EGYPT—JAPAN TECHNICAL COOPERATION

RICE MECHANIZATION PILOT PROJECT IN ARAB REPUBLIC OF EGYPT

GENERAL REPORT 1987—1990

AGRICULTURAL MECHANIZATION RESEARCH INSTITUTE,
MINISTRY OF AGRICULTURE, A.R. EGYPT

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA), GOVERNMENT OF JAPAN

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PREFACE

Agriculture plays a vital role in the Egyptian Economy. However there is an increasing food gap between food production and consumption due to two main reasons: (1) A rapid growth in population; and (2) A severe shortage of cultivated land. Accordingly, the government has realized the need to develop and use new and improved agricultural production technology, including agricultural mechanization, in order to increase food production vertically and horizontally. Agricultural mechanization will enhance land and labor productivity, optimize crop calendar, reduce costs, recover animal products losses and increase crop yields.

The current agricultural mechanization policy is based upon the integration and inter-relationship among the various activities which lead to the availability and accessibility of appropriate and efficient agricultural mechanization services to farmers. These activities are: research and development, local manufacture, repair and maintenance, extension and training and credits.

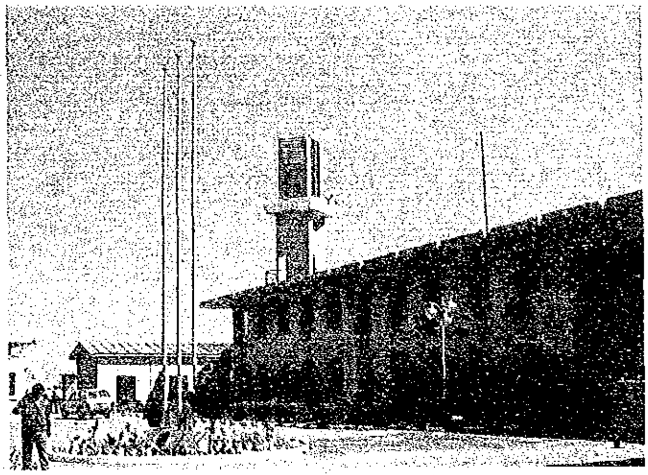
Several projects have been executed since the beginning of this decade with the collaboration of foreign governments and international organization, in order to achieve these polices. One of the main projects working in this area is the Rice Mechanization Pilot Project (RMP) With the collaboration of the Japanese Government represented by the Japanese International Cooperation Agency (JICA). The aiming of the project is to develop new and modern technology to mechanize agricultural operations for rice cultivation, which is one of the major strategic crop in Egypt. This project started in 1981, and it has been extended in 1986 for a second period to end in March 1990, after which a follow-up period of two years will be carried.

RMP has developed a standard rice cultivation mechanization system through a methodology based on two objectives, namely: (1) increasing land and labor productivities through research trials and experiments; and (2) Economic assessments of the outcomes of these trials. This cultivation system is disseminated to farmers through five satellite fields in four governorates growing rice.

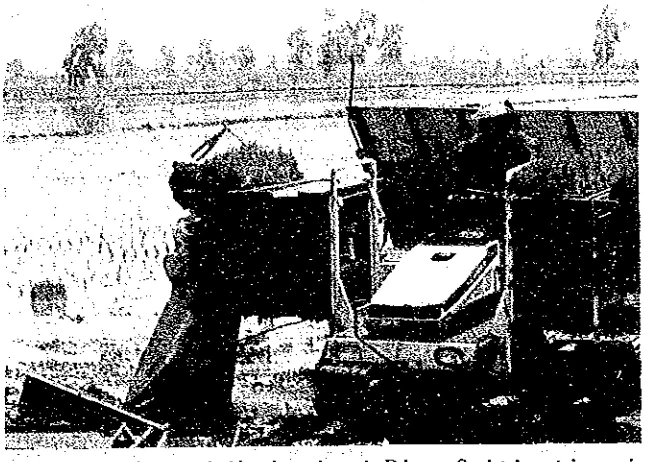
I would like to seize this opportunity to express my deep appreciation and gratitude to JICA for its collaboration and support, and to the Japanese Experts and their Egyptian Counterparts for their efforts and achievements in fulfilling the project objectives.

Prof. Dr. Ahmed F. El-Sahrigi

Director, Agricultural Mechanization
Research Institute and Agricultural
Mechanization Projects

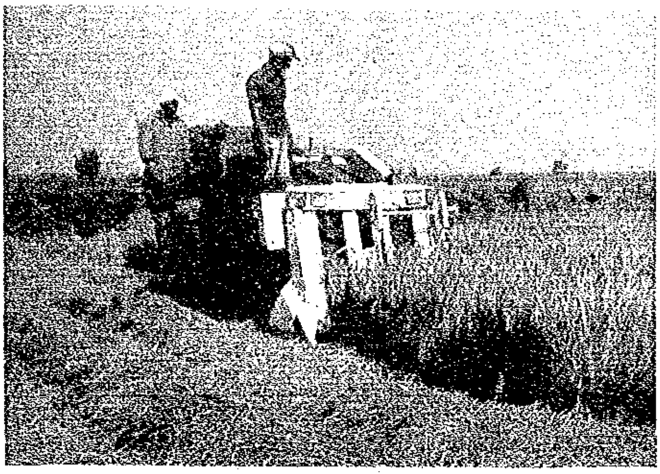


Rice Mechaization Center

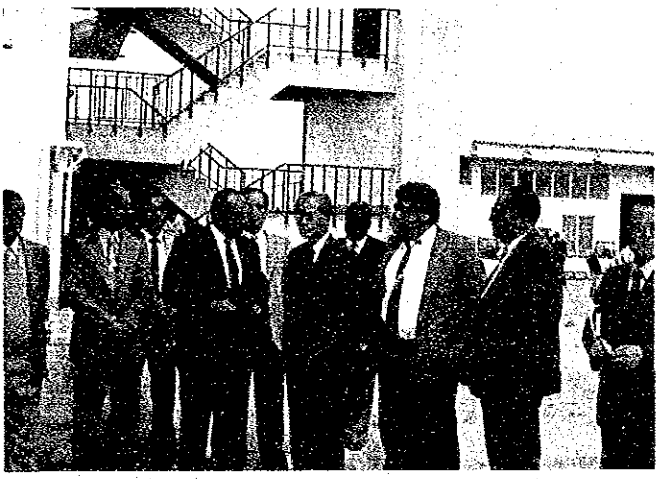


Demonstration of Mechanized Rice Cultivation in Misir Satellite Field

Field performance test proto type seeder mounted by riding type rice transplanter under wet field



Harvesting by Head-feeding type combine



Japanese Ambassador visited R.M.C (Fed. 1990)

JICA-President. Mr. Yanagita visited &
Observed Misir Sate''ite Field, RMPP.
July 1988.

Introduction

The Rice Mechanization Pilot Project started in 1981 as a mutual cooperation program between the governments of the Arab Republic of Egypt and Japan.

The aim of the Project is to establish the mechanical farming system for rice production by introducing appropriate techniques for the Nile Delta in Egypt.

The project activities were carried out at the experimental field in R.M.C, and the five satellite fields, in order to establish the mechanized rice farming system.

During the extended period (18 Aug. 1986 - 31 March 1990) of the technical cooperation, main stresses were placed on improving the standard mechanized rice farming system, so that it can be adapted by farmers under various conditions in the Nile Delta, and clarifying the possibilities of the mechanized system of direct sowing in this country.

It gives me great delight to report that cooperation efforts between the Japanese Experts and their Egyptian Counterparts have produced successful results in the achievement of the project's objectives.

This report, related to the technical cooperation for the Rice Mechanization Pilot Project, has been compiled by both the Japanese Experts and their Egyptian Counterparts, and has settled the results of the activities of the project over the extended period of three years and eight months.

I believe that this report will be useful for the development of the mechanized rice farming system in Egypt.

I wish to express my sincere gratitude to Dr. Ahmed F. El-Sahrigi, Director of Rice Mechanization Project; Dr. Zakaria El-Haddad, Former Deputy Director of Agricultural Mechanization Research Institute; Mr. Osama Kamel, Director of the Rice Mechanization Center; and to all Egyptian Counterparts who have extended to us their heartful cooperation and kindness during our stay in Egypt.

March 15. 1990

Dr. Toshio MURAKAMI
Team Leader,
Japanese Experts on the
Rice Mechanization Pilot Project
(RMPP)

Ministry of Agriculture,
A.R. of Egypt (MOA) - JICA

RMPP FINAL REPORT (II PHASE)
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* This report was typed and elaborated by Miss Salwa Shashien; Secretary for Japanese Expert Team in RMPP.

I. Verifying Experiment on Mechanized Rice Farming

1. Establishment of the Mechanized Direct-Sowing Cultivation Method

(1) Operations until Sowing

1) On Flooded Fields

a. Land-preparation

A succession of land-preparation operations is regarded as one of the most important key-points of the success of direct-sowing cultivation on both flooded and dry fields.

(i) Traditional land-preparation :

In the Nile Delta the area of traditional direct-sowing cultivation on flooded fields was estimated to total 170,000 feddans in 1989.

In this regard the most popular method or system of land-preparation consists of the following three processes:

Plowing (Tractor +chisel plow) → Irrigation (Engine+Pump) → Puddling (Animal +wooden puddler)

This "traditional method" of land-preparation is the simplest one.

(ii) Mechanical land-preparation :

(a). By the introduction and application of suitable machinery to the above mentioned "traditional system", more efficient and more accurate land-preparation can be achieved. The result of this is better germination and more efficient field management later on. This mechanical system consists of the following four processes:

Plowing	→ Mechanical Levelling	→ Irrigation	→ Mechanical Puddling
Tractor+ chisel	Tractor+ Scraper	Engine+Pump	Tractor+ P.T.O driven puddler

This method requires only 3.2 machine-working hours per feddan, and 4.0 manual-working hours per feddan for irrigation work on puddling.

(b). Technical information

The results of trials and surveys shows the following technical comments etc.

Kinds of Implement	Recommendation	Limits of levelling	Advice
Chisel plow	Target of depth: 15cm, 2 times	-	If many weeds or stumps remain it's better to use a mould board plow, followed by a disc harrow.
Animal-pulled wooden puddler	1-2 times	(after puddling) +4cm level	*1 assistant operator is needed.
Scraper	Once	before irrigation + 3.5 cm. levelled	*If the surface of soil is flat and even it can be omitted. *Laser-plane +1.5cm. level.
P.T.O driven rotary puddler	Once	(after puddling) + 3cm	*+2.7cm level by skillfull operator, while + 3.5cm level by unskillfull operator. *Be careful not to have "over puddling".

(Notes) Refer to Table- 5. Daily capacity and performance of each Implement (III-5-(2)-5)).

The operation accuracy of P.T.O drive rotary puddler is so excellent that the following merits can be expected:

1) levelling performance can be very high (± 2.7 - ± 3.5cm).

2) pulverizing and other puddling performances are also high.

It can prevent too much percolation (or leakage water) into the deep layer of soil.

If necessary, under the existing conditions it is possible to use a tractor-pulled wooden puddler instead of a P.T.O driven rotary puddler. This will serve to avoid over puddling, but it should be followed by good weed control work later on.

b. Variety

Relatively few options are available for rice variety in Egypt. Although RRTC released a couple of new varieties, not more than 7 or 8 varieties can be seen. New varieties which farmers use are Giza 175, Giza 181 and Gz 1368. However, there are conventional varieties, such as Giza 171, Giza 172, Reiho (Giza 173) and IR 28. All varieties are used for the direct-sowing cultivation method without any specific reason, and actually there is no special featured variety for this cultivation method.

The special characteristics, that the variety for the direct-sowing cultivation method on flooded land should possess, are as follows;

i. Early maturity

ii. Minimal decrease of number of spikelets per panicle under high plant-density conditions

iii. Flourishing growth in the early stages

iv. Resistance to lodging with short and tough culm and vigorous roots

v. Each individual plant must stand as vertically as possible with erect leaves but without overly luxurious growth which can interfere with the air circulation around it.

Early maturity :

When the late-maturity variety is sown late (due to some delay of the former winter crop) heading won't be so late, but the number of grains per panicle and the ripening ratio drop imperatively. Eventually, the yield decreases; however, the degree is less if the early-maturity variety is used (see Section f-Sowing Time-).

In addition, it is obvious that the variety with a higher yield in a comparatively shorter field-period is much more advantageous, especially considering the influences of former and successive crops.

This suggests the use of medium-early-maturity varieties with growing durations of 130-140 days for this cultivation method.

Less decrease in number of spikelets per panicle under high plant density conditions :

In the direct-sowing cultivation method, either on flooded fields or dry fields,it is rather difficult to obtain the optimum number of seedling stands. The tendency is toward high sowing density. If this were a premise, it would be better to increase the number of panicles using the "Panicle-weight-type" variety instead of the "Panicle-number-type". On the contrary, however, the "Panicle-weight-type" variety actually grows big panicles only when there are fewer of them. Under high plant-density the panicles may become much smaller. In short, it is unclear which "type" may bear more total spikelets per unit area.

Accordingly, in the direct-sowing cultivation method either on flooded field or dry field, it is recommended to use intermediate varieties which may be expected to have reasonable spikelet number per unit area under high plant density.

Flourishing growth in the early stages:

In this cultivation method, rice and weed plant growth starts together, and the rice plants will be defeated in a competition with the weeds; especially C_4 plants like barnyard grass. It would not be a problem if a herbicide could control most of the weeds, but no herbicide is so totally effective. Therefore, it is advantageous to plant a rice variety that thrives well at the early growth stage and defeats weed rampancy.

Resistance to lodging with short and tough culm and vigorous roots:

"Lodging phenomenon" can be roughly classified into two types: a) lodging from the plant base, which is a result of rooting failure (tumble type), and b) lodging from internodes, which is a result of weak culm (bend and break type). The lodgings observed in the direct-sowing cultivation method on flooded fields, are mostly of the former type.

Accordingly, varieties for this cultivation method should have the distinct feature for lodging resistance. Therefore, it should have luxurious root development to hold the rice stock steadily and, especially, root activation must be maintained under high plant density conditions until the late growth stage.

Plants must stand as vertically as possible with erect leaves but without overly luxurious growth which can interfere with the air circulation around them:

Rice plant style and leaf configuration, especially under high plant-density conditions, is the most influential factor in enabling for the optimum number of leaves to receive the necessary sunlight to function properly, and produce a good yield as the outcome. The leaves must be as vertical as possible, and the stock must be as compact (not open) as possible. Overly luxurious plant growth is undesirable, otherwise air circulation around the plants will be disturbed.

All in all, Giza 181 is recommended for this cultivation system in non salt-affected regions, and Gz 1368 in salt-affected regions.

Note ..... "Yield" in this paper refers to the paddy yield with husks

c. Seed treatment

For the most part, there is no difference in seed treatment between that used for the transplanting method and that used for the direct-sowing method on flooded fields. After acquisition of a clean dry paddy, seed selection is done by a salt water which specific gravity is 1.10-1.13. This is followed by seed disinfection, soaking in water, and pre-germination. The details are to be referred to a previous report (General Report 1982-1986) page 19. 2.1.1.2. (2)(c) Seed pre-treatment. The points are as follows;

(i) Awning;

(ii) Seed selection;

(iii) Seed disinfection;

(iv) Seed soaking;

(v) Hastening of germination;

d. Seed coating

Although the oxygen supply to seeds diminishes under a submerged condition, this condition, in itself, is not enough to suffocate germinating seeds unless they are covered by soil or buried in a puddled field. Therefore, the deeper the seed is buried in soil, the less the germination ratio becomes. The negative influence starts becoming apparent at 2mm depth, and beyond, in the soil. The influence of temperature is significant too, and in higher temperatures, oxygen shortage is accelerated, and consequently germination failures increase. On the other hand, sowing on the soil surface causes more

Table 1 The Results of Calper Coating Exp. on The Direct Sowing Cultivation Method on Flooded Field - RMC, 1989

Treatment Name	Days to Head	Days to Mat.	Diseases BL (5)	Diseases NBL (9)	Diseases Bs (5)	Lodge (%)	Plant Height (cm)	Panicle Length (cm)	No. of Spikelet /Panicle	No. Of Panicle /m^2	Ripen. Ratio (%)	1000 Grain weight (g)	Yield (t/ha)	Yield (t/f)
Calper Surface	92	128	1	1	1	0	87.7 a	21.7 a	109 a	391 a	92.8 a	26.5 a	8.0 a	3.4 a
Calper 3cm	92	128	1	1	1	0	87.1 a	21.4 a	105 a	373 a	92.6 a	26.5 a	7.9 a	3.3 a
Ordinary Surface	92	128	1	1	1	0	89.4 a	21.8 a	101 a	371 a	90.7 a	26.5 a	8.3 a	3.5 a
Ordinary 3cm	92	128	1	1	1	0	85.8 a	21.4 a	103 a	404 a	90.9 a	26.9 a	7.8 a	3.3 a
A.V.	92	128	1	1	1	0	87.5	21.5	105	386	91.7	26.5	8.0	3.4
C.V. (%)							2.57	2.59	16.85	5.68	3.61	1.12	8.54	8.69

Note ....* Values followed by the same letter are not significantly different at the 5% level

* Paddy Yields which are corrected to 14% moisture content (Yield in this paper is clean paddy yield with husks)

* Treatment name .... Calper surface = Calper coated seeds sown on the soil surface

  Calper 3cm = Calper coated seeds sown in the soil with 3cm depth

  Ordinary = Ordinary seeds

lodgings. Here exists the dilemma for sowing depth. In Japan, the idea of coating the seed with some kind of oxygen supplier has emerged in order to solve this dilemma.

So far, two coating materials have been found: $M-O_2$ and CaO_2. CaO_2 (calper) is now actually being practical use in Japan. Nakayama, and others, studied the use of those coating materials at RMC in the previous cooperation term. Further auxiliary experiments have been carried out by Watanabe, et al., in this phase of the project.

