system mainly consists of[2]

a) Cleaning : i) Ist cleaning (pre-cleaning) ii) 2nd cleaning iii) brushing, polishing and scouring ; b) Conditioning and tempering, c) Grinding and crushing ; d) Separation ; and e) Packaging and storing.

Bleaching (whitening of flour), is often considered a special step in the wheat milling process. It depends upon the quality of wheat. The average milling yield (flour) is about 65-70 percent depending upon the variety and quality of wheat.

The overall performance of a wheat processing plant is a function of the performance of individual machines. Usually, the overall performance index is obtained by multiplying the performance index of each machine in the process. For obtaining the best performance of a machine (i) the quantity of work by the machine should be maximum ; (ii) the quality of work done by the machine should be as best as possible ; (iii) the operator's skill and other operating conditions ; (iv) the quality of grain, etc. An attempt has been made to develop a mathematical expression for the performance of each machine in the wheat processing plant.

Theoretical Considerations

Performance index of wheat cleaner–Assumption : The separated dockages are free from significant amount of sound grains, i. e., no loss of grain during cleaning.

Referring to **Fig. 1** :

The amount of dockage present before cleaning = a lb./min.

Mass rate of dockage present in the cleaned product = b lb./min.

Actual mass rate of cleaned

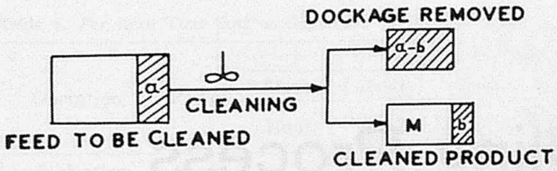

Fig. 1 Symbolic representation of wheat cleaning operation

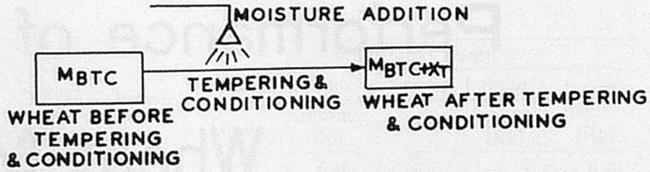

Fig. 2 Schematic diagram of tempering & conditioning of wheat

product after cleaning=M lb./min.

Mass rate of wheat+dockage before cleaning=(M+a) lb./min.

Mass rate of flow after cleaning=(M+b) lb./min.

Rate of dockge removed=-(M+a)−(M+b)=(a−b)lb./min.

Cleaning Index (C.I.)

$$=\frac{\text{Amout of dockage removed}}{\text{Total amount of dockage before cleaning}}$$

Validity of equation (A)

i) When the cleaner cannot separate any amount of dockage, the cleaning index should be zero, In this case a=b, hence cleaning index, 1−1=0.

ii) When some dockage is removed, the C. I. should lie betwween zero and one, let $b=\frac{a}{2}$

$\therefore$ C. I. $=1-\frac{a/2}{a}=\frac{1}{2}$

then o∠C. I.∠1.

iii) When the cleaner is able to remove all the dockage present before cleaning, then C. I. should be unity i. e. b=o, $\therefore$ C. I. $=1-\frac{0}{a}=1$.

Performance index of tempering and conditioning :

The safe moisture content for wheat storage is about 13 percent[1]. But for best milling result, the moisture content needs to be increased to 17 percent[3]. Therefore, wheat requires conditioning and tempering before grinding in order to toughen the brans, making it's subsequent separation easier from the flour during grinding. The process consists of adding a certain amount of water to the already cleaned wheat and allowing the mixture to stand for a predetermined length of time. The period of time during which the grain is allowed to stay in contact with the water depends upon the initial moisture content of the wheat, the hardness of the wheat kernel, and the plumpness of the grain. Tempering facilitates the milling operations and tends to create a condition favorable to desirable enzymic reactions which increase the flour yield.

Assumption : All the wheat grains are tempered and conditioned uniformly.

Referring to **Fig. 2** :

Mass rate of wheat before tempering and conditioning M_{BTC} lb./min.

Mass rate of clean wheat at optimum temperating= $(M_{BTC}+X_o)$ lb./min.

Amount of moisture added to correct the M_{BTC} lb./min. of wheat up to optimum moisture content (17 percent) for grinding= X_o lb./min.

Mass rate of clean wheat after tempering and conditioning-$=(M_{BTC}+X_t)$ lb./min.

Performance index of tempering and conditioning (T. C. I.) $=\frac{X_T}{X_0}$......(B)

Here, $\left(1-\frac{X_T}{X_0}\right)$ is the error factor in tempering and conditioning. Therefore, T. C. I. indicates the amount of error in conditioning and tempering of wheat during processing.

Validity of equation (B) :

i) If no tempering and conditioning occur, the perfomance index of tempering and conditioning will be zero, therefore, no moisture is added to the wheat grains, i. e., $X_T=0$, $\therefore$(T. C. I.)$=\frac{0}{X_0}=0$.

ii) If optimum tempering occurs, the T. C. I. will be unity i. e. $X_T=\frac{X_0}{X_0}$ $\therefore$ T. C. I. $=\frac{X_0}{2}=1$,

iii) If $X_T=X_o$, then the T. C. I. will lie between zero and unity $\therefore$

T. C. I. $=\frac{X_{0/2}}{X_0}=0.5$ $\therefore$ 0∠T.I.C.∠1.

Performance index of grinding (G. I.) *Assumptions* :

i) Performance index is calculated from lst feeding to final output before separation. It may be noted that in between lst feeding and final output there may have several steps in grinding.

ii) Mixture does not contain any whole grain after grinding.

iii) The final output before separation contains flour, bran and mixture only.

iv) Considering no unseen losses during grinding.

v) At optimum grinding there will be no existence of mixture.

Referring to the **Fig. 3** :

Mass rate of flow of clean wheat$=(C_1+M_f)$ lb./min.

Mass rate of flour obtained from (C_1+M_f) lb./min. at optimum grinding$=M_f$ lb./min.

Mass rate of bran obtained from (C_1+M_f) lb./min. at optimum grinding$=C_1$ lb./min.

Mass rate of flow of flour found after grinding$=M_n$ lb./min.

Mass rate of flow of bran found after grinding$=C_2$ lb./min.

$\therefore$ Amount of mixture found$=(C_1+M_f)-(C_2+M_n)$ lb./min.

$\therefore$ Grinding index (G. I.)$=\frac{(C_2+M_n)}{C_1+M_f}$........(C)

Validity of equation (C) :

i) When there is no mixture in the output, the perfomance index should be unity, i. e. $(C_1+M_f)-(C_2+M_n)=0$ $\therefore C_1+M_f=C_2+M_n$

$$\therefore \text{G.I.}=\frac{C_2+M_n}{C_1+M_f}$$

$$=\frac{C_1+M_f}{C_1+M_f}=1$$

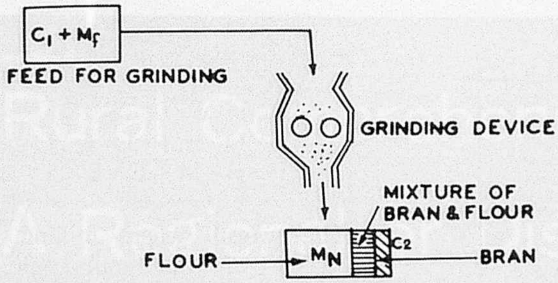

Fig. 3 Symbolic representation of grinding operation

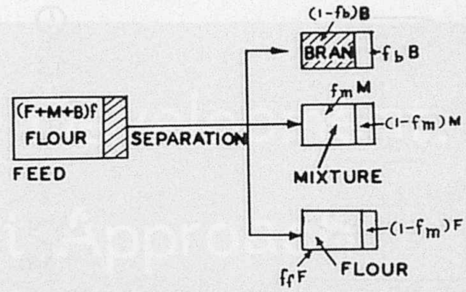

Fig. 4 Schematic diagram of separation process

ii) When the products are found to contain mixture, the G. I. should be zero, $(C_2+M_n)=0$

$$\therefore \text{G. I.}=\frac{0}{C_1+M_f}=0$$

iii) When the mixture found in one-half of the output, the G. I. should 0.5 i, e., the G. I. should lie between 0 and 1.

$\therefore\ (C_1+M_f) - (C_2+M_n) = \frac{1}{2}(C_1+M_f)$ or, $(C_2+M_n) = \frac{1}{2}(C_1+M_f)\ \frac{1}{2}(C_1+M_f)$

$$\therefore \text{G.I.}=\frac{\frac{1}{2}(C_1+M_f)}{C_1+M_f}=0.5$$

$\therefore\ 0 \angle \text{G.I.} \angle 1$

Performance index of separator : (S. I.) :

Assumptions : i) The separator has three outlets and ii) there is no less of mass during process of separation.

Referring to **Fig. 4** :

Mass rate of flow of flour from flour outlet = Flb./min.

Mass rate of flow of bran from bran outlet = Blb./min.

Mass rate of flow of mixture from mixture outlet = M lb./min.

Fraction of flour in the feed = f

Fraction of flour in sample from outlet = f_f

Fraction of flour in sample from bran outlet $=f_b$

Fraction of flour in sample from mixture outlet = f_m

Fraction of flour in mixture of separate flour and separated bran = f_x

If E_F be the flour effectiveness,

$$\text{Then, } E_F=\frac{\text{Amount of flour in collection from flour outlet. lb./min.}}{\text{Amount of flour in separated flour and separated bran, lb./min.}}$$

$$\therefore E_f=\frac{F.f_f}{(F+B).f_x}\ \text{......(i)}$$

If E_b be the bran effectiveness,

Then, E_B

$$=\frac{\text{Amount of bran in collection from bran outlet, lb./min.}}{\text{Amount of bran in separated bran and separated flour, lb./min.}}$$

$$\therefore E_B=\frac{B(1-f_b)}{(F+B)(1-f_x)}\ \text{...(ii)}$$

And, f E_s be the effectiveness of separation :

Then, E_S

$$=\frac{\text{Amount of separated sample from flour and bran outlets, lb./min.}}{\text{Total amount of sample feed to separater, lb./min.}}$$

$$\therefore E_S=\frac{(F+B)}{(F+B+M)}\ \text{......(iii)}$$

Thus, the performance index of the separator is given by the product of the equations (i), (Ⅶ) and (Ⅷ).

∴ Performance index of separator (S. I.) $=E_F \cdot E_B \cdot E_s$

$$=\frac{F.f_f}{(F+B).f_x}\cdot\frac{B.(1-f_b)}{(F+B)(1-f_x)}\cdot\frac{(F+B)}{(F+B+M)}$$

$$=\frac{(F.B)(1-f_b).f_f}{(F+B+M)(F+B)(1-f_x)f_x}\ \text{..................................(D)}$$

Validity of equation (D) :

i) Flour and bran have been completely separated by the separator. The outputs, such as flour, bran and mixture will come out only through the respective outlets. In this case, $f_f=1$, $f_b=0$, $f_m=0$ and $M=0$.

∴ S.I.

$$=\frac{(F.B)}{(F+B)^2(1-f_x)f_x}\ \text{....(iv)}$$

and $\frac{F.f_f}{F+B}\ f_x=F.f_f$ or. $f_x=F.f_f$

Substituting the value of f_x in (iv)

∴ S.I.

$$=\frac{(F.B)}{(F+B)^2}\cdot\frac{1}{\frac{F.1}{(F+B)}\left(\frac{F+B-F.1}{F+B}\right)}$$

$$=\frac{(F.B)(F+B)^2}{(F+B)^2(F.B)}=1.$$

ii) When all the variables are present, the separator index should be between zero and unity

Let, F = 6lb./min. and f_f = 0.80

B = 2lb./min. f_b = 0.20

M = 2lb./min. f = 0.50 f_x = 0.70

then S. I. = 0.457 ∴ 0∠ S. I. ∠1

iii) When the mixture of bran and flour fed to the separator, it does not get separated at all, i. e., all the amount comes from the mixture outlet only.

then, F = 0, B = 0. ∴ S. I. = 0.

Conclusion

The overll performance index of wheat milling is the product of all the indices multiplied by the ratio of the wheat cleaner.

$$WMI_o = (\text{C. I.}).(\text{T. C. I.}).(\text{G. I.}).(\text{S. I.}).\left(\frac{C_a}{C_r}\right)$$

Where, C_a is the actual capacity of the wheat mill. C_r is the rated capacity of the wheat mill.

WMI_o = Overall wheat milling index.

$\therefore WMI_0$

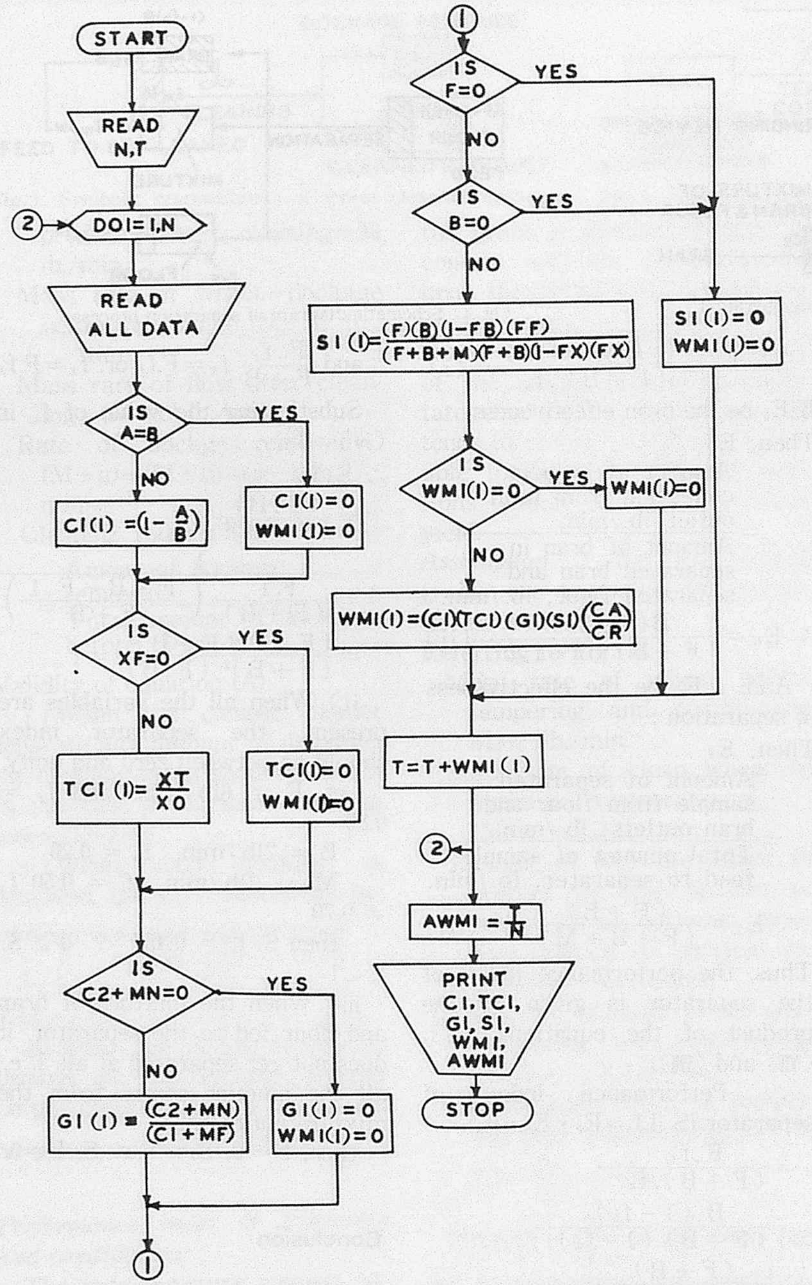

Fig. 5 Flow diagram of programme for evaluating overall milling index of a wheat mill

$$= \left(\frac{C_a}{C_r}\right)\left(1-\frac{b}{a}\right)\left(\frac{X_T}{X_0}\right)\left(\frac{C_2+M_n}{C_1+M_f}\right)\cdot\frac{(F.B.)\,(1-f_b)f_f}{(F+B+M)\,(F+B)\,(1-f_x)f_x} \quad \text{..............................} (E)$$

The overall wheat milling efficiency of the mill will be WMI_oX100 percent. If two or more machines of similar nature are in parallel in operations their performance index will be the average mean of the indices of each machine. The flow diagram for evaluation of wheat milling index is shown in Fig. 5.

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Rural Comprehensive Development: A Regional or District Approach

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Background

In almost all the developing countries there emerges a "Two Pole" economy in an ever more distinct form. This appears as two completely different patterns of life, one as far apart from the other, as the North from the South pole. It is not a matter of some people being rich and others poor, both sharing a common way of life. It is a question of two completely different ways of life where any common identity more and more diminishes.

We will probably find that in this "Two Pole" economy, in almost all the developing countries, 10 to 15 percent of the population form one pole live in one or two big cities. The other pole is formed by 85 to 90 percent of the population who live in the rural areas and small towns. Each group lives a totally different way of life. This is expressed, in a way, that members of the lower part of the first group have an income many times (maybe several hundred times) that of even the hardest working members of the second group.

This process, or the exstence of this "Two Pole" economy, produces social and political tension. It not only produces tension but a process of mutual poisoning. Industrial and commercial development undertaken by the first group, in the big cities, destroys the economic structure of the "hinterland" and the people of the second group, of the large rural areas, take their revenge (unconsciously) by massmigration to the big cities and poisoning them.

The end result is : a very small part of population, which is rich, is continually getting richer. A city proletariate, which is continually growing, is gradually becoming unmanageable. The cultural and economic structure of the rural sector is gradually disintegrating.

When trying to find a path which will lead towards a solution, the first task should be to recognize and understand the basic problems. The very major problem which one has to recognize and understand is POVERTY. Or, rather a degree of poverty which means missery and which degrades the human being. With our materialistic background and philosophy we are prone to see only the materialistic reasons for that state and overlook the immaterial factors. And yet, the major causes of extreme poverty are none-materialistic factors, such as lack of education ; a disintegrating cultural structure and lack of identity ; lack of organization to strengthen the weak ; etc.

Therefore, when trying to find that path leading to a solution, the question is whether this will be "modernisation" without taking into consideration social, religious or spiritual values. Even the people from countries with ancient religions, who care nothing for their ancient spiritual values and heritage, but want to travel, as fast as possible, the materialistic path to development and a "modern" economic structure, should ask themselves whether their ancient heritage is nothing better then a nostalgic dream. They should ask themselves wether this path of pure materialistic "modern" economy

*A bridged from a paper of the same title.

will actually lead them to places where they really want to be. Whether this path, without taking into consideration ancient spiritual values and heritage has not led to disastrous results : the collapse of rural culture and economy, the growth of a city proletariat, without nourishment for either body or soul.

If the disintegration of rural life continues, there is no way out, in spite of all the money spent. If however, the rural people are taught to help themselves, there certainly will be results to a development effort. Although material aid should not be belittled, intellectual aid, in the form of useful knowledge, may be more important. Assistance in the form of material gifts or help make people dependent. Assistance in the form of knowledge, useful knowledge, will make the receiver free and lead him on, on the path to independence. Give a man a seed grain and you are helping him a little bit, for a short time ; teach him how to grow and produce that seed grain and he can help himself all his life. Supply him with a simple grain drill ; this will cost quite a lot of money, he will be able to produce more grain, but he will still depend on being supplied with spare parts. Teach him how to build his own simple grain drill and he will not only be able to support himself, but be proud and become independent. This seems to be the major weak link in all foreign assistance programmes to developing countries and development planning. Naturally, it is easier to help those who can help themselves, than to help the helpless.

When looking at the developing world today, we find a lot of small nations, regions or districts clamouring for self-government and so-called independence. This is the simple and natural response to their position : the need for regional development. There probably is not much hope for the poor, unless there is a regional development effort, outside the big cities. There probably is no solution to today's position of a gradually disintegrating rural life, mass migration to the big cities and a countinually growing city proletariat, unless the structure of rural life can be changed. This requires the development and construction of a regional agricultural-industrial culture, so that each region or district can offer full employment and large variety of occupations to its population.

The existing political units (states) are most probably not such a size that overall development efforts will bring help to those whose need is greatest. In the majority of cases, these units are far too large. But if development plans and policy in each country are overall plans which concern the "country-as-a-whole", the natural drift will most probably be to "help those who can help themselves" ; in other words, to concentrate major efforts, for quick results, arround a few metropolitan areas. The vast majority of the country and its population will benefit very little and may indeed suffer (mass migration, etc.). The result of this type of development will be that a small minority will have their fortunes increased, while those who really need the help are left helpless. To find a solution of how to bring help to those who need that help most, a region or district has to have its own development plan and effort.

Besides the very many direct and indirect reasons already mentioned, justifying the idea of comprehensive regional development, there are two more reasons which should not be forgotten. The first one is the lack of sufficient capital to finance overall the "country-as-a-whole" development programmes. The second one may be even more important, the lack of sufficient trained and suitable personnel to man such overall programmes. The number of regions or districts in which comprehensive development programmes will be carried out can be based on the availability of capital and suitable personnel. Furthermore, one or two comprehensive regional development projects can be utilized as training ground for personnel, to cover similar projects in other parts of the country.

It is difficult to define what should be a Region or District. A lot depends on social and geographical circumstances. It should, however, have some inner cohesion and identity. The bigger the country, the greater is the need for this de-centralized approach to development

THE REGIONAL COMPREHENSIVE APPROACH

Introduction

After the area of the district has been decided upon, the first step will be to make a survey of the physical and social conditions of the district. Based on these facts, a group of specialists can draw up the framework of a development plan for the district, covering a timespan of, at least, ten years. The framework plan should be accompanied by a feasibility review, checking the feasibility of each and every item of the plan. This plan will then be handed over to the central goverement for review, adjustments, changes, corrections and acceptance. The final product will then form the development plan for the district. a warning sign though that a plan is usually the foundation for making changes. This means that during the implementation of the plan, continuous review will have to be carried out and the plan has to be adjusted to the ever-changing conditions.

The proposed plan has to be a

comprehensive one, i.e., a plan which covers all and every sphere of life of the District : education, culture (probably also religion), health, transport, communications, power, finances and economics, agriculture, industries, etc.

All these subjects are covered by ministries in the national government. In order to cut red tape and in order to centralize and concentrate on the whole effort and plan, it is suggested that a District Development Authority be established. This, in other words, will be the local representative of the central government. At the head of the Authority will be the general manager of the project. Depending on the composition of the national government, he will either represent the Prime Minister or the Minister of Planning and Economic Development (which exsists in many countries). In any case, the general manager of the Development Authority will represent the central government authority which operates and coordinates above the different implementing ministries.

The general manager will be assisted by five deputies who will be in charge of the different implementing departments :

a. Finances : representing the Ministry of Finance and Economy, being in charge of the whole financial aspect of the project.
b. Infrastructure : representing the ministries dealing with the development of transport-roads, rail, river, air ; communications-wireless telephone, post ; Power-electricity, etc.
c. Social Services : representing the ministries and dealing with development of ducation, culture, health and cooperatives.
d. Agriculture : representing and dealing with the development of agriculture.
e. Industry : representing the ministry and dealing with the development of industry.

Finances—The main burden will have to be carried by the central government, but this need not be the only source of financing. There are a number of international bodies, agencies and funds which can make development capital available. Private capital can also be mobilized for special projects. At a later stage, the local population can also participate in the financing of communally owned development enterprises.

Infrastructure—Conditions vary, but one thing is clear and generally accepted : unless minimum services and facilities are available, it is almost impossible to initiate a comprehensive or any development plan. Once such a plan has been started, the basic facilities and services have to be developed simultaneously along all the other spheres of life.

Social Services

Education—Development efforts require a lot of resources, the majority of which have to come from the tangible side. Probably the most vital, however, comes from the intangible side : EDUCATION. History teaches us that daring, initiative, economic planning and success come out of the mind of man. Without the foundation of education, man remains helpless, unable to help himself, to lift himself out of the stage of poverty and missery. These are the reasons why a major effort has to be invested in an educational programme, in a comprehensive development scheme.

The whole programme will have to be divided into two sections. One for child and youth education and the other for adult education. There should be an elementary school in each village and a secondary school in some of the townships of the district. The whole educational system should be adapted to changed conditions. This amounts to much more then placing additional children into schools. Education in the schools should teach the basic elements of a developing and building society, of how man can cooperate and live with his fellow man.

The field of adult education is of equal importance (at least) but is evoking a more difficult challenge. The basis of this effort is the village. Every man and woman in the village, up to a certain age, should be taught to read and write, know some basic manipulation of mathematics and be taught some elementary general subjects. The women of the village should be taught basic economics : nutrition, sanitation, health, family planning, sewing, handicraft, etc.

A natural question will be : who is going to teach all these subjects in all the villages, where are the teachers going to come from? The teachers are drawn to the towns and cities and do not want to take up jobs in the villages, nor are there enough teachers to cover all the villages. There are a number of solutions, none of them perfect, but something is better then nothing ! Government can issue an order that every university student, male and female, independent of the subject they study, spend 2/3 of their holidays teaching in a village with renumeration. Without this effort, certified by authority, they will not be able to continue their studies. All teacher graduates, male and female, will spend at least two years in villages, before any of them will be employed in town or city.

Another and perhaps a more revolutionary solution : Almost all, if not all developing countries have an army, usually built on compulsory service. The large majority of these countries have no actual exterior security problems. A small part of these soldiers, including females, who have suffient educational level, could be formed into an Education Corps. They should be trained in intensive courses for a few months and send to villages where they should serve one or two years. Each village should have a few Education Corps to cover the different subjects. An officer should be in charge of the education activities of the corps men of a few villages.

A step further should be a technical or professional school and an institute of higher learning in the district centre. These institutions take years to plan and man. They are therefore a long-range goal.

The faster specific and skilled persons can be supplied, the faster will be the implementation of the development plan. There is, therefore, need for an intermediate institution which can supply personnel to start operations. A seminary or training school can fulfil this quest. It should be able to run courses from a day or two, to up to several months. Courses can cover each and every subject dealt with by the Development Authority : a two-day course for a specific crop before the planting season ; a week's course for mechanics on a specific tractor accessory ; six months to train mechanics ; two months to train a new generation of village head men ; several months course for basic industrial professions ; training agricultural and industrial foremen ; administration personnel ; etc.

Many of the courses can be taught by the key personnel of the Authority. Teachers can be brought in for specific courses from the cities, others are available from many national and international firms.

Graduates will not be able to compete with graduates from professional schools or universities. But they will be able to bridge a gap which might very well turn into an abyss.

Culture—Theological staff and officials of religious institutions have a large influence on the local population. Familiarize them and let them participate, in some part, in the development effort.

For most of the rural population the beliefs, legends and customs, in short, folklore, form the framework of their lives. Take this away and they will find themselves suspended in a kind of vacuum, lacking balance and identity. The task should therefore be, not only to recover the already lost, but also to protect and spread the existing.

Health—There should be a hospital at least in the district centre, there should clinics in the townships and villages. The major missing link is the lack of personnel. Fundamental solutions are long-range with heavy investments. An interim solution has to be found.

A similar idea as suggested earlier in Education is to take some soldiers, train them for a few months and form them into a Health Corps. Send them to the villages. A simple clinic should be established in every village for the treatment of wounds (first aid), detection of diseases, preventive medicine, etc. The village clinic should be connected by telephone or wireless to the district centre. The Health Corps man can administer simple treatment. In more difficult cases he can get advice and instructions by wireless or phone from the doctor in the district centre.

Cooperatives—There is a trend today to move away from the single "owner-producer" to larger groups of production. This is for the fuller utilization of capital and equipment and the more complete use of skills and know-how. The question can be solved through cooperative units. Those cooperatives are known today all over the world and there are many different forms. The actual form has to be suitable to the local population, with the special atmosphere of a developing rural district.

As an example, different forms of cooperatives have existed in Israel for the last 60 years. But the development both in agriculture and industry would be unthinkable without the role of these cooperatives.

Agriculture

Background–Agriculture in the majority of the villages (specially those distant from the metropolitan centres) may be characterized as primarily a closed subsistence, non-economic in nature. Usually there is little change in its age-old pattern of production and little influence by advances made in agriculture in recent years. Three major factors contribute to this situation : **a)** the majority of the farmers suffer from lack sufficient land ; in many cases they rent land and divide the yield with the owner of the land. The bulk of the products grown are consumed on the farm. Little cash is required for the purchase of inputs or to market the products ; **b)** water supply and other resources are irregular, in many cases insufficient and not organized. The availability of these supplies does not always coincide with crop requirements **c)** a large percentage of the population of the developing countries still living in the villages and are engaged in agriculture, subsisting, almost altogether, on its own production. Consequently, the demand for farm produce is determined by only a small percentage of the population, living in towns and cities. However, only a small part of the potential customers have any real influence on the market, the others being restricted to the barest neccessities. Therefore, the market in this traditional form of agriculture is very limited.

The rate at which agriculture can be transformed into a more productive and profitable activity depends mainly on two items : a market-oriented economy which depends to a large extent on the rate of growth of the disposable income of the non-agriculture population and the change over to crops which can either be used as raw material for processing industries or exported. This conversion will require capital investment for tools and facilities.

The proposed programme should be a compromise between short-term and long-term objectives in that it attempts to exploit market conditions, wherever they exist, in building up a processing industry and an export market while building up the long-range tools to ensure the viability of the farm unit. It is suggested that a new agriculture pattern established while the old, traditional one is gradually phased out. The plan should be built in such a way that its first part maybe considered a transition stage into a modern market economy in that it allows the farmer to contiune to grow the crops required for his subsistence, while gradunally increasing that part of the crops marketed or processed.

Methodology of Planning :

Scope and Criteria, Planning Constraints, Ecological and Climatic Considerations, Demand Forecast, Evaluation of Crop Poofitability, Planning Procedure.

Description of Agriculture Plan :

Land Resources, Water Resources, Selection of Crops, Selection of Livestock, Classification of Farm Types, Plan for Farm Unit.

Implementation of the Plan :

Process of Village Development, Descripition of Development Phases.

(All the above subjects are dealt with in detail in the original paper).

Extension Service

Introduction-Attainment of the objectives of the district agriculture development project depends on bringing the farmers to identify themselves with the objectives and securing their full cooperation. This can be achieved provided the farmers are convinced that implementation of the project will result in the betterment of their living conditions and that a number of changes are introduced into existing sociological patterns. The initiation of these changes, as well as the introduction of modern agriculture techniques in the district will be the duty of the Extension Service.

It will be neccessary that the personnel of the service become fully acquainted with the traditions and customs of the villagers in order that they may be in a position to assess the farmer's motivations and attitudes in relation to all the aspects of the develoment.

To obtain the neccessary know-how specific to the district, a considerable amount of experimental work will have to be undertaken. It is therefore proposed that an agriculture research station be established in the district (if one does not already exist), to carry out experiments in the selection of crops and varieties best suited, determination of water requirements, irrigation methods, livestock breeding and improvement, etc.

