RESULT OF SURVEY AND VERIFICATION TRAIL IN MACHINERY DIVISION, 1984

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I. Study on Plowing System

1. Changes in Soil Hardness in Spring Time

Object

Delta soil contains much silt soil, its particles are homegeous shows high hardness due to drying, making its plowing work specific. Therefore, the vertical change in soil hardness of wheat are Bersim (Egyptian clover) fields, the main previous crop of paddy rice, during the period from the last day of irrigation to plowing time.

Method

1) Experimental field: Wheat and Bersim fields cultivated by farmers.
2) Measurement of soil hardness: Drug each field to make vertical distribution of soil and pushed in the hardness tester horizontally. Measurement was taken every 5 days starting on the 10th days after the last irrigation for each crop (May 13 - June 25), at an interval of 5 cm from the surface to the depth of 50 cm.
3) Type of soil tester: Used the Yamanaka type soil tester, measurement is shown in the average value of 3 points.

Result

The measurement value has been arranged in the form of changes in the vertical distribution of soil hardness as indicated in Fig. 1 and 2. Fig. 1 shows the case of Bersim field, where the soil hardness untill the 20th days after irrigation is almost the same in its vertical distribution, but surface layer's hardness increase on and after the 25th, especially in the layers above 10 cm on and after the 35th as a special feature. On the other hand, there is little change in the layers deeper than 15 cm.

Fig. 2 shows the vertical distribution of hardness in wheat field. It shows generally the same trend as Bersim field, but an increase in hardness starts in the layers near the surface earlier than Bersim field, showing marked hardness at the harvest season of wheat.