Based on their results, and suggestions given by the above-mentioned short-term experts, field experiments were carried out at RMC in 1989. However, the results show no obvious advantage in using Calper as a seed coating material.

Therefore, neither Calper nor any other seed coating materials can be recommended for the direct-sowing cultivation method on flooded fields at this moment.

e. Seeder

In the cultivation system of the direct-sowing cultivation method on flooded field, sowing is one of the most important operations, because the rice yield can be greatly affected by the accurate and precise control of seed-metering and sowing-depth in direct-sowing.

The direct seeder for the direct-sowing cultivation method on flooded field can be classified into two types: (i) one which can be used for sowing on the ground surface after puddling, and (ii) the other, which can be used for drilling after puddling. From the economical point of view of lowering the cost of production, the former type was chosen and tested. Two types of this kind of seeder can be considered. One is the row seeder which is mounted on the riding type transplanter and the other is the manually operated one. The direct seeder which can be mounted on the transplanter (which seemed to have potential for being produced in Egypt) and was preproduced and tested. However, some improvements were suggested for its practical application. (For further information, see the report entitled "Performance Test of Direct Seeder", that was made by Mr.Ibrahim Battawy, Essam Ghazy, and Matsumoto,I. in June 1989.)

As for the manual seeder, the possibility for practical use was discussed at the request of the Egyptians. Advice was given relating to the material and manufacturing techniques. The row seeder that was tried was improved and preproduced in Egypt. The result is that it is possible to produce this row seeder as shown in Picture 6.

The local preproduct of manual broadcaster and the Japanese manual broadcaster were tested. The results is as follows and the photographs are shown in Picture 1-5.

Table.1 Specification of the Local Preproduct of Manual Broadcaster in Egypt and the Japanese Manual Broadcaster

		The local preproduct of manual B.	The Japanese manual broadcaster
Overall length (mm)		515	380
Overall width (mm)		360	390
Overall height (mm)		570	550
weight (kg)		7.2	3.7
Hopper capacity (L)		13	13
Application width (m)	Fertilizer	6.5	6.5
	chemicals	4.5	4.5
S.D		7.08	7.41
Material	Hopper	Thin steel plate	Plastic
	Fram	wood	Plastic
	Spinner Disk	Aluminum	Plastic
	Gear Box	Aluminum	Plastic
	Gear	Steel	Steel
	Handle	Steel Rod	Plated Steel Rod

Necessary Improvements.

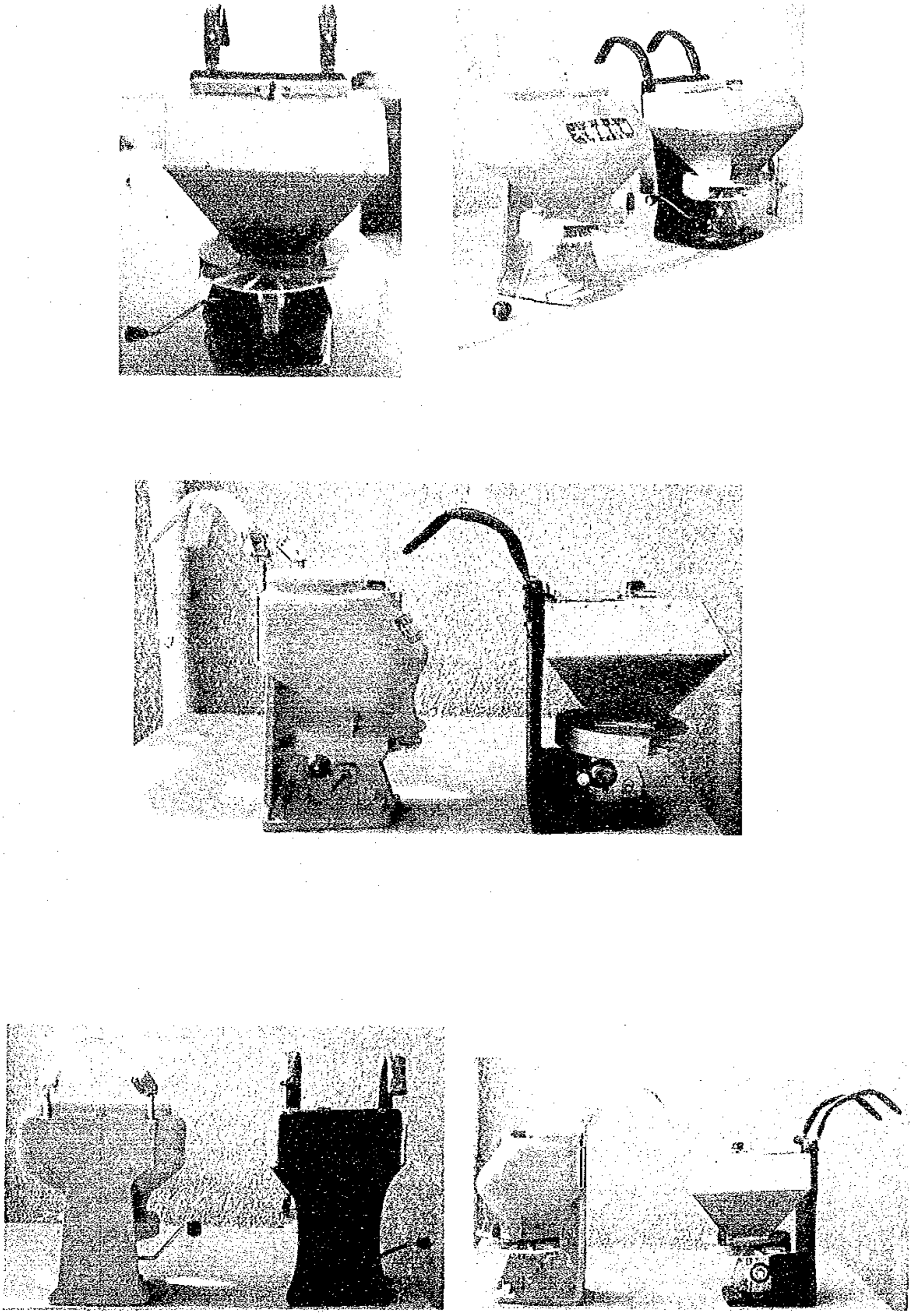
i. Weight Reduction.

ii. Cost Reduction.

iii. Life test.

Table.2 Kind of advantages and disadvantages of each seeder

Kind of Seeder	Advantages	Disadvantages	Remarks
Seeder attachment for riding type Rice Transplanter.	1) Can sow seed directly on paddy field. 2) Can do side dressing.	1) Seeder is costly because it is a single purpose direct seeder. 2) There is no established system of side dressing in Egypt. 3) Instability of sowing depth due to silky soil.	Is necessary for the improvement, distancing of planting rows and elevation of durability.
Prototype Seeder attachment for riding type rice transplanter.	1) Can be used for seeding on wet land. 2) Simple structure and easy adjustment. 3) Can sow a large number of seed, thus producing a higher yield.	1) Head land is unlevel under the front wheel of riding type rice transplanter 2) Hitch is weak.	Suitable for large land areas, but some improvement is necessary.
Manual Broadcaster	1) Machine is small, light weight and cheap. 2) Simple structure and easy adjustment. 3) Can be used on wet land. 4) Can be used to spread granular chemical fertilizer.	1) Hopper capacity is small(15L), so time is lost by frequent reloading.	Suitable for small farming areas.

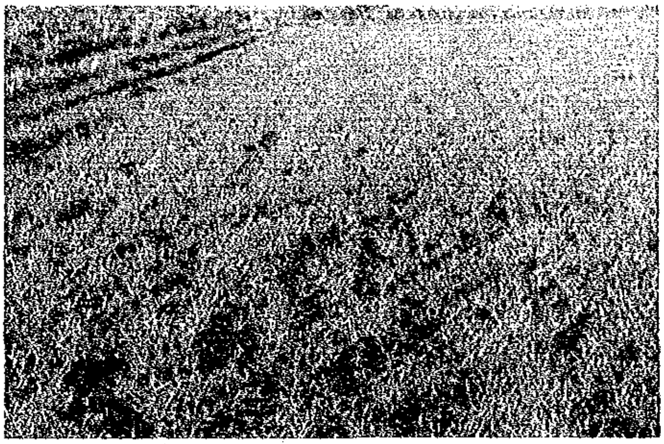


Picture 1 The local preproduct of manual broadcaster in Egypt

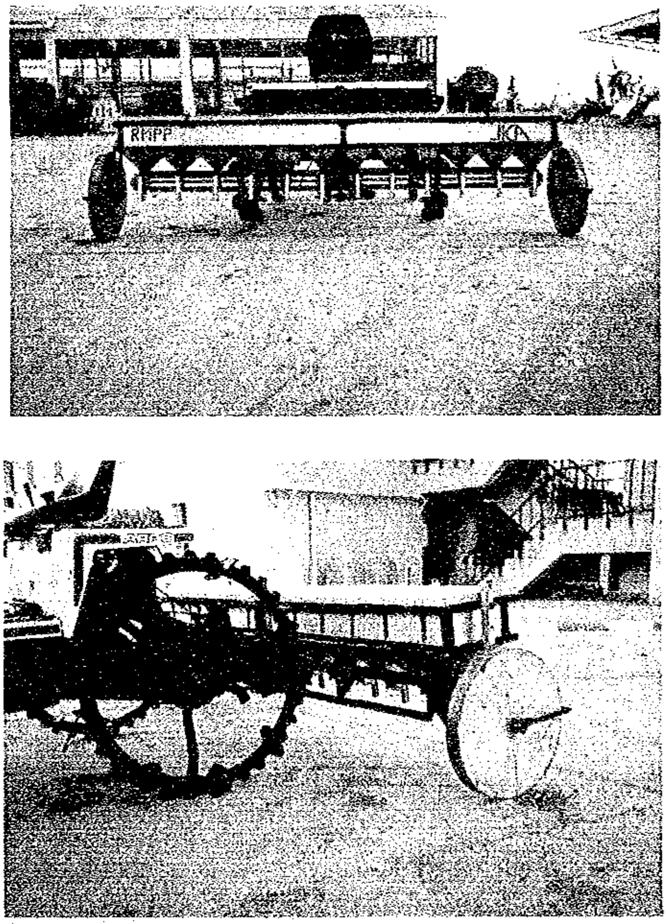
Picture2 Field test scene of the lacal preproduct of manual broadcaster

Picture3 Field test scene of the Japanese manual broadcaster

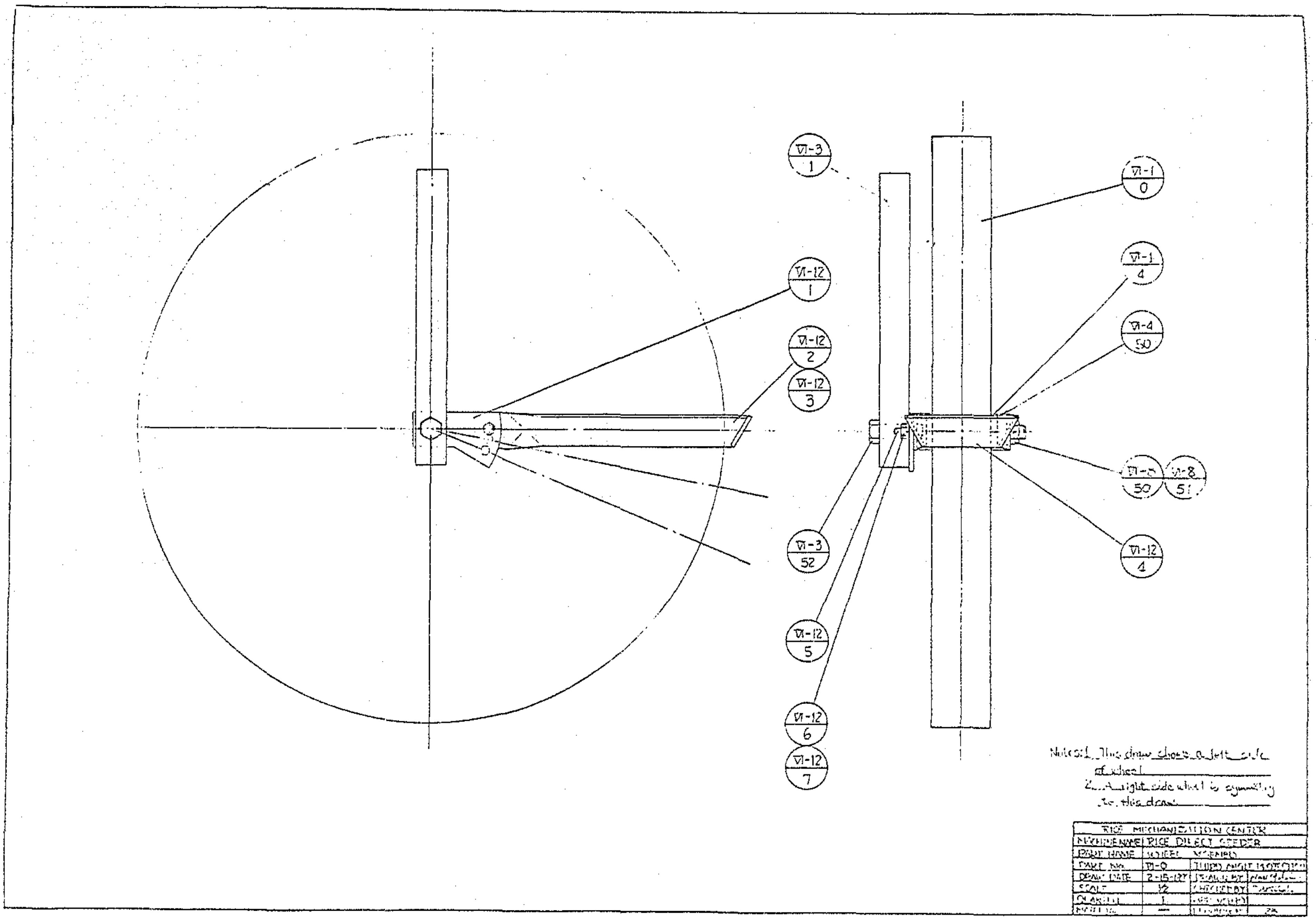
Picture4 Wheat 20days after seeding by the lacal preproduct of manual broadcaster