Functions and Methods of Operation :

In-service Training, Farmer Instruction, Liaison with Research Institutions, Demonstration Farms, Veterinary Service, Plant Protection Laboratory, Soil-Water Laboratory, Meteorological Service, Organization and Personnel.

(All the above subjects are dealt with in detail in the original paper).

Service Companies

Introduction-The idea behind the service company concept is, first of all, to free the farmers from all the worries other then growing crops and livestock. Agriculture which starts to move out from a closed subsistence stage to a more modern market-oriented form of agriculture, tends to become more and more complicated such, that the small villager is not able any more to cope with all the problems : inputs, irrigation water, machinery, marketing, etc. Besides new crops, new strains and improved livestock others will strain their worries of abilities to the limit.

It is, therefore, suggested to found three service companies which will render their services to the farmer at self-cost, without profit, in the most important spheres in developing agriculture : supply and marketing, water supply, agriculture and development machinery. (These are dealt with in detail in the original paper).

Besides removing a considerable amount of worries from the mind of the farmers, such Service Companies have sources of supply and financing open to them which cannot be reached by the individual famer. Agricultural inputs can be purchased through national or international tenders from the supplier offering the cheapest prices and the best terms. Produce can be sold to the highest bidder and not to the one who chance to pass by the farm and offer a below-market price. Irrigation water supply can be developed on a planned district level. Equipment can be purchased by tender from the supplier offering the cheapest price and the best terms. By optimum utilization of equipment, its cost to the user is reduced. Besides, the most important factor is a high level service and repair facility which can only be reached with great difficulty, or not at all, by the individual farmer.

Industry

Introduction-The field of industry is very large and can be divided into numerous sections. As we are dealing with a development project of a special district, first of all, the needs and requirements of that district have to be taken into consideration. After reviewing the whole field, a list of priorities has to be compiled, according to which the numerous industries have to be developed and according to which the department has to operate.

It should be kept in mind that the largest part of the population is finding its income, and will find it for many years to come, from agriculture. However, this income can be increased, on the one hand, by processing agricultural products and creating quite a lot working places, on the other hand, the farmer's income can be increased by manufacturing end-products from agricultural. raw materials (cotton-yarn, cloth ; sugar beet/cane-sugar, molasees, pulp, alcohol ; oil crops-oil, oil cakes, etc.)

These two fields should receive top priority when laying down the policy. They not only will be able to raise the income of a vary large part of the population but also be able to create many working places.

Next in importance in the extraction and utilization of raw materials : timber, metals, chemicals, etc. The production of finished products usually requires more skills and should be of lower proirity on the list.

Ownership-Ownership plays an important part in the development of industry and will have to be decided upon, based on local conditions. Each form of ownership-government, public, cooperative, private, has its pros and cons.

Both government and private initiative are important in accelerating industrial development. Government operations have the advantage that centralized planning succeeds in meeting recognized needs with scaled measures, but are limited by the rigidity and lack of inertia of a centralized administration, which cannot respond spontaneously to changing conditions. Private initiative can respond spontaneously to changing conditions. On the other hand, cooperatives formed by members of the local population, can very well serve the special local conditions. Further, a public enterprise, a service company (non—profit) may well be able to serve a very large section of the population to its benefit and that of the whole district.

Processing Company (non-profit)

A processing company, in the writer's home area is used here to illustrate the idea. The company belongs to 38 villages. Each village delegates a number of its members to work for periods of 3 years and more in the different plants of the company. The whole management consists of members of the villages and the management positions are rotated for a period of 5 years, at least. Aproximately half the workers of the company are outside employees. About 400 people work in the Company.

Each village used to process its own requirements. A central modern live stock feed processing enterprise was erected which supplies all the feed for all the livestock of all the villages : 1976—150,000 tons. A number of cheap local materials have been developed to replace expensive imported materials.

A number of large modern harvesting units harvest the alfalfa in the villages, from where it is transported to the plant and dehydrated. A number of crop residues are dehydrated here as well and processed for livestock feed. All the sugar beet of the area is harvested by this unit, too.

All the poultry and turkeys are dressed in the feed mill at annually planned dates for all the villages. Part of the meat is processed, the rest marketed or exported.

All the cotton harvest of the area is processed in a common cotton gin. There is also a plant protection material store which keeps all the recognized materials. Any material is available at cost price, day or night.

A cold storage plant was also established for perishable products such as meat which is sold to the member villages at wholesale prices and fruits such as apples pears avocado and bananas. All fruits in the whole area are delivered to the plant where they are sorted, graded and packed. Most of the fruit is stored in controlled air and sold on the market when favourable prices are reached and sold locally or exported. ■■

Influence of Available Soil Moisture on Soybean Size and Its Resistance to Breakage

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Introduction

Soybeans, when handled by mechanical means through commercial channels, are often subjected to breakage. Large percentage of broken and split beans becomes part of the foreign material used in determining the grade in marketing. Along with other factors such as moisture content and variety, the size of soybean is important in determining its susceptibility to mechanical damage, which increases with an increase in the bean size. Large beans free from broken particles and cracked seed coats, on the contrary, are preferred in the production of "tofu" in Japan because of their uniform soaking and softening characteristics.

This indicates the need for looking at the various production factors which influence the soybean seed size and as well as relating the bean size to its susceptibility to breakage. The information on breakage resistance of soybeans as influenced by the bean size may be useful to breeders in the development of new varieties with high resistance to mechanical damage despite their bigger bean size.

In this study, the soybean samples obtained through the various field experiments were analyzed to check for any possible interrelationship between the availability of soil moisture during various stages of growth and the resulting soybean size. The resistance to breakage of soybean samples was determined by a simple mechanical breakage test using a food blender and related to the representative bean size of the test sample.

Previous Studies

In literature, there is very little information available on the development of soybean size as affected by the availability of soil moisture. Instead, attention is usually focussed on the maximum possible yield obtained as a result of various irrigation trials (Yaron, 1971 ; Hall and Butcher, 1968 ; Hiler et al., 1971).

Seed size is usually not closely related to yield. Instead, a close positive correlation has been reported between soybean seed number and yield (Weber et al., 1966 ; Egli, 1975)

Seed size in soybeans is governed by its genetic make-up (Hartwig, 1973). However, the seed of a given cultivar will vary in size depending on the environmetal factors during the growth period.

Final yield, which depends on the product of seed number and seed size, may not be influenced by the genetic changes in seed size because of accompanying compensatory changes in seed number (Hartwig and Edwards, 1970). Soybean varieties with very large seed size do not yield more because they usually produce fewer seeds (Shibles et al., 1975).

Studies have shown that soybeans respond with increased yields to addition of supplemental water (Matson, 1964 ; Doss and Thurlow, 1974). Similar results have been reported under climatic conditions of Thailand where the irrigation of soybean is limited during the drying season (Lairungreung, 19 2 ; Lauenberger and Sukapond, 1972). The timing and amount of irrigation, however, must. be carefully controlled to obtain optimum yield.

Ashley and Ethridge (M978) have reported that seed size from nonirrigated soybean plants was smaller than from plants receiving irrigation treatments. They further reported that seed size was greater for plants receiving initial irrigation at pod fill than from either of the earlier irrigation treatments.

An imbalance between the soil moisture supply and the amount needed by the plant will result in a condition commonly termed as moisture stress. Shaw and Laing (1966) studied the effect of soil water stress applied to soybean at selected periods during flowering, pod initiation, and bean filling stages, Soil water stress was achieved by appropriate regulation of irrigation with provision for controlling natural precipitation. Maximum reduction in yield, due to moisture stress, occurred during, the last week of pod development and during the bean filling stages.

Stress applied at the end of the bean-filling period or at the beginning of flowering had small effect on yield. Shaw and Laing also reported that the moisture stress during the bean-filling stage reduced the seed size.

Soybean is not very sensitive to drought, except during the germination stage and pod filling period (Howell, 1979 ; Cartter and Hartwing, 1967 ; Arnon, 1972, Pendelton and Hartwing, 1973). Shortage or excess of water, which occure during the pod filling period or during flowering and fruiting, generally reduced seed size, seed quality and yeilds.

Experimental

The relationship between the soybean yield and availability of soil moisture during various stages of growth was recently investigated by Pusposutardjo (1977). Soybean samples, so obtained from the various field experiments, were further analyzed for their respective seed sizes and the breakage resistance. Experimental details are presented in the following.

The four growth stages of soybean, which are commonly recognized, were considered (Martin and Leonard, 1965 ; Howell, 1967; Cartter and Hartwing, 1967):

a . Germination stage, that is, from the seedling emergence until complete differentiation of the main axis.
b . After germination stage to the time of flowering.
c . The pod set or filling stage, and
d . Seed development stage until maturity period.

The treatment consisted of four levels of available soil moisture as follows :

i) 100–80 percent of maximum available water, that is, close to field capacity.
ii) 60–50 percent of maximun available water.
iii) 40–30 percent of maximun available water.
iv) 20–10 percent of maximun available water.

These treatments covered the possible minimum levels of soil moisture content on dry basis which were kept at each of the four stages of growth defined earlier and as well as during the whole growing period. In case the available soil moisture was controlled at a certain stage of growth, the plants were adequately watered during the rest of the stages.

The ranges of the available soil moisture were specified in view of the practical difficulty encountered in estimating the soil moisture depletion during given time interval. The amount of irrigation water to be applied was determined based on the direct measurement of the soil moisture content using tensiometers.

The available soil moisture for the experimental plots, ranging between a maximum at field capacity to a minimum at permanent wilting point, was estimated to be 17.6 and 17.9 percent on dry basis for root zone depth of 0–30cm and 30–60cm, respectively. Knowing the soil moisture content and the depth of root zone, the amount of irrigation water needed to achieve the set level of available soil moisture could be calculated. The detailed procedure for calculating the water deficit relative to a set irrigation level is given by Pusposutardjo (1977).

Plots of treatment were arranged in randomized block design, using three replications. Plot size was selected to be 2 x 2.5m, enabling to grow three rows of soybean in each plot with 75cm row spacing. Soybean of variety S.J. 2 was hand-planted during the last week of December 1976 at a rate of about 62.5 to 75 kg/ha. The plant density was maintained at 40 plants per meter square of plot area or about 28 plants per meter length of the row. After harvesting in the fourth week of March, 1977, the crop was dried for 2–3 days. The pods, taken from the middle rows to keep the border effects of the treatment to a minimum, were hand-shelled and exposed under room conditions for several days prior to the testing.

U.S. Standard sieves, with square openings of 6.68, 4.76, and 3.32 mm were used to determine the various weight-size fractions present in a soybean sample weighing 100 gram. Average values based on three sieving tests were used in computation of the representative soybean size in a given sample.

A general purpose food blender was used to estimate the resistance to breakage of soybean samples. Percentage breakage for 100 gm sample of soybean, after subjecting it to breakage for fixed period of time, was determined from the broken size fraction which passed through the sieve with 3.32 mm opening size. The average of three breakage tests was taken to represent the percentage breakage of a given soybean sample. Breakage tests were performed for three arbitrarily selected durations of 3, 7, and 12 seconds at a rotor speed of approximately 400 rpm.

Results

All soybean samples passed through the 6.62mm sieve and were completely retained in varying proportions on 4.76 and 3.32-mm sieves. Thus, the sample weight fractions being retained on 4.76 mm and 3.32 mm sieves were nominally assigned the size of the respective sieves. A weighted-mean size was computed for each sample and used at the representative soybean size for comparison purposes.

Fig. 1 shows the soybean size as affected by the availability of soil moisture througout the growing period. The bean size is apparently decreased with the availability of either too little mois-

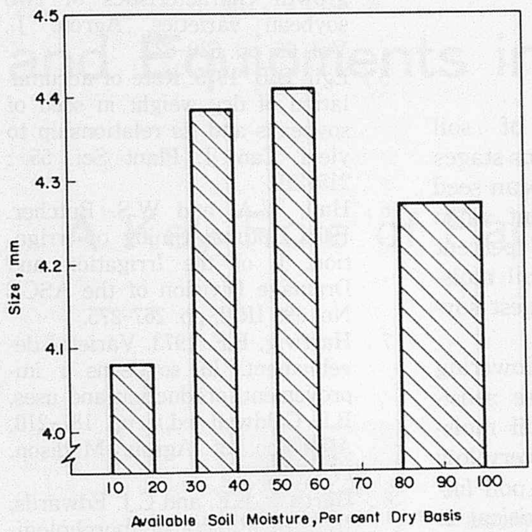

Fig. 1 Soybean size as a function of available soil moisture throughout the growing period

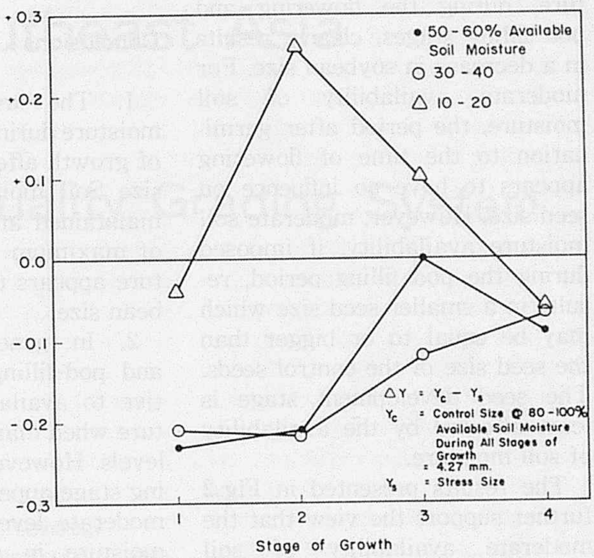

Fig. 2 Change in soybean size due to moisture stress applied at selected stages of growth

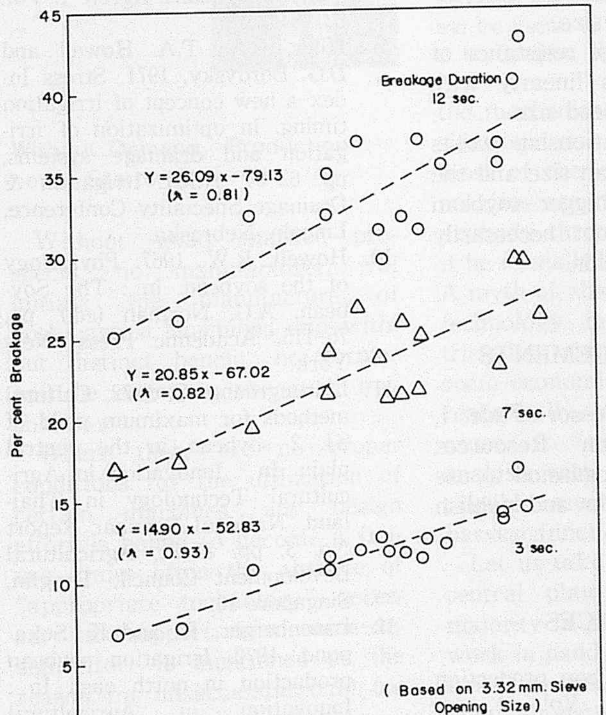

Fig.3 Effect of soybean size on breakage based on sieve opening of 3.32mm

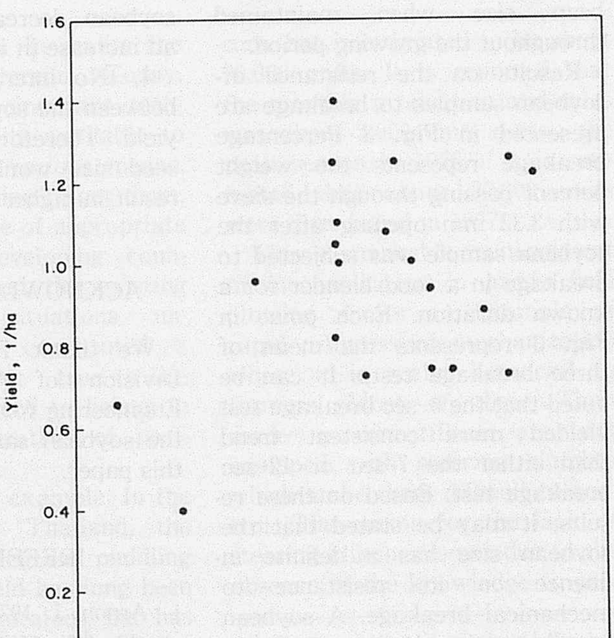

Fig.4 Relationship between yield and size of soybean obtained from various moisture stress experiments

ture or high moisture close to the field capacity. The soil moisture content, when maintained close to 50-60 percent of the maximum availability of soil moisture, appears to yield the biggest bean size.

Fig. 2 shows the effect of availability of soil moisture at various stages of growth on the seed size. Lowest availability of soil moisture, during the flowering and pod filling stages, clearly results in a decrease in soybean size. For moderate availability of soil moisture, the period after germination to the time of flowering appears to have no influence on seed size. However, moderate soil moisture availability, if imposed during the pod filling period, results in a smaller seed size which may be equal to or bigger than the seed size of the control seeds. The seed development stage is least affected by the availability of soil moisture.

The results presented in **Fig.**2 further support the view that the moderate availability of soil moisture favor the possible maximum development of soybean size when maintained throughout the growing period.

Results on the resistance of-soybean samples to breakage are presented in **Fig.** 3 Percentage breakage repesents the weight percent passing through the sieve with 3.32 mm opening after the soybean sample was subjected to breakage in a food blender for a known duration. Each point in **Fig.** 3 represents the mean of three breakage tests. It can be noted that the 3-sec breakage test yielded more consistent trend than either the 7-sec or 12-sec breakage test. Based on these results, it may be stated that the soybean size has a definite influence on its resistance to mechanical breakage. A soybean sample having bigger seed size would be more susceptible to breakage when subjected to some mechanical action.

In **Fig** 4, the soybean yield based on various experimental plots has been plotted as a function of the representative seed size. It is obvious that no interrelationship exists between the soybean yield and seed size. This is in line with the views expressed by Shibles et al. (1975) that bigger seed size would not ensure higher yield.

Conclusions

1. The availability of soil moisture during the various stages of growth affect the soybean seed size Soil moisture content when maintained around 50-60 percent of maximum available soil moisture appears to yield biggest soybean size.
2. In general, the flowering and pod-filling stages are sensitive to availability of soil moisture when maintained at very low levels. However, only the pod-filling stage appears to be critical at moderate levels of available soil moisture in regard to the development of seed size.
3. The breakage resistance of soybean decreases linearly with an increase in its seed size.
4. No interrelationship exists between the soybean size and the yield. Therefore, bigger soybean seed size would not necessarily result in higher yields.

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(*Continued on page* 41)

Prospects and Problems in the Promotion of Industrial Manufacturing of Rice Post-Harvest Processing Machines and Equipments in Southeast Asia

A Key-Role of Paddy Quality Grading System

by
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Without Demand, Production never Starts

Without good market prospects, no manufacturer will initiate the manufacture of post-harvest machines and without distinct benefit, no farmer will be eager to use such machines.

Where there are no proper conditions for the utilization of certain machines, any design effort is bound to become a failure. Quite often the absence of "appropriate technology" necessary to support a machine-design-effort is mentioned as the reason for unsuccessful trial for the mechanization. In reality the situation is different. Today, most of the contemporary technologies are readily available to anybody through various means, if he is really willing to get them. A myth of absence of appropriate technology in developing countries has simplified the existing socio-economic situations unrealistically and constituted a cause to neglect true-to-life analysis with regard to delays in possible mechanization of post-harvest functions.

Let us take an example. In the central plain of Thailand, the majority of plowing and puddling work in paddy field has long been done by water buffaloes, but has now almost been replaced by power tillers, most of which are made in Thailand. Total number of the machines is not known for sure, but is estimated to be about 90,000 units. It is reported that the monthly production and sales was about 5,000 units during the peak season in 1976[1/]. It is estimated that about 30,000 units were distributed in 1977.

This remarkable achievement of mechanization in paddy field plowing shows an example of rapid progress of mechanization where it is really beneficial to farmers. Most of these Thai-made power tillers are not equipped with steering clutches which make them difficult to control. The reason for the lack of steering clutches is not due to the absence of the knowledge to pro-

* The opinion expressed here are those of the expert and do not necessarily reflect the views of the ESCAP Secretariat.

1/ Feinberg, W : Agricultural Implements and Hand Tools Industry Survey in Thailand, UNIDO, Agricultural Mechanization in Asia. Vol. III No. 3 1976.

duce them but there is a stronger demand for the cheaper machines without steering clutches. However, some power tillers made in Thailand are equipped with these clutches.

There is no reason to doubt that, if threshers and paddy dryers could give as much benefit to farmers as power tillers do, they also can be manufactured and applied within a short span of time. At present, however, the profitability is still to be proven before the industry initiates investments in design and production.

Paddy Quality Appreciation Related to Investment-Incentives for Farmers

An overriding issue which delays the use of post-harvest machinery by farmers, is that the transaction of paddy is not done based upon its quality, especially when sold by farmers to middlemen, to commercial rice millers, or to agricultural cooperatives. Even if paddy quality is improved by better post harvest practices, the quality improvement may not be correctly reflected in the price. The absence of a quality assessment upon transaction is partly derived from the technical difficulties of the quality assessment of the paddy and partly from the absence of paddy grading standards and official grading methods. This not only discourages farmers to improve paddy quality, but also forces the middlemen and the processors to adopt a carefully adjusted purchasing policy in order to safeguard efficiency of their investments in produce and economy of their total operation. This subject has already been analyzed in the writer's other report[2].

In the case of threshers, its use might be feasible for farmers, even at present. However, the probable absence of appreciation of the cleanness of the produced paddy upon transaction, will eliminate the potential benefit for the users and discourage the required investment.

As for paddy dryers, the above situation is more critical. If the quality of paddy is not correctly assessed upon transaction, drying simply means reduction of total weight. In order to justify the use of dryers by farmers, moisture content of paddy must be properly appreciated so that required cost for drying, the loss in weight and improved quality will be sufficiently reflected through a better price for dried paddy. Quality conservation is one of the most important criteria in the adoption of paddy dryers. But such improvement in paddy quality is of no value to farmers if not financially appreciated, which can only be achieved through a proper quality assessment and related price differentiation.

What Could Delay the Manufacture and Introduction of Advanced Machinery for Commercial Rice Mills and Storages ?

Farmers in general are not sufficiently funded to finance, out of their own resources, the input necessary for the production of their paddy. In the limitation of the government supported financil institutions for rural activities, the farmers still have to depend on other sources of finance. The processing industry and the paddy traders depend on the produce of the farmers in order to secure the efficient continuation of their operation.

By financing the needs of the farmers they can assure their operational needs if a proper arrangement with farmers for the exclusive supply of the paddy *to be produced* is made.

Their investment through farmers include unpredictable risks since at the moment of advance payments no information is yet available about the quality and quantity of paddy which finally can be supplied in settlement of advanced payments.

This makes the rice trade and processing quite speculative and it is understandable from the point of view of the financers that they will try to device the most favourable conditions in order to reduce possible risks, including those from unforeseen results and market conditions. This situation makes the industry (and trade) more profit-oriented towards their financing function, then only secondly towards their, rather costly, processing function. This removes the incentive to upgrade the processing facilities even when better processing results could be obtained. In other words, buying and selling seems to be more profitable than *processing*.

The rice milling machinery manufacturing industry adjusts itself to this situation. Their production programme is mainly confined to spare parts, replacement machines or additional machines at possible cheapest price. They are not encouraged to develop or manufacture more expensive advanced machines because rice millers are not interested in the introduction of such machines. There is however a gradual progress in manufacturing technology such as the production of rubber-roll huskers. But this progress is by far too slow compared to the existing technical capabilities of the manufacturing industry and available processing technology.

2/ Koga, Y. : The Presnt Status of Post-harvest Rice Processing in Thailand and Prospects for Rural Industrialization Through Cooperative Ventures in Such Processing, ESCAP, 1977.

Cutting the "Gordian Knot": Introduction of Paddy Grading System

Supposing that paddy quality grading standard exists and each lot of paddy can be identified to some grades objectively on its transaction, then we can expect the following effects :

a. Promotion of bargaining power of farmers on their paddy selling, improvement in economical situation of farmers and the orientation to the formation of agricultural co-operatives :

Now that each farmer can ascertain the quality grades of his own paddy, he can insists on the prevailing price of paddy of the same grade at the time of selling. This can, of course, be attained better by a joint action of farmers which eventually leads to cooperative activities among them.

b. Feedback for the agricultural and post-harvest technology improvement :

As a farmer can by now recognize the quality of paddy he produces, he is able to reflect and reconsider the cause and effect of producing such quality grain. For example : The occurence of too much broken grain might be ascribed to too hasty drying procedure he had done or to prolonged exposure to rain of the grains right before harvest. Existence of excessive immature grain might be the result of deficiency of soil nutrition in the maturation stage. The high incidence of red rice might indicate required renewal of seeds ; high percentage of admixtures might suggest the necessity of better weeding during the vegetative growth of the plants, or required alteration of threshing and winnowing methods, etc.

This naturally leads to improvement in paddy quality as it is now reflected in the price of paddy proportionally unlike before. It also encourages, the use of proper machinery and equipment in the pre-and post-harvest operations. Specifically, in the case of post-harvest stages, timely, accurate and higher grade operations cannot be performed without machinery.

c. Alternatives in the work of commercial rice millers and formation of incentives for the improvement in their milling and storage technology :

Rice millers can no longer expect extravagant prices for their paddy buying as the quality of paddy is known beforehand. Their main source of profit has to be gradually shifted to more economical and less wasteful operation of milling and storage processes as observed in some developed countries. However, in order to promote such trend and to ensure a smooth continuation of marketing activities, there have to be proper measures to affirm the existence and interest of existing commercial rice millers.

There must be a realistic difference beween officially-set floor price of paddy and ceiling price of white rice considering the necessary costs of transportation, handling, milling, storage, unavoidable loss, etc. and depreciation of their facilities. It might also be necessary to clarify the prominent role that rice merchants have been playing in the marketing of agricultural products in domestic as well as international market. Institutional arrangements for the promotion of technical innovation of rice mills and storage should ensue : an arrangement that has long been left totally in the hands of private rice merchants.

d. Correct information collection on production and marketing or rice :

Even though it is difficult to obtain precise data of paddy grade in production and marketing, so long as paddy marketing is in the hands of the private sector, a popular practice of paddy grading will facilitate such work. More accurate statistics on such information in each province of the country will help to clarity the priorities of technical developments of pre-and post-harvest operations by farmers and rice millers. Governmental intervention on paddy and white rice marketing will also be more effective.

The planning for demand and supply of rice in a country cannot be effective until and unless qualitative and quantitative estimates of paddy are available to some extent of precision. If there should be such information at hand in combination with data on rice consumption then the prediction of surplus and deficit will be practicable with a much higher accuracy than is done today. It is quite clear that such reliable surplus-deficit forecast will improve the international rice market, for rice exporting countries as for rice importing countries.

Prospect for Paddy Grading Practice

The following steps might be required for the practice of paddy grading system on a nation-wide scale :

a. Stipulation of paddy grade standards :

These are supposed to incorporate the major criteria in deciding the quality of paddy such as moisture content, foreign matter content, discolored grain content, mixing of other kind of rice, immature and chaulky grain content, milling recovery, broken grains, etc. on each variety group. These criteria should apply to the bulk of the paddy produced in each country as to quality much of it in the medium grades. To that end, the prevailing quality of paddy in each region or province of the country must be surveyed using standard methods as suggested below :

(A suggestion to formulate a paddy grading standard has been given in writer's other paper.)[3/]

b. Standardization of paddy grade testing method :

Official procedure of testing, official testing equipment (type, brand, model) and official ways to use them have to be clarified and established.

c. Development of simplified paddy grade testing equipments :

The above official instruments may be located in laboratories of central and local government offices, federations of agriculture co-operatives, large commercial or cooperative rice mills so that they can be used for the verification of paddy grades when required. However, most paddy selling by farmers take place in the paddy fields or at farm yards. In order to facilitate paddy grade testing at the points of paddy selling, a simplified, inexpensive paddy grade tester has to be developed and used.

The tester should be as simple as possible but must show similar testing results with those of official equipments and be operated objectively regardless of the skill of the operator.

These official testing equipments should be easily procured because existing various grain testing equipments can be applied for this purpose and the cost need not be extremely low as they are mostly used in laboratories. However, specific in struments for use in the field need to be identified and developed first as they are not known yet.

It is worthwhile to consider the development of such equipment as one of the most urgent tasks of international organizations, taking into account that a common situation exists in most of Southeast Asian rice growing developing countries and it will be beneficial to all of them.

d. Production and dissemination of simplified paddy grade testing equipments and legalizing such measures for grading practice

After the development and trials the simplified paddy grade testing equipments have to be mass-produced with proper assistance to manufactures and users.

The introduction of the testing equipments might be initiated through paddy collection centers of agricultural cooperatives.

Farmers' reliance on the new paddy grading method adopted by cooperatives will promote the flow of graded paddy to cooperatives. It will induce the adoption of the same method by commercial rice millers and their middlemen. In the dissemination of the simplified grain testing equipments, local governments and cooperatives should distribute grain samples of each grade of paddy farmers so that they can compare the quality of their own paddy with the sample and to judge the grade by themselves. After the extention of paddy grading practice to some extent, the government might institute legal measures for the compulsory practice of paddy grading on each transaction of paddy together with a set of procedures for setting disputes on grades determination to be followed by official testing. Installation of official testing equipments and organizing of group training course for paddy inspection should be promoted. More precise description on the construction and the use of simplified testers should also be provided.

Subsequent Effects of Paddy Grading System

One probable reaction from farmers and rice merchants alike might be the anxiety to lower the actual selling price of paddy as a result of grading "objectively". However, this is not likely to happen because at present the actual paddy price is determined by such factors as (a) demand-supply condition ; (b) competition among buyers ; and (c) bargaining power of sellers and buyers. There will not be any change on the former two factors as a result of grading, The bargaining power of farmers, however, will

3/ Koga, Y. : Survey Report of Post-harvest Rice Processing in Indonesia, ESCAP, 1978, Unpublished.

be affected. There can be information among farmers on the prevalling price of paddy grade in each area. Buyers cannot lower the price any longer on the pretext of inferior quality of paddy being sold as the grade is objectively determined by now. The only possible way to lower the price for buyers is their joint effort in the area. In the same way, farmers can increase their selling price cooperatively declaring their minimum prices of each paddy grade in the area.

As may be evident so far, the paddy grading system might gain a foothold through the cooperation of farmers who are hitherto split by the difference and ambiguity of quality of their produced paddy.

Any rice miller should be willing to pay more for higher grade paddy which turns out more and better white rice. Even though price and the price difference among grades will fluctuate by market conditions all the time, higher grades will always fetch higher prices. The rice growers are sure to get better income by producing better quality paddy.

Farmers' interests to grow better quality paddy will be a powerful impetus for the introduction of post-harvest equipment.

For example, paddy dryers will reduce the proportion of broken grains compared to sundrying especially when alternately dried and wet by unexpected rains. Threshers not only improve labour efficiency but help to produce less damaged, cleaner paddy. Thus, dryers and threshers become real money-makers for farmers. Where demand exists, production follows. All of the fruits of research and development efforts by various agencies will really be utilized by manufacturers under such conditions.