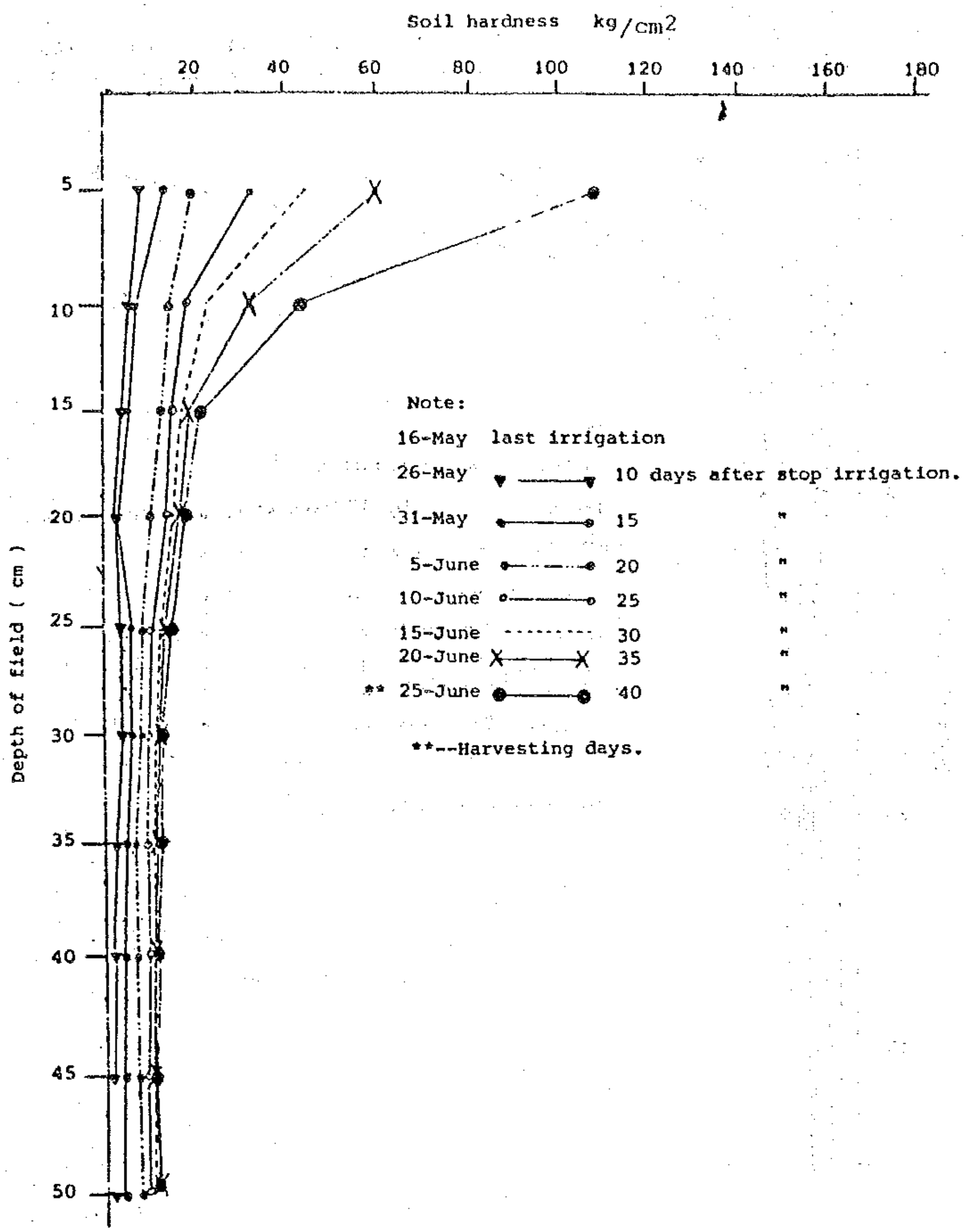


Fig. 1 Vertical distribution of soil hardness after last irrigation in clover field

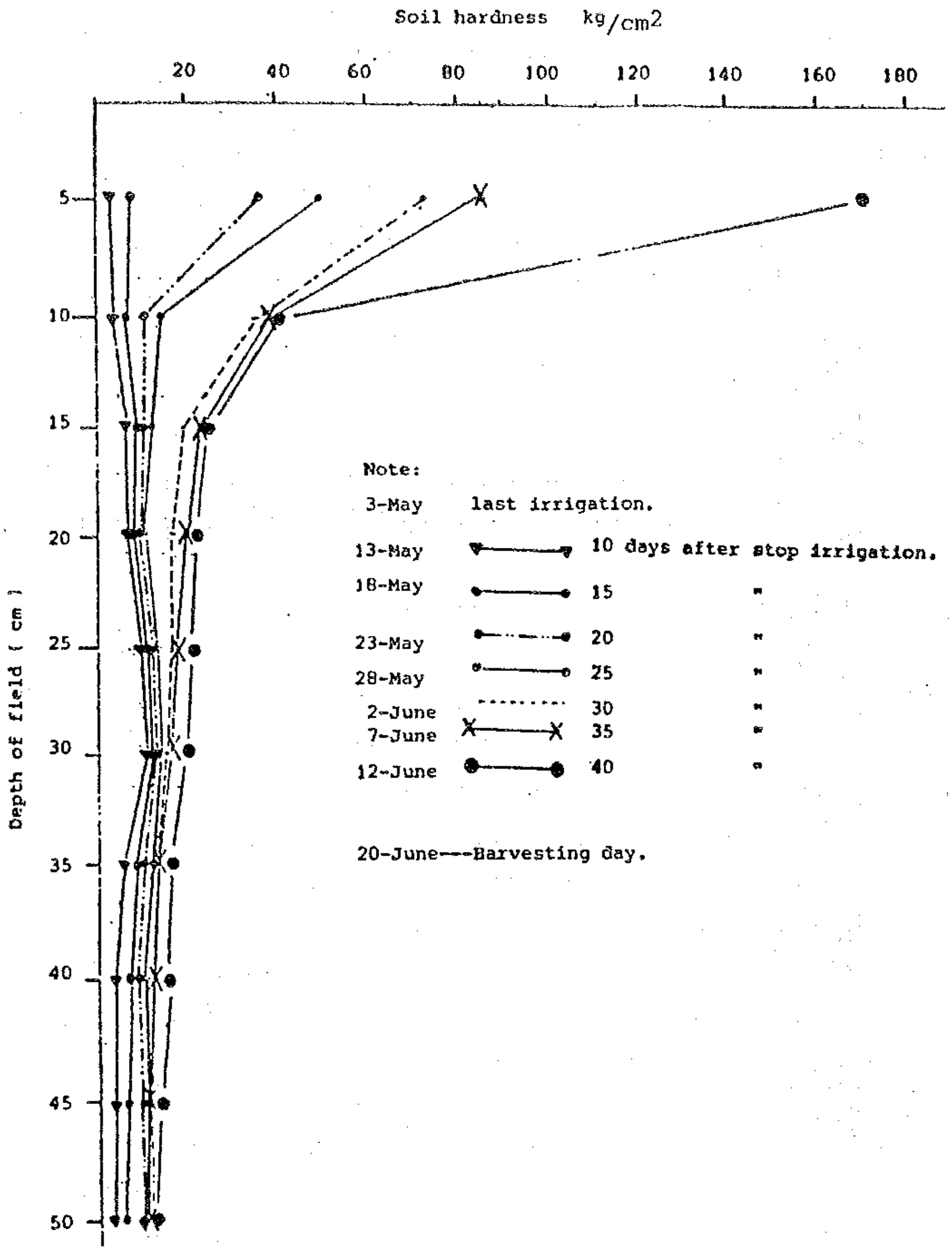


Fig. 2 Vertical distribution of soil hardness after last irrigation in wheat field