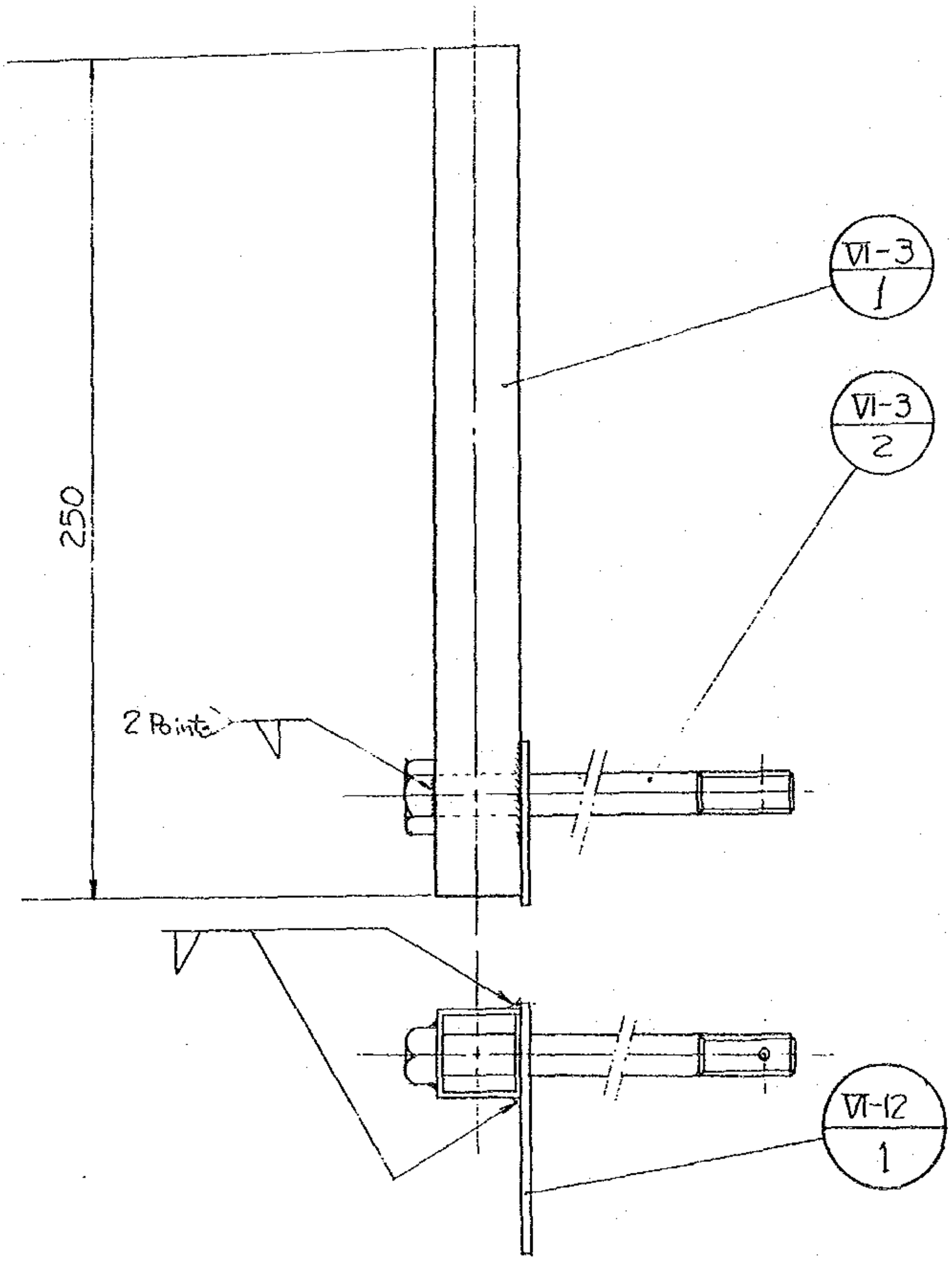


Picture5 Wheat 20 days after seeding by the Japanese manual broadcaster

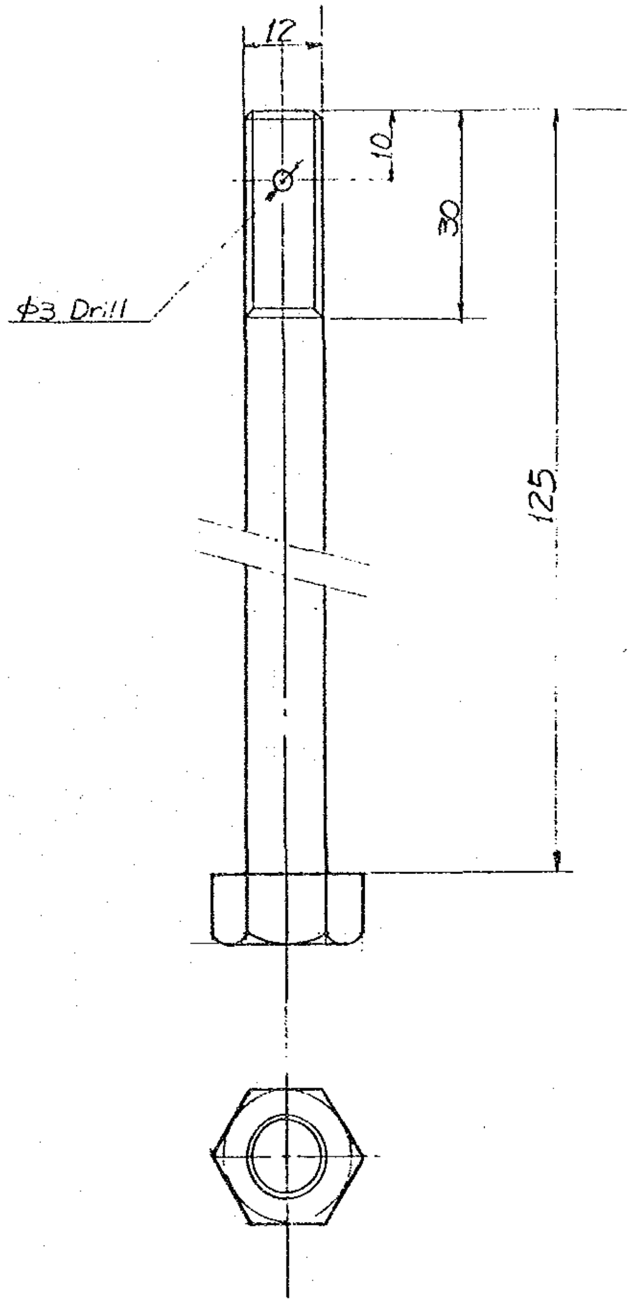


Picture6 The local preproduct of row seeder which is mounted on the riding type transplanter

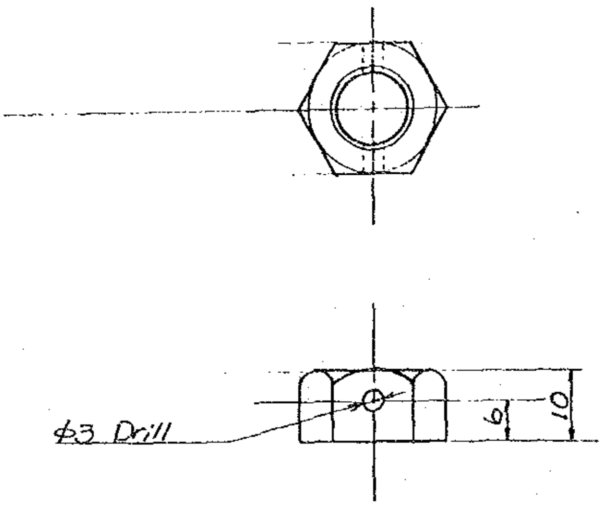

VI-3 / 1
VI-12 / 1
VI-12 / 2
VI-12 / 3
VI-3 / 52
VI-12 / 5
VI-12 / 6
VI-12 / 7
VI-1 / 0
VI-1 / 4
VI-4 / 50
VI-8 / 51
VI-12 / 4
Notes: 1. This draw shows a left side of wheel
RICE MECHANIZATION CENTER
RICE DIRECT SEEDER
PART NO. VI-0
SCALE 1/2



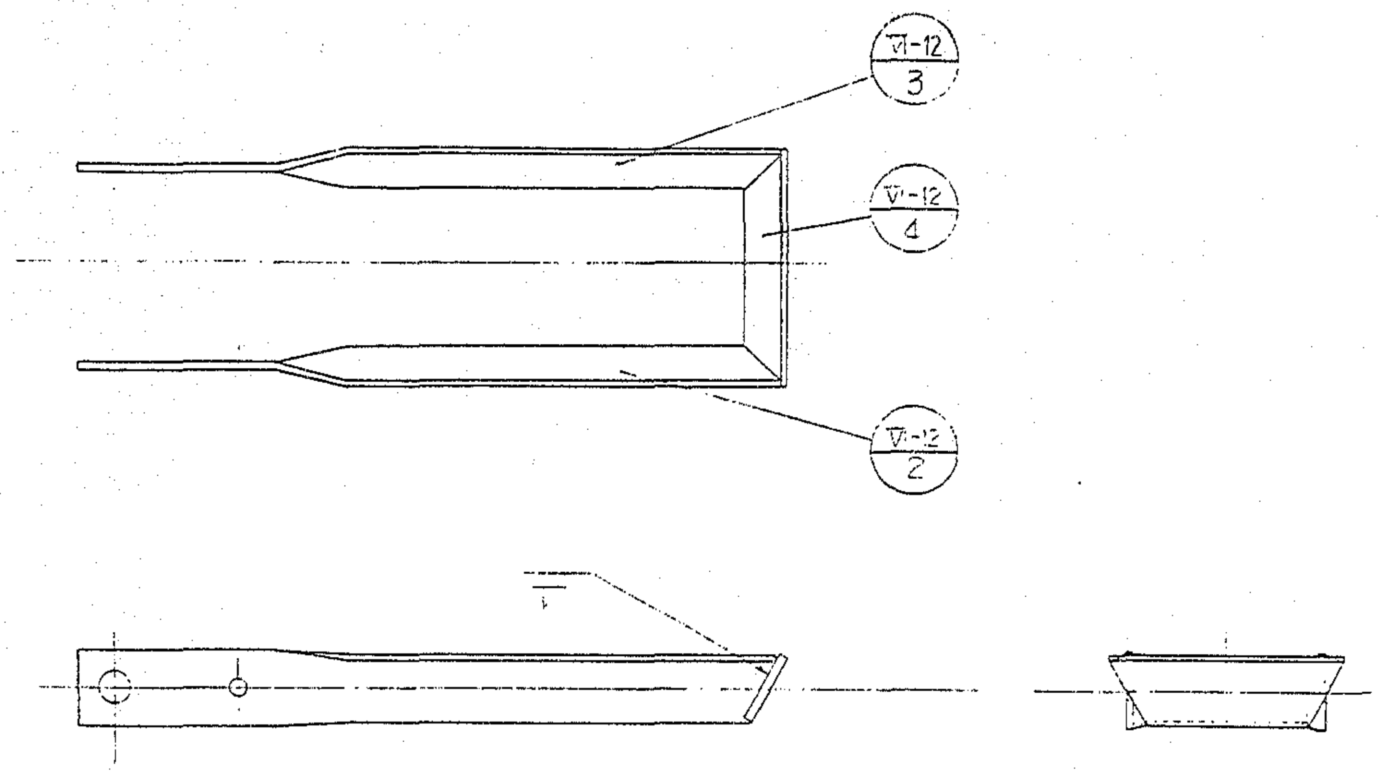
RICE MECHANIZATION CENTER			
MACHINE NAME	RICE DIRECT SEEDER		
PART NAME	WHEEL SUPPORTER CMP		
PART No.	VI-3-0	THIRD ANGLE PROJECTION	
DRAW-DATE	Feb.15.1990	DRAWN BY	Moustafa S.
SCALE	1/2	CHECKED BY	Sakamoto
QUANTITY	2	APROVED BY	
MATERIAL	—	DRAWING NO.	24



RICE MECHANIZATION CENTER			
MACHINE NAME	RICE DIRECT SEEDER		
PART NAME	BOLT M12x110		
PART NO.	VI-3-52	THIRD ANGLE PROJECTION	
DRAW-DATE	Feb.15.1990	DRAWN BY	Moustafa
SCALE	1/1	CHECKED BY	Sakamoto
QUANTITY	2	APROVED BY	
MATERIAL	7T	DRAWING NO.	25

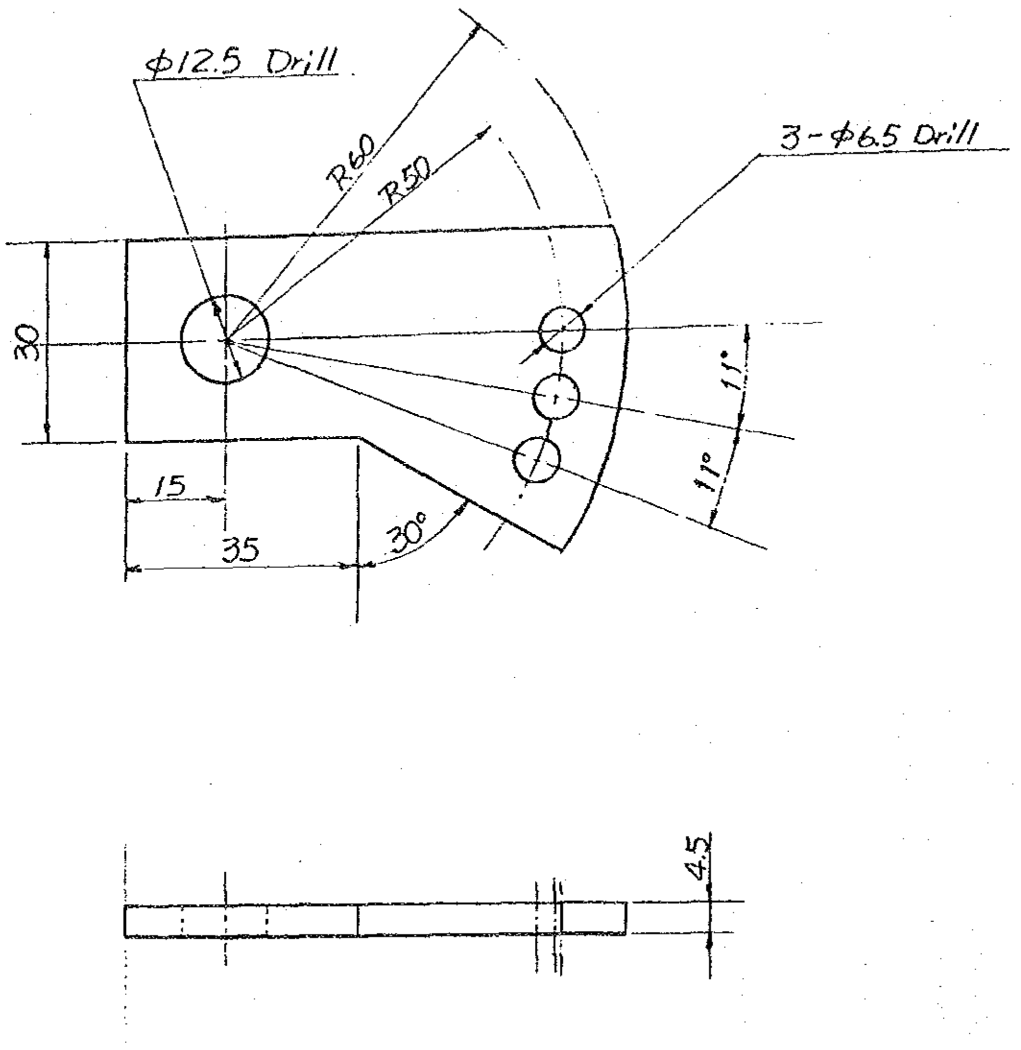


RICE MECHANIZATION CENTER			
MACHINE NAME	RICE DIRECT SEEDER		
PART NAME	NUT		
PART No.	VI-3-3	THIRD ANGLE PROJECTION	
DRAW-DATE	Feb.15.1990	DRAWN BY	Moustafa S.
SCALE	1/1	CHECKED BY	Sakamoto
QUANTITY	2	APROVED BY	
MATERIAL	SS41	DRAWING No.	26

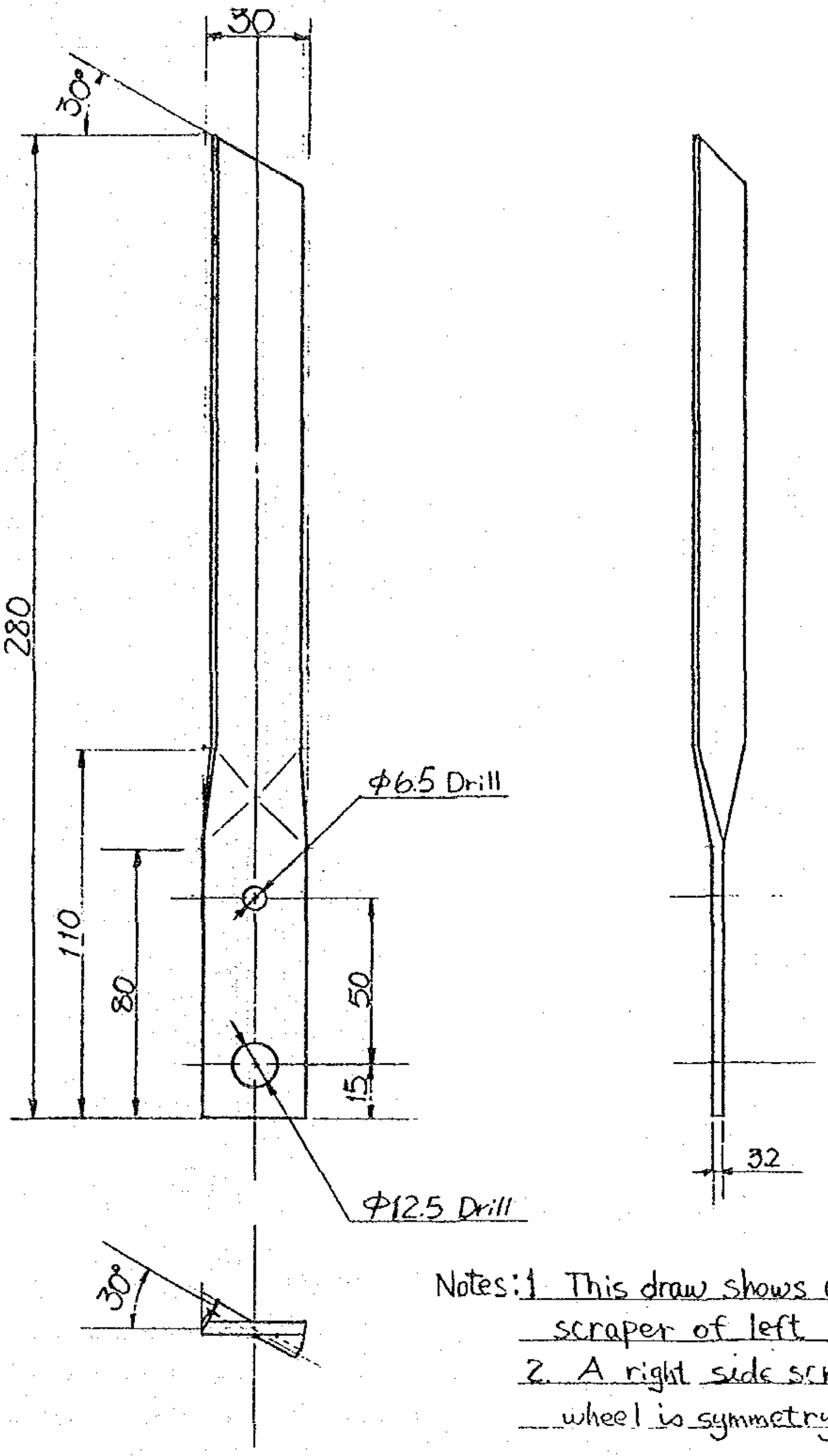


Notes: 1. This draw shows a left side of scraper component.
2. A right side scraper component is symmetry to this draw.