Improvement in paddy quality and introduction of post-harvest machinery and equipments for this purpose will result in a reduction of grain loss which is sometimes incorrectly regarded as the sole purpose of post-harvest technology improvement.

The innovation works in two folds. One is the reduction of grain loss at farm level by the use of those equipment as the operations become more efficient and simpler. The other takes place in industrial or commercial level. Poor quality paddy has been the major factor in lowering the milling recovery of white rice especially of head rice in milling stage and in increasing damage during storage. Through the use of generally upgraded quality and classified grades of paddy, milling and storage in commercial mills will be much improved. More than that, the interest of rice millers will be focussed on technological improvement of their facilities. ■■

Influence of Available Soil Moisture on Soybean Size and Its Resistance to Breakage

(Continned from page 36)

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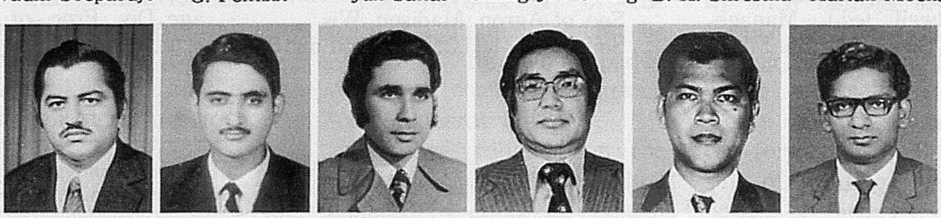

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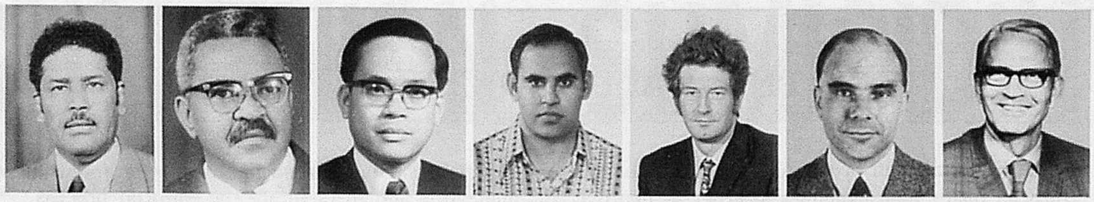

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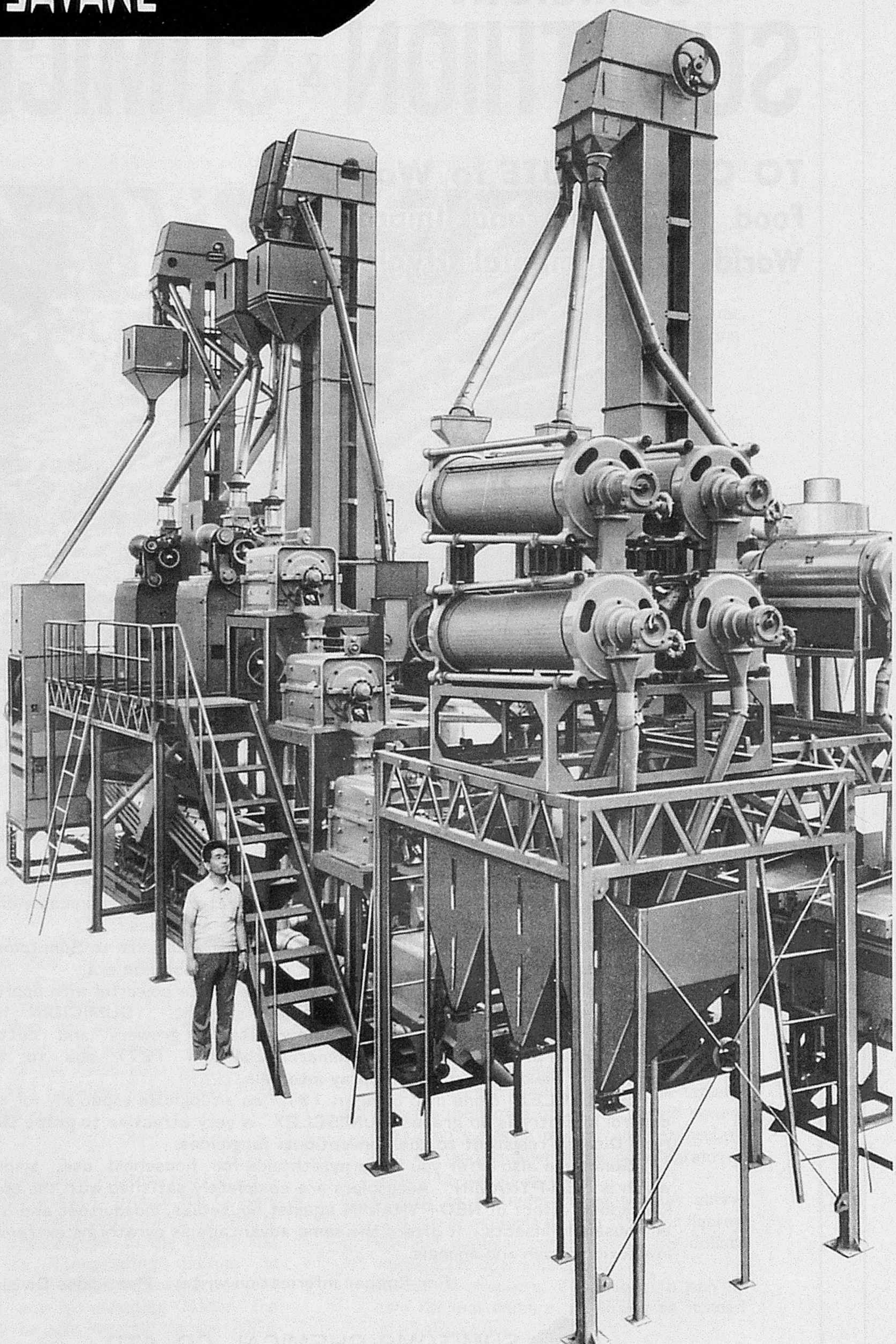

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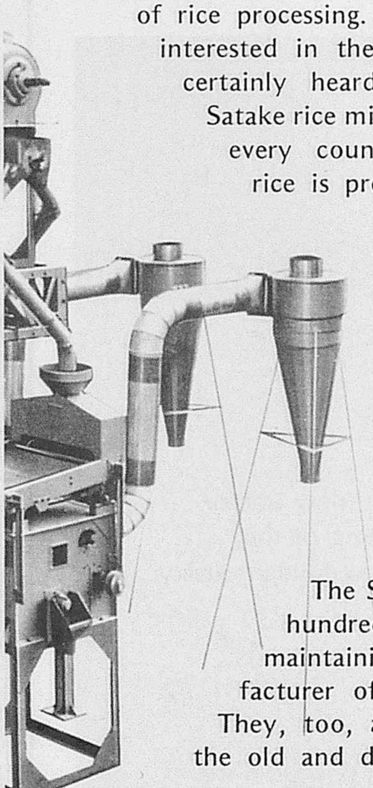

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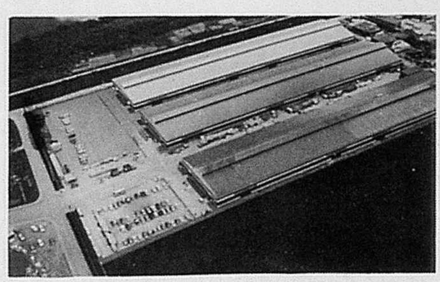

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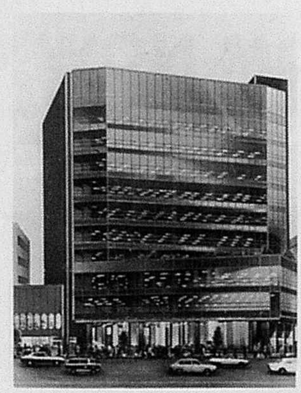

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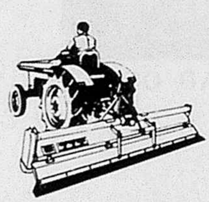

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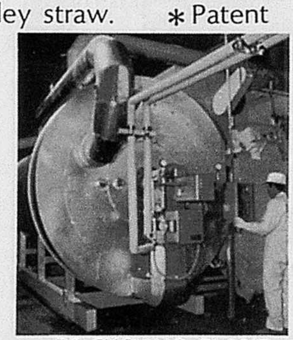

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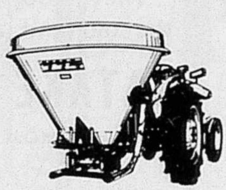

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Economic Aspects of the Introduction of Small Tractors in Developing Countries

A Philosophy for Small Tractor Development

by
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The FAO definition of farm mechanization encompasses all sources of power : man, animal and motorised, and considers all stages and processes of sophistication in the development and use of machinery and equipment. Mechanization is thus seen in the context of a possible support to agricultural production and improvement.

The post war history of aid to less developed countries (LDC's) has moved from the 1950's emphasis on industrialization through the 1960's enthusiastic promotion of agricultural production to the present careful (one would hope) multidisciplinary planning approach. Farm mechanization has therefore experienced the roles of : an input to agriculture, that as a sector played second fiddle in the 1950's ; an input of great interest in the 1960's ; and now as a carefully assessed, selective system orientated possible input.

It is now largely agreed that the new and improved soft and hard technologies to be adopted by the LDC's must be both appropriate and acceptable. That is not only in terms of operational and technical suitability but also with particular regard to the recipient socioeconomic environment, and the resources and aspirations of its members. Defining the latter is of course hazardous. Machine design and development may itself approach a fairly rigid and well practiced science in terms of producing a machine to do the job. However defining the social, political, psychological, economic and cultural environment in which the machine needs to make a contribution, and thereby defining the job that needs doing and the possible ways of doing it, does not lend itself to fine calibration. This environment is ever changing, comprises many apparent anomalies and actual conflicts, and is subject to many and varied interpretations according to the spectacles of those who care to comment on it. To make a contribution mechanization and in this case the small tractor, must meet the needs of those who use it. Mechanization policy, and more specifically machine design should be decided on after a careful assessment of resource endowment and the recipient's needs (at farm, regional and national levels). The approach required should be a simultaneous, multidisiplinary one if mechanization is to enhance agricultural and economic development.

Small tractors have been viewed by their promotors as an appropriate though undeveloped stage in the dynamic process of farm mechanization. Before considering the development of small

* This paper was presented at the Spring National Conference of the Institution of Agricultural Engineers, held at the National College of Agricultural Engineering, Silsoe, Bedford, on 21 March 1978.

tractors and the need for a guiding philosophy, an attempt must be made at defining what is often understood by the term "small tractor". Its promoters have looked for the following main attributes :

1] Simple construction using mass-produced components, assembling or fabricating as much as possible locally;
2] Safe and easy operation and maintenance;
3] Reasonably rugged construction and reliable performance ;
4] Improved performance [quantity and quality of work] compared to that of a pair of oxen ; and
5] Low initial cost, i. e. within the cash or credit reach of a "small farmer".

Both three-and four-wheel designs have been developed usually below 20 hp. The small tractor for LDC's has, with a few exceptions, concentrated on a scaled down version of the developed word's [DC] conventional tractor. For this paper "small tractor" dose not include pedestrian controlled tractors sometimes referred to as power tiller tractors. Many of the comments though apply equally to the latter type.

It is the authors' contention that to date small tractor development has largely not answered the LDC's need for greater farm power. Why has small tractor development failed? Though technical imperfections may well have played their part, this paper will not comment in detail on this aspect. However, it is proposed that the main reason for failure is the totally inappropriate approach to the problems of agricultural development.

Small tractors have so far largely been the concern only of the agricultural engineering profession. In part this has been due to the reluctance of other disciplines to involve themselves in the issues of farm machinery development. Although this has not been so in the area of work systems design. The language of machinery develoment, whilst necessarily technical in nature, has often precluded communication between engineer and non - engineer. The resulting blinkered approach has been unable to resolve the enormity of unfamiliar and complex problems that confront many such well -meaning attempts at improving the lot of the developing world. Thus small tractors have been conceived, developed and even sold in blissful ignorance of the full implications of their ultimate use and effect.

It is argued here that small-tractor development should respond to the needs of the farmers for whom it is intended. What are the mechanization needs of the LDC farmers and following from this what is the potential market for small tractors in the LDC's ? The private LDC smallholder demand for a small tractor will mostly depend on :

1] Power requirements [holding size and farm production system, present and potential] and the extent to which existing power supply is a constraint to improvement.
2] His net income and expected net income with a small tractor ;
3] The machine's price and associated ownership and use costs ;
4] The prices and net benefits of alternative power sources ; and
5] The net income associated with spending an equivalent amount on the best alternative investment, e. g. fertiliser, irrigation, [i. e. the opportunity cost of the small tractor investment].

This is a simplified demand function outlining the main variables. Within these, other variables of importance : the availability and cost of credit ; the price relationships between the price of small tractors on the one hand and the price, availability and productivity of other farm inputs, and the price received for agricultural produce on the other hand ; and the present level of farm mechanization technology. Another factor is the attitude of LDC people to farming and within this their attitude to modern farm mechanization.

How do these factors influence farmers' effective demand ? A major demand factor is that of farm size. Total farm power requirements and holding size by production system are interdependent. LDC farms are generally small, fragmented with small, inefficient plot sizes and complex tenurial patterns. Many small tractor promoters have aimed at

Table 1. Examples of Frequency Distribution of Holding Size (Unit : ha)

	Country	%	less than	%	less than	%	gtr than	of Which "Emergent Farmers" %	…	to	…
FAO	Lesotho	51	1.6	98	6.1	2	6.1		?		
	Swaziland	27	1.0	88	5.0	12	5.0		?		
	Malawi	63	1.6	98	4.9	2	4.9		?		
	Ghana	55	1.6	79	6.1	11	6.1	3	8.1	to	12.1
	Zambia	51	1.0	96	5.9	4	5.9	2	5.9	to	7.9
DUFF	India	40	1.0	90	5.0	10	5.0	6	5.1	to	10.0
	Indonesia	70	1.0	98	5.0	3	5.0	2	5.1	to	10.0
	Bangladesh	52	1.0	97	5.0	4	5.0	3	5.1	to	10.0
	Sri Lanka	65	1.0	96	5.0	4	5.0	3	5.1	to	10.0
	W Malaysia	45	1.0	96	5.0	4	5.0	3	5.1	to	10.0
	S Korea	38	1.0	100	5.0	0		0			
FAO	Chile	?		80	5.0	21	5.0	11	5.0	to	20.0
	Ecuador	34	1.0	74	5.0	26	5.0	11	5.0	to	10.0

the "emergent" 6-to 8-hectare farm. But where does this "emergent" tropical farmer exist? **Table 1** is taken from Duff [1977] and FAO [1970]. There is a dearth of accurate modern data on agriculture in the LDC's. However, **Table 1** gives an analysis of the frequency distribution of holding sizes for some LDC's. This analysis ignores more intensive agriculture, i. e., multi-cropping which will be considered later in the paper.

Size of holding alone greatly limits the immediate market for small tractors. Latin America appears to offer the greatest market potential using this criterion. The inequality in the distribution of factors of production within the developing countries is well known but perhaps the extent of this inequality is not fully appreciated. As 80 to 90% percent of LDC holdings are of less than 5 hectares the present market for individual ownership and use of tractor farm power is limited. The reader will point to the relative abundance of land in a number of LDC's. Unfortunately, there are built-in pressures in the LDC economy that maintain the relationships of general inequalities. Taking Africa as an example, traditional patterns of ownership and use of land, i. e., usufruct (rights to use only) characterised by small fragmented and widely dispersed holdings restrict the opportunity for expansion and consolidation of land. This combined with pressure on the farming sector to absorb an increasing rural population greatly limits the scope for sophisticated mechanization. In fact policies which encourage mechanization may endanger the viability and continued existence of small family farms. However, where collectivisation, consolidation and multi-cropping of land is feasible then there is a greater case for motorised mechanization. But here the small tractor is only one alternative. As it stands at present it is probably an inferior one. both technically and financially.

Of prime importance is the requirement that farmers be better off as a result of using small tractors.

Low prices and low yields within a predominantly subsistence agriculture in the LDC's assist in sustaining a vicious circle of poverty and greatly restrict the farmers ability to adopt new technology. The scope for such 'lumpy', medium term investments as the small tractor is thus limited. Referring to 1973 [the last date for which international GNP figures are available] the lowest cost mass produced agricultural tractor available in UK, i. e., the Leyland 154, cost US$ 2,450 [FOB]. Assuming a 5 year life. from World Bank Atlas figures the GNP per capita of 86 LDC's [approximately 64% percent of those to which Britain now gives financial or technical help] is less than the annual $ 480 depreciation on such a tractor. Average national income figures of course hide great inequalities of distribution. These figures have unfortunately been little researched. It is apparent however that LDC smallholders can seldom afford the individual purchase of motorised mechanization.

For individual material improvement the LDC smallholder has to learn to take more and more calculated risks. The conservative attitude of a farmer justifiably restricts him from taking too big a risk. The LDC farmer takes a risk when he mechanizes. He can share the ownership or use of machinery and equipment either by using credit facilities or entering into various methods of multifarm use of machinery. In common with requirements for production the availability of credit is often restricted to the favoured minority. Traditional land tenureship and hence lack of acceptable collateral often pravents LDC smallholders from receiving any credit. Often what local credit is available is made at prohibitive interest rates. Again the vicious self-sustaining circle of subsistence and poverty is difficult to break. Careful assessment of credit worthiness on the basis of farm management ability rather than collateral might be an improvement. Even if credit is available the small tractor is not generally within the credit capacity of the smallholder. Alternatively, if a farmer could profitably borrow $1,500 to $2,000 for a small tractor why not £3,000 to £4,000 for the cheapest imported DC tractor?

Turning to the costs of small tractors, costs of manufacture are largely governed by basic design and the associated volume of production. that new designs are significantly different from previous ones. Without fundanental design changes reduction in unit size inevitably leads to less than proportionate reduction in cost of manufacture. Without doubt, motorized farm mechanization is expensive for the LDC's. Fixed costs can either be spread over a greater number of hectares or larger number of jobs. The latter has given rise to more complicated and more costly machines. In the light of previous comments, to spread machinery costs over a greater number of hectares, must lead to considerations of multifarm use or restrict small tractors to farmers facing very specific circumstances. Variable costs are largely difficult to reduce. These views need to be seen in the context of increasingly expensive fossil fuels which suggest higher fixed and operating tractor costs in the future. For mechanization to be justifiable it needs to offer considerable economies of scale.

In examining the costs and benefits of small tractors to the farmer, attention must be paid to the cost and effectiveness of available alternatives. Hypothetically, compared to its most immediate alternative, the imported DC tractor, the initial cost and, consequent hourly cost of operation should favour the small tractor. However with full use initial cost per horse power, initial cost per effective horse power, work rate and hence hourly cost of operation per unit of output should still favour the imported DC tractor. Furthermore, a farmer does not just buy a tractor but also after-sales service, availability of spare parts and complimentary inputs, and in the LDC farmer's case, a need for greater knowledge-for operation, maintenance and management. In short, an improved level of both soft and hard technology. To be appropriate, small tractors require the same kind of infrastructural support that should be, but is often not available for conventional tractors in spite of the commercial interests of large, established manufacturers and their agents.

In a free market situation the profitability of a private small tractor investment would have to be judged against that of alternative sources of farm power : human ; animal ; pedestrian controlled tractor ; and the multifarm use of imported tractors. It is here that detailed farm production system studies have an important part to play. The smallest holdings are likely to feel there is no alternative to family labour. Slightly larger holdings may hire labour and those still larger may be able to profitably use the services of oxen, buffalo, camel, donkey or mule. For other holdings up to 10 hectares, in many LDC's there is little immediate alternative [multifarm machinery use excepted] to human and animal power. Smallholdings is Asia and the Far East have success, but its international dry-land equivalent elsewhere is yet to mature. Some LDC's in Latin Amercia, Asia and the Far East have developed the multifarm use of imported conventional tractors through private contracting, a method yet to catch on in Africa.

Where does the small tractor fit into this ? The frequency distribution of holding sizes as described before greatly restricts the number of markets for which a small tractor can be considered and these markets already have their more competitive approaches to mechanization. The small tractor case is left with the residue. Small tractors are more likely to prove attractive to the small private farmer where power supply is a recognised production constraint and where for a variety of reasons alternative power sources are limited, e. g., no history of, and no present interest in animal use ; try panosomiasis ; and population farmers experiencing labour/power shortages during peak work periods and who have the opportunity, via larger hectarage or multi-cropping to increase the production of high value cash crops [usually export or horticultural]. It is important to remember that to be most effective mechanization needs to be part of an appropriate package of inputs. Such requirements often narrow the field to those farmers enjoying the attention of most favourable agricultural development projects.

The farm power market in the LDC's is usually imperfect. Government intervention in the form of tractor hire schemes for those who have access to them, frequently undercuts most farm power alternatives, and thereby reduces any market for small tractors. Furthermore, duty free concessions to machinery importers, heavily subsidised credit to purchasers [particularly in inflationary times] and tax allowances on operating costs mean that for those few who are fortunate to obtain a tractor, it might as well be a big one, especially with private contracting as an additional lucrative enterprise.

A number of successful forms of multifarm use of machinery do exist, with gradation of ownership and use from individual ownership of one machine and limited shared use [Sri Lanka, Yemen Arab Republic, N. Nigeria, Ecuador] to the purchase by many farmers of the services of a number of mechanised crop operations, e. g. Gezira scheme in Sudan and Mwea in Kenya. The knowledge. ability and infrastructural support required for the effiicient and profitable [multifarm] use of a small tractor is little short of that required for the [multifarm] use of, for instance, a Massey Ferguson 135 ; especially when consdered relative to the predominant lack of expertise with any machinery in many LDC's.

If a farmer spends his limited funds on a small tractor, he cannot spend them on other things. Mechanization is often competing for limited fund, with other forms of improved technology, particularly those which directly increase yields per hectare, such as improved seeds, fertilisers and sprays. Experience has shown that the returns to investment in the latter are generally much greater than to mechanization. For the small farmer whose major constraint, apart from capital, is land rather than labour, technologies which increase yields per hectare rather than those which increase yields per worker make most sense and appear most financially attractive. Increased use of fertilisers and improved seed varieties can usually be relied upon to increase yields but mechanization is only likely to increase yields if it leads to improved timeliness and is complementary to other inputs.

In fact, improved basic farm husbandry methods are usually a prerequisite for successful mechanization. Thus, where farmers are not yet ready for small tractors, encouraging farmers to adopt them can involve real. ['opportunity'] costs in excess of the more obvious out of pocket expenses.

As mentioned previously it is a prime requirement that farmers would be better off as a result of using small tractors. But predicting and measuring the net benefits of mechanization is difficult. Many costs and benefits associated with mechanization are indirect, hidden and therefore not immediately obvious. Some knowledge is required concerning the financial [and social] implications of alternative input-output strategies before it can be said that investing in more power is a most cost-effective way of employing limited resources. Overcoming power constraints by tractorisation may simply transfer the bottleneck to other resources, e. g. management, which may well frustrate the potential gains to be had from improved power supply. It is here, particularly at farm level, that much more research needs to be done. It is generally considered that the small farmer is intuitively a rational decision maker, making the best of a difficult situation. It remains the responsibility, however, of policy makers, design engineers, manufacturers and distributors to provide him with alternatives which have a reasonable chance of meeting his needs.

So far we have only considered the private sector's demand for the small tractor. Even in situations where the investment in small tractor production and use is seen to be financially more profitable [for manufacturers and users] than existing alternatives, such an investment may not be socially profitable and appropriate to the true resource endowment of the economy. Private profit rarely equates to social profit. Market prices do not often provide a meaningful basis for sound national or regional decision making where the objective is to maximise social welfare by making the best use of limited, community resources. For example, LDC currencies are generally overvalued and the true worth of scarce foreign exchange to the developing economy is not reflected in official exchange rates. Because of the predominance of both unemployed and underemployed labour in many LDC's, labour [even where it attracts only a bare subsistence wage] is often overpriced in real, economic [social opportunity cost] terms. Whilst, market prices may encourage the adoption of imported, capital intensive mechanization projects which essentially substitute scarce and expensive capital for a plentiful, and otherwise unemployed labour resource, there is a realisation on the part of many governments that a rational agricultural development [and mechanization] policy should favour endogenous labour-using projects, and discriminate against exogenous capital intensive projects. This applies to small and large tractors alike.

This paper has looked at the market for small tractors in order to illustrate a preferred philosophy for assessing and planning agricultural development. Before we turn to this philosophy it would be remiss not to consider briefly the supply aspects of small tractors, especially with regard to the problems facing local manufacture in LDC's. The political prestigious ability to supply its own tractors may encourage an LDC to short cut recommended procedures. A small tractor, locally manufactured, sold at greatly subsidised prices on credit and at the exclusion of alternative farm power sources may be financially attractive to the farmer, but it would probably prove expensive to the economy. In many cases, with current designs, most parts have to be imported at considerable real cost, and unless governments are confident that the investment produces reciprocal real benefits [export revenues, import substitutions, greater social welfare] then local manufacture can only represent a hidden long term drain on the scarce capital resources of the economy.

Many aid policies today centre on more aid to the poorest of the poor. The implementation of some multilateral aid in some areas now follows a careful step by step approach to agricultural development. Within this philosophy a larger number of LDC smallholders are offered a minimal package of improved physical inputs or farming methods with the object of gradual development. This approach, in common with the history of mechanization in the developed world, tends to create conditions where motorised mechanization falls late in the process of agricultural development. Furthermore. the failure of industrialisation to create work opportunities in LDC's and the realisation that [at least until the turn of the century] the farming sector needs to adsorb the growing rural population, has meant that tractorisation per se, and many of the preconditions for it [larger holdings, commercialised land tenure arrangements etc.] are rarely compatible with the important social, political and economic objectives of increasing rural incomes, maintaining rural employment [often through access to land use], and improving agricultural output.

To repeat, it is the authors' contention that the inappropriate approach to the problem of agricultural development has caused small tractor development to fail thus far. [Tractor engineers should not feel alone in this respect, the same can be said of many irrigation engineers and their products].

It may well be that where specific conditions allow there is a case for the small tractor; – favourable holding size and net income – present and projected ; favorable design and price ; and the lack of alternatives. But these provisos have not been adequately researched.

The philosophy is not a new one. It is a further request for a simultaneous multi-disciplinary approach to agricultural development. Though this must be undertaken with an understanding that economic development takes time. Too much too soon can be just as much a problem as no help at all. Many projects have failed through over-concentration on one aspect to the detriment or exclusion of others. Farm mechanization can not be isolated. It can only be a successful process once other conditions have been met or set in motion. Many of the problems that have so far confronted small tractor development could have been anticipated by those knowledgeable in the field of rural sociology and the LDC peoples and politics ; agricultural credit ; farm management ; tropical crops and livestock ; soils ; machinery manufacture ; etc. as well as farm power. And the production formula will be unique for each country and region.

With regard to the implementation of the philosophy, which question has to be answered first : 〔1〕 Are small tractors technically feasible ? or 〔2〕 Are small tractors needed and wanted ? They are of equal importance and neither must be overlooked as they enjoy a symbiotic relationship. An examination of technical feasibility can assist a more accurate assessment of needs and the best ways of fulfilling them in view of the resource environment. An assessment of needs and resources can set physical and financial parameters for the engineer to work within. Overlapping engineering and "non -engineering" exercises should see a project from conception through to completion. But conceptually all development projects commence with the problems and potential of the individual LDC farmer and farm. And this is where small tractor development should begin.

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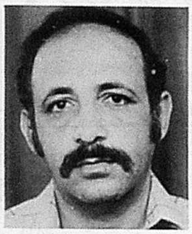
Design Measures for Cotton Stalk Clearing Machines



by
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Introduction

According to 1796 data, cotton ginned, seed and oil represented 52.6 percent of the value of total exported agricultural commodities of the country. Thus cotton production is an important sector of the national economy.

One of the difficulties in cotton production is the need to clear the ground of old cotton plants after harvest 2, 3, 4, 5, 9, in order to rid the field of Black arm and leaf curl diseases[6,8].

Both bacterial and virus diseases can be transmitted from season to season through the stems or debris of old crops that harbour white flies.

Pulling cotton stalks by hand is difficult. Cotton hand-pullers now widely used were design originally by Massey[8] in 1932. The pattern of clearing cotton fields has assumed four basic processes, namely; uprooting the stalks; gathering and stacking them; raking up the remaining debris ; and burning the heaps of stalks and debris as a pest control measure.

Previous Work and Objectives

Flooding Technique

Massey[8] reported that the survival of Black arm disease between seasons can be effectively controlled by flooding the whole field. This technique seems to be impractical as a standard operation for the whole Gezira area even when sufficient water is available during May and June.

Cutter Blades

An alternative method of minimizing labor in uprooting the cotton stalks and preventing ratoon development, is to cut old plant roots at least 6 inches below soil level.

Different shapes and size of cutter blades have been devised and tried but none proved really satisfactory in providing the first effective step of cutting the roots[2,4,7,9]. This was because the cutter blades were not wide enough to cut the roots effectively. Certain efforts have since been made to build satisfactory stalk pulling machines. The principles of operation of most promising machines are as follows :

1. N. I. A. E., four-row pulling machine-The machine is semi-mounted with two gauge wheels and is power take-off shaft-driven (**Fig. 1**).The gripping and pulling devices are the two driven inclined pneumatic tyres. Tests have shown that the machine is cabable of working at a rate of 3 feddans* per hour. The ratio of stalks pulled varied between 97.7 and 99.2 percent.

2. Boby root puller. This is a two-unit machine, with a trailer and is power take-off shaft-driven. The device for gripping and pulling consists of two revolving pneumatic tyres set on an inclined plane (**Fig. 2**). The tyres are compressed together so that a grip is made on stalks passing between them. After pulling the plant, a conveyor system consisting of two inclined V-belts supported by a large number of idler pulleys transfer the loose plants upwards to the rear of the machine and releases them at a height of about 150 cm for loading on the trailers.

El Zubeir[4] studied the relationship between the length of the tap root and magnitude of pull required. The difference in the magnitude of pull was related to the order of pulling : one plant out of several plants in one hole. The maximum magnitude of pull required to pull a single plant was about 100 kg.

The author[2,3] investigated the necessary amount of pull of a single stalk and the required yield lift to loosen the roots. The greatest yield lift required was

* Feddan is a unit of land size equivalent to 4,200m^2.