As stated above, it has become clear that soil hardness near surface differs very much according to the variety prerivous crops untill the time of plowing. The difference is considered to be due to different evaporation rate from the surface of soil caused by the structural different in plant cover, and to difference in crop's transpiration rate. It is scheduled to develop studies based on these data, because the soil hardness at plowing has a close relation with the selection of plowing method.

2. Establishment of Plowing System

Object

A complete rotation system is adopted in the Delta areas, and all crops are cultivated by irrigation. Generally, the plowing work of paddy rice is performed after the lapse of 30 - 40 days from the last irrigation for previous crops, and the rate of water content in soil is very low due to dry climate, showing extremely high soil hardness. Therefore, it had studied plowing methods which are suitable for such a high soil hardness.

Method

1) Plowing time: Assuming previous crops to be wheat and Bersim, studied 3 kinds of plowing methods, on the 30th days and the 45th from the last irrigation, respectively.
2) Plowing methods: a) Chisel plowing with tractor - 50 PS, working width 1.6 m. b) Rotary plowing with tractor (straight shink type blade) - 45 PS, working width 1.3 m. c) Rotary plowing with tractor (L-shaped type blade) - 45 PS, working width 1.3 m. The working speed was adjusted of chisel plow at 0.71 m/s, rotary straight shink type blade and L-shaped type blade at 0.58 m/s, and all plowing depth at 15 cm.
3) Plowing frequency: One plow and two plows, respectively.
4) Measurement of soil crush ratio: Classified sizes of clod after plowing and indicated in the rate weight/m^2.

Result

Results of survey are indicated in Table 1, Fig. 3 and 4. As shown, clod diameter of the 30th day plow is larger than that of the 45th day plow for all plowing methods, which clearly shows that clod diameter becomes larger as soil hardness increases. Besides, soil breaking rate improves in the two plow method as compared with the one-low in all plowing methods as regards plowing frequency.

As for the effect of difference of plowing method on crush ratio, chisel plowing has larger clod distribution than rotary plowing, showing interior crush ratio.

Table 1. Percentage of Clod Diameter and Plowing System Relationships

Plowing System	Plowing time	30	45	30	45	30	45	30	45	30	45	30	45
Clod diameter (cm)		< 2		3		5		8		10 <		Total (%)	
Chisel plowing	1	27.96	11.8	10.30	9.97	10.80	7.00	16.92	9.23	34.02	62.00	100	100
	2	33.24	16.4	10.05	5.89	11.30	10.29	15.46	19.83	29.95	47.59	100	100
Rotary plowing pow knife	1	48.76	9.73	20.04	12.17	12.27	12.87	14.44	16.34	4.49	48.89	100	100
	2	61.34	21.62	20.90	24.98	13.48	26.42	4.28	18.92	–	8.06	100	100
Rotary plowing straight knife	1	61.73	11.47	25.51	9.17	12.76	12.94	–	32.29	–	34.13	100	100
	2	78.44	18.27	16.54	14.27	5.02	24.17	–	30.26	–	13.03	100	100

Notes:

	Soil hardness kg/cm^2	Rate of moisture content (%) 15 cm depth average.
30 days	18	11
45 days	33	9

Neither of the rotary plowing methods is considered suitable especially for the 45th day plowing when the surface soil hardness is very high, making it impossible for blade to reach the predetermined depth. As a result of observation of soil crush by irrigation after plow, complete crush of large clod over 10 cm diameter was confirmed in about one hour.

It was also made clear that there is no difference in crush ratio in the case of mechanical puddling after crush.