RICE MECHANIZATION CENTER			
MACHINE NAME	RICE DIRECT SEEDER		
PART NAME	SCRAPER CMP. left		
PART No.	VI-12-0	THIRD ANGLE PROJECTION	
DRAW DATE	2-16-1993	DRAWN BY	Nourtah S.
SCALE	1/2	CHECKED BY	S. Sakamoto
QUANTITY	1	APROVED BY	
MATERIAL	—	DRAWING No.	27

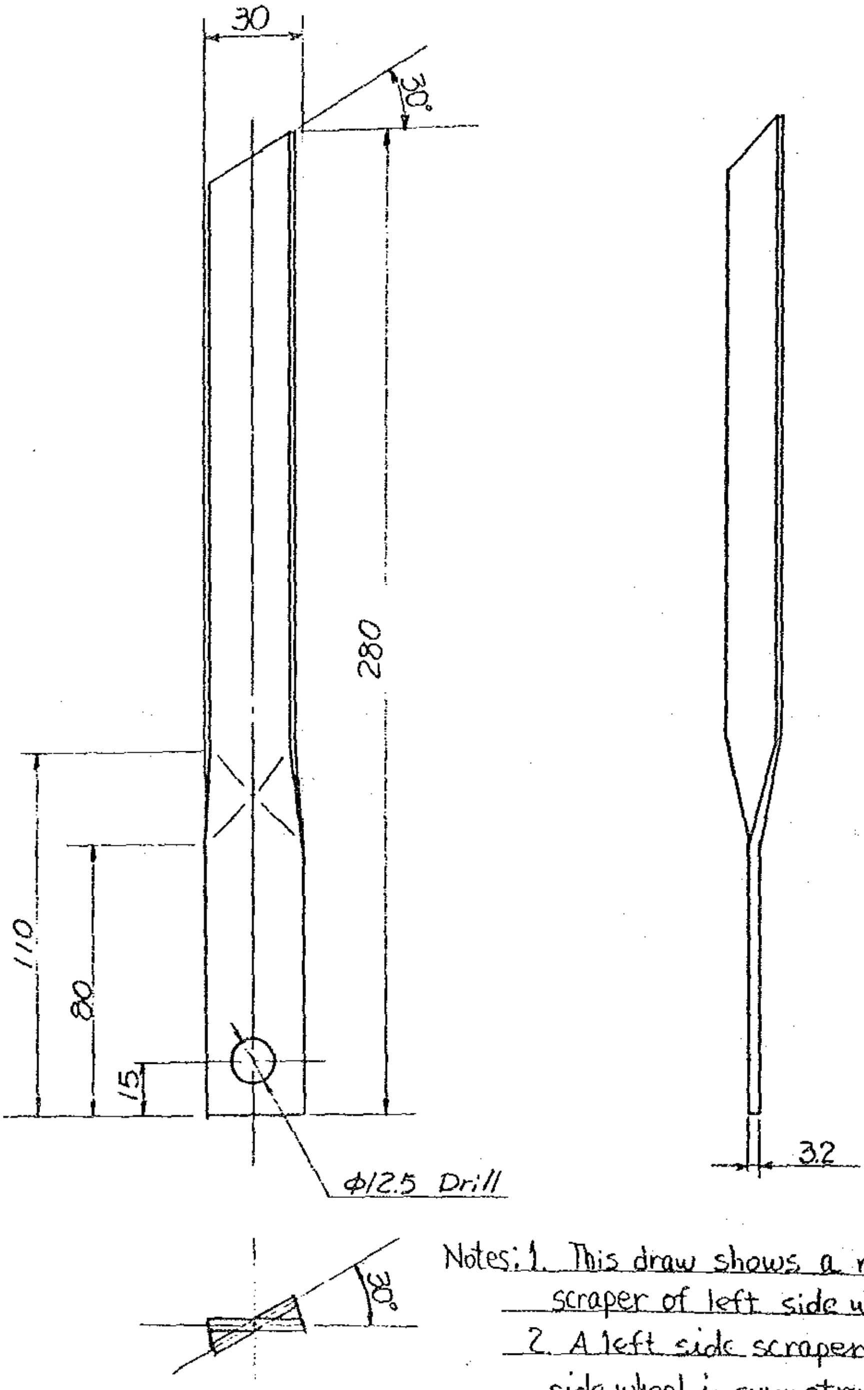


RICE MECHANIZATION CENTER			
MACHINE NAME	RICE DIRECT SEEDER		
PART NAME	ADJUSTING PLATE, scraper		
PART No.	VI-12-1	THIRD ANGLE PROJECTION	
DRAW DATE	2-25-1990	DRAWN BY	Moustafa E.
SCALE	1/1	CHECKED BY	Sakamoto
QUANTITY	2	APROVED BY	
MATERIAL	SS41	DRAWING No	28



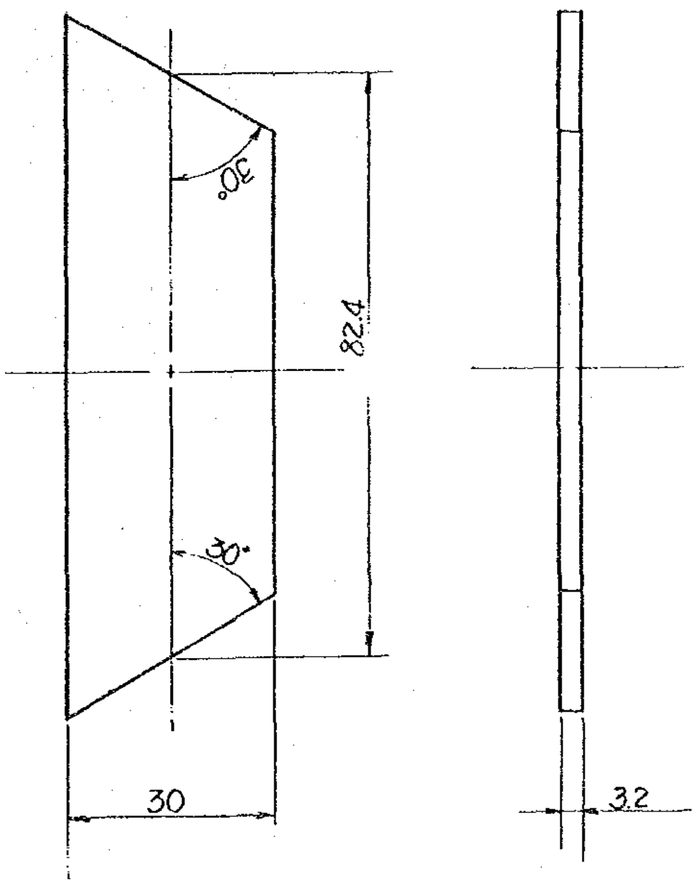
Notes: 1. This draw shows a left side scraper of left side wheel.
2. A right side scraper of left side wheel is symmetry to this draw.

RICE MECHANIZATION CENTER			
MACHINE NAME	RICE DIRECT SEEDER		
PART NAME	SCRAPER, left and right		
PART No.	VI-12-2	THIRD ANGLE PROJECTION	
DRAW DATE	2-16-1990	DRAWN BY	Moustafa S.
SCALE	1/2	CHECKED BY	Sakamoto
QUANTITY	1	APROVED BY	
MATERIAL	SS41	DRAWING NO	29

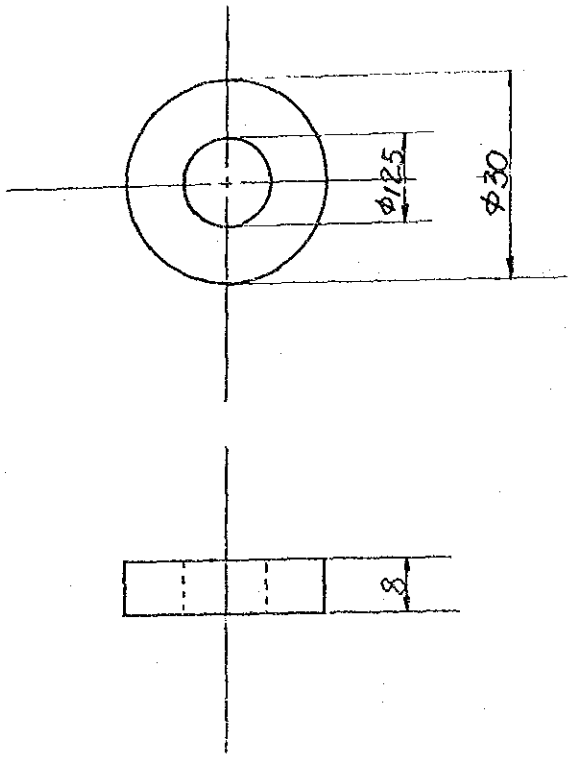


Notes: 1. This draw shows a right side scraper of left side wheel.
2. A left side scraper of right side wheel is symmetry to this draw.

RICE MECHANIZATION CENTER			
MACHINE NAME	RICE DIRECT SEEDER		
PART NAME	SCRAPER, right and left		
PART No.	VI-12-3	THIRD ANGLE PROJECTION	
DRAW DATE	2-16-1990	DRAWN BY	Moustafa S.
SCALE	1/2	CHECKED BY	Sakamoto
QUANTITY	1	APROVED BY	
MATERIAL	SS41	DRAWING No.	30



RICE MECHANIZATION CENTER			
MACHINE NAME	RICE DIRECT SEEDER		
PART NAME	SCRAPER, rear		
PART NO.	VI-12-4	THIRD ANGLE PROJECTION	
DRAW DATE	2-16-1990	DRAWN BY	Moustafa C.
SCALE	1/1	CHECKED BY	Sakamoto
QUANTITY	1	APROVED BY	
MATERIAL	SS41	DRAWING No.	31



RICE MECHANIZATION CENTER			
MACHINE NAME	RICE DIRECT SEEDER		
PART NAME	COLLER, wheel		
PART No	VI-4-1	THIRD ANGLE PROTECTION	
DRAW DATE	2-25-1990	DRAWN BY	Mangstelo C.
SCALE	1/1	CHECKED BY	Sakamoto
QUANTITY	2	APROVED BY	
MATERIAL	SS41	DRAWING No.	32

PARTS LIST

PART No.	PART NAME	MATERIAL	Q'TY OF ONE UNIT	DRAWING No.
VI-0	Wheel Ass'y	--	--	23
VI-1-0	Wheel CMP.	--	--	14
-1	Wheel Side Plate	SS41F, t=0.8	4	15
-2	Wheel Band	SS41F, t=2.0	2	15
-3	Supporting Plate	SS41F, t=2.0	2	15
-4	Bush	SS41B	2	15
-5	Supporting Plate	SS41F, t=2.0	4	15
VI-2-0	Wheel Guide CMP.	--	--	15
-1	Wheel Guide Pipe	SS41, □31×31	2	15
-2	Nut M8	4T	4	15
-3	Bolt M8×25	7T	4	—
VI-3-0	Wheel Supporter CMP.	--	--	24
-1	Wheel Supporter Pipe	SS41, □26×26	2	24
-2	Bolt M12×125	7T	2	25
-3	Nut M12	4T	2	26
-5	Cotter Pin 25×30	--	2	—
VI-4-1	Coller	SS41B	4	32
VI-7	Bush	Brass	2	15
VI-8	Spring Washer	--	4	—
VI-9	Washer 6	--	4	14
VI-10	Bolt M6×80	7T	4	14
VI-11	Nut M6	4T	4	14
VI-12-0	Scraper CMP.	--	--	27
-1	Adjusting Plate	SS41F	2	28
-2	Scraper, left & righ	SS41F	R1, L1	29
-3	Scraper, right & lef	SS41F	R1, L1	30
-4	Scraper, rear	SS41F	2	31
-5	Bolt M6×20	4T	2	23
-6	Nut M6	4T	2	23
-7	Spring Washer 6	--	2	23

f. Sowing time

It is generally recognized that a delay in harvesting the preceding winter crop (such as Egyptian clover (Bersim), wheat, barley, broad bean, flax, and etc.) delays sowing the rice (successive crop). Researchers say that the delay of sowing brings down the yield, and this theory was proved by experiment at RMC in 1988. Two varieties (early, and late-maturing) were employed for the experiment. Both varieties showed gradual decreases in yield according to delays in sowing time. A significant decrease was recorded in the yield of the June 16th-sowing treatment compared to earlier sowings treatments. This result suggests that the sowing time should not be later than the last day of May. Since the first half of May sowing treatment recorded the best results, the overall recommendation for the optimum sowing time of this cultivation method could be from the 1st of May to the 15th of May.

When harvest of the former winter crop is delayed and rice sowing is obliged to be later than the 16th of June, more than a 40% decrease in yield can be anticipated.

g. Sowing density

As a premise to decide the seed amount, it is necessary to set a target in plant density. Therefore, the ideal number of seedling stands per unit area must be studied in order to obtain the maximum yield. It is recognized in Japan, where solar energy is relatively small, that 100-200 seedling stands per m^2 is the optimum number. While in the Nile Delta area,

Table 1 The Results of Seasonal Sowing Experiment (The direct sowing cultivation method on flooded field) (V. Giza 172) -- 1988, R M C

Treatment /_1	Sptout ratio (%)	Days to Head.	Days to Mat.	Plant height (cm)	Panicle length (cm)	No. of panicles /m2	No. of grain/ Panicle	Percent-age of rip. (%)	1000 grain weight (g)	Yield /_3 t/ha	Yield /_3 t/f
1 May	17.2 a	105 a	146 a	116 a	22.6 a	182 a	155 a	98.8 a	25.7 a	7.1 a	3.0
16 May	17.8 a	108 a	145 a	117 a	22.6 a	183 a	139 a	96.6 ab	25.5 a	6.4 a	2.7
1 Jun.	24.3 b	105 b	139 b	117 a	22.8 a	227 b	123 a	87.3 bc	26.1 a	6.2 a	2.6
16 Jun.	16.8 a	99 b	128 c	105 b	21.1 b	154 a	122 a	80.8 c	26.0 a	3.6 b	1.6
Average	19.0	107	139	114	22.3	186	134	90.9	25.8	5.8	2.5
C.V. (%)	11.3	1.7	1.4	1.4	3.4	12.5	17.5	6.7	2.2	18.8	

Ref ...... /_1 = Sowing dates

/_2 = The values followed by the same letter are not significantly different at the 5% level.

/_3 = Adjusted to 14% moisture content

Table 2 The Results of Seasonal Sowing Experiment (The direct sowing cultivation method on flooded field) (V. IR 19743 - 46) -- 1988, R M C

Treatment /_1	Sptout ratio (%)	Days to		Plant height (cm)	Panicle length (cm)	No. of panicles /m2	No. of grain/ Panicle	Percent-age of rip. (%)	1000 grain weight (g)	Yield /_3	
		Head.	Mat.							t/ha	t/f
1 May	23.2 a	103 a	135 a	77.3 a	19.9 a	319 a	100 a	84.0 a	25.0 a	6.4 a	2.7
1 Jun.	29.5 a	99 b	134 a	75.4 ab	19.6 a	335 a	63 b	92.4 a	24.5 a	4.6 ab	2.0
16 Jun.	26.5 a	99 b	126 b	75.0 b	19.2 a	298 a	64 b	93.1 a	23.3 a	4.1 b	1.7
Average	26.4	100	132	75.9	19.6	317	75	89.8	24.3	5.0	2.1
C.V. (%)	19.4	4.5	2.4	1.6	6.3	30.1	17.5	12.6	5.6	26.1	

Ref ...... /_1 = Sowing dates.

/_2 = The values followed by the same letter are not significantly different at the 5% level.

/_3 = Adjusted to 14% moisture content

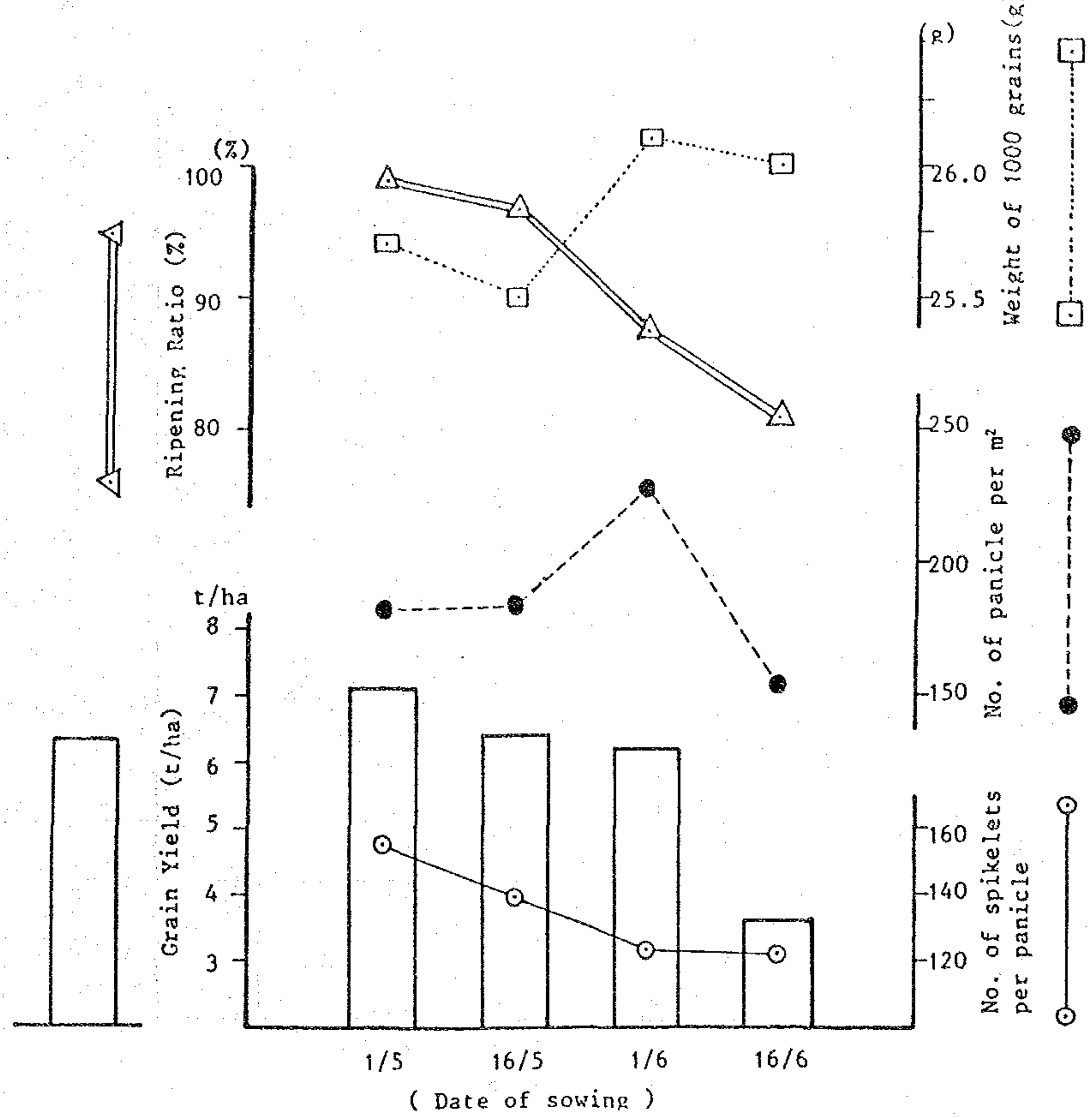


Fig. 1 Yield and yield components-- Seasonal sowing experiment (Var. = Giza 172) -- 1988,RMC