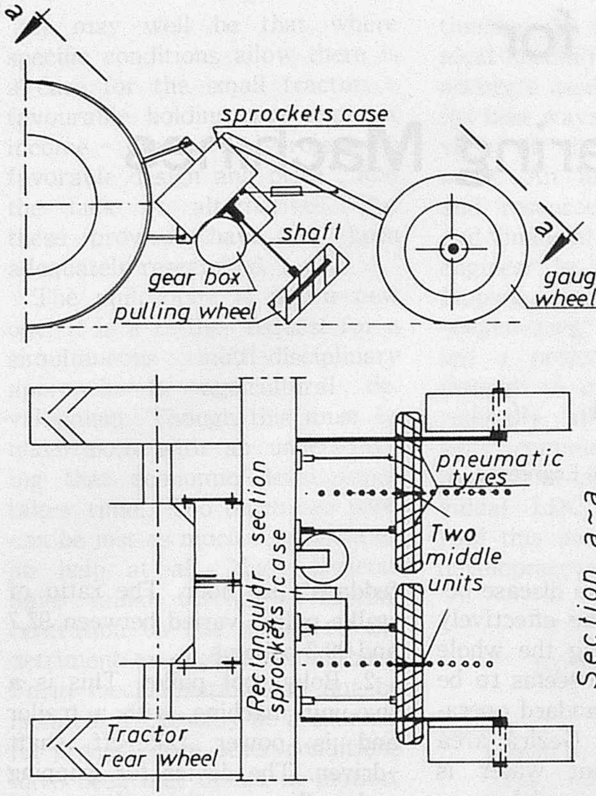


Fig. 1 N.I.A.E. Mechanical Cotton Root-Puller

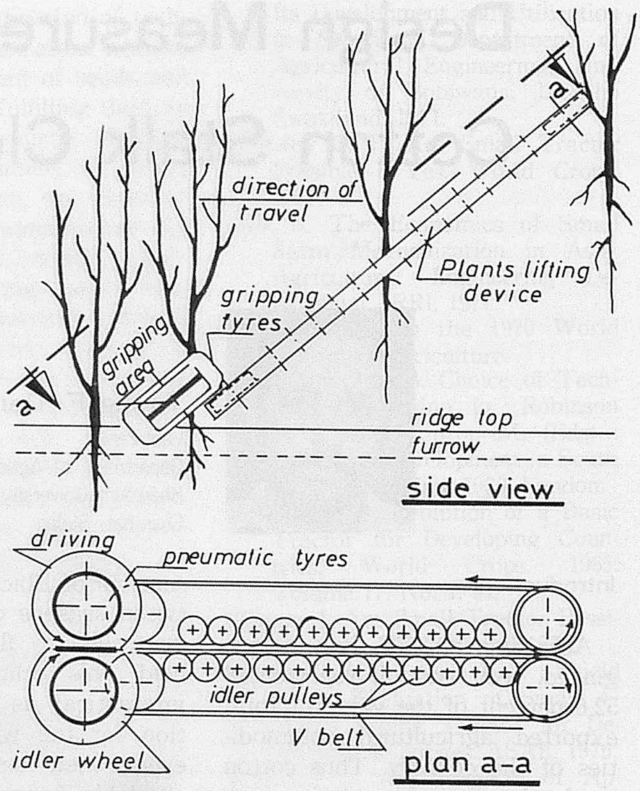


Fig. 2 Pulling and Lifting Devices of the Boby Mechanical Cotton Root-Puller

4.9 cm and a required pull of 121 kg. The same investigations have shown the a relation existed between required pull and lift, on the one hand, and percentage of plants pulled according to root length and thickness, on the other. It was found that the highest proportion of plants (37.1 percent) had root length of 38-45 cm. No relationship was found between root length and the necessary yield lift. With regard to root diameter, the highest proportion of plants (62.9 percent) had a diameter of 1.3～1.9 cm at ground surface. Likewise, no relationship was found between root diameter and yield lift.

The main objective of the present study is to examine the fundamental conditions which affect the mechanization of this operation and to provide data for guidance of future attempts where the practices of cultivation and planting need to be considered. The main procedures were to collect some basic data from actual field conditions which include measurement and assessment of cotton plant spacing and the density of plants in a row.

Width of Occupied Area by Plants on Ridge Top and Spacing Between Plants on Two Neighbouring Rows

In the irrigated cotton area in the Gezira, blocks of land of 10 feddans are denoted by numbers. Fach numbers (as one unit) is ridged by drawn equipment at 81 cm apart. However, no markers are used and this gives rise to uneven spacing. Normally four or five row ridgers are used. In the second step, ridged numbers are cut in Angaias* by digging water ditches and raising of borders. Each number contained 14 Angaia. This area comprise 187 rows running across the strip.

The planting and thinning of Angaias are carried out manually and thus are subject to the individual skill or reliability of the labourers.

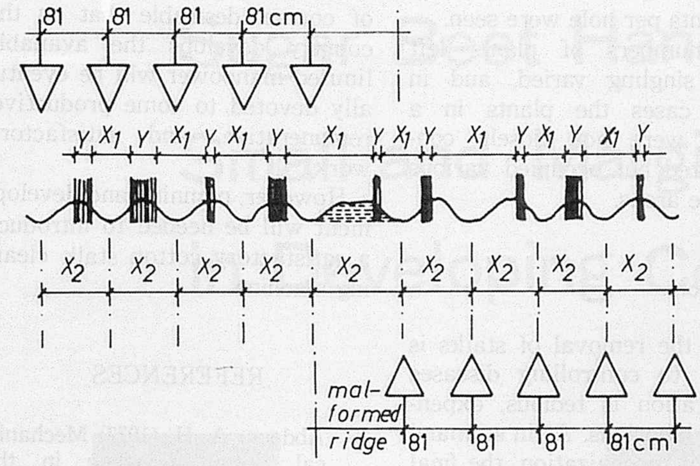
The combination of the poor ridge spacing and uneven plant spacing along the rows, produce variations which can and do effect the performance of machines engaged in any subsequent inter-row operations.

Hence finding the actual field-dimensions is necessary for assessing further mechanization of cotton production in Sudan.

Measurements of row width, plant spacing and occupied area of plants on ridges were made for ten successive rows in an Angaia. This was done for three Angaia in each number and carried out for nine numbers, so that 270 rows were measured over a wide ared, since the numbers were from different blocks (90 feddans) in the Gezira.

To help in the measurements a frame system was used. The frame sides were metal bars 165 cm. long and 1.3 cm. diameter.

*Angaia is the smallest field unit area of 20 m×150 m.



Y Width of the area occupied by plants on ridge top

X_1 Free space between plants on two neighbouring ridges

X_2 Average central distance for 10 successive rows

Fig. 3 Field Dimensions of Plants on Ridges in the Gezira

Fig. 4 General View of Cotton Stand at Pulling-out Season in Gezira, Sudan

Table 1. Statistical Analysis of Measurements Y, X_1 and X_2.

Item	Average	t test	Upper level	Lower level
Y Width of occupied area by plants (cm)	18.035	±2.397	20.432	15.638
X_1 Free spacing (cm)	65.887	±2.590	68.477	63.297
X_2 Rows central distance (cm)	83.922	±1.302	85.224	82.620

Each average (10×3)9=270.

A pair of bars were set parallel to each other to enclose all plants on the ride top. Three dimensions were measured, namely Y, X_1 and X_2 (**Fig. 3**) where :

Y the occupied distance, represented by the distance between the two bars on one ridge top ;

X_1 the free space, represented by the distance between the two bars on two neighbour ridges ; and

X_2 the average central line distance, represented by the width of 10 successive rows divided by 10.

The results of the measurements are shown in **Table 1**.

Spacings between ridges were adjusted to 81 cm and fixed. However, in joining one run with another, variations occured with the outside ridge as no side markers are used. (No side markers have been found suitable for local conditions).

Ridged land by a four body ridger included one mal-formed ridge every four successive ridge. The width of the mal-formed ridge must equal 81 ±the average calculated error for the four ridges, hence :

$81+4\ (83.922-81.00) = 92.688$ cm.

Thus to deal with subsequent operations using a multi-row machine or implement this variation in ridge space for one in every four of the ridge, needs to be considered in the dimensions and setting of the machines.

Obviously the elimination of non-uniform ridge spacing is desirable but so far this has not been possible to achieve in the conditions prevailing.

Number of Plants per Angaia and its Components

Planting and thinning cotton plants in the Gezira is done manually or by using simple tools. Assessing the reliability of hand tools as aids for determining plant populations is of considerable interest to mechanization and agriculture alike, since the performance of these tools affect the ultimate number of plants per unit area.

The standard length of the Angaia rows is 20 cm. Accordingly the following parameters were determined in studying the components of plant population :

—Number of holes per row
—Number of plants per hole
—Number of plants per row
—Number of plants per Angaia

The number of plants per hole and the total number of plants in the row were counted in a random manner, taking three different counts from each Angaia and then the averages were calculated. The counts were done at different localities in the Gezira so that a fair representation could be obtained.

Results are as shown in **Table 2.**

Table 2. Analysis of Cotton Plant Population

Item	Average	t test	Upper level	Lower level
Plants per row	135	± 14.4	120	149
Holes per row	44.8	± 7.0	37.8	51.8
Plants per hole	5.995	±0.388	2.667	3.323

Some observations about the counting results :

—A positive and significant correlation was found between the number of plants and number of holes per row.

—The spacing of 45 holes per row is equivalent to 44.4 cm between holes. The estimated upper and lower level of spacing were 50.2 and 38.6 cm. Accurate even spacing between holes was hardly seen in the study sites.

—Population of plants per feddan according to the above computed number is less than the theoretical known one of 50,000 plants per feddan.

—Counts were taken during the pulling season. Plant numbers taken at an earlier ocasion may be more than those recorded here, since mortality of some plants during the season is possible.

—It is worthy of note that calculated average of 2.995 ± 0.388 plants per hole is very close to the theoretical population of 3, but single counts of 10 plants per hole were seen.

—The numbers of plants left after singling varied, and in some cases the plants in a bunch were not closely concentrated but occupied various surface areas.

Discussion

While the removal of stalks is essential to controlling diseases the operation is tedious, expensive and laborious. As in so many aspects of mechaization, the final operations are dependant on the precision of the initial planting of the crop. On a survey of actual crops it was found that 20.432 cm, was the maximum width of ridge-top occupied by plants. However for multi-rows machine, consideration must also be given mal-formed ridges from mismatching between runs with the ridger. This needs to be accounted for under present operational conditions, where markers increase an average of 11.688 cm. as estimated from the width of this mal-formed ridge which is not the normal standard width.

Density of plants is an important factor affecting the design of machine cutter or gripping units. The survey shows that in normal fields the average number of plants is 135 on standard row, where plant holes spacing is 44.4 cms, and 3 plants per hole. The study has identifiel a number of factors which need consideration for the development of mechanization in the Gezira and other projects. Currently, much of the clearing of stalks and debris is done by casual labour which is a social and economical problem. However, as agricultural schemes increase in size and mumber, this condition may not remain. It is, of course, desirable that as the country develops the available limited manpower will be eventually devoted to some productive, remunerative, and satisfactory work.

However, planning and development will be needed to introduce a satisfactory cotton stalk clearing machine.

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Sugar Beet Hand Drill for Small and Marginal Farmers in Developing Countries

by
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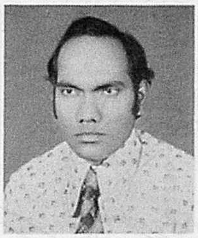

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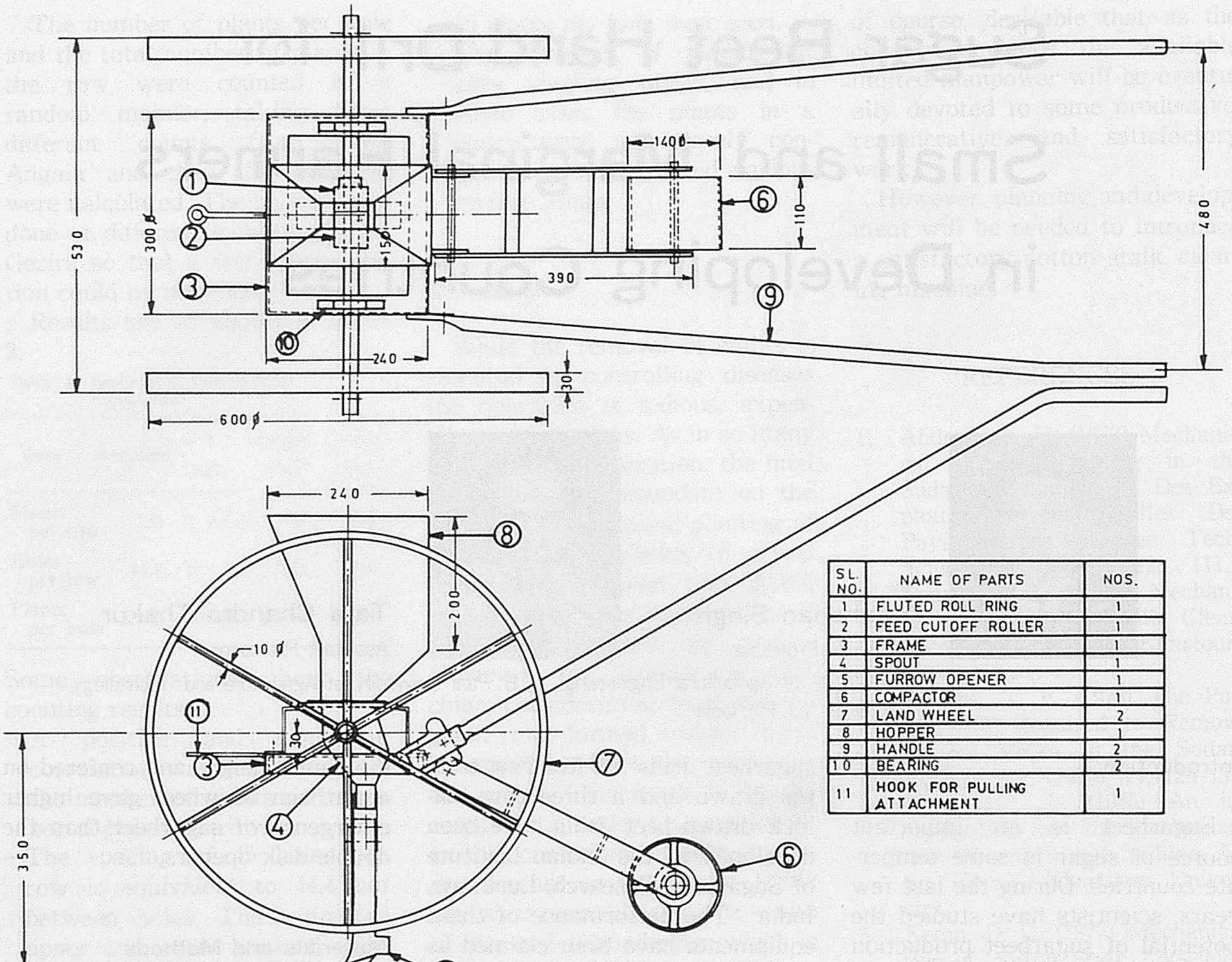
Introduction

Sugarbeet is an important source of sugar in some temperate countries. During the last few years, scientists have studied the potential of sugarbeet production in northern India. Due to lack of suitable epuipments for sugarbeet cuitivation, all operations involved in its production is done manually. Sugarbeet is generally planted manually with the help of a dibbler or "Khurpi" which requires large labour force : about 250 man-hours per hectare. Moreover, it is difficult to maintain proper depth and desired quantity of seeds per hill by this method. The conventional seed drills available in India for planting cereals are not suitable for sugarbeet. These drills clog frequently because of irregular shape of seeds and do not release the seed uniformly. In view of the above factors a hand-drawn sugarbeet drill was designed and developed for planting beets on flat ground and ridges.

Horizontal disc, vertical cell wheel and belt feed seed metering devices have been reported on sugarbeet drills[1]. A five-row tractor drawn and a three-row bullock-drawn beet drills have been developed at the Indian Institute of Sugarcane Research, Lucknow, India[2]. The performance of these equipments have been claimed as satisfactory. However, the test results are not available. Srivastava[3] developed a hand drill with stationary hole type metering device provided with nylon brush type agitator. He reported that the field trials had given satisfactory performance with a field capacity of 0.8 ha/day (8 hrs) at a walking speed of 2.5km/hr for sowing unpolished sugarbeet seeds at uniform depth. Barmington[4] studied the effect of seed size and cell size on cell filling of processed sugarbeet seed in a horizontal plate planter having 11/64 inch (4.36mm) diameter cells. He found that the beet seeds closely graded to size limits of 7 to 8/64 inch (2.78–3.17mm), 8 to 9/64 inch (3.17–3.57mm), and 9 to 10/64 inch (3.57–3.97mm), gave a cell fill of about 140, 100 and 90 percent, respectively. Barmington[5] also reported that a row flange furrow opener with 1.25 inch (31.75mm) height and centered on a flat rim of wheel gave higher emergence of sugarbeet than the double disk openers.

Materials and Methods

The drill consists of a frame, a single-row hoe type furrow opener, a fluted wheel type seed metering device, a seed hopper, a double coil agitator, and a roller type compaction device **(Fig. 1)**. All the components of the drill are fixed over a mild steel frame. Two handles are provided with the frame to push the drill forward during operation. The metering device of the drill consists of a fluted wheel, a solid side roller with key, ring, ring retainer and a housing **(Fig. 2a, b, c)** The fluted roll and the ring are made in two halves in order to change them easily without removing the bearings and wheels at the time of changing the fluted rolls for different crop seeds. The metering device rotates in a cast aluminum housing attached to the centre of the shaft on which the driving wheels are



SL. NO.	NAME OF PARTS	NOS.
1	FLUTED ROLL RING	1
2	FEED CUTOFF ROLLER	1
3	FRAME	1
4	SPOUT	1
5	FURROW OPENER	1
6	COMPACTOR	1
7	LAND WHEEL	2
8	HOPPER	1
9	HANDLE	2
10	BEARING	2
11	HOOK FOR PULLING ATTACHMENT	1

All dimensions are in mm.

Fig. 1

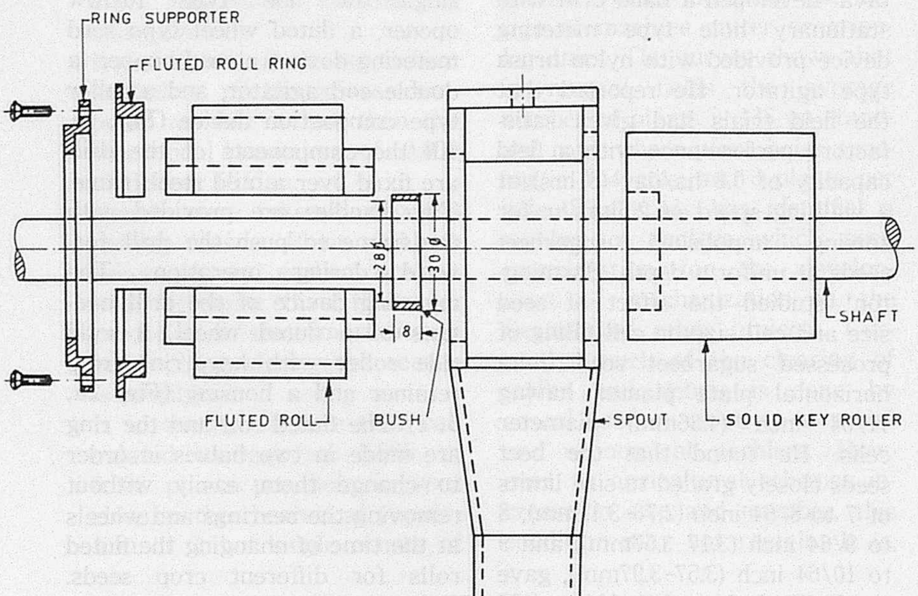


Fig. 2a Seed metering device setting

mounted.

The seeds are picked up by the fluted roller from the hopper and carried away through the confined area to the projected part of the housing which leads to the furrow opener. No extra seed tube is required as the furrow opener is directly attached to the seed metering housing. A fixed plate cut-off device has been provided with little clearance to wipe off the excess seeds from the grooves of the fluted roller. A double coil tension spring has been provided on the fluted roller from two sides of the housing. The spring gives agitating action to the seeds which reduces the interlocking of seeds due to their irregular shape and, consequently, reduces choking of the metering device. A hoe type furrow opener has been used for seed placement.

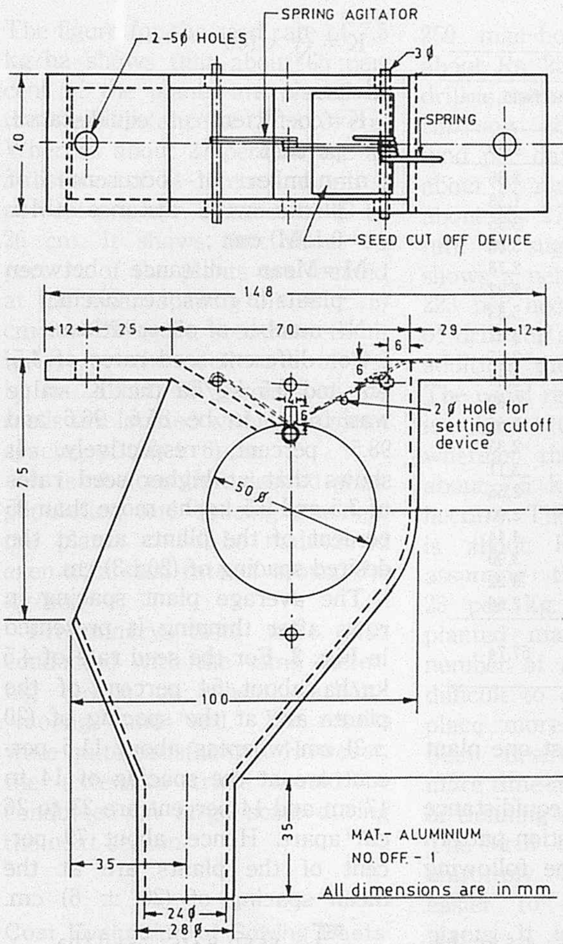


Fig. 2b Spout with seed cut-off device

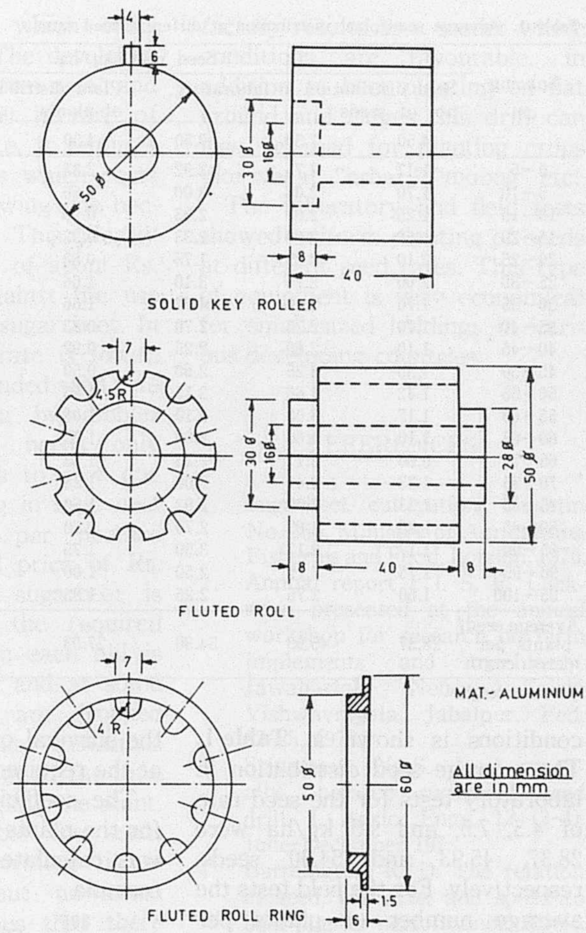


Fig. 2c

The height of the openers varies with the planting of beet on flat ground or ridges. The seed boot is half-open from the rear side to facilitate better visibility of falling seeds in the furrow. A roller type seed covering device is attached in the rear of the drill to cover and press the soil around the seeds for better emergence. Markers are not required as the distance between two wheels is kept at 50 cm apart which is row-to-row spacing of sugarbeet crop. The wheels leave clear marks on the ground which serves the purpose of marker. Power to the metering device is directly transmitted by one of the driving wheels. The left wheel has been kept free to rotate but the right wheel is keyed to the shaft on which the metering device is mounted. At the time of turning at the field ends the drill is turned on the free wheel to disengage the device.

Experimental Technique

Intensive tests have been conducted to analyse the performance of the seed drill in laboratory and field conditions. In the laboratory experiments a wooden plank of about 4-meters long and 0.3 meter wide was selected and fixed on a levelled ground. The plank was then coated smoothly by grease. The drill was operated at the three different seed rate settings of 4.5, 7.5, and 9.5 kg/ha. For each rate setting the tests were replicated thrice and the average seed distribution pattern was noted. On the other hand, in the field experiments six plots of about 5 m × 5 m were prepared. Three plots were kept level for flat sowing while the other three plots were used for ridge sowing by making ridges at spacing of 50 cm. The seeds were sown at the same rate settings as in the laboratory and the plant population was recorded after germination. For each seed rate three rows were selected at random and the plant population was noted over a distance of 4 m in each row. Observations were also taken after thinning the crop to find out the distribution of plants with respect to the desired plants spacing of 20 cm. The thinning was done manually by random selection of the unwanted plants as done on commercial basis.

Results and Discussion

The average seed/plant distribution at three different seed rates under laboratory and field

Table 1. Average seed/plant distribution at different seed rates

Spacing cm	Seed rate, kg/ha					
	Seed distribution in laboratory, no. of seeds			Plant distribution in the field, no. of plants		
	4.50	7.50	9.50	4.50	7.50	9.50
0−5	1.17	2.75	2.92	2.33	3.75	2.66
5−10	1.70	2.08	3.00	1.66	2.25	1.33
10−15	1.25	2.00	2.83	0.70	2.92	3.55
15−20	1.60	2.60	2.33	0.92	3.17	3.00
20−25	2.10	2.25	1.75	0.83	1.66	2.78
25−30	2.00	2.75	3.10	1.66	1.75	3.22
30−35	1.70	2.50	4.70	1.66	2.08	5.33
35−40	1.70	2.75	2.70	0.83	1.75	3.22
40−45	1.10	2.60	2.25	0.92	1.75	2.55
45−50	1.33	2.25	2.60	0.50	1.83	2.44
50−55	1.42	1.66	3.10	1.83	3.00	0.89
55−60	1.17	3.08	3.10	1.08	3.50	1.66
60−65	1.10	1.66	2.00	1.75	2.00	2.33
65−70	0.60	2.17	2.25	1.33	1.66	3.11
70−75	1.33	2.41	3.00	1.25	1.66	2.55
75−80	1.33	1.92	1.92	1.50	1.42	2.90
80−85	1.25	1.83	2.70	1.70	2.17	4.44
85−90	1.17	2.17	3.50	1.75	2.08	3.90
90−95	1.75	1.75	2.50	1.00	2.50	3.22
95−100	1.60	2.75	2.25	1.83	2.66	2.66
Averege seed/ plants per meter length	28.37	45.93	54.80	27.03	43.56	57.74

per meter length

conditions is shown in **Table 1.** The average seed distribution in laboratory tests for the seed rate of 4.5, 7.5, and 9.5 kg/ha were 28.37, 45.93 and 54.80 seeds, respectively. For the field tests the average number of plants per meter length were 27.03, 43.56 and 57.74, respectively. The results reveal that the seed distribution patterns in the laboratory tests are very much similar to that of field tests. The recommended desired plant population is five plants/m at a spacing of 20 cm each. From the table, it is clear that even at the lowest seed rate of 4.5kg/ha the desired plant population per meter length could be maintained. However, the seed distribution pattern for 4.5 kg/ha is about one seed in 5 cm length on either side of the desired distance of 20 cm whereas for 7.5 and 9.5 kg/ha seed rates it is about 2-3 seeds. This shows that at the seed rate of 4.5 kg/ha there is a possibility of larger gaps amongst the plants in case the plants die at the desired spacing. In the case of higher seed rates there are always more than two plants at the desired spacing, hence there are fair chances for the survival of at least one plant at the required distance.

The coefficient of equidistance for the plants distribution pattern was calculated by the following formula :

$$K = \frac{n}{N} \times 100$$

where,

K = coefficient of equidistance, percent.

n = number of occurence of plants with distance ($M \pm 0.15M$) cm. ;

M = Mean distance between plants in rows, i.e., 20 cm.,

N = number of observations.

For different seed rates of 4.5, 7.5, and 9.5 kg/ha the 'K' value was found to be 86.6, 96.6 and 98.5 percent, respectively. It shows that at higher seed rates of 7.5 and 9.5 kg/ha more than 95 percent of the plants are at the desired spacing of (20±3) cm.

The average plant spacing in rows after thinning is presented in **Fig. 3**. For the seed rate of 4.5 kg/ha about 54 percent of the plants are at the spacing of (20 ±3) cm whereas about 11.5 percent are at the spacing of 14 to 17 cm and 14 percent are 23 to 26 cm apart. Hence, about 79 percent of the plants are at the mean spacing of (20 ± 6) cm.

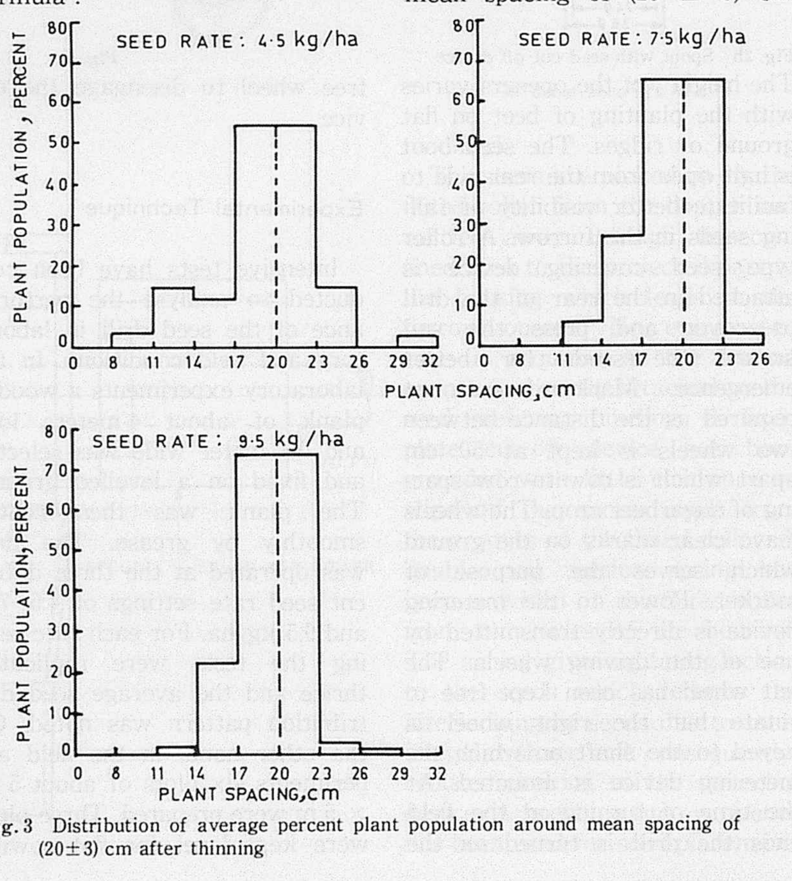


Fig. 3 Distribution of average percent plant population around mean spacing of (20±3) cm after thinning

The figure for the seed rate of 7.5 kg/ha shows that about 65 percent of the plants are placed at the mean distance of (20 ± 3) cm. Whereas about 27 percent are at a distance of 14–17 cm and only 3 percent are at a distance of 23 to 26 cm. It shows that about 95 percent of the plants are located at the mean spacing of (20 ± 6) cm for 7.5 kg/ha seed rate. Similarly, for the seed rate of 9.5 kg/ha, about 98 percent of the seeds are located within the mean spacing of (20 ± 6) cm.

It is obvious that desired plant population and spacing amongst the plants could be maintained even at a seed rate of around 7.0 kg/ha.

Preliminary tests were also conducted with the same metering device on wheat, "arhar," "moong," and "urd." The results were quite satisfactory. However, the extensive trials would be conducted on large scale during the next season.

Cost Evaluation of Sowing Beets with Drill

The studies conducted for cost evaluation of sowing sugarbeet with dibbler and seed drill reveal that the dibbler requires about 250 man-hours/ha which costs about Rs. 250/ha. The developed drill is operated by two men* and can sow about 0.60 hectare of land per day. Hence, it requires about 27 man-hours which costs about Rs. 27 for sowing one hectare of sugarbeet. This clearly shows a net saving of about Rs. 223 per hectare against the use of drill for sowing sugar beet. In addition, the seed rate is lower. The usual recommended seed rate is about 10 kg/ha by dibbler whereas the drill needs only about 7.5 kg peeds to sow one hectare. The saving in seed cost is about Rs. 60 per hectare assuming the seed price of Rs. 25 per kg. When sugarbeet is planted manually, the required number of seeds on each hill is difficult to controll and at some place more seeds are dropped than desired. This consumes more time and energy at the time of thinning and singling the plant. The drill distributes the seeds uniformly and therefore it is easier to take out unwanted plants. It is obvious that there will be some saving of cost in thinning of beets when planted by drill.

*One for pulling and other for controlling the drill.

Conclusion

The designed beet drill is capable of producing very satisfactory results as a seeder where conditions are favourable. In addition to beet planting on flat ground and ridges this drill can also be used for planting crops like wheat, "arhar," "moong" etc.

The laboratory and fleld tests showed uniform planting of seeds at different seed rates. This type of equipment is very economical for small-sized holdings in various developing countries.

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Hand-Operated Cassava Harvesters

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Abstract

When cassava is harvested by hand, mostly simple implements are used, for example, a fork or a boom with halter to lift the roots out of the soil.

In this paper two types of cassava harvesters are described. After cutting off the stem the plant is gripped by a self clenching pair of tongs. The difference between the two types is that the first design requires two persons and the second design can be operated by one man. (On request drawings for construction and manufacturing of the tools will be available).

Introduction

Cassava, a root crop, is harvested by lifting the roots from the soil. The roots can be dug up by a fork or spade. However, by doing this there is a risk to damage, to cut or to break the roots. This damage means losses at harvest time ; further it makes the roots more susceptible to infestation by fungus and bacteria.

As the cassava plant has a strong woody stem and the roots are rather strongly tied to the stem, the system of pulling out the whole plant by its stem can well be used especially for cassava grown on light and soft soil, e. g., sandy soils. Dry clay soils, however, are too hard, with the result that the roots will tear from the stem. The pulling system can be used best for varieties which have rather short roots and where the roots are well distributed round the stem. Varieties with long roots and where the roots are placed at some distance from the stem are less or not suited. The roots will break off from the stem.

To pull out a cassava plant by hand without assistance cannot be done as the force needed to pull out a plant can be more than 1000 N. It is necessary to apply some instrument which can be operated by hand. A lever is a suitable device (Grace, 1971).

Usable Classes of Levers

Of the three classes of levers two are suitable for the lifting system. (The different points of impact on the lever are abbreviated as follows : the points of impact of the load, load-point, the point of impact of the bearer, bearer-point and the point of impact of the human force man-point).

a. The lever of the first class, where the bearer-point lies between the load-point and the man-point. The lever rotates round the bearer-point. The direction of the force of the man is downwards. The highest value which this pressing force can reach is the weight of the man (Fig. 1).

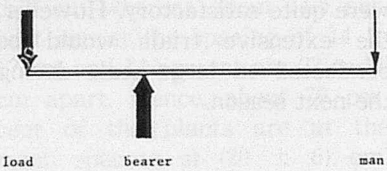

Fig. 1 Lever of first class

b. The lever of the second class, where the load-point lies between the bearer-point and the man-point. The lever also rotates round the bearer-point. The direction the force of the man is upwards. The highest value which this force can reach, is the weight that a man can lift (Fig. 2).

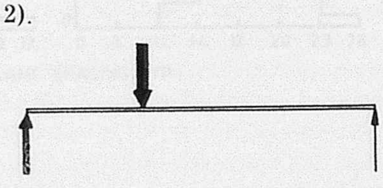

Fig. 2 Lever of second class

The relation of the distances between the different points of impact determines mainly the required lifting force of the lever. To get a lifting force of 1500 N, the maximum which a cassava plant of a year old can resist, a leverage factor of 3 or 4 will be needed, depending on how the man applies his force.

Fastening Cassava Stem to Lever

With the use of the lever system for lifting out the cassava the problem arises on how to fasten the cassava stem to the boom of the lever in a simple and easy way. The use of a withhalter is simple but not easy for the halter to tighten itself by lifting. A less simple but easy to use solution is the application of tongs which derive their gripping action from the lifting force, the so-called self-clenching tongs. Two kinds of tongs were developed :

a. Tongs with chains **(Figs. 3 and 7)** .

These tongs are connected to the boom by two pieces of chain in such way that during lifting the tongs clench to the cassava stem. The tongs are opened by hand and placed round the cassava stem. The construction has been made in such a way that the force on the clenching plates of the tongs is 3/2 times the force needed for lifting out the cassava plant **(Fig. 4)**. This ratio is large enough to prevent the cassava stem from slipping out of the tongs. On the other hand, it is not so large that it will cut off the cassava stem. The clencher plates, 5 mm, thick, are slightly rounded but have no teeth.

By hanging on chains the tongs have enough freedom of movement to make possible a big angle of rotation from the tongs to the boom. This makes it easier to set the tongs by hand round the cassava stem. After lifting the cassava the tongs must be released by hand. This means that one man operates the tongs while another man works the boom.

b. Tongs with plates **(Figs. 5 and 8)**.

The tongs, which can be controlled by the same man who also operates the lever, are fastened to the boom with less freedom of movement, so that by manipulating the boom the clencher plates can be placed round the cassava stem. By manipulating the tong's lever the tongs are opened and can be closed after the clencher plates lie along the cassava stem. The two chains are replaced by two extender plates on each side. The extender plates are connected to the lever boom so that the boom lies between the turning point of the plates and the fulcrum of the tongs. The tongs are of the extending type. On pulling together the tops of the extender plates by a rope fastened to the tong's lever, the tongs are opened and their fulcrum is very near to the underwire of the boom so that they can only move little. In this situation it is possible to put the clencher plates along the cassava stem. On releasing the rope the tongs grip the cassava stem by gravity. On lifting, the force on the clencher plates increases at about the

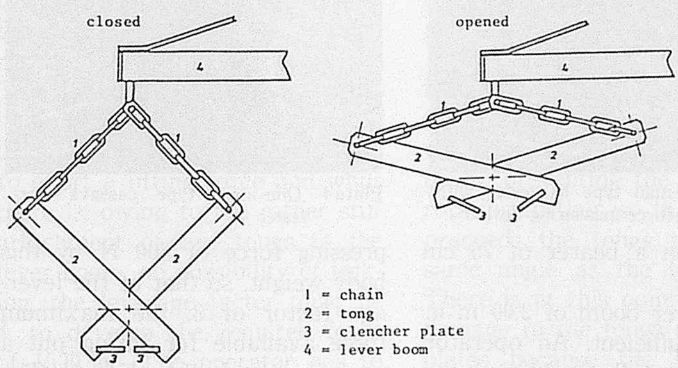

Fig. 3 Tongs with chains

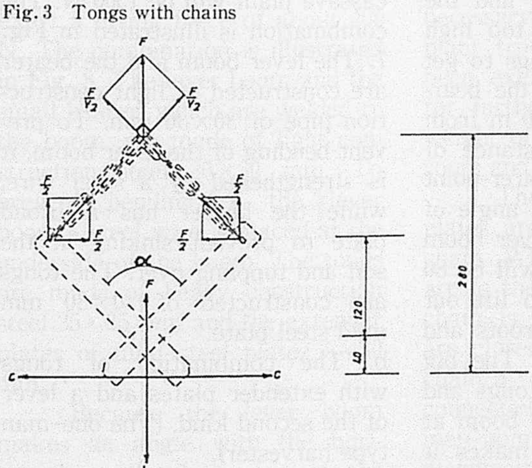

Fig. 4 Relation between pulling force (F) and force on clencher plates (C) when $\alpha = 90^\circ$ $C = \frac{3}{2}F$ Lifting force needed $L = F$

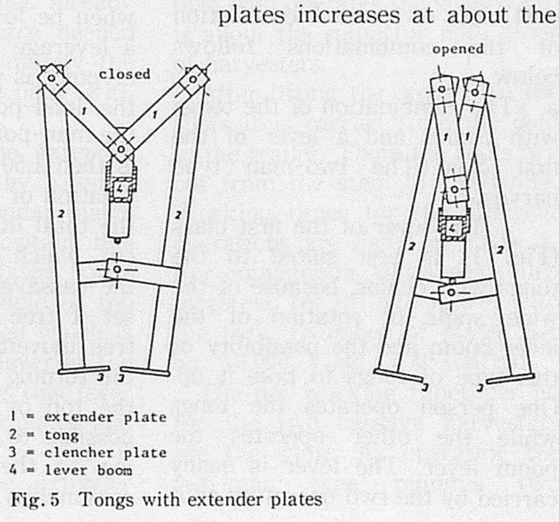

Fig. 5 Tongs with extender plates

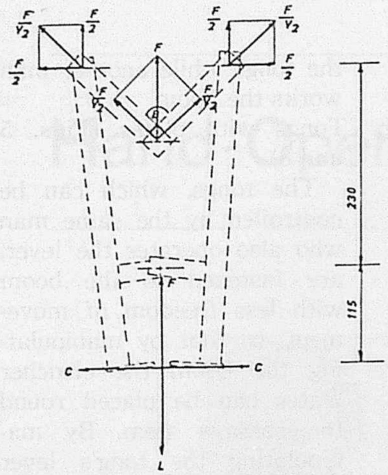

Fig. 6 Relation between pulling force (F) and force on clencher plates (C) when B=60° F=C Lifting force needed L=F

same rate as the force for lifting out the cassava plant (**Fig. 6**).

To prevent the cassava stem slipping out between the clencher plates, the plates are supplied with teeth. The close relation between the uprooting force and the force on the clencher plates is choosen in order to get more space under the fulcrum of the tongs. This space is needed to get enough freedom for putting the clencher plates easily along the cassava stem.

Type of Tongs and Class of Lever

Each of the two types of tongs described above is suited to its own class of lever. A description of the combinations follows below.

a. The combination of the tongs with chains and a lever of the first class.(The two-man type harvester).

The lever of the first class (**Fig. 1**) is best suited to the tongs with chains, because of the wide angle of rotation of the lever boom and the possibility of this type of tongs to take it up. One person operates the tongs while the other operates the boom lever. The lever is easily carried by the two operators as it

Plate 1 Lifting cassava with fork

Plate 2 Damaged roots by fork lifting

Plate 3 Two-man type harvester with lifting force measuring device

Plate 4 One-man type cassava harvester

is placed on a bearer of 75 cm high.

A lever boom of 2.00 m in length is sufficient. An operator only 1.50 m tall would find the end of a longer boom too high when he lowers the tongs to get a leverage factor of 3, the bearer-point is placed at 0.50 m from the load-point. The distance of the man-point to the bearer-point is then 1.50 m. With an angle of rotation of 60° of the lever boom the total lifting height will be 80 cm, which is enough to lift out the cassava stem with roots and set it free on the soil. The big free movement of the tongs and the turning point of the boom at the top of the bearer makes it possible to shake off soil adhering to the roots. A man can reasonably supply a maximum pressing force of 800 N by this body weight, so that at the leverage factor of 3, the maximum force available for lifting out a cassava plant will be 1500 N. The combination is illustrated in **Fig. 7**. The lever boom and the bearer are constructed of light construction pipe of 30×30 mm. To prevent bending of the lever boom, it is strengthened by a steel wire, while the bearer has a broad plate to prevent sinking in the soil and toppling over. The tongs are constructed of 10×30 mm mild steel plate.

b. The combination of tongs with extender plates and a lever of the second kind. (The one-man type harvester).

The tongs with extender plates are especially designed to be controlled at a distance by the

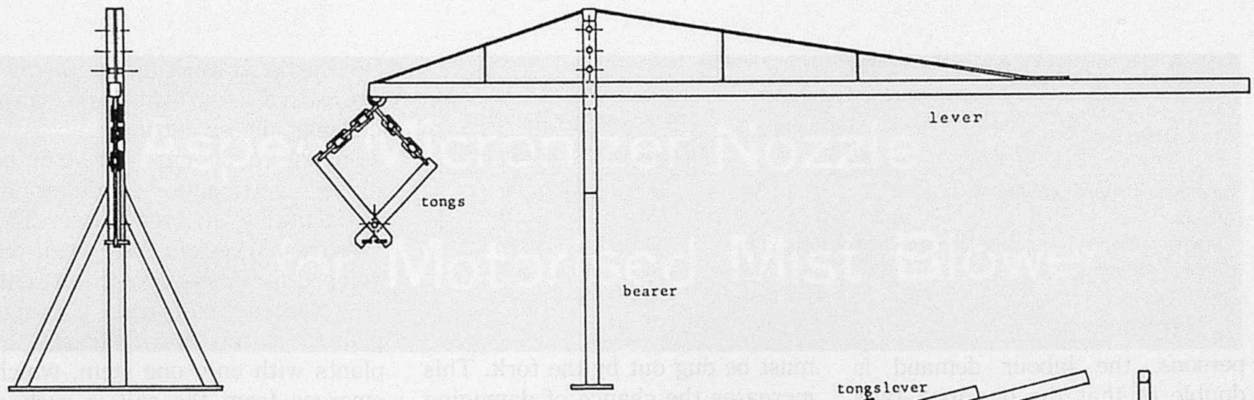

Fig. 7 Two-man type harvester

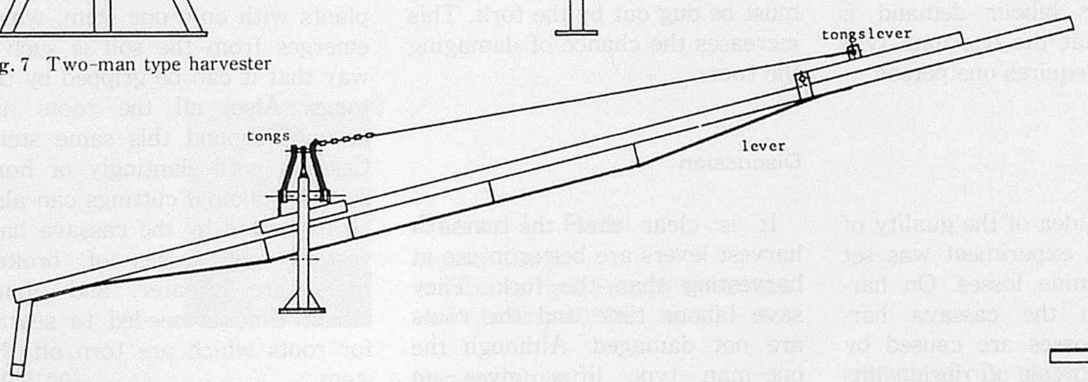

Fig. 8 One-man type harvester

same person who operates the lever, so that one person can do the job. As this type of tongs has to be rather stiffly connected to the lever boom, only a small rotation of the boom is possible. The lever of the second kind, illustrated in **Fig.** 2, is best suited to doing this. As the operator has to exert a lifting force and while there is, owing to the rather stiff attachment of twe tongs to the lever boom, no possibility of jerking, the leverage facter must be 4, to develop the required force of 1500 N. The operator has to exert a lifting force of about 400 N. The combination is illustrated in **Fig.** 8. The lever boom and the small bearer, which are welded to the boom, are made of light construction steel 30×30 mm. To prevent bending of the lever boom a steel wire is placed at the underside of the boom. The tongs are made of heavy construction steel 25×25 mm and the extender plates of mild steel plates 5×30 mm.

Because the lever boom makes an angle with the horizontal at the beginning of the pulling process, the shaft on the boom, on which the extender plates rotate, makes the same angle with the boom so that the shaft lies horizontal. The tongs can rotate about 10° in the shafts at the top of the extender plates. After the cassava plant has been lifted about 20 cm, the fulcrum of tongs comes in contact with the wire on the underside of the boom, preventing the tongs from rotating further, so that as lifting proceeds the tongs turn at the same angle as the lever boom. There is at this point no risk of damage to the tongs or extender plates because the large force necessary to break the cassava plant from the soil has already been exerted. The force needed for further lifting is merely the weight of the cassava plant with roots and adhering soil.

The tops of the extender plates are connected by a small chain. When the extender plates are in the extended position, this chain is straight and the tongs are closed. In the middle of the chain a rope is fastened which is connected to a small lever at the man-point. By moving this lever downwards the rope is pulled and the chain is snapped so that it pulls the tops of the extender plates to each other and the tongs will open.

Method and Capacity

Before the cassava is harvested it is necessary to remove most of the above-ground part of the cassava plant. A small piece of the stem, 10-15 cm in length, must be left to be gripped by the cassava harvester. The cassava stem is cut off at this height by a bushknife. The cut off part is thrown aside. Then the cassava is lifted out of the soil. The effort of the man who operates the lever boom is about the same for both kinds of harvesters.

After lifting the stem with the roots it is carried from the field to the trailer. There the roots are cut from the stem by bushknife. Working times for the different operations are listed in **Table 1.** For comparison, times were also measured for lifting cassava with the fork. (Number of plates per ha : 10,000. Yield : a 40 ton/ha).

The net working times per ha for the two cassava harvesters are the same. As operating the two-man type requires two

Table 1. Net working time of different harvest operations for fork and two types of cassava harvesters (Unit : manhours/ha)

Operation	Fork	Type of Cassava Harvester	
		Two-man type	One-man type
Cutting off above-ground parts	30	30	30
Lifting	180	120	60
Carrying to trailer and loading (average distance: 6 m)	20	20	20
Cutting off roots	30	30	30
Total	260	200	140
Relative	100	77	54

persons, the labour demand is double of that the one man type which only requires one person.

Losses

To get an idea of the quality of the work an experiment was set up to determine losses. On harvesting with the cassava harvester, the losses are caused by roots which break off during lifting and stay in the soil, while at harvesting with the fork losses also arise through damage to the roots by the fork. About sixty plants were harvested with each of the diffierent methods. The results are listed in **Table 2.**

With the fork 12.3% of roots remained in the soil, while 7.8% of the roots that were harvested were damaged. With the use of the cassava harvesters there were no damaged roots. The roots which remained in the soil, by breaking off from the stem, could easily be taken out of the soil by hand. With the use of the lifters the roots were mostly readily visible in the hole which remains in the soil after lifting out the cassava plant. The roots are already moved to some extent so that they are easy to take out by hand. In this way these roots are not lost. With the use of the fork it is more difficult to find the broken roots owing to the greater amount of soil adhering to the root mass. To find them the hole must be dug out by the fork. This increases the chance of damaging the roots.

Table 2. Cassava losses and yields at harvest

Implement	Broken Roots which remain in soil		Roots on stem not damaged		Roots on stem damaged		Yield
	tons/ha	%	tons/ha	%	tons/ha	%	tons/ha
Fork	6.13	12.3	39.71	79.9	3.87	7.8	49.71
Two man type	2.65	5.6	44.63	94.4	–	–	47.28
One man type	2.17	4.4	47.44	95.6	–	–	49.61

Discussion

It is clear that the cassava harvest levers are better in use at harvesting than the fork. They save labour time and the roots are not damaged. Although the one-man type lifter gives an important saving in labour, it will not mean that the two man type is unsuitable. The latter is more sturdy and therefore more suited for rough conditions. Also, the construction is simpler and easier for local manufacturing. The implement will work reasonably well even if the specifications are not rigorously adhered to during construction. This lever is also more resistant to wear.

The one-man tool is very well suited to circumstances where the skill of the manufacturer and the user are at a sufficient level. When this is not the case, the construction and the use may possibly become a disappointment.

The two-man harvester needs two persons to operate. However, it is not necessary that these two persons should be two adult men. The person who operates the tongs can be a boy or a woman. This type of lifter is therefore well suited to areas with relatively unskilled small farmers whose families also work on the farm.

Cassava is grown from corm cuttings. These cuttings, pieces of stem 20 to 30 cm long, can be placed vertically, slantingly or horizontally in the soil. The cassava harvesters have been developed for cassava with vertically planted cuttings. Cuttings planted in this way give rise to plants with only one stem, which emerges from the soil is such a way that it can be gripped by the tongs. Also, all the roots are grouped around this same stem. Cassava with slantingly or horizontally planted cuttings can also be harvested by the cassava harvesters, but losses of broken roots are greater and more labour time is needed to search for roots which are torn off the stem.

Conclusions

- —The manually operated cassava harvesters save labour time and reduce the losses at harvest time.
- —The two-man type is best usable on small family farms. (Simple construction).
- —The one-man type harvester fits in for farmers with adequately skilled labourers and where saving of labour time is important.

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Aspee Micronizer Nozzle for Motorised Mist Blower

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Abstract

In modern agriculture concentrated spray solutions are widely used. However, the sophisticated equipment required to spray these chemicals are beyond the reach of the developing countries. This has provoked a thought as to how best use could be made of simple and less sophisticated equipment for these concentrated spray solutions. An effort is made in this direction to achieve the effectiveness by making modifications in the existing equipment. The experiments were performed by changing the conventional spray jet nozzle (AMN) in a motorised mist blower. The performance of AMN was compared with that of spray jet nozzle (SJN) and was observed that the AMN nozzle is superior. The effective swath increases, volume mean diameter (VMD) decreases and volume of pesticide required per hectare decreases when applied with AMN nozzle. The control droplet application (CDA) technique can be schieved in a better way by the use of AMN nozzle.

Nomenclature

Units

cm^2 = Square centimeter.
km/h = Kilometer per hour.
l/ha = Liter per hectare.
l/min = Liter per minute.
m = Meter.
mm^3 = Cubic millimeter.
ϕ = Droplet diameter.
μm = Micrometer (0.001 mm = 1 Micron).

Abbreviations

AMN = Aspee Micronizer Nozzle.
CDA = Controlled Droplet Application.
NDR = Nozzle Discharge Rate.
RPM = Revolutions per Minute.
SJN = Spraying Jet Nozzle.
SVAR = Spray Application in l/ha.
ULV = Ultra Low Volume.
VMD = Volume Mean Diameter.

Introduction

Losses in the production of food, fibre and fodder are crossing the limits of billions of dollars due to diseases, pests and failure to feed the plants and animals properly and efficiently. Pests are our enemies since they consume food as much as human beings and also prevent efficient growth of raw materials.

The expenditure on pesticides is hundreds of millions of dollars. But a large portion of this expenditure is wasted because of the inefficient methods of application. If the methods used for application of modern chemicals are efficient, then not only will they reduce the cost to the farmer but also make the pesticides available to those farmers who are deprived of their use today and thus the billions of acres of farmland can be brought under cultivation by new methods by organising the application of pesticides in a scientific manner.

In recent years agricultural chemistry has made tremendous progress. And equally well is the progress of the development of equipment used for the application of these new chemicals in a very efficient manner. In old days it was thought that any device for spreading dry materials or for spraying liquids would work, but we know now after years of experience that these chemicals are to be used sparingly and applied efficiently.

Non-scientific method of pesticides application results in a waste of chemical, money and ultimate production loss by two ways : a) application of sublethal dose results in inadequate pest control and pests develop resistance against pesticides. and b) application of excessive dose results in excessive consumption of pesticide and consequent shortage and entails additional cost of pesticides. The latter adds to the loss of pesticides due to run-off (dripping), creates possibility of toxicity in the harvested crops and product, and contamination and environmental pollution.

There is unanimity in the agricultural world that these new chemicals is a must and should be used efficiently and economically and even safely with proper means of application equipment.

CDA–Controlled Droplet Application

CDA is a new term coined by E. J. Bals, the father of ULV spraying technique. The term CDA is more relevant to the efficient spray application rather than the term ULV. In CDA the uniformity of droplet spectra is more important than the size of the droplet. The droplet size should be commensurate with its intended function and can vary from 200 μm to 400 μm VMD in low volume application.

The CDA technique is used to create a fine mist to cover all exposed areas of plants so that they become deposited with myriads of droplets of pesticides of appropriate sizes to implement their function effectively and efficiently.

The analogy given by Bals (2) is extremely useful in understanding this principle.

"The significance of droplet size becomes clear by of a man standing under a large tree in a heavy downpour of rain; he escapes soaking because the large drops of rain are deflected by the thick foliage. However, if he stood under the tree in a fine mist he would become thoroughly drenched by small particles of moisture.

In conventional spraying, the top leaves of the plants catch the large drops of spray and protect the lower leaves, and some of the drops join together and run off the top leaves and so are wasted. with contact insecticides, the insects that have been protected by the top leaves will survive.

The results of conventional spraying can also be compared to a garden after a heavy fall of rain : you can pick your way around the occasional puddle on the garden path without getting your feet wet, but when a light dew covers the lawn it is comparable to the result of controlled Droplet Application–after a few steps your shoes become dripping wet as they pick up the fine droplets of dew on the grass.

In terms of order of magnitude the relationship between grass on a lawn and a human being's legs is roughly the same as the relationship between the hairs on a plant and an insect's legs. Therefore, when controlled droplet application spraying is used, it becomes extremely difficult for the insect to avoid the dew of insecticide to which it finds wherever it turns on the leaf or stem of the plant.

These examples clearly illustrate that the critical factor is the size of the droplet. It is the size of the droplet and the force with which it impinges on the selected target that is more important than the total amount of liquid used.

The total amount of liquid used bears no relation to the effect achieved. The important aspect is the study of the behaviour of a droplet and its ability to impinge on its selected target relative to its size and the amount of active chemical carried.

Thus Bals has rightly said that the efficiency of the spraying machine is inversely proportional to the range of droplet it produces.

Principles

Concentrated spray solution came into use since early fifties. The use of concentrated spray solution requires treatment of a hectare of crop area by a few litres of liquid. This has presented a new problem to the designer of spraying machine. In order to achieve adequate coverage with the smaller dose of spray chemical, the droplets should be smaller (fine) in size, as it is evident that the area covered by a given volume of spray increases as the droplet size decreases.

The fundamental function of the plant protection equipment is to atomize the spray solution into fine droplets to have a thorough coverage on a desired target.

For effective pest control, uniform droplet density on the target is essential. If the droplets are bigger in size the requirement of spray volume will increase. In fact this has been a major principle around which most of the recent researches have been made for reducing the spray volume per unit area.

The advantages are many: requirement of water-pesticide carrier is reduced ; saving in time and spraying labour, output per day increases. less spray volume means fine particles and no dripping and efficiency of pesticides increases due to better coverage.

Marginal reduction in spray volume can be achieved by increasing spraying speed or by changing working pressure of the nozzle in conventional manually operated hydraulic sprayer. But for greater reduction in spray volume one has to think of a nozzle which can produce fine particles with low discharge rate–i. e., a new design of nozzle.

While in scientific pest control technology, the objective is to reduce the spray volume, yet it must be ensured that they are not reduced to such a small size that they evaporate due to temperature or humidity before settling down on the target as they drift away by wind and miss the target.

Pressure Atomizing Nozzle

The conventional pressure atomizing nozzle is basically an orifice. The flow rate of the nozzle is approximately proportional to the square root of the pressure (1) and the average droplet size produced by it varies approximately to the inverse square root of the pressure. Thus, any change in the flow rate would necessarily require a change in the pressure and the droplet size distribution. Fine droplets can be produced with a small orifice and high pressure. Thus nozzle for such an application must give small droplet size and yet not be liable to blockage. If a small volume of liquid is to be delivered through a relatively large orifice, the liquid flow must be low. In such a case the liquid will not break up into a fine spray as it emerges into the atmosphere. The orifice size cannot be reduced beyond a certain limit due to reasons of blockage. At the same time increase in pressure requires a higher horse power. Therefore, both factors cause limitation in pressure atomizing nozzle for the reduction of droplet size and the spray volume.

Air Blast Nozzle

It is an established principle that a drop of liquid is always broken up in an air stream whenever the friction forces, due to its relative motion, exceed those of surface tension which it contains. The theoretical drop of maximum size which can survive at a relative velocity of 304 m/sec. is about 10 μm and at 152 m/sec 40 μm (4).

It is essential that the droplets produced by an air blast nozzle should be ejected at a high velocity to enable them to penetrate deeply into the drops and still retain sufficient power to settle.

The above principle is utilised in the air blast nozzles where slow moving liquid is injected into a high velocity stream of air for atomization into smaller droplets.

Production of particles of even size depends on wind velocity. Also, the excessive speed of the air blast will produce very small droplets which may drift away by air. Thus wind velocity has certain limitations in the working of an air blast nozzle.

Spinning Disc Type Nozzle

In order to get a narrow range of droplet sizes, micronizer nozzles are used. Droplet formation in a spinning atomizer--micronizer occurs from centrifugal force. Marshall reported that there is a pronounced influence of peripheral speed on droplet size, but a smaller effect of feed rate. Smith has found that atomizer could produce a narrow spectrum of droplet sizes. (5) (6).

In this case the droplets are produced by a spinning disc which rotates at a high RPM. The liquid is fed by gravity on to the serrated disc and the droplets are produced by the centrifugal force.