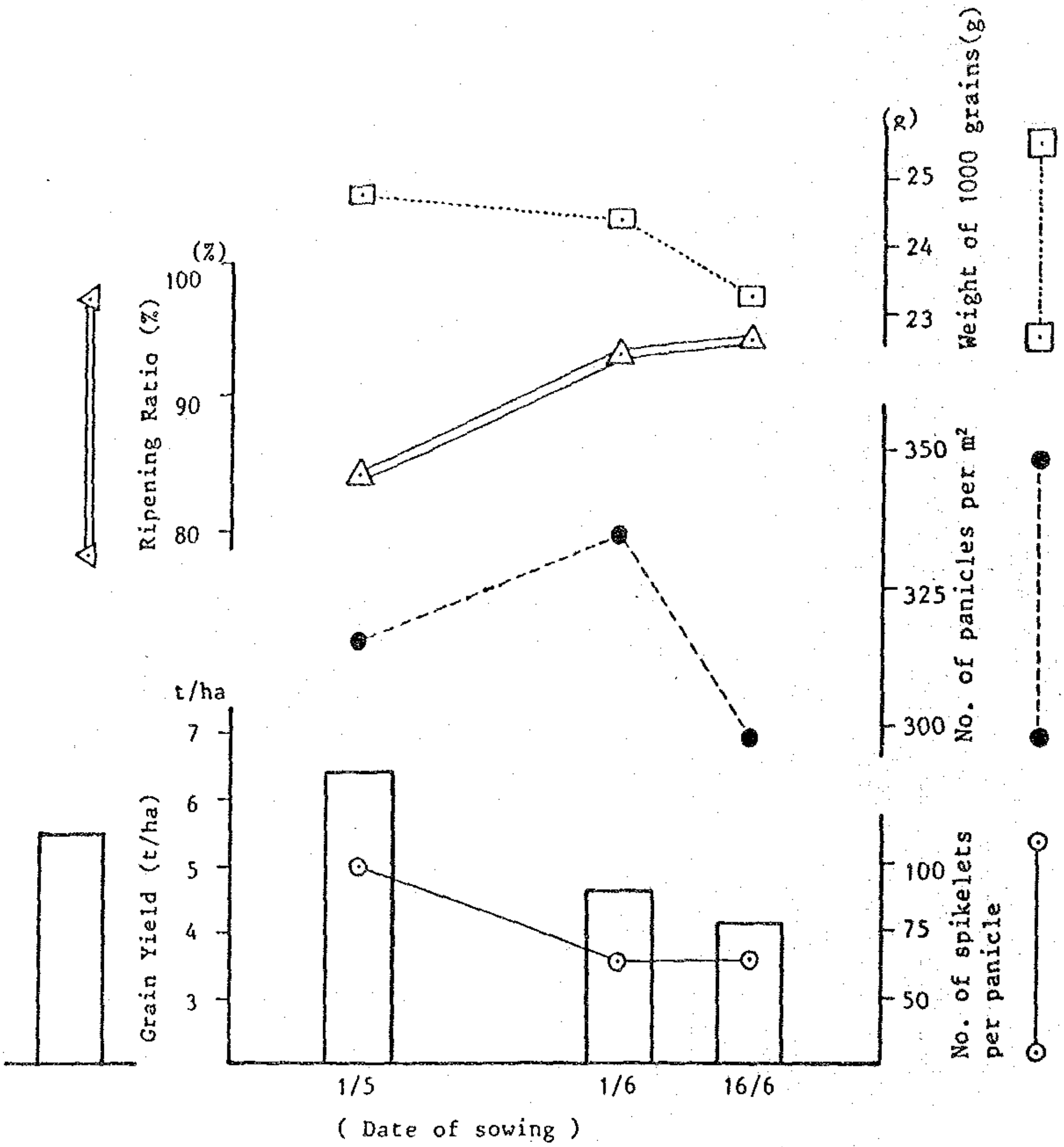


Fig. 2 Yield and yield components-- Seasonal sowing experiment (Var. = IR 19743-46) -- 1988,RMC

where there is abundant solar energy, as many as 250 seedling stands per m^2 could be acceptable. However, this would create overly luxurious plant growth in fertile soil, so the ideal number turns out to be only 200 (see Fig. 4). Consequently, the target number of seedling stands per m^2 should be 200-250 as a standard.

Other targets must be set for uniform germination and seedling distribution in the field, and this depends on land preparation, puddling, sowing operation and etc. Provided that uniform seedling stands in the field are secured, even 100 seedlings per m^2 could guarantee a tolerable yield as high as 4 tons/feddan or more.

To obtain 200-250 seedling stands per m^2, the seed amount should be about 30-70 kg/f (70-160 kg/ha) according to the results of the experiments conducted in RMC in 1987 and 1989 (see Tables. 1,2 and 3, and Figures. 1 and 3). The seed amount must be increased when the expected sprouting ratio is low, and it must be decreased when the soil is fertile (the target of plant density then is 200).

h. Sowing mode

Sowing methods can roughly be classified into three modes: a) broadcast, b) drill-sowing, and c) dibbling. It also can be classified to sowing in saturated water conditions (water is drained after puddle before sowing), and sowing in submerged water conditions.

In the sowing method used on water-saturated fields, the

Table 1 The Results of Sowing Density & Fertilizer Experiment On The Direct Sowing Cultivation Method On Flooded Field 1987, R M C

Treatments Nos. I Seed A	II Nitrogen	Days to Head	Days to Maturity	Diseases /1 BL (1-2)	Diseases BL (5)	Diseases NBL	Percentage of Lodging %	Plant Height (cm)	Panicle Length (cm)	Nos. of spikelet /panicle	Nos. of panicle m²	Ripening ratio %	1000 grains weight	Yield /2 (Ton/ha)	Yield (Ton/ f)
20 Kg/ha	60 Kg/ha	88	132	1	1	1	20	90.7	21.9	129	521	92.8	20.6	10.09	(4.24)
	90 "	87	131	1	1	1	27	87.7	21.7	124	610	93.6	20.9	10.56	(4.44)
	120 "	88	131	1	1	1	20	95.8	22.3	117	559	90.8	21.0	10.41	(4.37)
	150 "	88	132	1	1	1.5	18	96.9	22.4	137	538	91.5	20.7	10.82	(4.54)
40 Kg/ha	60 Kg/ha	87	130	1	1	1	24	91.7	20.7	108	672	92.0	20.8	11.08	(4.65)
	90 "	86	130	1	1	1	06	89.3	20.3	118	655	94.0	20.9	10.74	(4.51)
	120 "	87	131	1	1	1.5	17	89.7	20.9	106	646	93.6	21.1	11.13	(4.67)
	150 "	86	130	1	1	1.5	26	90.9	20.5	116	595	93.6	20.8	11.04	(4.64)
60 Kg/ha	60 Kg/ha	86	130	1	1	1	09	85.9	19.8	96	675	90.4	20.8	10.66	(4.48)
	90 "	86	130	1	1	1	21	87.7	21.6	108	620	92.1	20.9	11.07	(4.65)
	120 "	86	130	1	1	1.3	41	88.7	20.8	103	641	93.6	21.1	11.64	(4.89)
	150 "	86	130	1	1	1.5	43	87.9	20.9	97	719	93.5	21.1	11.81	(4.96)
80 Kg/ha	60 Kg/ha	86	130	1	1	1.3	08	84.1	19.2	89	754	93.1	21.3	9.88	(4.15)
	90 "	86	130	1	1	1.5	26	84.0	19.4	79	746	94.0	21.1	9.88	(4.15)
	120 "	85	129	1	1	1.8	45	89.4	19.7	99	836	89.5	21.5	10.62	(4.46)
	150 "	85	129	1	1	1.8	30	85.0	20.4	98	728	94.4	21.2	10.33	(4.34)
Total Average		86	130	1	1	1.3	24	89.1	20.8	108	657	92.7	21.0	10.73	(4.51)
C.V. I		-	-	-	-	9.76	60.99	3.75	3.40	8.6	10.97	2.27	1.14	8.77	
C.V. II		-	-	-	-	28.44	55.01	3.63	4.16	15.3	11.67	3.96	1.82	4.44	

Note.......... /1 BL (1 - 2) Leaf Blast in Seeding, BL(5) = Leaf Blast in Heading, NBL = Neck Node Blast

/2 Adjusted to 14% of moisture contents

Table 2. Yield Average (Sowing Density & Fertilizer EXP. D. S. Flooded, t/ha), RMC 1987

Nitrogen / Seed amount	60 Kg/ha	90 Kg/ha	120 Kg/ha	150 Kg/ha	Average
20 Kg/ha	10.09	10.56	10.41	10.82	10.47 a
40 Kg/ha	11.08	10.74	11.13	11.04	11.00 a
60 Kg/ha	10.66	11.07	11.64	11.81	11.29 a
80 Kg/ha	9.88	9.88	10.62	10.33	10.18 a
Average	10.43 a	10.56 a	10.95 a	11.00 a	10.73

* (Values followed by the same letter are not significantly different at the 5% level)

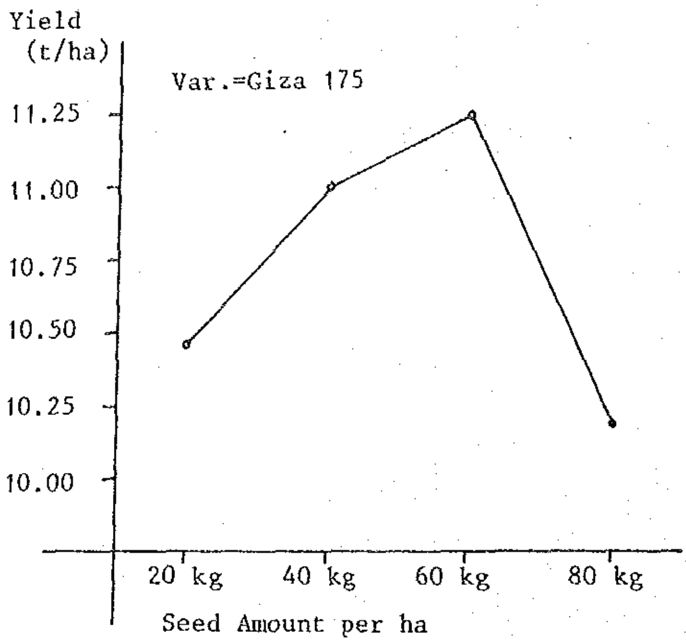


Fig. 1 Seed Amount and Yield
(Direct Seeding-Wet Condition)

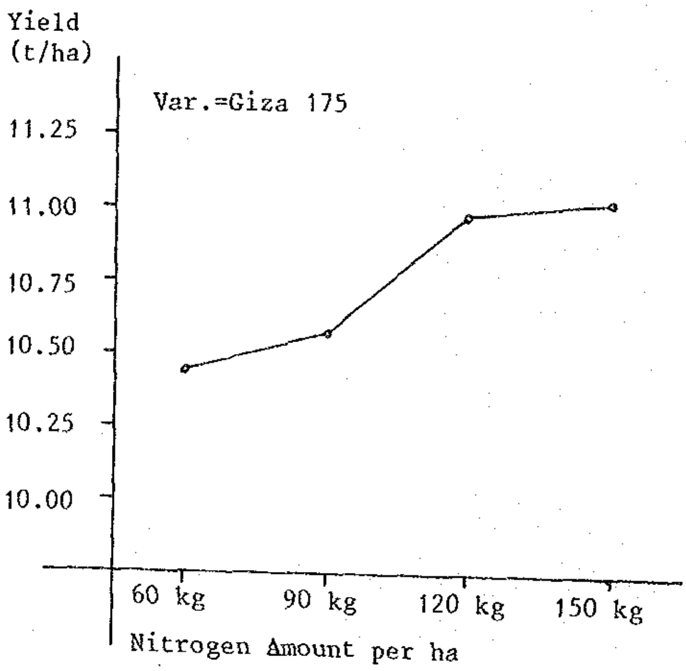


Fig. 2 Nitrogen Amount and Yield
(Direct Seeding - Wet Condition)

Table 3 The Results of the Experiment on Manual Sowing Machine for the Direct Sowing Cultivation Method on flooded field - RMC, 1989

Treatment	Days to		Diseases			Lodge (%)	Plant Height (cm)	Panicle Length (cm)	No. of Spikelets /Panicle	No. Of Panicle $/m^2$	Ripen. Ratio (%)	1000 Grain weight (g)	Yield	
Name	Head	Mat.	BL (5)	NBL (9)	Bs (5)								(t/ha)	(t/f)
15kg/f	93	129	1	1	1	0	94.4 a	22.4 a	115.6 a	401 d	92.3 a	26.5 a	9.35 b	3.93
30kg/f	93	129	1	1	1	0	94.4 a	22.0 a	109.6 ab	451 cd	93.3 a	26.5 a	9.88 ab	4.15
45kg/f	92	128	1	1	1	0	92.5 a	21.4 ab	100.8 abc	449 cd	92.1 a	26.4 a	9.35 b	3.93
60kg/f	92	128	1	1	1	0	92.0 a	21.6 ab	103.0 abc	550 a	91.7 a	26.8 a	10.34 a	4.34
75kg/f	91	127	1	1	1	0	92.7 a	21.4 ab	97.8 bc	493 bc	93.7 a	26.8 a	10.27 a	4.31
90kg/f	91	127	1	1	1	0	90.9 a	21.0 b	93.3 c	543 ab	91.7 a	26.7 a	10.09 ab	4.24
A.V.	92	128	1	1	1	0	92.8	21.6	103.4	481.0	92.5	26.6	9.88	4.15
C.V.(%)	-	-	-	-	-	-	4.4	3.1	9.4	6.7	1.8	1.9	5.55	

Note ...* Values followed by the same letter are not significantly different at the 5% level

* Yields are corrected to 14% moisture content

* Treatment is seed amount per feddan

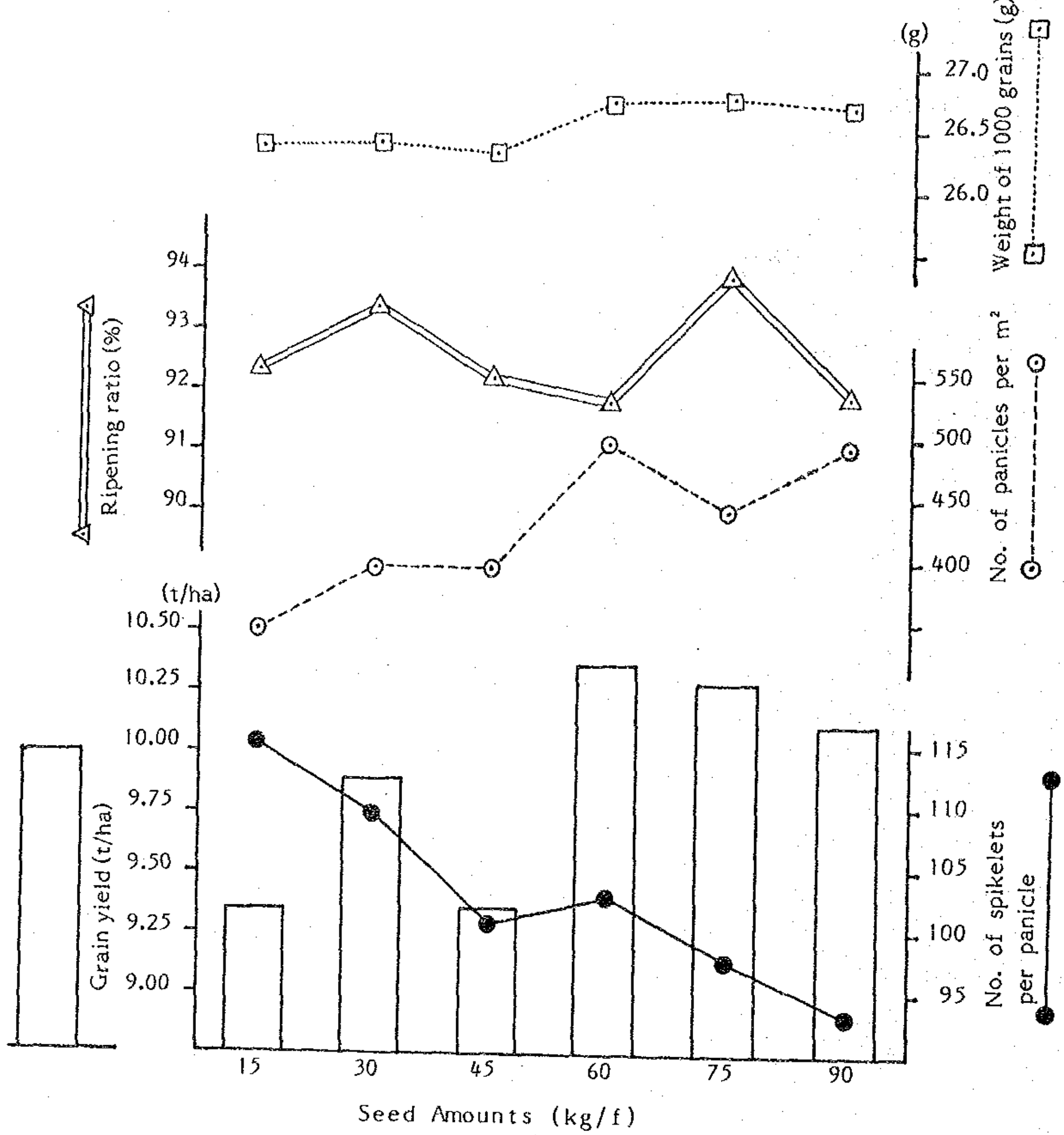


Fig. 3 Experiment on Manual Sowing Machine for the Direct Sowing Cultivation Method on Flooded Field - RMC, 1989

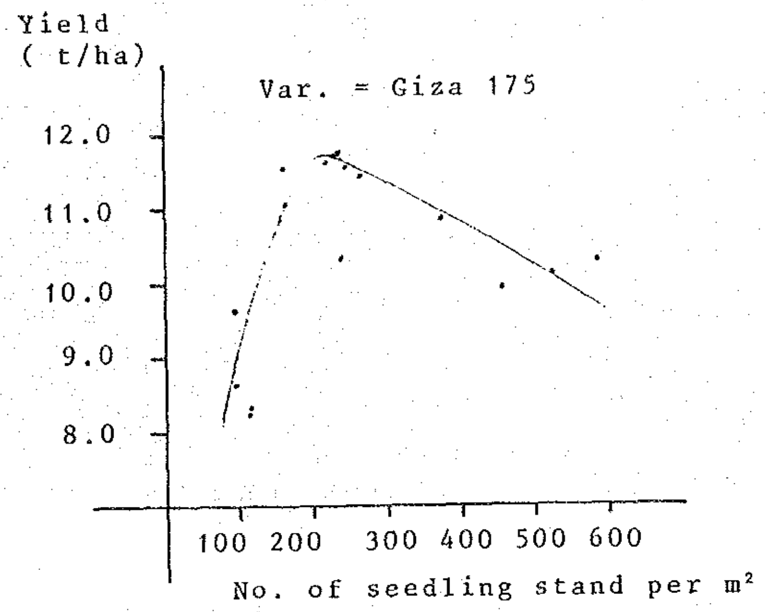


Fig. 4. No. of seedling stand per m² and yield
--Experiment on density and fertilizer amount
(Direct seeding under wet condition)

field surface must be gelatinous. But, if the surface becomes harder during the sowing operation it may affect seed germination or increase the tumbling of seedlings after sprouting.