Droplet Spectrum

The number and size of droplets per cm² reaching the crop, play their part in determining the

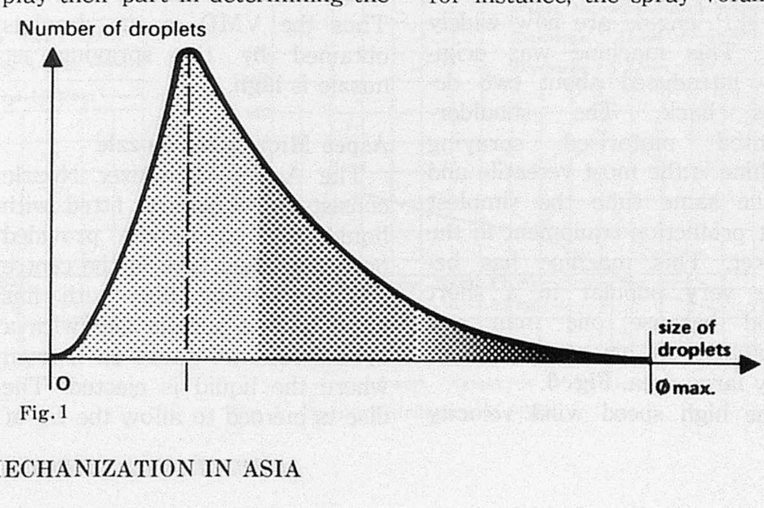


Fig. 1

biological efficacy of the treatment. (Other factors : the efficacy of the product, the dosage rate and the correct timing of the application).

Any quantity of liquid (water, spray mixture or ready formulated ULV Product) sprayed through a nozzle atomizer produces droplet spectrum. The spray is not composed of identical drops but a droplet spectrum, whose distribution in percent of large, medium and small droplets always remains approximately the same. **Fig. 1.** (Ref. 3).

Since pesticides are applied as a volume, it is not only the droplet number but also the volume of all the droplets in the spectrum which is decisive to biological efficacy.

There are several parameters of droplet size, although the most widely used is the volume median diameter VMD measured in micrometers (μm=Micron). The VMD is the mean diameter which divides a spray into two equal parts by volume, one half containing droplets smaller than this diameter and the other containing droplets which are larger. **Fig. 2.** (Ref. 3).

In agricultural spraying the droplet diameter is always expressed as VMD. If the biggest droplet diameter of an applied spray is known, the VMD can be found by the empirical formula :

$$VMD = \phi \max \cdot x0.45$$

In any spray application the VMD is the decisive quantity. If, for instance, the spray volume is

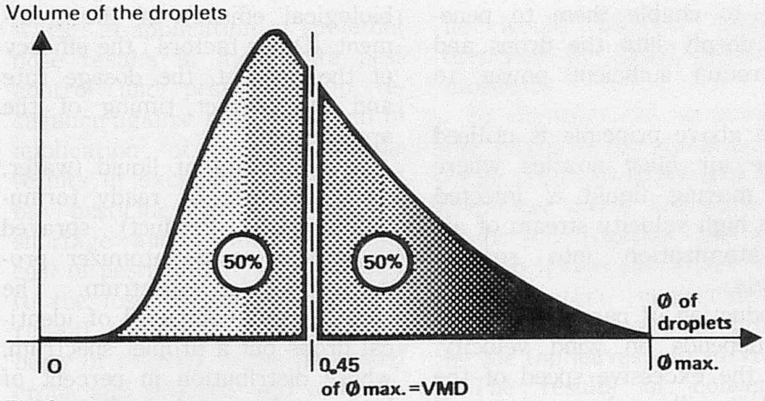


Fig. 2

to be changed without impairing the biological efficacy, the VMD is the arithmetical quantity for this change.

The unit of measurement for the droplet size is its diameter in micrometers.

For efficient insect control the minimal droplet density should be over 50 droplets per cm² with diameter ranging from 100 μm to 500 μm.

Development of Aspee Micronizer Nozzle

In developing countries high volume spraying is still followed by a majority of cultivators. Lately low volume application has become popular. The commonly used equipment is the motorised knapsack mistblower fitted with the standard spraying jet nozzle (air blast nozzle).

Knapsack Motorised Mistblower

Motorised knapsack mistblowers powered by a high RPM, low H.P. engine are now widely used. This machine was originally introduced about two decades back. The shoulder-mounted motorised spraying machine is the most versatile and at the same time the simplest plant protection equipment in the market. This machine has become very popular in a short period because one man can operate it on his own and can spray large area. **Fig. 3.**

The high speed wind velocity (250 km/h) produced by the blower breaks the spraying liquid into fine particles and also carries the particles to the target to penetrate the foliage and settle. The standard mistblowers are equipped with air blast nozzle.

Spraying Jet Nozzle

The spray jet nozzle consists of a main housing from which wind is passed at high velocity and is fitted with liquid tube. The opening of the liquid tube falls in the centre of the main housing. The dosage sleeve has been provided in the liquid tube to achieve four different types of discharge rates. **Fig. 4.**

The spray is produced by feeding the liquid pesticide on to the centre through liquid tube by force of gravity. The air blowing at high velocity from the blower breaks the droplets into particles and these particles are thrown to the target with the air velocity. The particles formed by such methods are bigger in size and range from 50 μm to 750 μm. Thus the VMD of the droplets obtained by the spraying jet nozzle is high.

Aspee Micronizer Nozzle

The Aspee Micronizer Nozzle consists of a housing fitted with liquid tube, a spindle provided onto the liquid tube in the centre and a spinning disc with fins fitted onto a spindle and with a cylindrical wire gauze on it from where the liquid is ejected. The disc is pierced to allow the tip of the liquid feed to approach the periphery of the disc.

The spray is produced by feeding the liquid onto the centre of a fast spinning disc. The disc is provided with fins so that it could get rotary momentum from the velocity of air coming from the blower. The liquid picks up the rotary velocity of the disc and spreads outward under the influence of centrifugal force. Finally, it is projected from the periphery through wire gauze in the form of droplet. The direction taken by the liquid particles after they leave the disc is presumably a resultant between the radial and rotary velocities attained at

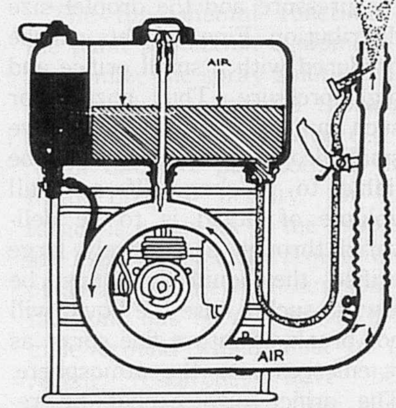


Fig. 3 Mistblower sprayer

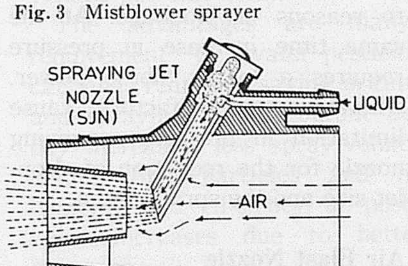


Fig. 4 Spraying Jet Nozzle (SJN)

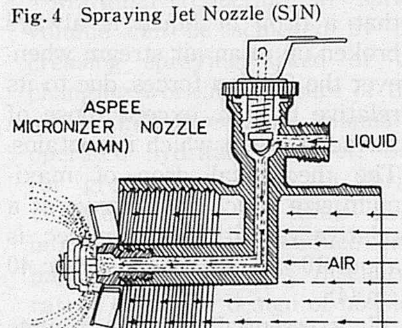


Fig. 5 Aspee Micronizer Nozzle (AMN)

the last moment. **Fig. 5.**

The particles which are coming out from rotating gauze are controlled in size with respect to the sieve size of gauze and RPM of spinning disc, i. e., wind velocity. The atomization is completed when the droplets are thrown out of the micronizer with high wind velocity which is also passing over the spinning disc.

AMN nozzle has been designed basically to achieve two objectives : to produce spray particles with smaller VMD, and to reduce SVAR, i.e., volume required to spray an area of one hectare

Both these aspects have been studied in a small experiment for the AMN Nozzle and conventional SJN Nozzle. The details are given in this paper.

Experimental

Apparatus and Material.

1. Mistblower fitted with Villiers L34 Engine 1.2 H.P., 5500 RPM.
2. Spraying Jet Nozzle, with suitable dosage sleeve to have discharge rate of 1.0 l/min. and 1.5 l/min.
3. Aspee Micronizer Mozzle, AMN, with two suitable dosage control discs to have discharge rate of 1.0 l/min. and 1.5 l/min.
4. Kromekote paper size 5 cm. x 7.5 cm.
5. Strubin lens 15X (counting factor 2.3)
6. Stands, one foot high with holders to hold kromekote paper.
7. Spray mixture of water with 1% aqueous solution of purple colour and stamp pad ink of kores.

The spray mixture was sprayed with motorised mist blower for obtaining droplet stains on kromekote papers which were kept on 7 different holder stands at a distance of 1.5 m successively. Thus covering a swath length of 9 m down winds. The spraying speed was 2.5 km/hr.

AMN and SJN nozzles were used with two different discharge rates, viz., 1.0 l/min. and 1.5 l/min.

With each (i.e. AMN and SJN) nozzle arrangement, spraying was carried out as per above parametres exposing 3 sets of kromekote papers, one set after the other. Thus each nozzle and for each discharge rate, there were 3 replications giving 3 cards for each position.

Calculations and Results

The comparison of AMN Nozzle with SJN nozzle is made by calculating the following salient features of spraying :

i) Effective swath.

ii) Application rate.

iii) Volume mean diameter (VMD)

iv) Droplet size and density.

In all the cases, water is used as the medium. The spread factor of the droplets on kromekote paper has been disregarded.

1. Effective Swath

For each position, on 3 cards representing 3 replications the number or droplets were counted with strubin lens. The total number or droplets obtained on 3 cards for each position were added and divided by three to get an average number of droplet cm^2. The data are presented in **Table 1.**

Table 1.

Droplet Distribution Along the Total Swath Mean Number of Droplets/cm^2

Distance in Meter m	SJN Nozzle NDR in l/min 1.0	SJN Nozzle NDR in l/min 1.5	AMN Nozzle NDR in l/min 1.0	AMN Nozzle NDR in l/min 1.5
0. m	1	–	68	1
1.5 m	36	10	106	175
3.0 m	130	136	87	198
4.5 m	135	170	75	168
6.0 m	18	48	41	74
7.5 m	26	16	23	34
9.0 m	19	6	23	12
Total	365	386	423	662
Average Density	41	43	47	73

The graph has been drawn for the above data by plotting the number of droplets on the vertical plain and the swath distances in meter on the horizontal plain. The droplet distribution can be observed in **Figs. 6 & 7.**

Taking 50 as the number of droplet/cm^2 an ideal droplet density for biological control, the effective swath width was interpolated from the graph. In other words, the swath calculated from the graph gave the effective distance over which the droplet density was more than 50 cm^2.

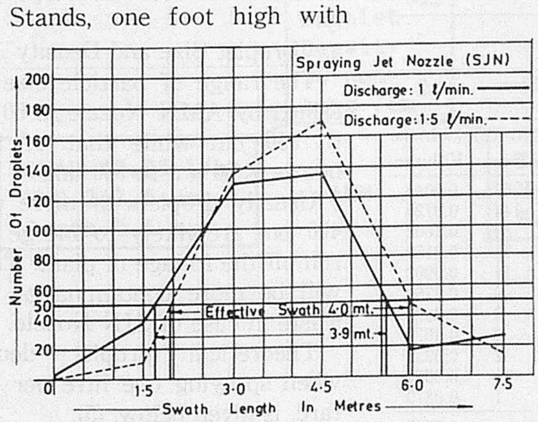


Fig. 6 Droplet distribution of SJN

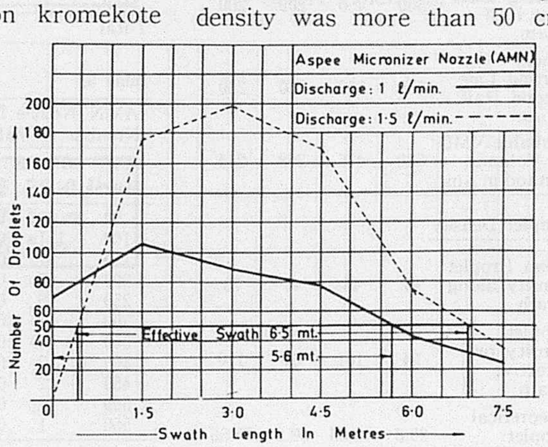


Fig. 7 Droplet distribution of AMN

Table 2.

Droplet Distribution Along the Effrctive Swath

Distance in Meter m	SJN Nozzle NDR in l/min 1.0	SJN Nozzle NDR in l/min 1.5	AMN Nozzle NDR in l/min 1.0	AMN Nozzle NDR in l/min 1.5
	Mean Number of Droplets/cm²			
0.0 m	–	–	68	–
0.5 m	–	–	–	50
1.5 m	–	–	106	175
1.7 m	50	–	–	–
2.0 m	–	50	–	–
3.0 m	130	136	87	198
4.5 m	135	170	75	168
5.6 m	–	–	50	–
5.7 m	50	–	–	–
6.0 m	–	48	–	74
6.9 m	–	–	–	50
Total	365	404	386	715
Average	94	101	69	110
Effective Swath	3.9 M	4.0 M	5.6 M	6.5 M

Table 3.

	SJN Nozzle NDR in l/min 1.0	SJN Nozzle NDR in l/min 1.5	AMN Nozzle NDR in l/min 1.0	AMN Nozzle NDR in l/min 1.5
SVAR-Swath				
Effective Swath in m	3.9	4.0	5.6	6.5
Application Rate SVAR in l/ha	61.5	90	42.85	55.38
VMD				
Maximum ϕ in μm By practical	750	750	550	550
VMD by Formula in μm	337.5	337.5	247.5	247.5
Total Volume of droplet in mm³	1.4258	1.5356	1.1455	1.1505
50% Volum in mm³	0.7129	0.7678	0.5727	0.5752
ϕ near Parting Line First Half in μm	500	450	200	200
ϕ near Parting Line Second Half in μm	550	500	250	250
Probable VMD by Volume Method in μm	520	475	208	244
Droplet Density				
Mean Droplet Density along Swath	41	43	47	73
Droplet Density on Effective Swath	94	101	69	110
Theoretical Droplet Density	29.8	43.65	52.2	67.56

The effective swath calculated for each nozzle arrangement is given in **Tables 2 & 3**.

The mean number or droplet/-cm² along the effective swath were calculated by adding the total number of droplets counted on the paper falling within the effective swath and dividing the total number of droplets by number of observed points. The mean number of droplets/cm² are also given in **Tables 2 & 3**.

2. Application Rate (SVAR)

The pesticides application rate by each nozzles for both discharge rates were calculated by considering the effective swath length using the formula :

SVAR Application rate in l/ha.
= Swath in × spraying speed in km/h.

3. Volume Mean Diameter (VMD)

For calculating VMD, two methods have been adopted.

In method one, on each card, 5 biggest droplets were marked and the actual diameter was measured by strubin lens. The maximum diameter where at least two droplets were obtained was treated as the maximum diameter of the droplet. The VMD was calculated using, the formula :

VMD = ϕ maximum × 0.45 (constant)

Table 3.

In method two, on each paper the number of droplets of various micron sizes were measured within 3 mm radius around the biggest droplet, at one place only. The reading of 3 replications of each position, were added for each category of droplet size and the total number of droplets of different micron sizes ranging from 50 mm to 750 mm were calculated.

The actual total volume of the droplets of different micron sizes were calculated by the formula ;

Volume of a droplet in mm³
$= (\phi/2)^3 \times \pi \times (4/3)$.

The total volume applied by the entire droplets spectrum was calculated. **Table 3** for VMD, **Table 4** for SJN and **Table 5** for AMN.

From **Tables 3,4 & 5**, approximate diameter dividing the total volume into equal halves, was interpolated and this was termed as VMD. The VMD found by the first method is considered to be more reliable.

The VMD of AMN & SJN are 247.5 μm and 337.5 μm respectively.

4. Droplet Size and Density

The range of particle size obtained by AMN Nozzle is 50 μm to 550 μm while that of SJN nozzle is 50 μm to 750 μm.

Usually droplets of more than 400 μm are likely to merge and run off the foliage of plant. There will be more contamination and waste in case of SJN Nozzle.

Theoretical droplet density when spraying one litre per hectare, is given below. (5).

Table 4.

SJN Nozzle Droplet-Size, Number & Volumes

ϕ Micron	At NDR 1.01/min. No.	At NDR 1.01/min. Volume	At NDR 1.51/min. No.	At NDR 1.51/min. Volume
50	49	0.0032	20	0.0013
100	79	0.0395	80	0.0400
150	49	0.0882	65	0.1170
200	12	0.0504	27	0.1134
250	8	0.0656	10	0.0820
300	6	0.0846	7	0.0987
350	4	0.0896	5	0.1120
400	3	0.1005	2	0.0670
450	2	0.0952	2	0.0952
500	1	0.0654	1	0.0654
550	1	0.0870	1	0.0870
600	1	0.1130	1	0.1130
650	1	0.1436	1	0.1436
700	1	0.1794	1	0.1794
750	1	0.2206	1	0.2206
Total		1.4258		1.5356

Table 5.

AMN Nozzle Droplet-Size, Number & Volumes

ϕ Micron	At NDR 1.0 l/min. No.	At NDR 1.0 l/min. Volume	At NDR 1.5 l/min. No.	At NDR 1.5 l/min. Volume
50	30	0.00195	67	0.0044
100	111	0.0555	144	0.0720
150	97	0.1746	89	0.1602
200	57	0.2394	75	0.3150
250	15	0.1230	11	0.0902
300	12	0.1692	9	0.1269
350	3	0.0672	3	0.0672
400	2	0.0670	2	0.0670
450	2	0.0952	2	0.0952
500	1	0.0654	1	0.0654
550	1	0.0870	1	0.0870
Total		1.1455		1.1505

Droplet in μm	Number of droplet per cm^2
10	19099
20	2387
50	153
250	1.22
340	0.485

For four different application rates the theoretical droplet density is found by using the above data and is presented in Table 3.

Conclusion

It was found that AMN Nozzle is superior to the SJN Nozzle.

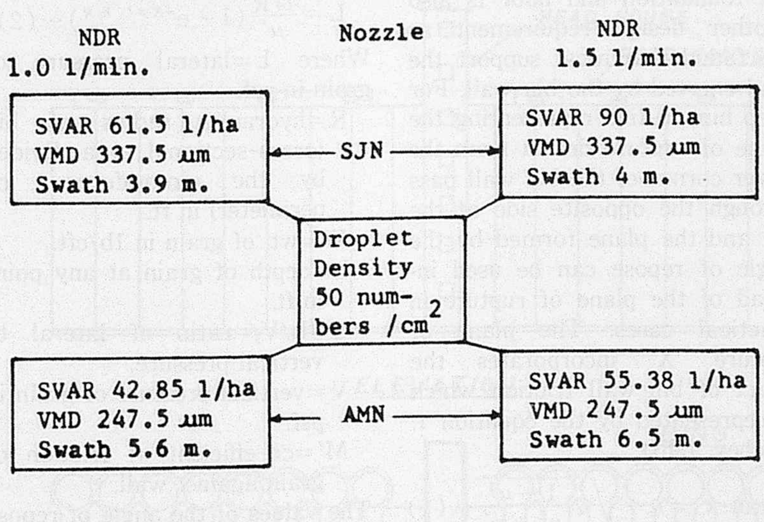
1. The effective swath of AMN Nozzle increased by 43.5 percent to 62.5 percent.
2. The volume of pesticide required to cover one hectare–SVAR decreases by 30 percent to 38 percent when applied with AMN Nozzle.
3. The volume mean diameter in AMN Nozzle decreases to 247.5 μm (from 337.5 μm with SJN Nozzle).
4. The droplets size has been controlled well. The droplet density increased compared to theoretical one.

In ULV spraying by hand-held battery operated micronizer, the droplets produced have no kinetic energy of their own. Here natural wind is the essential force that makes it possible to carry the pesticide to penetrate foliage and land on target. A minimum wind speed of 5 km/h is essential for spraying with such equipment. Without wind, the droplet would not have sufficient momentum to make an impact on target. This consideration makes this type of application unsuitable for use in still air.

It is essential that the droplet spectrum emitted be preferably uniform. The droplet of controlled size can be produced by the use of micronizer Nozzle with motorised mistblower. The additional advantage of this light and compact mist blower is that the droplet reaches the pre-determined target surface at high speed due to the air blast.

The main advantage of the AMN nozzle is that the crop being treated with it will be satisfactorily sprayed and waste will be avoided. Thus this method is of great advantage to the developing countries.

Sohematic Diagram



What is stated above are the results of experiments carried out to find out the possibility of devising attachment for conventional equipment to make them suitable for spraying concentrated solution. Further experiments are still under progress to control swath and particle size as per requirement of different types of pesticides.

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Design and Construction of Deep Vertical Food Silo in Bangladesh

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Introduction

Nearly all grains produced in farms are stored before they are finally processed and consumed. The storage period may consist from a few weeks holding on the farm and transit or may extend to a few months. Inadequate storage facilities contribute to an enormous annual loss of food grain and it is estimated that about 10 to 20 percent of the total food grain produced in Bangladesh in lost during processing and storing. To minimise these partially, the Food Department of the then Pakistan Government initiated in 1968, the construction of modern food silos for storing food grains in four different places : Chittagong, Ashugonj, Demara and Santaher.

These silos were vertical concrete grain-storge deep bins with some auxilary units like head house and delivery chamber etc. The design for all of them use more or less same except for the variation of number of bins in each unit.

Methodology

Design procedure

In designing grain storage bin the lateral pressure exerted by the grain to be sotred is determined by selecting the cross-section and dimension of the bin. The lateral pressure exerted and the load supported by the bin wall will govern the strength requirement of the sidewall and hoops. The weight supported by the foundation and floor is also another design requirement as the foundation must support the load exerted by the bin wall. For deep bins, a line representing the plane of rupture drawn from the lower corner of the bin wall pass through the opposite side of the bin and the plane formed by the angle of repose can be used instead of the plane of rupture in practical cases. The plane of rupture 'X' incorporates the effect of bin-wall friction which is represented by the equation 1. (Richey, 1961).

$$\tan x = \mu + \sqrt{\mu \frac{1+\mu^2}{\mu^2+\mu'}} \cdots (1)$$

Where x = angle with the horizontal.

μ = internal co-efficient of friction of grain.

M′ = co-efficient of friction of grain against wall.

Various physical properties of the grain and structural materials of construction must be determined for design purposes. Information on physical properties of agrlcultural products can be had by estimation, simple tests and using available equations. In designing a deep bin Janssen's equation is used widely for determining the lateral pressure as in equation 2. (Nerbaur, 1961).

$$L = \frac{\omega R}{\mu'}(1 - e^{-K\mu' \, h/R}) \cdots (2)$$

Where L = lateral pressure of grain in psf.

R = hydraulic radius of bin (cross-sectional area divided by the circumference of perimeter) in ft.

W = wt. of grain in 1b/cft.

h = depth of grain at any point in ft.

k = L/V, ratio of lateral to vertical pressure.

V = vertical pressure of grain in psf.

M′ = co-efficient of friction of grain against wall.

The values of the angle of repose can be determined if the value of k is known from equation 3. (Richey, 1961).

$$k = \frac{1 - \sin\phi}{1 + \sin\phi} \cdots\cdots\cdots\cdots (3)$$

Again, if walls carry a load equal to p lbs per linear foot of the wall, where p is the total lateral pressure on the bin wall then it can be determined by the equation 4. (Richey, 1961).

$$p\mu' = \omega R\left(h \frac{R}{k\mu'}\right) \cdots\cdots\cdots\cdots (4)$$

Where h = height of the bin in ft.

The load supported by the bin wall is obtained by multiplying the circumference in feet by p. The load supported by the floor is the difference between the total weight of grain and the load supported by the vertical wall. The selected values of w, k, are found with Janssen's equation as given in **Table 1** (Richey, 1961) if the grain to be stored is wheat. If we know the lateral pressure or the vertical wall load per feet of the bin and height of grain (wheat), we can find the diameter of the bin from the curves in **Figs.** 1 & 2. Concrete circular bins are always reinforced with steel in vertical and horizontal positions. The horizontal reinforcements may be in the form of ring or spiral and these are placed around the silo to carry the lateral pressure of the grain. The amount of horizontal reinforcement can be calculated from the equation 5. (Richey, 1961).

$$As = \frac{L.g.D}{24\ fs.} \cdots\cdots\cdots\cdots (5)$$

Where As = area of steel rods for

Table 1. Storage Data on Selected Products

Product	Unit Weight, lb/cu ft ω	Angle of Repose, Deg. ϕ	Co-efficient of Friction on Self tan ϕ	Co-efficient of Friction μ'			Ratio of L/V k
				Steel	Smooth Concrete	Smooth Wood	
Ear corn	28	....	....	....	....	0.62	....
Grain :							
Sorghum	44.8	33	0.65	0.372	0.33	0.3	....
Peas	48	....	....	0.263	0.296	0.268	....
Paddy 14% MC	41.6	36	0.73	0.41	0.52	0.44	0.48
Rye	44.8	26	0.49	0.406	0.35	0.33	0.4
Shelled corn	44.8	27	0.51	0.374	0.423	0.308	0.65
Soybeans	48.0	29	0.55	0.366	0.442	0.322	....
Wheat	50.0	28	0.53	0.40	0.42	0.46	0.6
Silage :		....					
Corn	30	....	....	0.70	....	....	....
Gass	30	....	....	0.82	....	....	....
Straw, chopped	....	....	....	0.22	....	....	....

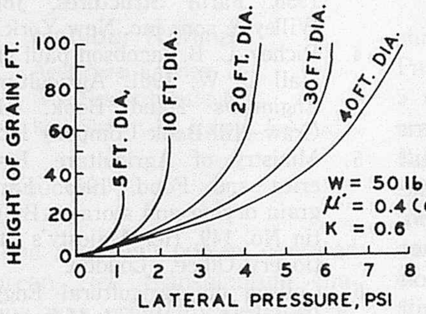

Fig. 1 Lateral pressure in cylindrical bin based on Janssen's equation

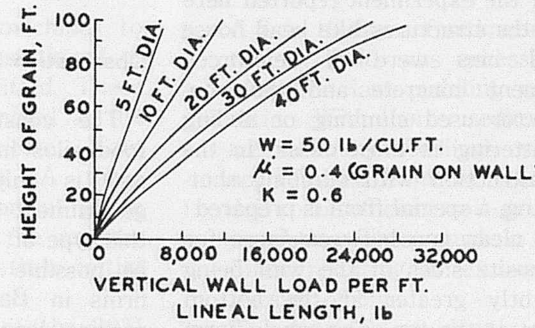

Fig. 2 Vertical wall loads on cylindrical bin

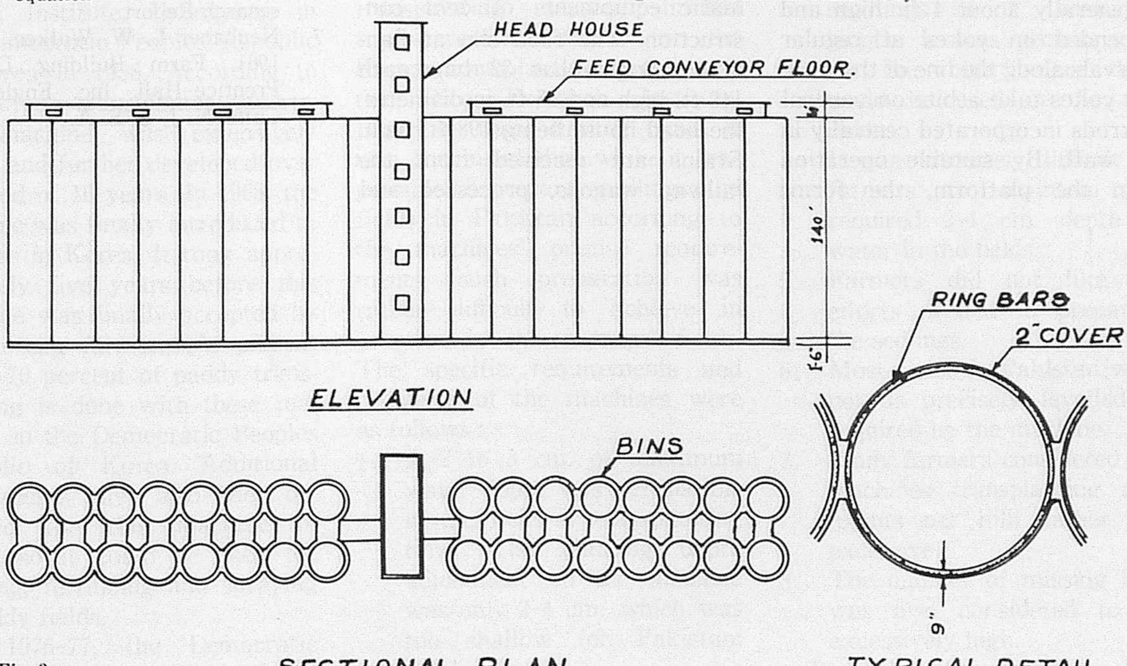

Fig. 3

given depth of stored material in sq. inches.

L=grain pressure at a point midway between bars in psf.

g=vertical spacing of rods in ft.

D=diameter of the bin in ft.

fs=allowable unit stress in rod in psi.

Reinforcement should be placed near the outside of the wall, and at least 2 inches clear cover is to be given so that the concrete will protect the steel from rusting and fire as in **Fig.** 3.

Construction procedure

For the construction of deep silo, contractors have to show great ingenuity and skill, and they have to be equiped with modern construction machineries. For the experiment reported here all the structures like head house and bins were of reinforced cement concrete and the contractor used climbing or sliding shuttering in most cases. In the construction with climbing shuttering, a special from is prepared: the clear gap between faces for opposite sides of the wall being slightly greater at the bottom than at the top. The whole form is generally about 4 ft. high and suspended on yokes at regular intervals along the line of the wall. The yokes take a bite on vertical jackrods incorporated centrally in the wall. By suitable operation from the platform, the forms travel slowly upwards due to oil pressure and fresh concrete being poured in the top. This operation was repeated until the form reached the top of the structure. The difficulties of this type of construction are : placing the reinforcement sufficiently fast to keep pace with the rate of slide of the forms and once the slide had started, there should be no stop until the total height of the structure has been accomplished. Two practical points in regard to sliding shuttering are worthy of mention. The jackrod should be left cast in to the work and not recovered. The second point is that the earlier exposure to atmosphere of the fresh concrete walls, in certain cases, is necessary for special precautions in curing.

Observation and Comments

The construction of modern food silos involves large capital and is only possible for the government organizations. Again, this type of construction will not be possible by the construction firms in Bangladesh as it will require large number of automatic equipments of civil construction. The food silo at Santahar, Bogra, has 32 bins each 140 ft. high and 15 ft. in diameter, the head house being 198 ft. high. Grains are received from the railway wagons, processed and elevated to the food conveyor floor and fed to the bins from the top.

Technical personnel must be trained in the field of processing and storing of grains before they are engaged in such projects. These four silos help much in processing and storing of food grains produced in the country.