In the case of sowing on submerged water flooded fields, the relative surfaces of water and land tend to be disturbed and stirred by movements of the sowing machine or the sowing person. This may cause irregularity in the seed distribution, both vertically and horizontally. In the case of a manual sower or hand apparatus a water depth of about 5cm may be appropriate. Deeper water (5-10cm) may be suitable for big sowing machine.

In both water conditions, attention must be paid to uniform sowing. This is the most important point of this cultivation method.

Each sowing mode (broadcast, drill-sowing and dibbling) has both advantages and disadvantages, and it is difficult to select one as the best. However, with the progress in technology for a higher sprouting-ratio and efficient weed-control, the broadcast sowing method may be the most advantageous in the sense of working efficiency and high yield potentiality.

There is an issue for row orientation in case of the drill-sowing method. But, no specific advantage for any direction has been observed so far.

DIRECT SOWING CULTIVATION METHOD

Picture 1 On Dry Field (Drill Sown)

Picture 2 On Flooded Field (Broadcasted)

2) On dry field

a. Land-preparation

It is difficult to find any traditional direct-sowing cultivation practice on dry fields in the Nile Delta at present.

(i) Mechanical land-preparation on dry fields. Based on the results of trials, experiments and surveys at RMC, the Mechanical land-preparation system, which consists of the following four processes, has been established tentatively:

Namely

PLOWING	→	MECHANICAL HARROWING	→	MECHANICAL LEVELLING (1)	→	MECHANICAL LEVELLING (2) & PRESSING
TRACTOR & CHISEL PLOW		TRACTOR & DISC HARROW		TRACTOR & SCRAPER		TRACTOR & HEAVY DUTY WOODEN PRESS LEVELLER
(2 TIMES)		(ONCE)		(ONCE)		(ONCE)

Notes: * If many weeds or stumps remain it is better to use a mouldboard plow, followed two times by a disc harrow, instead of chisel plow.

** If the soil surface is evenly flat the scraper operation can be omitted.

*** Heavy-duty wooden press-levellers have such an efficient performance that excellent land preparation will be achieved. The operation of this locally made implement can be substituted for a Roller.

It should be observed that this system (method) takes fewer machine-working hours (2.7 hours/feddan) compared to mechanical land-preparation on flooded fields (3.2

hours/feddan) except irrigation.

(ii) Technical Information

A) Purpose of land-preparation:

1) To prepare a good seed-bed field with small soil-clods and a well-levelled surface of the field.

2) To mix soil with fertilizer.

3) To help weed control.

4) To bury remaining stumps.

B) Relationship between germination ratio and soil-clod size.

The more the composition of the soil includes soil-clods of less than 2cm in diameter, the higher the germination ratio becomes. Between them the positive co-relation is clearly observed. For example, a germination ratio of about 35-45% in practical experience would be expected at the 80% level of soil-clod ratio (weight of soil-clods less than 2cm diameter divided by the total weight of all soil-clods X 100). Refer to Figure 1:

Namely, modeling it as follows:

* Large clods——>Deeper sowing——>less germination
* Smaller clods-->Shallower sowing---->more germination

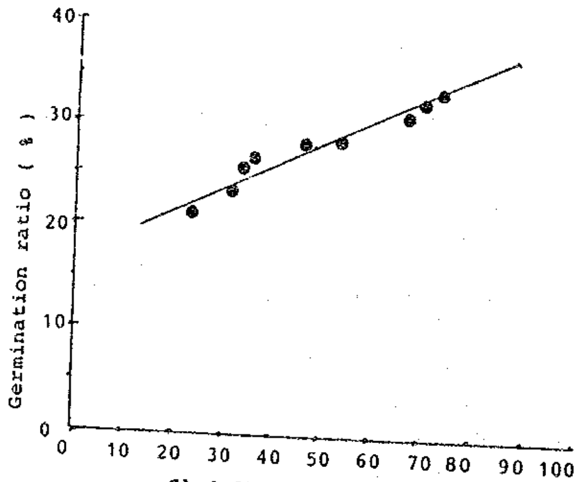


Fig.1 Relation between cold diameter and germination ratiotion

Remaks: Y=16.958- (0.222 x X)... r= 0.96 (1989)

C) Relationship between soil-clod size and kinds of land preparation systems.

On land preparation systems: the more the number of operation processes increases, the higher the ratio of soil-clods under 2cm dia. becomes. As a result of this one can expect an increased germination ratio accompanying an increase in the number of processes of land-preparation. For example, in the case of C system which has 3 processes (chisel [2] --- Disc Harrow --- Roller [2]), 57% - degree of soil-clod ratio was counted. It showed 39.5%- level of germination ratio.

Table 1 - Comparison of Germination ratio and soil-clod ratio among 4 systems (1989, RMC)

Kinds of Systems	Soil-clod ratio of less than 2 cm Dia.	Number of Seedlings per $1m^2$	Germination Ratio
	%		%
A	46	163	31.4
B	49	198	38.0
C	57	205	39.5
D	71	213	41.0

(Notes) 1) The four kinds of land preparation systems are as follows

A) Chisel (2) ... Disk

B) Chisel (2) ... Disk .... Roller

C) Chisel (2) ... Disk .... Roller (2)

D) Chisel (2) ... Disk .... Roller ....Scraper

2) Seed rate; 60kg/f by grain drill seeder on May 25th.

3) 1 Plot 243 m^2.

D) Effect of soil condition to soil-clod of less than 2cm dia. ratio: Trial result (1989) on it was shown in Figure 2 (Page 175).

It seems that there was some difference of soil-clod of less than 2cm dia. ratio between two kinds of soil conditions due to different previous crops. That is:

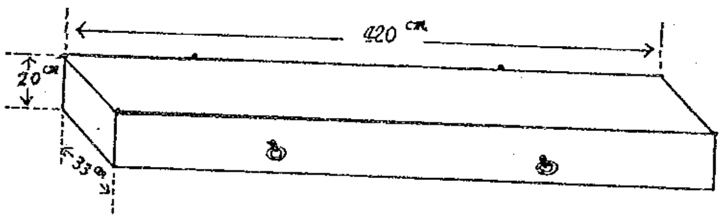
i) Soybean (1989) Egyptian clover (1988-89): its higher soil-clod ratio.

ii) Rice (1989) Egyptian clover (1988-89): its lower soil-clod ratio (1989).

In this regards, further study is needed.

E) Dimensions of Heavy-duty wooden press leveller.

* Dimmension: width 420 cm X height 20 cm X depth 33 cm.
* Kinds of wood: Eucalptus sp. (Arabic; Cazwarine)
* Estimated cost: 50 LE (in local market)



F) Field performance of implement.

It's listed in Table 5 (Refer to (III-5-(2)-5)).

b. Variety

The appropriate variety for the direct-sowing cultivation method on dry fields requires different features from the direct-sowing cultivation method on flooded fields, since their sowing methods, field conditions when sowing and the circumstances of the first few weeks differ greatly. But as is mentioned in the previous section, the varietal option here is so limited that there is no special recommendation besides the one for the direct-sowing cultivation method on flooded fields.

However, there are several features which the suitable varieties for this cultivation method must possess, besides common good qualities (as in the transplanting method or general resistabilities to diseases and insects). They are as follows ;

(1)High ability to sprout from soil with vigorous growth in the early growing stages, especially under deep sowing conditions.

(2) Resistance to lodging

(3) Resistance to become shorter under high plant-density

(4) Good light receptive style with erect leaves

(5) Medium shattering habit, and grains without awn

This cultivation method especially needs varieties with high sprouting-energy. It is also important that they should not have any awn at all, since this may be an obstacle for smooth seed delivery from the drill sower.

Table 1 Sprouting ratio - Experiment on seed treatment and irrigation timing on direct sowing cultivation method on dry field - RMC, 1989

Irrigation timing / Seed treatment	Immediately after sowing	6 hourse after sowing	One day after sowing
Dry seed	60	40	32
Soaking only	72	56	56
Pre-germinated	16	0	0
Over-germinated	4	0	0
Total	38	24	22

Note ...* Temperature (at 2:00 pm)
1. Air .... 31.5 ^{o}C
2. Soil (in shade) .... 31.5 ^{o}C
3. Soil (under sun) .... 53.0 ^{o}C
4. Water (under sun) .... 38.8 ^{o}C

* Sowing time was 10:00 am

* Figures are sprouting ratio by %

* 1/500 a wagner's pot was used for each treatment

* Pots were placed under sun

c. Seed pre-treatment

The point which is different from other cultivation methods in seed pre-treatment is that the pre-germination treatment should not be given in this direct-sowing cultivation method on dry fields. Therefore, seed treatment processes after seed acquisition is as follows : a) awning, b) seed selection, c) seed disinfection, and d) seed soaking. As seed-soaking is effective, even if done for one day, it is recommended. In an urgent case, however, dry seed can be used with tolerable success. However, in that case, the quantity of seeds must be increased by 20-30% since a lower sprouting ratio is to be anticipated. Germinated seeds tend to become damaged under dry and hot field conditions (see Table 1). Because it may take several hours to finish the sowing and irrigation operations seeds are obliged to endure severe circumstances for at least 5-6 hours.

d. Chemical seed treatment and seed coating

Irrigation is essential after sowing in the direct-sowing cultivation method on dry fields in the Nile Delta because there is almost no rain fall during this season and the soil has a minimum moisture content. Water is drained within a day (by one method or another), but seeds rot if they are sown too deeply or in poorly-drained fields. The possibility of using Calper as a coating material was pointed out by Watanabe, et al., in 1987, and was tried in the field the following year (see Tab.1 and Fig.1). At the same time, Hydroxy-isoxazole

Table 1. Experiment on Seed Treatment in The Direct Sowing Cultivation method on Dry Field 1988, RMC.

Treatments	Seeding Stand Ratio (%)	Days to Heading	Days to Mat.	Lodg (%)	Plant Height (cm)	Panicle Length (cm)	No. of grains/ panicle	Percentage of rip. (%)	1000 grains weight (g)	No. of panicle /m2	Yield t/ha	Yield t/f
1.Control	35.1 a	74	105	0	91.9 a	22.2 a	107.7 b	92.2 ab	27.0 a	448.3 ab	7.96 a	(3.32)
2.Calper only	33.4 b	74	105	0	94.1 a	22.1 a	113.9 ab	92.9 ab	26.5 a	410.6 ab	8.46 a	(3.53)
3.Tachigaren	35.9 a	74	105	0	94.4 a	22.0 a	121.7 ab	93.0 ab	26.6 a	521.0 a	9.02 a	(3.76)
4.Gypsum+Calper	21.6 d	75	106	0	93.8 a	23.0 a	127.7 a	93.7 a	26.1 a	361.3 b	8.21 a	(3.42)
5.Calper+Tachi.	28.8 c	74	105	0	93.4 a	22.6 a	113.3 ab	91.6 b	26.4 a	414.3 ab	8.87 a	(3.69)
6.Gypsum only	0 e	-	-	-	-	-	-	-	-	-	-	-
A.V.	31.0	74	105	0	93.5	22.4	116.9	92.7	26.5	431.1	7.09	(2.95)
C.V.(%)	3.20	-	-	-	22	3.2	8.2	1.1	2.4	18.3	14.81	

Note .... * Values followed by the same letter are not significantly different at 5%

* Yield are corrected to 14% moisture content

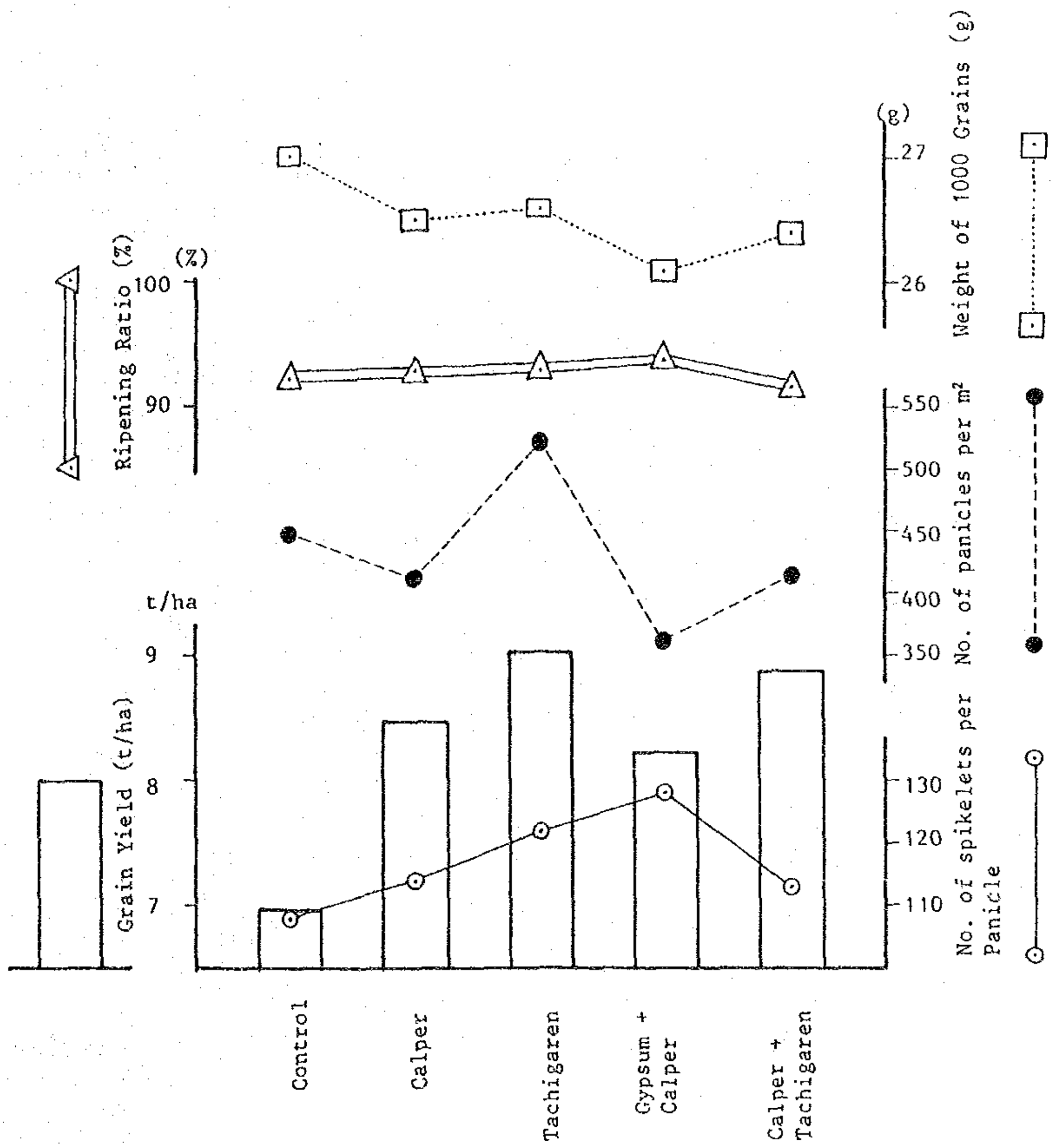


Fig. 1 Experiment on Seed Coating in The Direct Sowing Method on Dry Field -- 1988, RMC

Table 2 The Result of Experiment on Tachigaren in the Direct Sowing Cultivation Method on Dry Field - RMC, 1989

Treatment	Days to		Diseases			Lodge (%)	Plant Height (cm)	Panicle Length (cm)	No. of Spikelet /Panicle	No. Of Panicle $/m^2$	Ripen. Ratio (%)	1000 Grain weight (g)	Yield	
Name	Head	Mat.	BL (5)	NBL (9)	Bs (5)								(t/ha)	(t/f)
Control	99	131	1	1	1	0	85.8 a	21.6 b	106.9 b	411.3 a	90.7 a	26.2 a	7.31 a	3.07
Tachigaren 1%	103	135	1	1	1.3	0	86.8 a	23.1 ab	120.3 ab	374.3 a	86.7 ab	25.8 a	7.25 a	3.05
Tachigaren 2%	104	135	1	1	1.5	0	86.5 a	23.8 a	137.2 a	351.3 a	77.8 b	25.7 a	7.08 a	2.98
Tachigaren 3%	104	135	1	1	1.5	0	85.4 a	22.3 ab	111.4 b	384.5 a	90.7 a	25.6 a	6.29 a	2.64
Tachigaren 4%	101	135	1	1	1.3	0	86.9 a	22.3 ab	111.3 b	387.8 a	87.7 ab	26.3 a	6.44 a	2.83
Tachigaren 5%	104	135	1	1	1.5	0	86.4 a	22.2 ab	109.9 b	406.5 a	91.4 a	25.9 a	6.88 a	2.89
A.V.	103	134				0	86.3	22.5	116.2	385.9 a	87.5	25.9	6.92	2.91
C.V%							4.4%	4.7%	11.9%	13.1%	7.9%	2.1%	10.6%	

Note ...* Values followed by the same letter are not significantly different at the 5% level

* Yields are corrected to 14% moisture content

powder (Tachigaren,-said to have some side-effects to activate roots) was included in the experiment as a treatment. Since the results revealed some positive effects with the latter chemical the test was repeated the following year (1989) (see Tab.2). No significant effect was observed in this 1989 experiment. It may be assumed that there would be no obvious effects under high temperature conditions compared to lower temperature conditions. High PH value and high salinity level may have influenced it, but this was not confirmed by the experiment.