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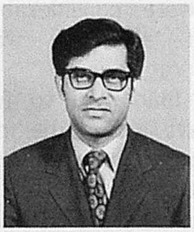
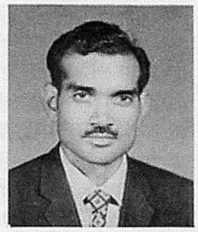
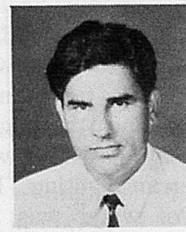
Modification and Testing of Korean Paddy Transplanter in Pakistan



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Introduction

The six-row power operated Korean rice transplanting machine was originally designed at the Agricultural Machinery Research Institute, Pyongyang in the Democratic Peoples' Republic of Korea in 1958. According to the Korean transplanter experts, this machine was extensively tested and further developed over a period of 10 years. In 1968, the machine was finally introduced to farmers in Korea. It took approximately five years before this machine was finally accepted by the Korean farmers. At present about 70 percent of paddy transplanting is done with these machines in the Democratic Peoples Republic of Korea. Additional attachments have also been developed for this machine in Korea so it could be used for weeding, fertilizing and spraying of paddy fields.

In 1976–77, the Democratic Peoples' Republic of Korea shipped as gift 50 machines to Pakistan. The first installment of 5 machines was airlifted. These machines were assembled at the Rice Research Institute, Kala shah Kaku, Punjab. A three member Korean technical group came to Pakistan in the summer of 1976 to assist in their initial trials.

In the beginning of the 1977 transplanting season, limited trials were conducted for the Korean transplanting machines at the Rice Research Institute. Based on these limited trials, it was concluded that while it was possible to prepare seedlings and fields in Pakistan according to the machines' precise requirements, such preparation was rather difficult to achieve in practice in the farmers' fields. The specific requirements and problems of the machines were as follows :

1. A 2 to 3 cm. of maximum water depth was permissible in the field at transplanting time. The planting depth adjustment on the machine was only 2–4 cm. which was too shallow for Pakistani conditions.
2. A 7 to 10 days of sedimentation of field was necessary after the last puddling operation. With shorter sedimentation, many seedlings were not released from the prongs due to insufficient soil gripping action. These stuck in the forks resulting in excessive missing of hills.
3. The machine could only use seedlings of 9" maximun length. It was necessary to cut the roots before these could be used in the machines.
4. It was extremely difficult for farmers to maintain the required 2–4 cm. depth of water in the fields.
5. Farmers did not like the efforts needed in preparing the sedlings.
6. Most fields in Pakistan were not as precisely levelled as required by the machine.
7. Many farmers considered the machines transplanting rate (plants per hill) rather too excessive.
8. The number of missing hills was also considered to be excessively high.

Towards the end of 1977

season, The IRRI-PAK Agricultural Machinery Program and the Rice Research Institute jointly conducted a series of additional trials at Kala Shah Kaku to cross-check the machine performance under varying field and seedling conditions. The following conclusions were arrived at during these tests.

Rice seedlings raised by the semi-dry method for 30-40 days were better suited for use with this machine. Paddy fields must be farily level and thoroughly puddled with soil particles well settled before transplanting. The desired depth of water was 2-6 cm. The average missing and improperly planted hills were 18.11 percent. One man was able to manually transplant the 18.11 percent missing hills while walking behind the machine. The average number of plants per hill with dry raised seedlings was 2.49. Additional trials were also conducted at the Rice Research Institute, Dokri under the supervision of the Korean experts. The results in Sind indicate a performance with average of 3 plants per hill and an average of 10 percent missing hills with field water depths of 2-4 cm.

In February, 1978, a cooperative research project in collaboration with the University of Agriculture, Faisalabad, Rice Research Institute, Kala Shah Kaku, Lahore and IRRI-PAK Agricultural Machinery Program was started before the advent of regular transplanting season. Seedlings were raised in February and March in a green house at the University of Agriculture. Various modification work was conducted at the Farm Machinery Workshop of the University.

Modification and Development Work

The Korean transplanter was tested and modified to solve the following operational problems that were encountered during the 1977 field trials.

1. Shallow planting depth did not permit adequate anchoring of plants in the ground. Planted seedlings were uprooted due to wave action caused by the machine movement. The problem was very severe when operating in deep water and in poorly sedimented soils.
2. The machine was planting too many seedlings per hill and the number of missing hills were excessively high.

Three different approaches were tried to facilitate planting in deep water. These are described below :

a) The concept of a free floating planting mechanism was tried by incorporating the following design changes in the machine.
   1. The extended portion of rear wooden strips were cut to make room for a free floating transplanting mechanism.
   2. The setting depth adjusting bolt was replaced with a suspension spring to permit a floating movement of the transplanting mechanism.
   3. The rear part of the machine was supported on two wheels. To reduce the load on these wheels, two small skids were attached under the axles.
   4. The PTO shaft length was increased to accommodate the greater movement of the transplanting mechanism due to floating movement.
   5. Two skids were also attached to the rear of floating transplanting mechanism to permit it to follow the top soil surface for transplanting at a uniform depth.

The object of the above modifications was to support the major part of the machine weight on wheels and not on the wooden sleds which caused water flow and waves. While the major weight was supported by wheels, the planting depth was maintained with the floating transplanting mechanism which followed the soil top surface. Tests of this modified machine indicated that load requirements of the machine were considerably increased and mobility was hampered.

To decrease load, and to further reduce wave action the following additional modifications were incorporated.

1. The wooden sled of the original machine was completely replaced with an M. S. angle iron structure to completely eliminate wave action.
2. Only one skid was attached directly behind the floating transplanting mechanism to facilitate turning of the machine.
3. The suspension spring on the floating mechanism was replaced with a counter weight to maintain uniform counter balancing throughout the up-and-down movement of the transplanting mechanism.
4. Larger diameter wheels with an adjustable axle mounting were designed to eliminate soil bulldozing action that was encountered with smaller wheels.

Tests with these modifications eliminated the wave action. However, extra power was required by this modified machine as compared to the original machine.

b) A second machine was modified to reduce wave action and increase planting depth by incorporating the following changes :
   1. The original full width sled in the machine was replaced by seven 3″ wide wooden slats spaced 5-9″ apart. This was done so

the spaced slats would permit flow of mud and water in between the slats and thereby reduce the flow and wave action on both sides of the machine.

2. The length of the setting depth adjusting bolt was increased to permit greater planting depth of up to 6 cm.
3. The PTO shaft was increased in length to accommodate the greater up-and-down movement of the planting mechanism.

The modified machine was tested in the field and the following observations were made :

1. The wave action produced by the machine movement was considerably minimised.
2. Increased tilting of the transplanting mechanism increased the angle between the seedling forks and the groung and this affected seedling placement. While the planting depth was increased to 6 cm. plants did not anchor properly in the soil due to the changed fork placement angle.
3. The machine did not move smoothly in the field specially on turns and needed more power for operation.

c) The Korean engineer had conducted experiments in Korea on increasing planting depth and had brought some modified parts, i. e., a crank and a fork mounting tube for testing in Pakistan. These modified parts and some of the other modifications that were carried on the third machine are described below :

Transplanting Mechanism

a. Modified crank arm (Fig. 1)
In the original machine, the distance between holes A & B and B & C was 240 cm, and these holes were along one straight line. In the modified machine, the distance between holes B & C was increased to 267 cm. by cutting and adding a 27 mm. flat bar piece. The center of hole C was lowered by 10 mm. from the line connecting hole centers A & B as shown in **Fig. 1.**

b. Transplanting mechanism mounting frame (**Fig. 2**)
The length of the two tubular members of the transplanting mechanism frame was increased by 22 mm. These two arms were cut at a distance of 380 mm. from point A and two 22 mm. extension pieces (**Fig. 3**) were welded as shown in **Fig. 2.**

c. Seedling fork mounting brackets (**Fig. 4**)
Six new brackets which were longer than the original brackets were fabricated from M. S. flat bar as per drawings in **Fig. 4.**

d. Welding of fork mounting brackets to fork mounting tube (**Fig. 5**)
The original fork mounting brackets were replaced by the modified brackets (**Fig. 4**) by welding to the tube at an angle of 58–0.5° as shown in **Fig. 5.**

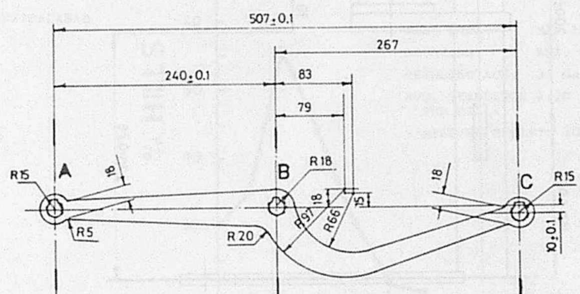


Fig. 1 Modified Crank Arm

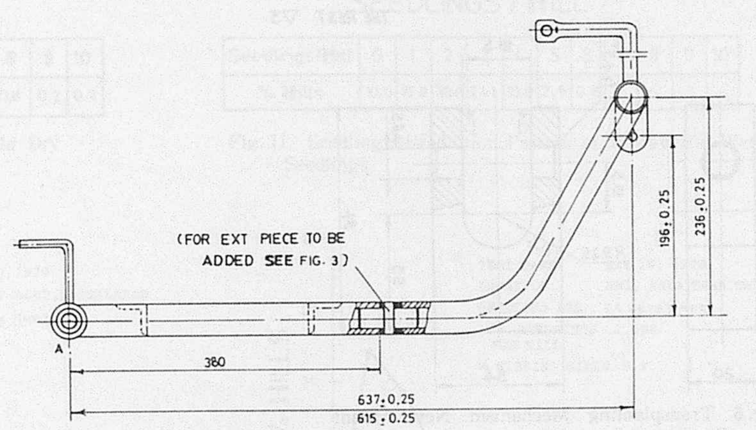


Fig. 2 Modified Transplanting Mechanism Mounting Frame

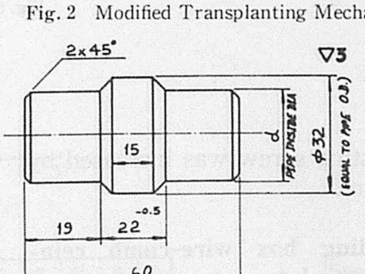


Fig.3 Transplanting Mechanism Mounting Frame Extension Piece (Quantity. Req 2, Material M.S.)

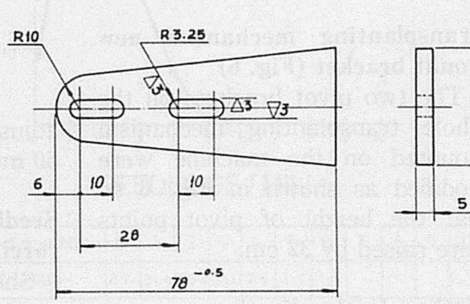


Fig. 4 Modified Seedling Fork Mounting Bracket (Quantity Req. 6, Material M.S.)

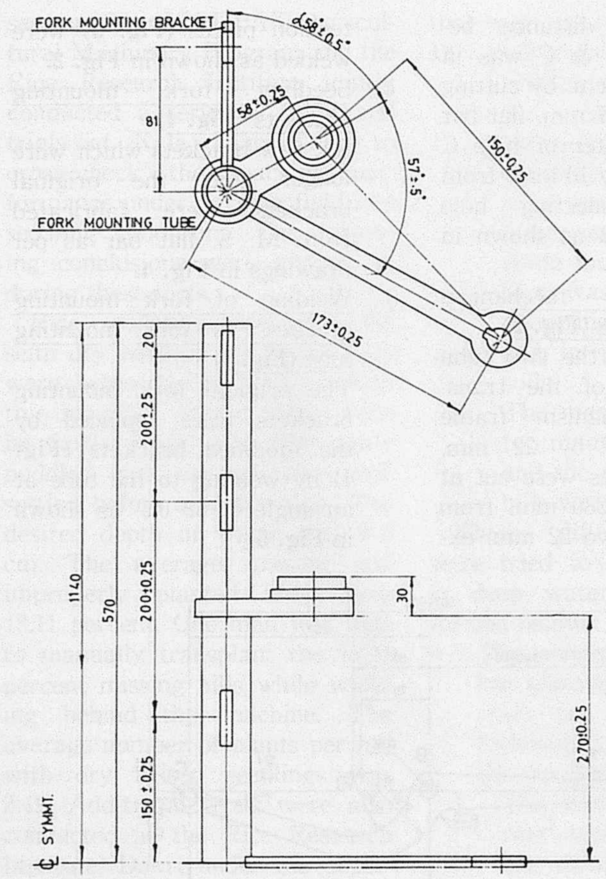


Fig. 5 Modified Fork Mounting Tube

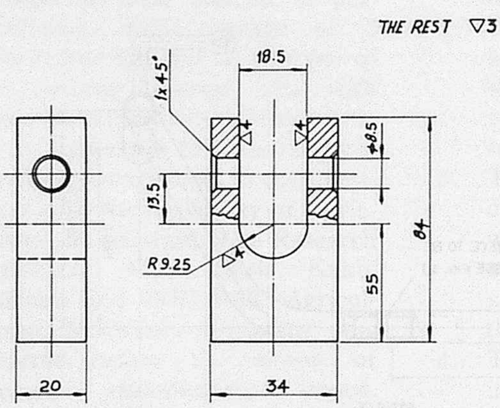


Fig. 6 Transplanting Mechanism New Mount Bracket (Quantity Req. 2, Material M.S.)

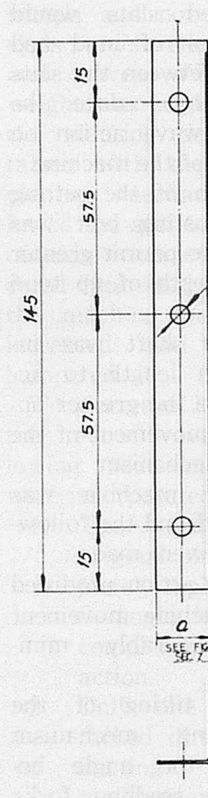


Fig. 7 Seedling Box Wire-comb Reinforcing Plate (Quantity Req. 6, Material M.S. Sheet 20#)

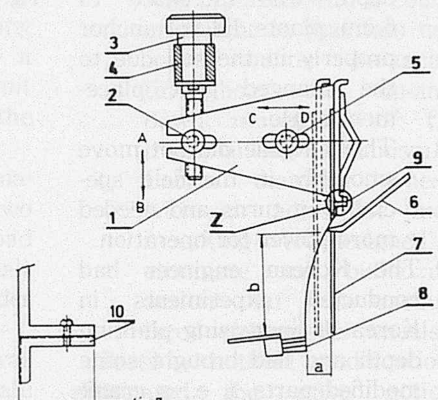


Fig. 8 1-Installation Plate, 2-Adjusting Nut, 3-Adjusting Nut, 4-Bush, 5-Adjusting Bolt, 6-Setting Finger, 7-Comb Wire, 8-Brush, 9-Comb Wire Frame, 10-Seedling Box Wire Comb Reinforcing Plate

Transplanting mechanism new mount bracket (Fig. 6)

The two pivot brackets on the whole transplanting mechanism mounted on the machine were modified as shown in **Fig.** 6 so that the height of pivot points were raised by 32 cm.

Setting depth adjusting screw

The length of setting depth adjusting screw was increased by 50 mm.

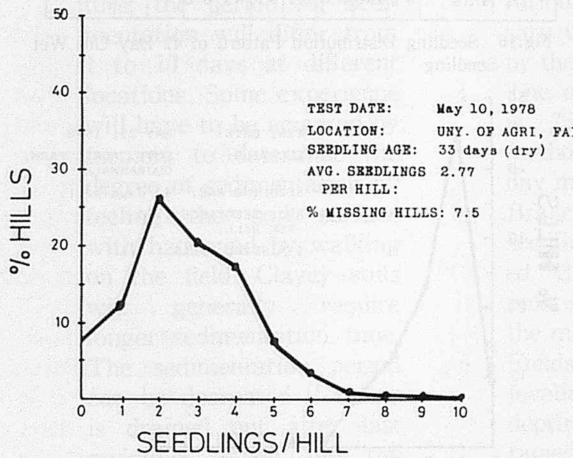
Seedling box wire-comb reinforcing plate

Sheet metal reinforcing plates were mounted on the comb in the seedling boxes as shown in **Fig.** 7. These plates were bolted on the back side of comb wires to reinforce the steel wires in one direction as shown in **Fig.** 8 and to reduce the number of extra seedlings being dragged out of the seedling boxes during transplanting.

Field Tests

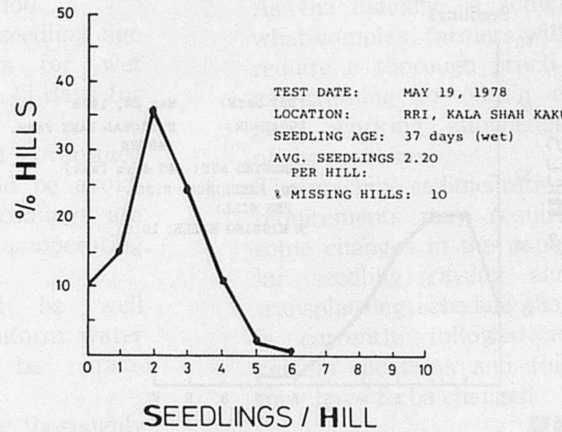
The modified machine was extensively tested at six different locations in Pakistan. The test results are shown graphically from Figs. 9–18. The highlights follow:

1. The machine works satisfactorily if its pre-requisites like thorough field puddling, sedimentation of soil particles and washing and trimming of seedlings grown by wet method and only washing in case of seedling grown by dry method are fulfilled.
2. The machine can transplant one acre in four hours with an average plant population of 2.25 plants per hill and missing hills of 8.1 percent.
3. The machine transplants uniformally in the field with about 80,000 hills per acre against 47,500 to 59,000 hills by random conventional method of transplanting.



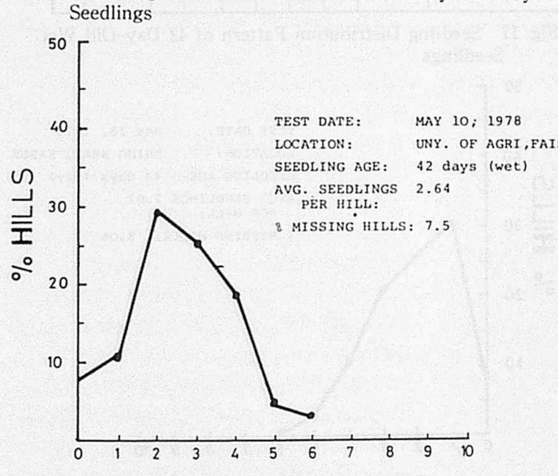
Seedlings/Hill	0	1	2	3	4	5	6	7	8	9	10
% HILLS	7.5	14.8	26.2	20.3	17.5	7.5	3.3	1.1	0.8	0.2	0.2

Fig. 9 Seedling Distribution Pattern of 33 Day-Old Dry Seedlings



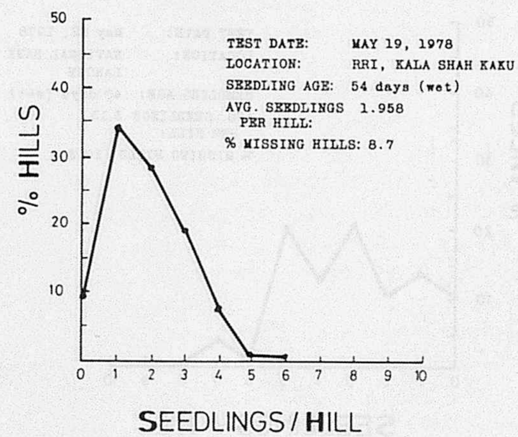
Seedlings/Hill	0	1	2	3	4	5	6	7	8	9	10
% Hills	10.0	15.8	35.8	24.1	10.8	2.5	0.8				

Fig. 11 Seedling Distribution Pattern of 37 Day-Old Wet Seedlings



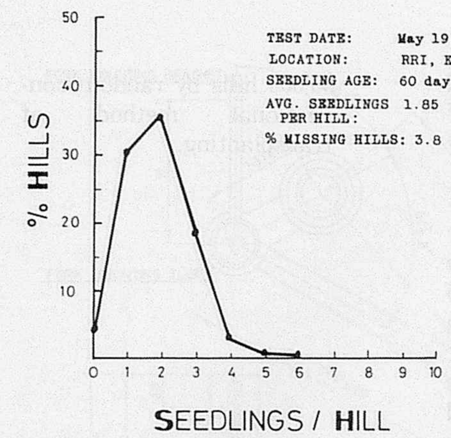
Seedlings/Hill	0	1	2	3	4	5	6	7	8	9	10
% Hills	7.5	11.8	28.9	25.9	18.9	4.3	3.1				

Fig. 10 Seedling Distribution Pattern of 42 Day-Old Wet Seedlings



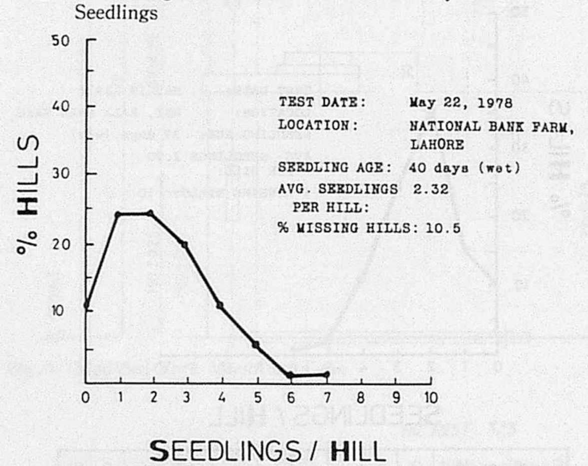
Seedlings/Hill	0	1	2	3	4	5	6	7	8	9	10
% Hills	8.7	34.4	28.3	28.0	7.5	2.7	1.1				

Fig. 12 Seedling Distribution Pattern of 54 Day-Old Wet Seedlings



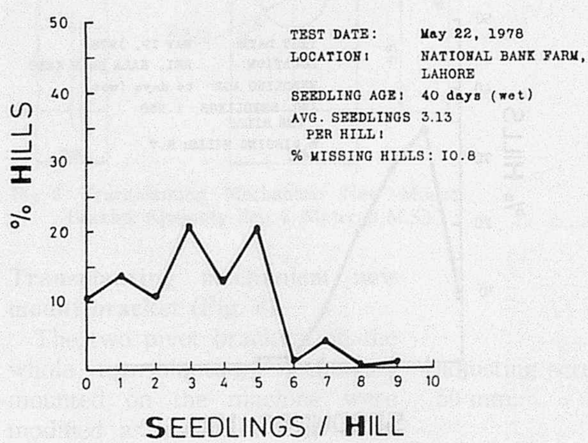
Seedlings/Hill	0	1	2	3	4	5	6	7	8	9	10
% Hills	3.8	30.8	35.5	18.61	3.8	1.6	0.5				

Fig. 13 Seedling Distribution Pattern of 60 Day-Old Wet Seedlings



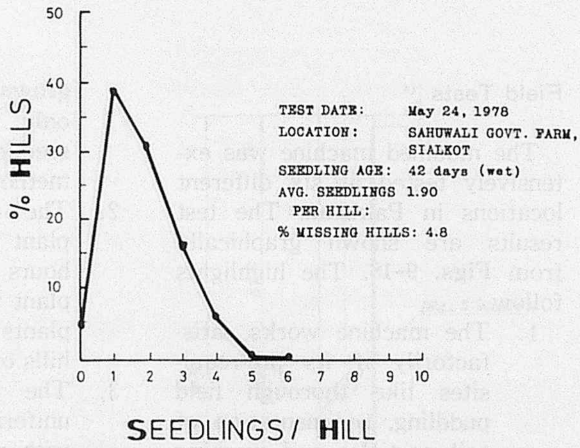
Seedlings/Hill	0	1	2	3	4	5	6	7	8	9	10
% Hills	10.5	24.2	24.2	20.0	11.5	5.2	2.1	2.1			

Fig. 14 Seedling Distribution Pattern of 40 Day-Old Wet Seedlings



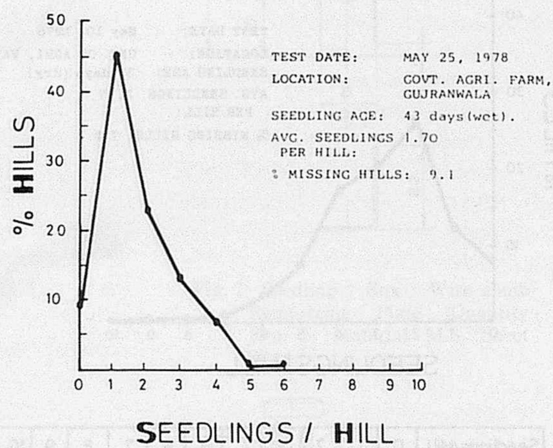
Seedlings/Hill	0	1	2	3	4	5	6	7	8	9	10
% Hills	10.8	13.3	11.6	22.5	13.3	20.8	2.5	4.1	0.8		

Fig.15 Seedling Distribution Pattern of 40 Day-Old Wet Seedling



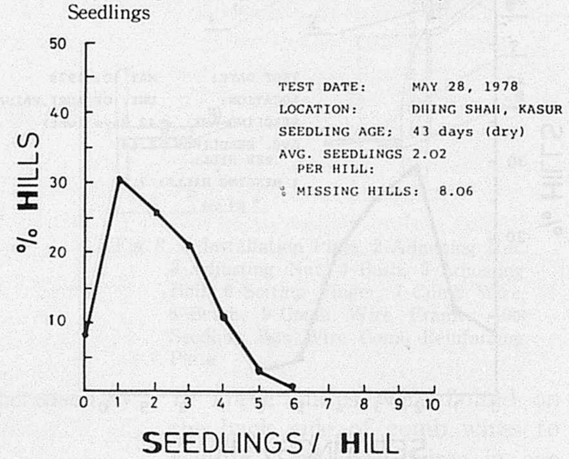
Seedlings/Hill	0	1	2	3	4	5	6	7	8	9	10
% Hills	4.8	38.6	31.6	16.9	6.6	1.9	0.2				

Fig.16 Seedling Distribution Pattern of 42 Day-Old Wet Seedling



Seedlings/Hill	0	1	2	3	4	5	6	7	8	9	10
% Hills	9.1	45.2	23.0	13.3	7.2	1.6	0.2				

Fig. 17 Seedling Distribution Pattern of 42 Day-Old Wet Seedlings



Seedlings/Hill	0	1	2	3	4	5	6	7	8	9	10
% Hills	8.06	30.55	25.85	21.11	10.83	3.05	0.55				

Fig. 18 Seedling Distribution Pattern of 43 Day-Old Wet Seedlings

Critical Operating Conditions

Following are some of the important points which were observed while working with these machines and must be kept in mind for achieving satisfactory performance :

1. After the last puddling operation, adequate setting of the soils sedimentation is essential without which the machine may not be able to work properly. Depending on the soil texture, the period for sedimentation will differ from 1 to 10 days at different locations. Some experience will have to be acquired by farmers to determine the degree of sedimentation by feeling the soil surface with hand and by walking on the field. Clayey soils will generally require longer sedimentation time. The sedimentation period can be decreased if water is drained out after last puddling. When the top surface of the field is baked, water should be added again before transplanting.
2. Although it was possible to operate the machine at up to 15 cm. of water depth in the field, generally, the water depth should not exceed 10 cm. for optimum operation.
3. To avoid entangling of roots of seedling raised by the wet method, seedling must be thoroughly washed and then roots trimmed to 2-5 cm. with a pair of scissors. This additional operation may not be necessary using seedlings raised by the dry method.
4. The optimum seedling age is 25-40 days for wet method and 30-45 days for day method.
5. Branched and over-aged seedlings should be avoided. Uniform seedlings are most suitable for operating the machine.
6. Fields should be well levelled, so uniform water depth could be maintained.
7. Field should be thoroughly puddled so it does not have too many clods.

Machine Limitations

1. Farmers will have to raise 15 "marlas" of seedlings for each acre to be transplanted by the machine. The land for raising seedlings should be thoroughly prepared and well manured. The seed should be uniformally broadcast in order to get seedling of uniform size (i.e. 5-8 mm.) It is advisable if dry method of raising seedlings be practiced for transplanting with the machine.
2. As the machine is somewhat complex, farmers will require a thorough practical training to obtain a good working knowledge of the machine.
3. The machine sedimentation requirements may require some changes in the popular seedling raising and transplanting schedule that is currently followed in certain locations and this may have to be changed. ■■

IDA to Lend $55 Million for Fertilizer Plant in Pakistan

by World Bank (IDA News Release No. 79/11, September 7. 1978)

The International Development Association (IDA), the soft-loan affiliate of the World Bank, has approved a $55 million credit for a fertilizer project in Pakistan. The $260.3 million project will help to meet Pakistan's growing requirements for nitrogenous fetilizer using locally available gas.

Sponsored by the Fauji Foundation (Pakistan) and Haldor Tφpsoe A/S (Denmark), the project consists of the construction of a 1,725 ton per day urea plant, including an intermediate ammonia plant of 1,000 ton per day capacity at Goth Macchi, Punjab Province. It also includes the construction of a 33-mile pipeline to transport gas from the Mari field to the project site and all necessary ancillary facilities. A newly established company, the Fauji Fertilizer Company Limited, will carry out the project.

Some $79 million annually in foreign exchange will be saved as a result of the project. Other benefits include management training, assured fertilizer supplies, and development of a marketing organization. The project will employ about 660 people.

Equity financing for the project will be provided by the Fauji Foundation ($27.6 million), Haldor Tφpsoe A/S ($5 million), the Danish Industrialization Fund for Developing Countries ($5 million), the Islamic Development Bank ($10 million), and a consortium of Pakistani financial institutions and commercial banks ($30.3 million). In addition to the $55 million IDA credit, the following are also participating in lending funds for the project : U.S. Agency for International Development ($40 million), Kreditanstalt fuer Wiederaufban-Germany (DM95 million), the Italian Government ($7.4 million), and a consortium of Pakistani financial institutions and commercial banks ($40 million).

The IDA credit is for 50 years, including 10 years of grace. It carries no interest, but has a service charge of 3/4 of 1% per annum to cover administrative costs.

NOTE : Unless otherwise specified, money figures are expressed in U.S. dollar equivalents.

Pilots Trained for a War on Bird Pests

by feature (Food and Agriculture Organization, Rome F/78/8, November 1978)

Rome : Pilots and ground crews are being trained in the Republic of Tanzania in order to mount an air war on a bird which weighs only an ounce or two and yet destroys crops over huge areas of Africa.

The training is being carried out under the Technical Cooperation Programme (TCP) of the Food and Agriculture Organization. The one-year $185,000 TCP project, which became operational this month, provides for the training of pilots, engineers other personnel in aerial chemical spraying techniques and in the repair and maintenance of aircraft and equipment. The aim is to strengthen the Tanzanian Government's National Bird Control Unit which seeks to protect crops from pests.

The main pests are grain-eating Quelea birds whose depredations on crops have made the sparrow-sized creatures the scourge of farmers in central Africa where they pose a serious threat to food production.