Therefore, no chemical seed treatment, except for disinfection by thiuram-benomyle (Benlate-T), is recommended.

e. Seeder

In the direct-sowing cultivation method on dry fields, sowing is one of the most important operations, because the rice yield can be greatly affected by the accurate and precise control of seed-metering and sowing-depth. The broadcaster, the grain drill seeder, the row seeder and the planter which are attached to the rotary tiller are mainly used. However, the grain drill seeder is recommended because it can cover, in one pass, the ditching, soil covering and compacting processes. It is also recommended in the Nile area in Egypt.

Table.1. Kind of advantages and disadvantages Of each seeder

Kind of Seeder	Advantages	Disadvantages	Remarks
Broadcaster(for tractor)	1) hopper capacity is large (200-1200L) therefore the frequency of reloading is reduced. 2) Efficiency is high as the possible working speed is 4-6km/hr. 3) Spreading width is 6-12m which leads to high efficiency. 4) Spreading of chemical fertilizer is possible.	1) After seeding a tooth harrow is needed. 2) Can not perform row seeding.	Grain drill seeder has a higher efficiency than broadcaster as covering is required after seeding with the boadcaster.
Grain Drill Seeder	1) Machine can do opening groove, seeding, covering and firming in one pass operation. 2) Can be used on a large field due to large hopper capacity 3) Can be used to spread seed and chemical fertilizer simultaneously.	1) The weight of the grain drill seeder is heavy, accordingly it is necessary that the machine be a four wheel drive tractor of beyond 50ps class or a two wheel drive tractor of beyond 70 ps class. 2) In the case of soaked seeds, sowing frequency deteriorates.	Suitable for direct sowing on large areas of dry land.
Row Seeder (attachment type for rotary tiller)	1) Machine can do opening groove, seeding, covering and firming in one pass operation.	1) Working speed is slow (1-2km/hr). 2) Can not be used with a rotary tiller in Egypt due to texture of soil.	Working speed is slower than a grain drill, so it's efficiency is lower than the grain drill.
Planter	1) Machine can do precision sowing. 2) Machine can do opening groove, seeding, covering and firming in one pass operation.		

f. Sowing time

Fundamentally, there is no difference between the optimal sowing time of the direct-sowing cultivation method on flooded fields and the one on dry fields, though germination and initial growth in the direct-sowing cultivation method on dry fields tends to be delayed roughly one week than that of the direct-sowing cultivation method on flooded fields. Therefore, the harvest might also come one week later.

To repeat: from the 1st of May till the 15th of May is the optimum planting season, and the 16th of May till the 31st of May is next best.

g. Sowing density

The ideal plant-density in the direct-sowing cultivation method on dry fields is 200-250/m^2; this is the same as that of the direct-sowing cultivation method on flooded fields. So, seed amount must be aimed at obtaining this plant density. Somehow, the germination ratio on dry fields is generally about 10% lower than that on flooded fields, so 10kg more seeds per feddan is desired. On the other hand, when an excessive increase of seed coincides with a high germination-ratio by chance, this situation may be followed by an excessive number of panicles, weak culm, lodging, and short panicles. The outcome will undoubtedly be a low yield. This is the reason why a deliberate schedule in the seed amount and careful field management are important.

Consequently, the seed amount should be 40-80 kg/feddan, according to the anticipated sprouting-ratio and the soilfertility. Considering all the above-mentioned, it is clear that less seed combined with deliberate land preparation, uniform germination and thorough field management may be advantageous in order to obtain a higher yield.

h. Sowing depth

The appropriate depth of sowing in direct-sowing practice on dry fields is quite different from the before-mentioned cases (1) - h.). Namely:

(i) After the mechanical land preparation is finished, the dry or soaked seeds are sown by a grain drill seeder on dry fields just before the first irrigation.

The recommended sowing depth is 1-2.5 cm. on well-harrowed and levelled dry soil.

In this regards, the deeper the sowing depth is, the poorer the germination will be. Seeds that are sown into the deep layer of soil can not grow up to be good seedlings. (refer to Fig.-1)

On the other hand, if the seeds are sown just on the soil-surface (so-called 0-0.5 cm. depth) the following three disadvantages will occur:

a. Floating-away of seeds during the first irrigation.

b. Bird attacks.

c. Over-heating or dehydration by direct sunshine.

(ii) Example

As one example, the result of trials in practical scale are shown in Fig.-1.

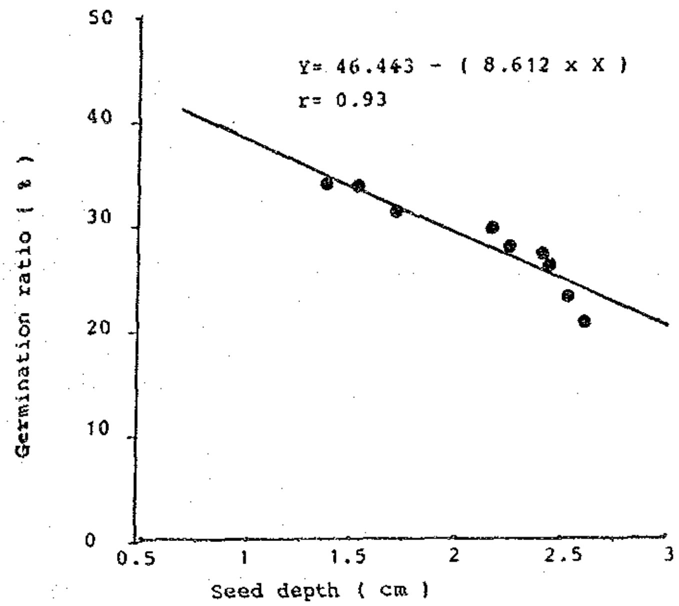


Fig.1 Relation between seed depth and germination ratio (1989)

(iii) Others

Usually, the germination ratio or seedling establishment ratio in the case of mechanical direct-sowing on dry fields by a grain drill seeder is poorer than that of traditional sowing by hand or by manual-broadcaster on a flooded field, due to a lot of irregularity of the sowing depth and so forth. Therefore, a careful accurate adjustment of the sowing depth-control-leveler of the grain drill seeder is required, as well as accurate land preparation and sowing operation, etc..

2) Field Management after Sowing

1) Water management

a. On flooded fields

Since sowing is done under puddled and flooded conditions in this cultivation method, there is almost no fear of water shortage at the beginning. On the other hand, however, there is a tendency to give no consideration to drainage. Poor drainage may cause poor rooting, instability, and growth retardation in the plants. Partial water-stagnation tends to cause patches of uneven growth.

Therefore, it is essential to have cleaning or rearrangement of the drainage canals, an under-drainage system (if possible), and thorough land-leveling.

Water must be kept 5cm deep for 7-10 days after sowing. Then, the water must be drained completely for 2-3 days to hasten rooting by giving oxygen to the rice plants. As a result of this process the rice plants may stand well and adapt to the soil. In case the seeds are covered or buried in soil, the germination-ratio may drop sharply. In that case drainage should be done much earlier. Since sprouting is hastened by "little" soil-moisture and "much" air, fields tend to be drained for a long time, but this condition promotes "weed-flourish" as well. As a summary: water should be kept as long as possible during the early growth stage and drained after sprouting.

After about 20 days from sowing the water-control system must resemble that of the mechanized-transplanting system, and the "intermittent" irrigation-system is to be employed.

Especially after the middle-growth stage, when the fear of weed prevalence dwindles, the field must be dried-up several times in order to re-oxidize the reduced soil and give oxygen to roots. The fields of the direct-sowing cultivation method on flooded fields becomes reduced condition than the transplanting method, since the former fields are kept submerged much longer than the latter.

The root systems of plants in this cultivation method are obviously shallower than those of the direct-sowing cultivation method on dry fields and the transplanting method. Accordingly, mid-summer drainage when lower inter-nodes elongate (about 35-42 days before heading) may have some effect on lessening lodging.

b. On dry fields

Irrigation just after sowing is the first irrigation in this cultivation method. Desirable results can be obtained if the fields are drained one day after irrigation (see Tab. and 1-2 also Fig. 1-1 and 1-2). However, no clear difference can be seen in fields with excessive water percolation (see Tab. 3). 70-80% of soil moisture-content is said to be optimum for germination and sprouting of seeds. Irrigation and drainage operations, until enough sprouts can be seen on the ground, must be carried on in consideration of the above-mentioned items. Attention must be paid, especially, to excessive soil-moisture content. The next irrigation is to be given before the soil surface becomes too hard to be like a canopy to sprouts.

This is called flush water and is aimed at moistening the soil surface so that the sprouts can pass through the hardened surface. This irrigation is to be repeated several times (with an interval of approximately one week) until plants become high enough to tolerate field submergence (that is when the plants have 3-4 leaves and are about 20 days old). Submergence-duration must be increased gradually after that, and finally follows the same water management as that of the transplanting method.

With this cultivation method, field conditions are rather dry compared to other cultivation methods and is more oxidized so that intermittent-irrigation or mid-summer drainage may not be as effective as other cultivation methods. This kind of irrigation-method may be employed according to field conditions.

Table 1. WATER MANAGEMENT TRIAL ON DIRECT SEEDING METHOD UNDER DRY CONDITION - 1987, R M C

Treatment		Seedling stand per m²	Head date	Mat. date	Diseases /1 BL (1-2)	NBL	BS	BL (5)	Lodg %	Plant Height (cm)	Panicle length (cm)	Nos. of panicle /m²	Nos.of sp./ panicle	R.R	1000 grains weight	Yield /2 t/ha	(t/f)
One day	Dry seed	121	93	135	1	1	1	1	60	79.3	21.4	363	116.5	93.9	20.9	5.41	(2.28)
	Soakin- only	109	93	135	1	1	1	1	50	77.6	21.7	283	123.7	91.8	20.7	5.27	(2.22)
	Soaking+germ.	71	93	135	1	1	1	1	35	82.3	22.0	421	135.4	93.1	20.5	5.55	(2.34)
Two days	Dry seed	91	93	135	1	1	1	1	80	79.2	20.3	330	126.7	90.1	19.9	4.20	(1.77)
	Soaking only	105	93	135	1	2	1	1	80	79.1	21.3	351	131.9	93.3	19.9	4.73	(1.99)
	Soaking +germ.	54	93	135	1	1	1	1	60	84.3	21.6	418	130.2	91.6	20.9	6.72	(2.83)
Three days	Dry seed	100	93	135	1	1	1	1	60	79.1	21.4	252	129.6	94.4	20.2	4.76	(1.99)
	Soaking only	86	93	135	1	1	1	1	70	80.2	21.1	301	113.8	94.0	20.5	4.34	(1.83)
	Soaking+germ.	47	93	135	1	1	1	1	80	80.1	22.9	377	163.3	90.3	19.6	4.37	(1.84)
Four days	Dry seed	74	93	135	1	1	1	1	80	76.8	21.2	266	125.4	83.4	21.0	4.17	(1.76)
	Soaking only	48	93	135	1	1	1	1	80	76.6	22.0	180	132.1	90.5	19.4	2.33	(0.98)
	Soaking+germ.	17	93	135	1	1	1	1	50	79.6	20.8	280	113.8	91.7	19.4	2.48	(1.05)
A V E R A G E			93	135	1	1.1	1	1	65.4	79.5	21.4	318.5	128.5	91.5	20.2	4.53	(1.91)

Note...../1 BL(1-2) = Leaf Blast in seedling, BL(5) = Leaf Blast in Heading, NBL = Neck Node Blast

/2 Corrected for 14% of moisture contents

/3 40 days after seeding

Table 1-2 TABLE OF YIELDS & SEEDLING STANDS
(WATER MANAGEMENT TRIAL ON D.S. DRY) - 1987, RMC

Seed Treatment \ Irrigation Treatment	1 1 day	2 2 days	3 3 days	4 4 days	Average
1 dry seed	5.41 (121)	4.20 (91)	4.76 (100)	4.17 (74)	4.64 (96.5)
2 Soaking Only	5.27 (109)	4.73 (105)	4.34 (86)	2.33 (48)	4.17 (87.0)
3 Soaking + Germination	5.55 (71)	6.72 (54)	4.37 (47)	2.48 (17)	4.78 (47.3)
A V E R A G E	5.41 (100.3)	5.22 (83.3)	4.49 (77.7)	2.99 (46.3)	4.53 (76.9)

Note...... Values are t/ha, ( ) are seedling stand No. per m² measured 40 days after seeding

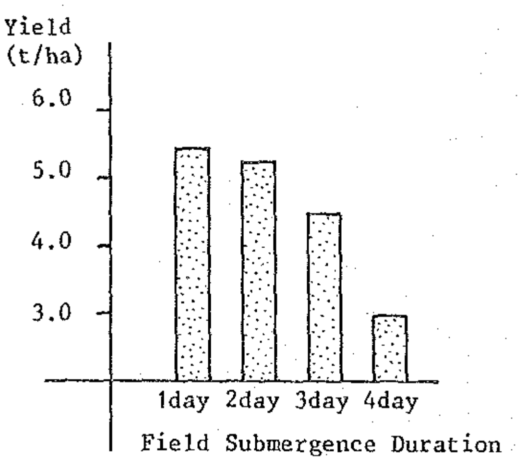


Fig.1-2 Yields of each Water Management -- RMC, 1987

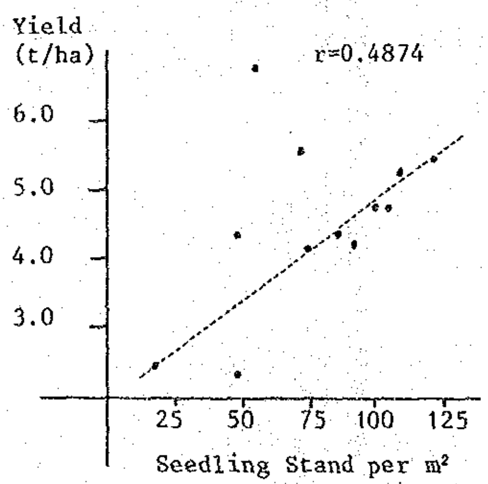


Fig.1-1 Seedling Stand and Yield -- RMC, 1987

Tab. 3 Results of Irrigation Experiment on Direct Sowing Cultivation Method on Dry Field - RMC,1989

Treatment	Days to		Diseases			Lodge (%)	Plant Height (cm)	Panicle Length (cm)	No. of Spikelet /Panicle	No. Of Panicle /m²	Ripen. Ratio (%)	1000 Grain weight (g)	Yield	
Name	Head	Mat.	BL (5)	NBL (9)	Bs (5)								(t/ha)	(t/f)
A	98	137	1	1	1	-	84.2 a	21.8 a	112 a	471 a	91.7 a	25.8 a	7.20 a	3.02 a
B	98	137	1	1	1	-	83.6 a	21.5 a	119 a	412 ab	92.3 a	25.8 a	7.27 a	3.05 a
C	98.2	137	1	1	1	-	86.2 a	22.1 a	113 a	475 a	92.9 a	25.4 a	7.40 a	3.14 a
D	98.2	137	1	1	1	-	85.5 a	22.2 a	118 a	394 b	91.6 a	25.9 a	7.50 a	3.15 a
A.V.	98.1	137	1	1	1	-	84.9	21.9	115.4	438.4	92.1	25.7	7.35	3.09
C.V. (%)			-	-	-	-	2.00	2.7	5.27	9.63	.95	1.47	9.37	

Note ....* Values followed by the same letter are not significantly different at the 5% level

* Yields are corrected to 14% moisture content

* Treatments are as follows ;

A = 1 day submergence after sowing

B = 2 days submergence after sowing

C = 3 days submergence after sowing

D = 4 days submergence after sowing

2) Weed Control

a. Sprayers

Mainly two herbicides, Benthiocarb and Ronster, are used in Egypt. (These products are used in the form liquid). The speed sprayer, the boom sprayer, the power sprayer, the knapsack type power sprayer and the manual sprayer can all be considered for use in herbicide applications. Since the speed sprayer sprays the herbicide with the help of the current generated from the blower, it can not be recommended because of insufficient of pressurized action of spraying onto the ground surface. The four other types can suitably be used for weed control. Depending on the tank capacity and the method of mounting, advantages and disadvantges can be found. In addition, the difference in field conditions for direct-sowing [whether on the direct-sowing cultivation method on flooded field or on dry field] must be considered, based on the farming scale and the moment of spraying.

(i) Sprayer for herbicide application under the direct-sowing cultivation method on dry field :

Power sprayer, knapsack type power sprayer and manual sprayer can be used for weed control. The boom sprayer can also be used for weed control if applied on about the 20 days after sowing. Under this 20 days after sowing condition the tractor can easily be operated because of the dried ground surface, the short height of the seedlings and minimal damage to them from the tractor.

Special attention must be paid when turning the tractor. This must be done with the brake engaged, and the turn should

Table.1 Kind of advantages and disadvantages of each sprayer

Kind of Sprayer	Advantages	Disadvantages	Remarks
Boom Sprayer	1) Spray tank capacity is large. 2) Application width is large and travering speed is about 2.5km/hr, thus the boom sprayer is high efficient. 3) Water can be fed into the sprayer by Jet Pump which is equipped with the boom sprayer.	1) Can not work on wet land, because the weight is heavy. 2) Rice plants are crushed by tractor tyre.	Can be used for weed control 20 days after sowing using direct sowing cultivation method on dry field.
Power Sprayer	1) Can be used in any condition.	1) Needs more than one person for operation. 2) Needs some implement such as a tractor trailer for transplanting the sprayer, water and herbicides.	1) Can be used in direct seeding in wet and dry conditions. 2) Can be used on small and large farms.
Knapsack type Power Sprayer	1) Can be used in any condition. 2) Can be operated by one person.	1) Small spray tank capacity which wastes time in refilling with herbicide. 2) Very noisy thus it can not be used for long periods of time.	1) Can be used in direct sowing in wet or dry conditios. 2) Can be used on small and medium-sized farms.
Manual Sprayer	1) Can be used in any condition. 2) Can be operated by one person.	1) Small spray tank capacity it must be refilled frequently thus time is wasted. 2) Manual spraying is stressful and exhausting for the worker.	Can be used on small farms only.

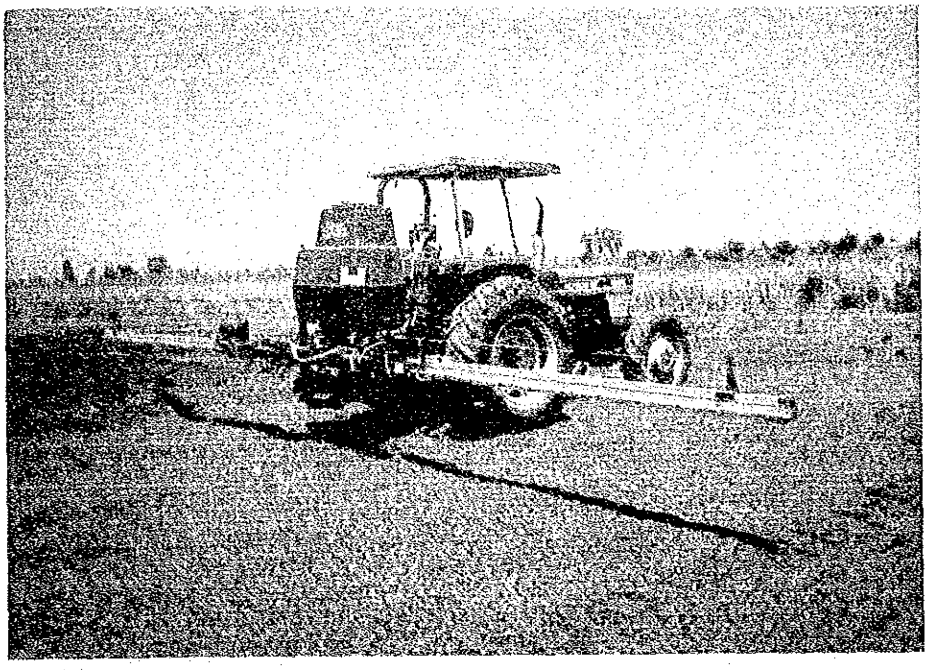


Fig2 Herbicide spraying test by the boom spryer in the Direct Sowing Cultivation Method on Dry Field.

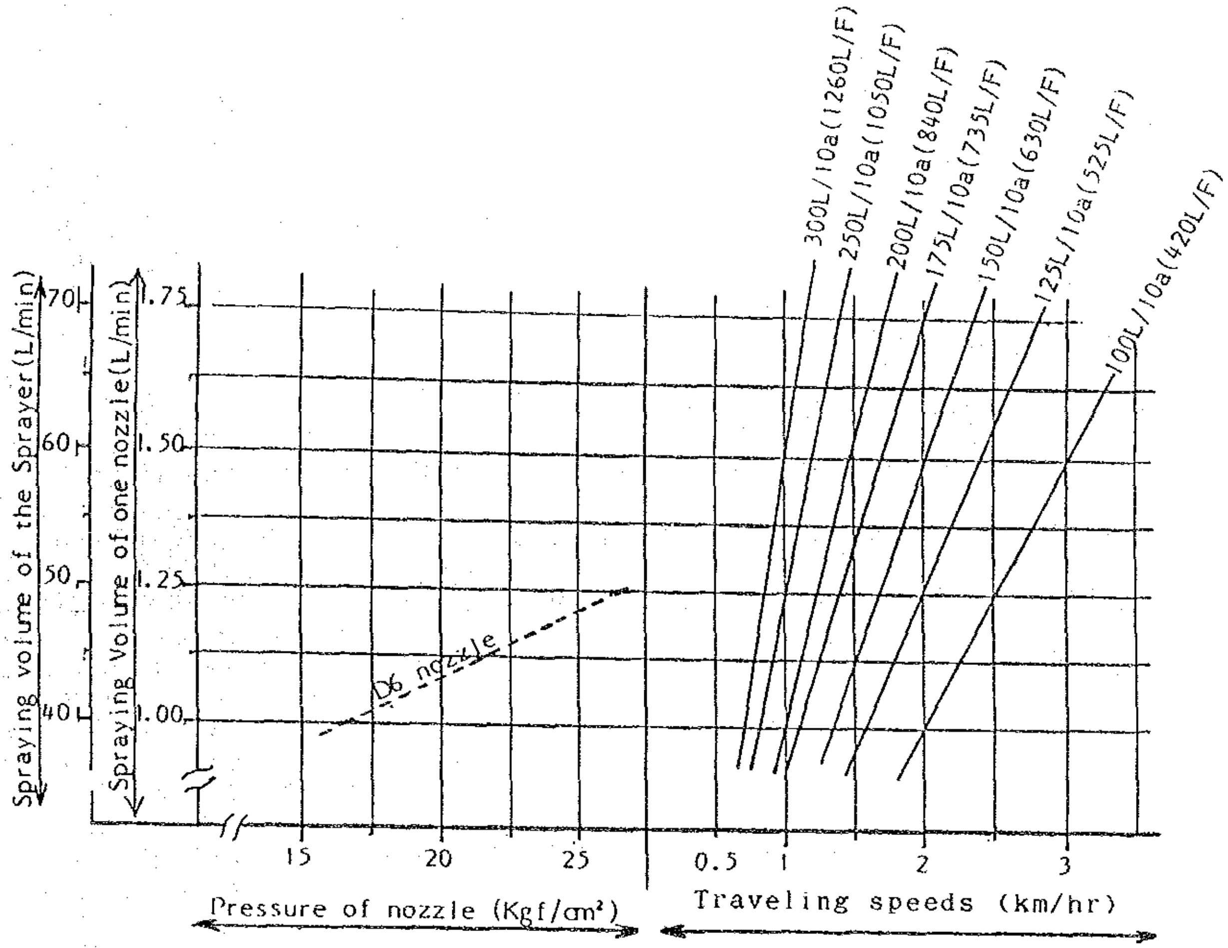


Fig.1. Relation between pressure of nozzle and spraying volume.

Note: $\text{Traveling Speeds} = \dfrac{\text{Spraying volume of one nozzle(L/min)}}{\text{Spraying volume for 10a(L)}} \times 200$

be done with a wide turning radius for the purpose of protecting the plants from traffic damage by tractor.

(ii) Sprayer for weed control in the direct-sowing cultivation method on flooded field :

Power sprayer, knapsack type power sprayer and manual sprayer can be used.

Table 1 shows advantages, disadvantages and suitable field of each sprayer.

b. Paddy weeds in the Nile Delta

Principal paddy weeds in the Nile Delta are shown in Table 1. Among them, Echinochloa crus-galli and Cyperus difformis (annual weeds), and Cyperus esculentus and Diplachne fusca (perennial weeds), are the most noxious. Weed amount and varieties seem to be comparatively less in crop-rotated fields, though they are not at a level in which protective means are not required. Weeds are observed in the farmers fields, though more weeds can be seen in the State farms.

In the direct-sowing cultivation method, C_4 plants (such as Echinochloa Spp. and Cyperus Spp.) may defeat rice plants in growth competition if no protective measures are taken. They are more virulent in the direct-sowing cultivation method on dry fields where no puddling takes place. In addition, in larger areas with the mechanized-cultivation system, management tends to be extensive and more weed prevalence is anticipated. That is why a sophisticated weed-control system is needed.

H. Morita (short-term expert) illustrated the major perennial weeds in RMC (Fig. 1-6). He also suggested their control measures, as is seen in the figures listed later on.

Table 1 Common Paddy Weeds in the Nile Delta

Annual Weeds:

Scientific Name	Family	Distribution
Echinochloa crus-galli	Gramineae	almost all paddy fields
Echinochloa colonum	Gramineae	almost all paddy fields
Cyperus difformis	Cyperaceae	RMC, Misir, Saft Khalid
Ammania baccifira	Compositae	RMC, Serw
Eclipta alba	Compositae	RMC, Serw
Xanthium strumarium	Compositae	RMC, Misir, Saft Khalid

Perennial Weeds:

Scientific Name	Family	Distribution
Cyperus rotundas	Cyperaceae	RMC
Cyperus esculentus	Cyperaceae	RMC,Misir,Gimmeza,S.Khalid
Panicum repens	Gramineae	RMC
Pasparam pasparoides	Gramineae	RMC
Cynodon dactylon	Gramineae	RMC
Scripus planiculmis	Cyperaceae	Idfina
Diplachne fusca	Gramineae	RMC, Serw.
Scripus tuberosus	Cyperaceae	RMC, Serw, Saft Khalid
Phragmites australis	Gramineae	Idfina

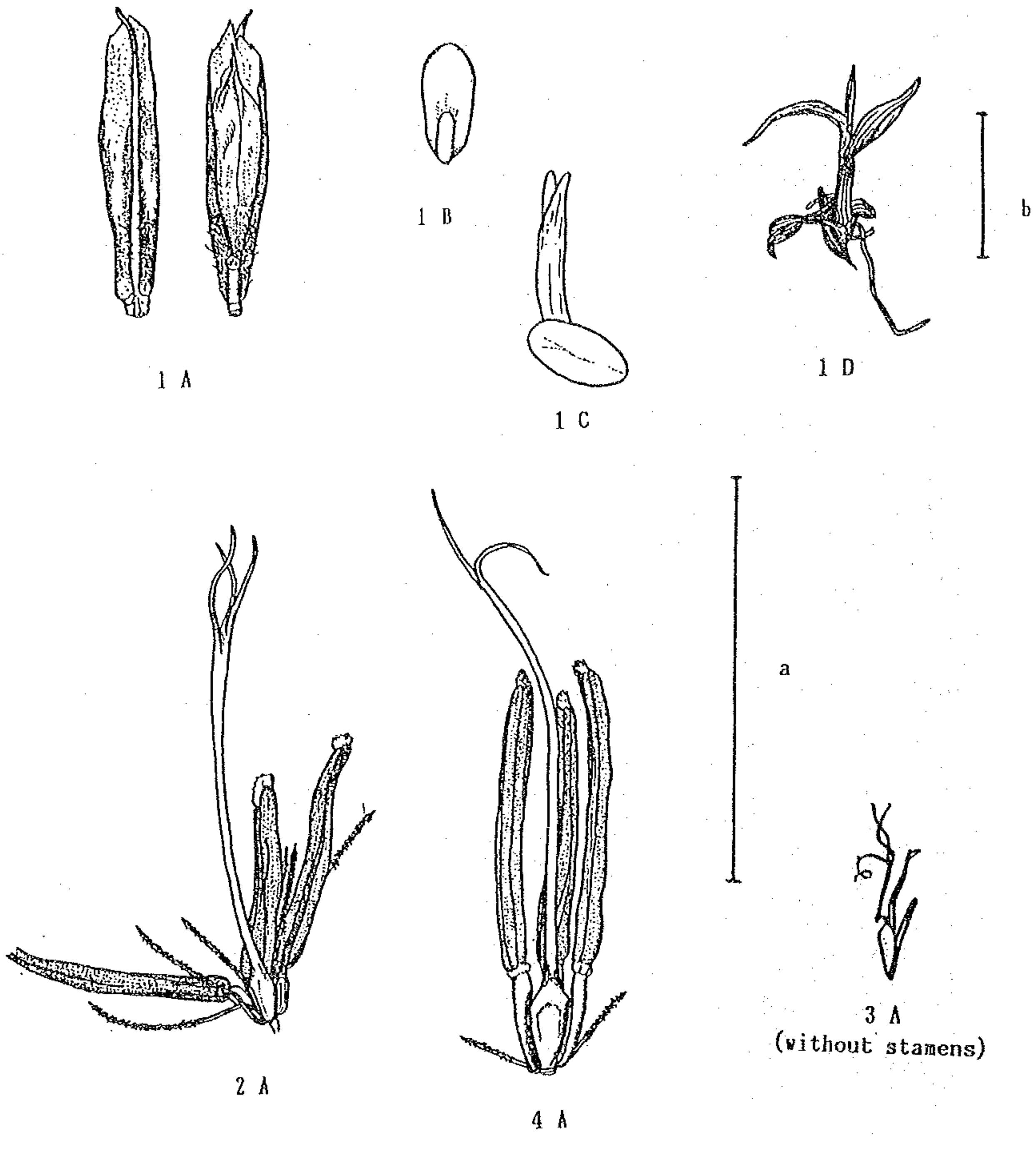


Fig. 1. Details of D.fusca(1), S.tuberosus(2), C.esculentus(3) and S.planiculmis(4).
A:floret B:caryopsis C:plumule D:seedling
scale: a-- 5mm b-- 9mm

Fig. 2. Diplachne fusca P.Beauv.,

R.M.C Meet El Dyba 13,Feb.,1988

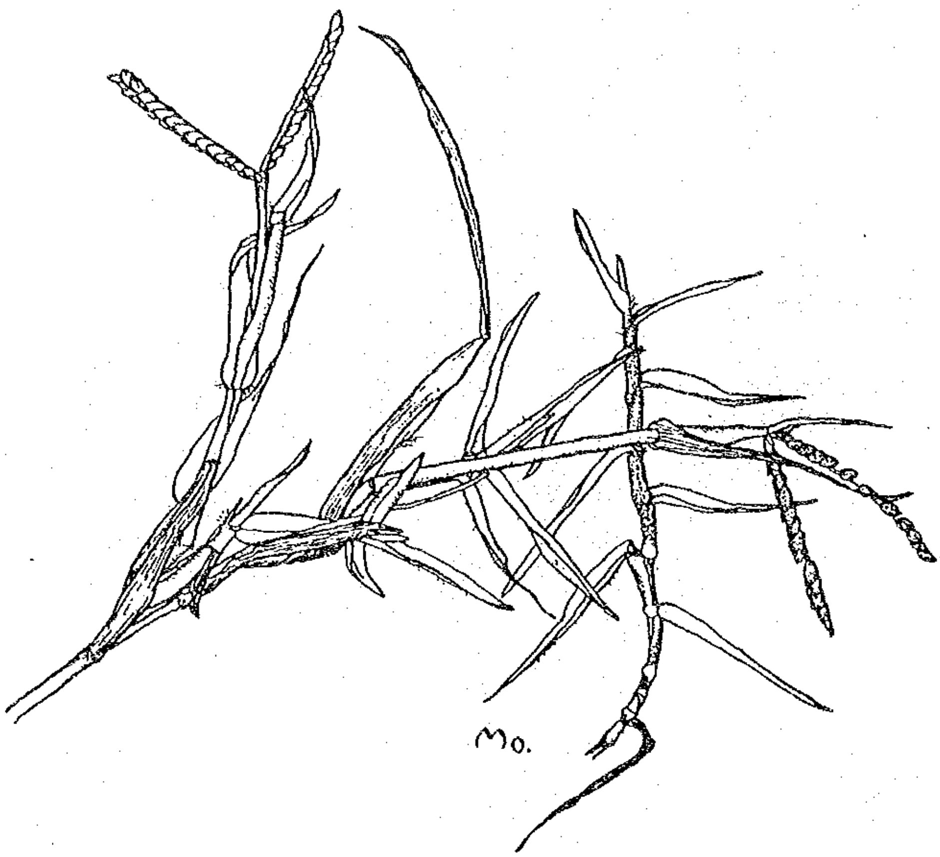


Fig. 3. Paspalum distichum L.,
R.M.C Meet El Dyba 15,Feb.,1988

Fig. 4. Scirpus tuberosus Desf.,
R.M.C Meet El Dyba 9,Feb.,1988

Fig. 5. Cyperus esculentus L.,
R.M.C Meet El Dyba 18,Feb.,1988

Fig. 6. Scirpus planiculmis Fr.Schmidt,
Idfina Satellite Farm, 22,Feb.,1988