"Quelea birds are found by the millions in Africa and they are even more persistent than locusts", said Dr. Clive Elliott, of Oxford, U.K., the FAO ornithologist in Tanzania, emphasizing the seriousness of the problem.

The birds generally eat wild grass seeds, but when these are not available they will descend on farmers' crops at the end of the rainy season when the crops are ripe and the birds begin to breed, Dr. Elliott explained. "Each bird can consume from three to five grams of grain. resulting in tremendous losses in crops".

The depredations have increased in recent years, he added, hindering government efforts to grow more food crops, like millet and sorghum, to meet domestic needs. An estimated 20 to 30 percent of crops production is lost each year to the birds, discouraging some farmers from planting at all.

Dr. Elliott, who has worked on pest control in the Lake Chad area, personally conducted spraying missions from aboard a helicopter in central Tanzania last Spring, working under an emergency $250,000 TCP grant. The success of this project in identifying and uprooting Quelea colonies led to the present pilot training project for continuing and expanding the war on the pests.

Various methods have been tried in the past to control the birds. They range from the laying of protective netting over crop fields to attacking the Quelea birds in their nests, by chopping off branches or burning down the trees, or setting off explosives at the base to shock and kill the birds.

One common method is to gather children and adults in the field to scare the birds away by shouting and making noise. Another is to wrap individual grain stalks with protective layering.

Aerial spraying, however, has proved to be the best approach. Describing the method as applied under last Spring's TCP project, Dr. Elliott said :

"We would, first of all, search out the birds in their colonies, either from aboard the helicopter or with the help of scouts moving about on the ground. Then we would proceed to spray the birds in their nests with an avicide called Fenthion, a mixture of organo-phosphorous and gasoline".

The spraying was done at sundown when the birds are roosting for the night and in the proportion of ten litres of avicide per hectare. The pests often would die within a matter of hours, without undesirable ecological side-effects. Some 30 bird colonies were eradicated in the spraying operations, which lasted from March until June 1978 and involved a 360,000-square kilometre area in central Tanzania.

Dr. Elliott, a conservationist, stressed the need for action against the Queleas so as to reduce crop losses in a continent which, statistics show, is already lagging behind all other developing regions in food production and which must produce much more food. The extermination operations are no threat to the species itself, one of the world's most numerous, he emphasized.

The pilot training project was approved by the Director-General of FAO, Edouard Saouma, during a visit to Dar-es-Salaam in September. The TCP operation is a continuation of earlier FAO activities under the U.N. Development Programme and will be implemented in conjunction with the Desert Locust Control Organization for Eastern Africa.

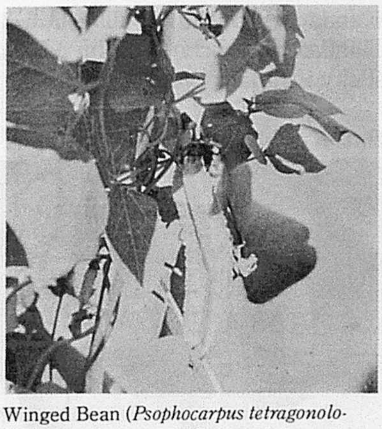
International Symposium on Chinese Cabbage

by ABOUT AVRDC, No. 2, 1978

AVRDC plans to hold the first international symposium on Chinese cabbage during Oct. or Nov., 1979. Scientists specializing in Chinese cabbage research will gather to review the latest progress in breeding, crop protection, physiology, management including economics, post-harvest problems, and seed production technology. We are working out the details of this symposium now, and invite comments from fellow scientists. Enquiries, suggestions, and comments should be directed to N.S. Talekar, Associate Entomologist and Crop Coordinator for Chinese cabbage at AVRDC.

International Winged Been Trials

by ABOUT AVRDC, No. 2, 1978



Winged Bean (*Psophocarpus tetragonolobus*)

AVRDC has been selected as one of 23 sites around the world for the 1st International Cooperative Winged Bean (*Psophocarpus tetragonolobus*) Variety Evaluation Trials. Organized in 1978 by the Asia Foundation, Dr Tanveer N. Khan of Australia's Dept. of Agriculture is the overall research coordinator. At AVRDC, Dr. Charles Y. Yang, Legume program Leader, is in charge of the program.

The evaluation trials are designed to test the adaptation of selected winged bean varieties under a wide range of environmental conditions, provide sources of germplasm a cooperator may use directly, identify areas of the world suitable for winged bean production, and test the response of the crop to different environments.

There should be no shortage of seed for this work. Other sites can be added to the initial sites in : Australia, Bangladesh, El Salvador, Burma, Costa Rica, Guatamala, India, Indonesia, Korea, Liberia, Nepal, Malaysia, Mexico, Nigeria, Pakistan, Papua New Guinea, Panama, Philippines, Sri Lanka, W. Samoa, Taiwan, Thailand, and U.S.A. ■■

NEW PRODUCTS

Kubota L1802 Tractor

All types of the tractor in this series have a three-cylider 18 ps engime, which vibrates little and makes few noise. This tractor shows perserevering even in wet fields where an excessive load is charged because the engine has increased the capacity of torque in low gear.

As for the system of transmission, Full Constant Mesh is adopted for the first time. It is operated smoothly and there is no fear for suffering a loss and a abrasion in gear. Transmission range is 16 forward and 4 reverse gears and besides this it has also super low speed gear (creap speed). Operation and mobile capacity has been more and more increased than before because creap change gear lever and sub-change gear lever are united.

As large-sized tires having large ground contact area has been recently developed and are adopted, this tractor is suitable for various working like not only in paddy fields but also fields and dairy.

By hydraulic position control system is kept the farm working machinery position set in advance and displays its great power for puddling or cultivating and management in fields.

Colours in body can be chosen from four optional colours in your taste besides basic colour (orange and white).

In this series we have also L2002 (20ps), L2202 (22ps), and L2402 (24ps).

(Kubota, Ltd. : 2-22, Funade-cho, Naniwaku, Osaka, Japan)

Mitsubishi D2350 Tractor

This is the first tractor in this class that develops 23 ps, mounted a four-cylinder engine. It makes few noise, vibrates little and makes you little tired from many hours working. The engine is a type of vortex flow and effective, and excels in starting capacity and economy. This is superior to others in the capacity of low speed torque that is equivalent to hard working.

Transmission range is 18 forward and 6 reverse gears, carrying super low speed (0.2km/h). It is equipped with Mitsubishi own position control system. The rotary is 1,510mm in center, 1,410mm in side, which is able to do extensive working effectively. P. T. O. alone has 4 speeds in a transmission.

In this series besides this we have another one, D2350 Tractor with four wheel drive.

(Mitsubishi Kiki Hanbai Ltd. : Kanda Mitsubishi building, 3-6-3, Kanda Kajicho, Chiyodaku, Tokyo, Japan)

Satoh ST 3220 Tractor

This tractor develops 32 ps, mounted a high-powered and quiet four-cylinder 1,400 cc water-cooled Diesel engine.

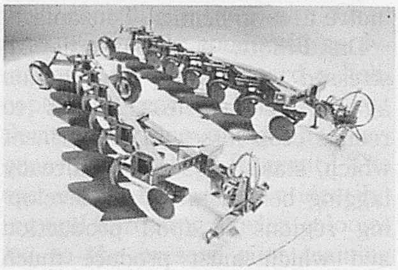
Transmission range is 15 forward and 3 reverse gears and besides this it has super low speed gear (0.06m/sec.). It has large-sized tires so that it excels in the capacity of a traction and the farm working in wet fields.

It can be operated entirely at hand, and makes you little tired because of its deluxe seat. Safty devices are complete, such as safty cover, safty switches etc. Its rotary is a frange type strong even for firm soil. Being extended, its double sides turn into puddling rotor. Rotary tilling width is 1,570mm and concerning lifter its maximum lift is up to 1,250kg by position control system.

In addition to this, we have another one, ST 3240 tractor with four wheel drive.

(Satoh Agricultural Machine Mfg. Co., Ltd. : Kanda Mitsubishi Building, 3-6-2, Kanda Kajicho, Chiyodaku, Tokyo, Japan)

John Deere 2600 and 2800 Series Plow



John Deere has introduced two new semi-integral plows with adjustable width of cut, improved clearance, exclusive hydraulic steering, and exceptional light draft characteristics.

The new models are :

The 2600 (left) Series, available in 4-, 5- or 6-bottom sizes, the lightest-draft plow John Deere has ever manufactured. It features a 15×20 cm mainframe and is designed for in-furrow plowing.

The 2800 (top) Series, available in 4–, 5–, 6–, 7– or 8-bottom sizes for in-furrow plowing or 6–, 7– or 8-bottom sizes for on-land plowing. In its draft testing, the 2800 Series proved superior to all other competitive plows tested. The 2800 Series has a 20×20 cm mainframe, said to be one of the most rugged mainframes available on any semi-integral plow.

Width of cut is adjusted manually on the 2600 Series Plows, hydraulically on the 2800 Series. Manual adjustment to 40, 45 or 50 cm permits the operator to tailor width of cut to match varying soil conditions or available horsepower, and to vary the amount of crop residue to be turned under. Hydraulic adjustment from 35 to 60 cm provides those same advantages plus the ability to make adjustment on-the-go for finishing irregular lands or headlans or plowing around field obstructions.

Hydraulic steering, a John Deere exclusive, eliminates loose joints and steering pipes, provides improved maneuverability and reliability, and permits shorter headlands. A control cylinder mounted on the plow hitch crossbar actuates a steering cylinder that turns the plow's tail wheel.

Both the 2600 and 2800 Series Plows are available with exclusive John Deere light-draft NU Bottoms that incorporate a wide share, big landside, and a new bottom and share support that eliminates the need for moldboard braces.

(John Deere Intercontinental Ltd. : Moline, Illinois 61265, USA)

International 740 Wing Lift Scarifier

The International soil conditioning equipment range has been broadened following the release of the 740 Wing Lift Scarifier.

The 740 is available in two sizes—7.42 m with 45 tynes and 8.75m with 53 tynes.

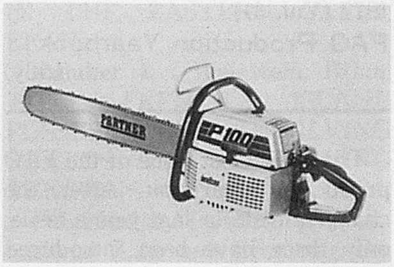
The 740 consists of a rugged main frame and hinged wings. A single hydraulic cylinder spreads out the wings, controlled by cable-operated slave rockshaft.

"C" frame extensions with four tynes each can be added to each wing to provide a larger 8.75m working width. Wings are spring-loaded to maintain accurate depth control in hard soil conditions. Springs are adjustable to allow a pressure reduction in softer soil conditions.

Clean frame design provides excellent trash flow between the heavy-duty tynes. Tyne design and spring pressure combine to give excellent penetration. Although a wide machine in working position, the 740 Wing Lift Scarifier folds to a convenient size for ease of transport.

(International Harvester Australia Ltd. : P. O. Box 4305, Melbourne, Victoria, 3001, Australia)

Partner P 100 Chain Saw



Earlier this year Presented two new professinal saws, the P55 and the P70. The professional range is now increased by a new P100. This is a 100 cc chain saw which has the same features as the two smaller ones. The P100 is equipped with Partner's new easy-start-system, which is based on a unique cylinder design. The saw is also equipped with Partner's new transistor ignition system Ignitron, and optional chain brake. As the new P100 also is a light-weight and handy chain saw compared to other saws of the same size, it will undoubtedly be well accepted on the market.

〔Technical data〕

Engine : 100 c.c. (6.1 cu. in), Ignition : Partner ignition transistorized ignition system, Fuel tank : 1.0 litre (1.76 Imp. pints-2.12 US pints), Oil tank : 0.55 litre (1.0 Imp. pints-1.2US pints), Bar : Solid nose, Bar length : 22″-36″, Cutting equipment : Chain pitch 0.404″, drive link thickness 1.5 mm (0.058″), Weight : 8.2 kg (18.1 lb), including 22″ bar, chain and chain brake.

(AB Partner : Fack, S-43120 Mölndal, Sweden) ■■

NEW PUBLICATIONS

1977 (Vol. 31) FAO Production Yearbook (Italy)

This is the 3lst issue of the FAO production yearbook. After the changes mede in last year's issue, only three have been introduced this year. In most tables relating to crops, livestock and production means, the five-year average 1961–65 has been substituted by the three-year average 1969–71. Secondly, also in the tables on production index numbers the base period has been shifted from 1961–65 to M969–71. The third and most important change is the introduction of national average producer prices for the period 1969–71 as weighting coefficients to aggregate the production of each country against the common regional wheat-based price relatives for the period 1961–65 which were used previously (see other details on index numbers in the Notes on the Tables). Also worthy of note is the fact that two other country groups have been introduced in the Yearbook : one, All developed countries, covering developed market economies, eastern Europe and the U.S.S.R. ; the other, All developing countries, covering developing market economies and Asian centrally planned economies.

For almost all commodity tables, data shown include figures for the year appearing on the cover of the Yearbook. However, several figures for that year are FAO estimates based on unofficial information and are, therefore, preliminary.

Published by Food and Agriculture Organization of the United Nation, Rome, Italy.

Yanmar Diesel Engine Instruction Book (Japan)

This book is edited for the distributors and users of Yanmar in abroad as an instruction. Concerning all Yanmar Products, this is explained in elaborate prose its types, constructions, faculties, capacities, characteristics, operations, etc. by Yanmar.

This is composed of 5 volumes, that is, 1. Diesel Engine, 2. Engine, 3. Marine, 4. Industrial Machinery, 5. Agricultural Machinery. A lot of fine colour-printing photos and diagrams are introduced. They fascinate all readers and this is edited so as to understand easily.

Publicatios is by Yanmar Diesel Co. Ltd., 1-1, 2-chome Yaesu, Chuoku, Tokyo, Japan

Food and Social Policy, I (U.S.A.)

Technological advances in food production and recent population growth have spurred predictions of both feast and famine for mankind in the coming years. The new book "Food and Social Policy, I" offers some of the latest thinking on the human and social aspects of food production, distribution, and consumption.

The book is a result of the first Midwestern Conference on Food and Social Policy held in Sioux City, Iowa in 1976. This conference brought together food experts from government, the private sector, and academia. These authorities deal with the dooms, utopias, gaps, problems, and opportunities of food and map the food outlook to the year 2000.

FOOD AND SOCIAL POLICY, I provides an engaging discussion and debate of the major issues currently facing agribusiness. The readable, nontechnical style of the volume will make it appealing to the layperson as well as to agricultural economists, agronomists, and rural sociologists.

The main contents of this book are as follows :

1. Food and the Future of Civilization/*Earl C. Josepb, William*
2. Generalists and Specialists/ *CurrierJ. Holman*
3. Corporate Agriculture and the Family Farm/*Gilbert C. Fite,*
4. The Question of Triage-Who Shall Die ?/*George A.*
5. Role of Food in Foreign Affairs/*U. S. Senator John C. Culver, David Lenefsky, and Carl Parrini*
6. Food as Foundation of Civilization/*Walt W. Rostow, Wayne Rasmussen, Wilbur Zelinsky, and Phillips Foster*
7. Food and Celebration/*Louis I. Szathmary II*
8. Intraindustrial Communications in Agribusiness/*Robert* F.
9. Feeding Animals versus Feeding People/*C. D. Van Houweling, James G. Kendrick, David H. Stroud, and Arnold Paulsen*
10. Agricultural Policy for the United States/*John A. Schnittker,*
11. Feasibility of a Food Reserve System/*Trudy H. Peterson, Leo V. Mayer, Dean R. Kleckner, and George P. Anthan*
12. Farm-Retail Price Spread/ *Donald E. Farris, R. B. McCreight, Robert J. Ludwig, and Charies M. Wilson*
13. Closed Cities Issue/*B. H. Jones, J. T. Brown, Jr., Louis P. Havrilla, Harry H. Smith, and William L. Heubaum*
14. Grain Inspection/*James V.*

Risser, Arnold F. Waldstein, Edward W. Cook, and Leslie E. Malone

15. Regulation and Market System/*U. S. Congressman John B. Anderson*
16. Research and Education in Agriculture/*Leon S. Pope, Michael F. Jacobson, Daniel I. Padberg, and Julia S. Hewgley*
17. Urban Expansion versus Blach Soil/*Burl A. Parks, Fred Schwengel, Roger Blobaum, and Walter W. Goeppinger*

1978, 415pp., ISBNO-8138-1090-6

Published by Iowa State University Press, South State Avenue, Ames, Iowa 50010, USA.

The World Food Problem and U. S. Food Politics and Policies : 1977

(U.S.A)

As a follow-up to *World Food Problems and U.S. Food Politics and Policies, 1972-1976,* this volume reviews 1977 developments. This readings book explores the continuing causes and dimensions of the world food problem, the legitimate role of international institutions seeking to alleviate the problem, and policy directions adopted by the United States.

The World Food Problem and U.S. Food Politics and Policies : 1977 scrutinizes the various points of view that interplay in finding solutions to world food problems such as religious mores, humanistic, beliefs, economical needs, ecology requirements, and foreign policy directions. Farm programs and policies are analyzed. Future trends and prognostications of the severity of the world food crisis are forecast. The insights contained in this volume make it extremely valuable for understanding the world food problem.

1978, 199 pp., 0-8138-0970-3, $6.95

Edited by Ross B. Talbot (Professor of political science, Iowa State University)

Published by Iowa State University Press, South State Avenue, Ames, Iowa 50010, U.S.A.

Small Area Studies Series Occasional Papers in Small Area Studies

(U.S.A.)

Small Area Studies is the new Occasional Papers Series which seeks to focus, primarily, upon the legal and economic issues pertinent to those developmental choices. The Series will concern itself with Federal relationships within the U.S. context as well as the related experiences of other metropoles and dependencies. The focus will be multidisciplinary in character and will inculude studies which treat particular legal, political and economic issues.

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Occasional Papers in Small Area are as followings.

Number 1. : Malloy, Michael P. (ed.), LEGAL-CONSTITUTIONAL ISSUES OF THE ASSOCIATED STATES : CONFERENCE PROCEEDINGS.

Number 2. : Leibowitz, Aronold H., THE PUERTO RICAN COMMONWEALTH

Number 3. : Gilmore, William C., LEGAL PERSPECTIVES ON ASSOCCIATED STATEHOOD IN THE EASTERN CARIBBEAN.

Number 4. : Weinstein, Brian, THE FRENCH ISLAND POSSESSIONS : EVOLVING STATUS AND CONTINUING TENSIONS

Published by Institute of International (Law and Economic Development, Investment Building, Suite 345, 1511 K Street, Northwest, Washington, D.C. 20005, U.S.A.

The Agricultural Tractor 1855-1950

(U. S. A.)

The Agricultural Tractor : 1855-1950 is a well-illustrated history of the development of the agricultural tractor in the US. Author R. B. Gray has written a book strong on technical specifications explaining the evolution of farm tractors whille including much information about the companies that built them. 160 pgs., 8½ × 11 in., softbound. Member price : $8.00 ; Non-member price : $12.95.

To : American Society of Agricultural Engineers, P. O. Box 410, St. Joseph, Michigan 49085, USA.

BACK ISSUES

(Vol. 9 No. 1, 1978～)

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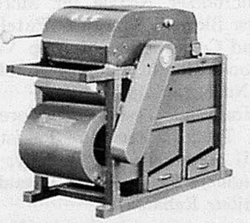

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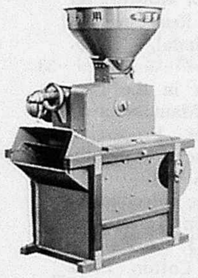

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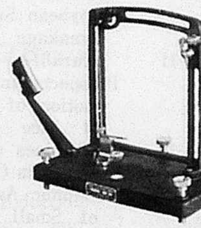

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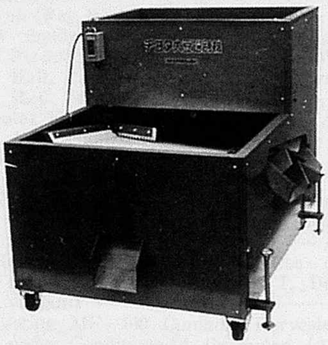

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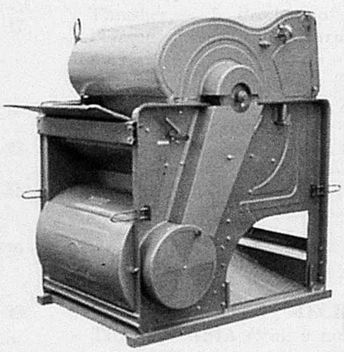

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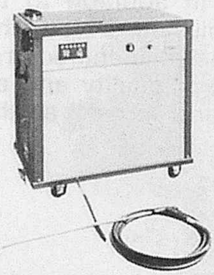

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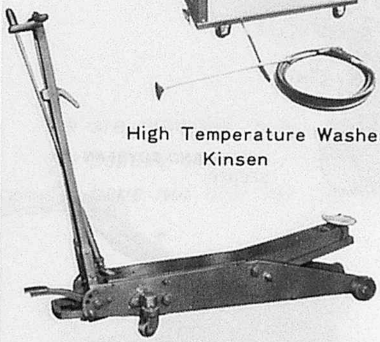

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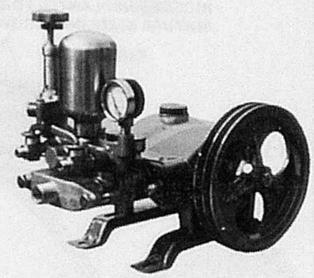

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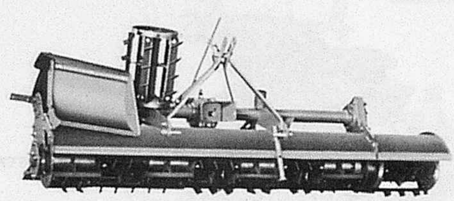
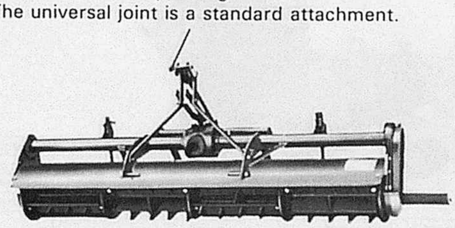
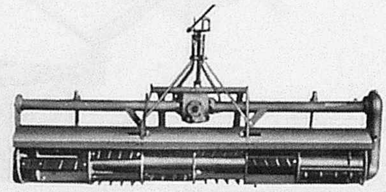


Model HZ-3300



Model HY-201



Model HD-20A

Models	Dimensions (L×W×H)	Weight	Harrowing Width	PS of Tractor required	Rotor R.P.M (PTO540)	3point linkage	Working Speed	Capacity
HY−201	618×2137×952mm	199kg	2000mm	15−25ps	211rpm	Cat. 0.1	2.0−3.0km/h	30〜50a/h
HD−20A	950×2400×1160mm	280kg	2300mm	25−35ps	248rpm	Cat. 1	2.5−5.0km/h	40〜90a/h
HZ− 3300	1050×3670×1100mm	488kg	3330mm	above40ps	278rpm	Cat. 1.2	2.5−5.0km/h	60〜130a/h

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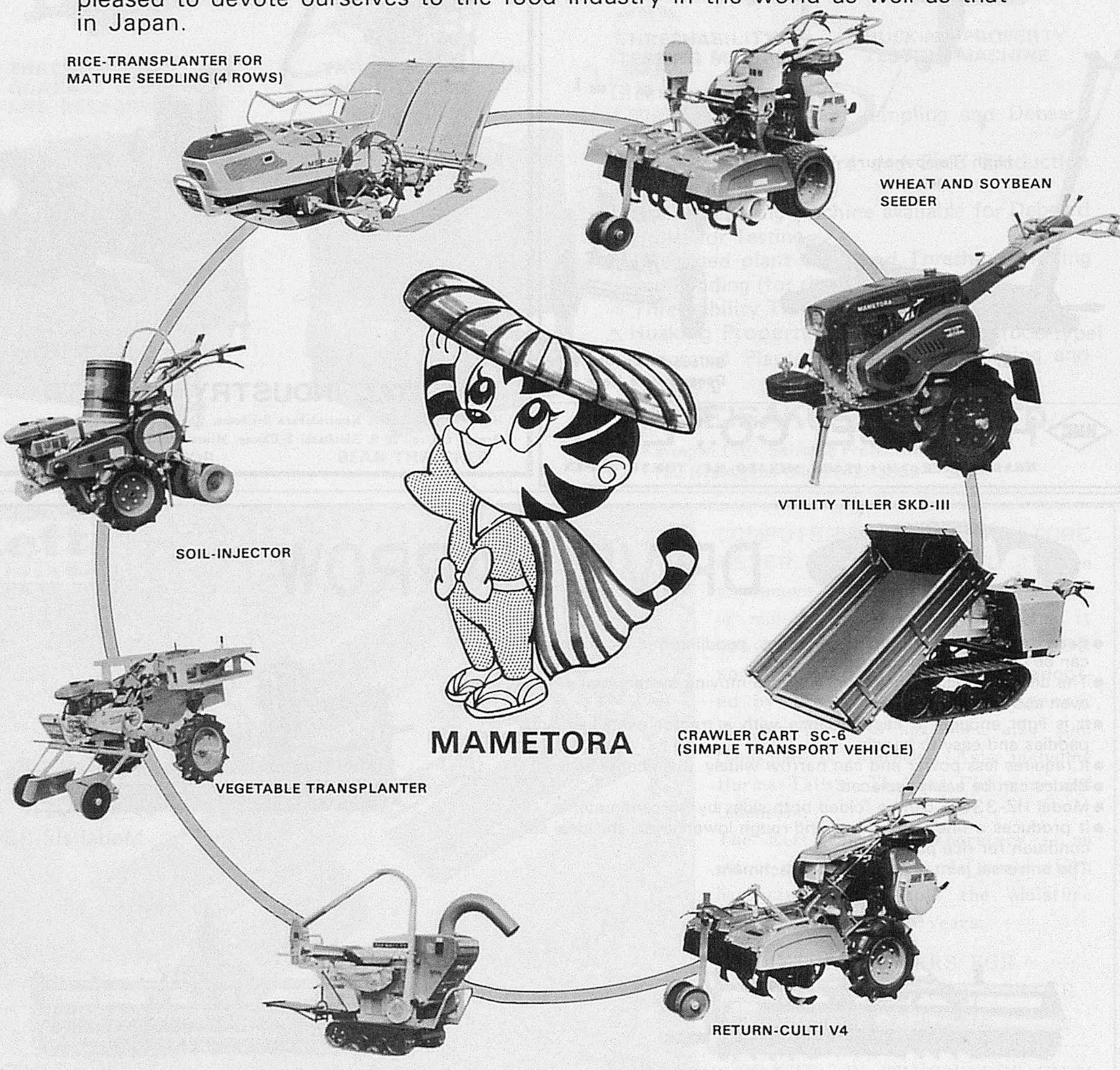

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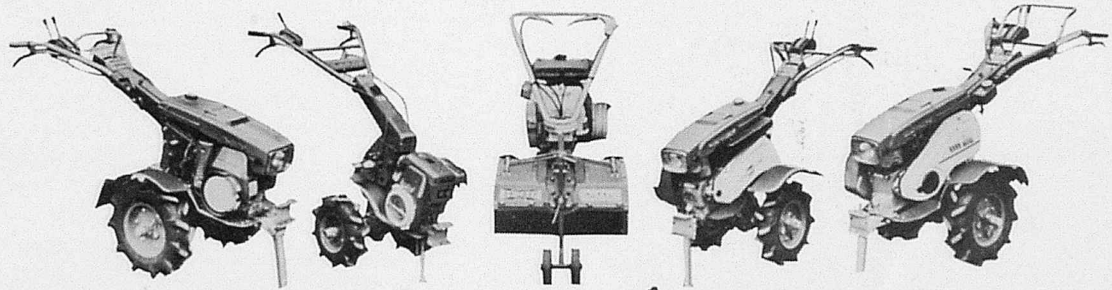

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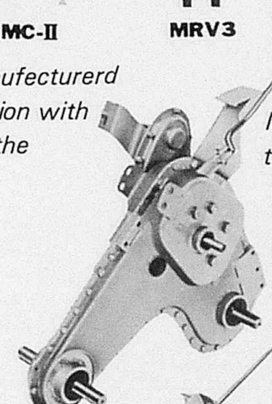
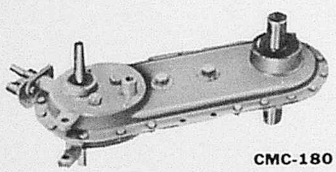
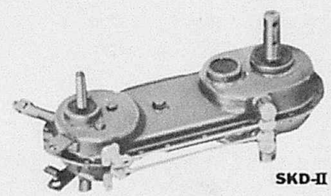


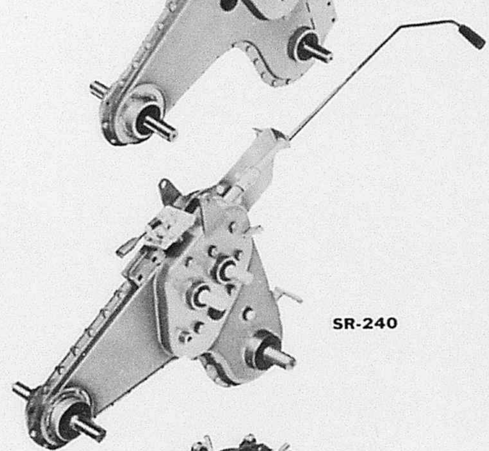
MRV3



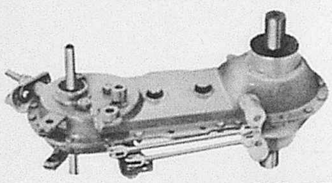
CMC-180



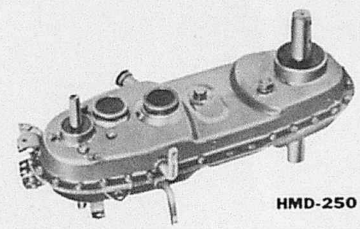
SKD-II



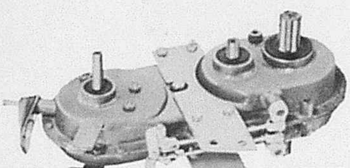
SR-240



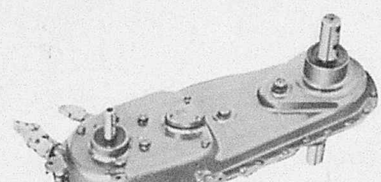
DMC-180



HMD-250



UK-13



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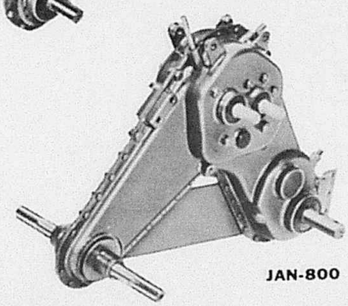

JAN-800

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