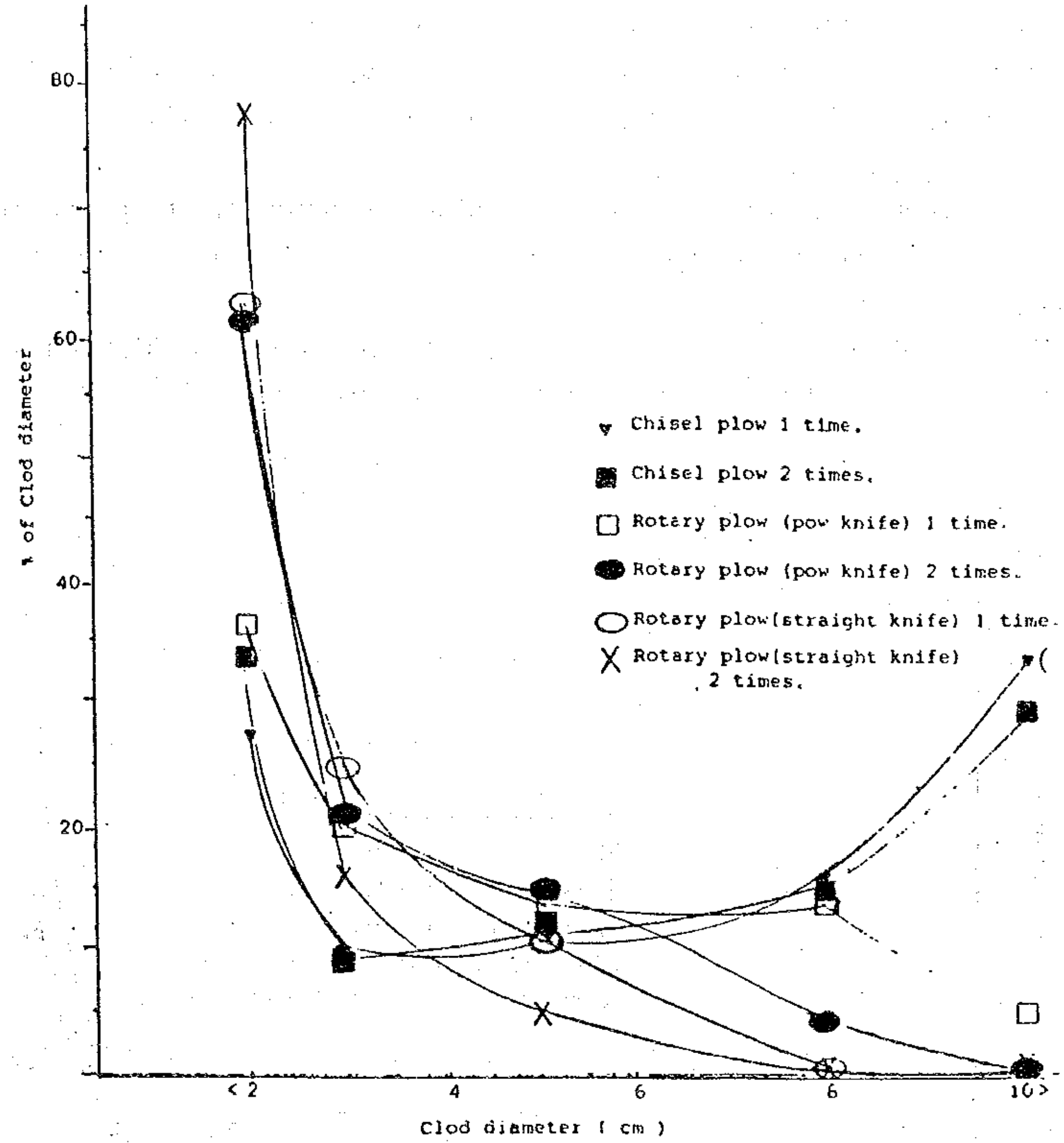


Fig. 3 The relationship between plowing system and variation of clod diameter after stop irrigation 30 days

Regarding the difference in crush ratio according to the kinds of blade in rotary plowing, the straight shink type blade has higher crush ratio that L-shaped type blade for both the 30th and the 45th day plows.

On many occasions, however, both type blades do not reach to the predetermined depth, because weeds and straws of previous crops tangle with these blades in plowing.

It is necessary to increase plowing frequency to reach the plowing depth of 15 cm.

Although Nile Delta soil shows remarkably high hardness due to its high silt content and dry climate, its soil grains easily separate by containing water due to the high degree of base satulation.

Therefore, the degree of crush ratio according to the difference of plowing method in paddy rice cultivation does not give any influence on transplanting.

In conclusion, rotary plowing is definitely superior to chisel plowing in crush ratio, but irrigation and puddling eliminate difference between the two.

The conclusion was reached that chisel plowing, which has higher performance and efficiency than rotary plowing, is more practical.

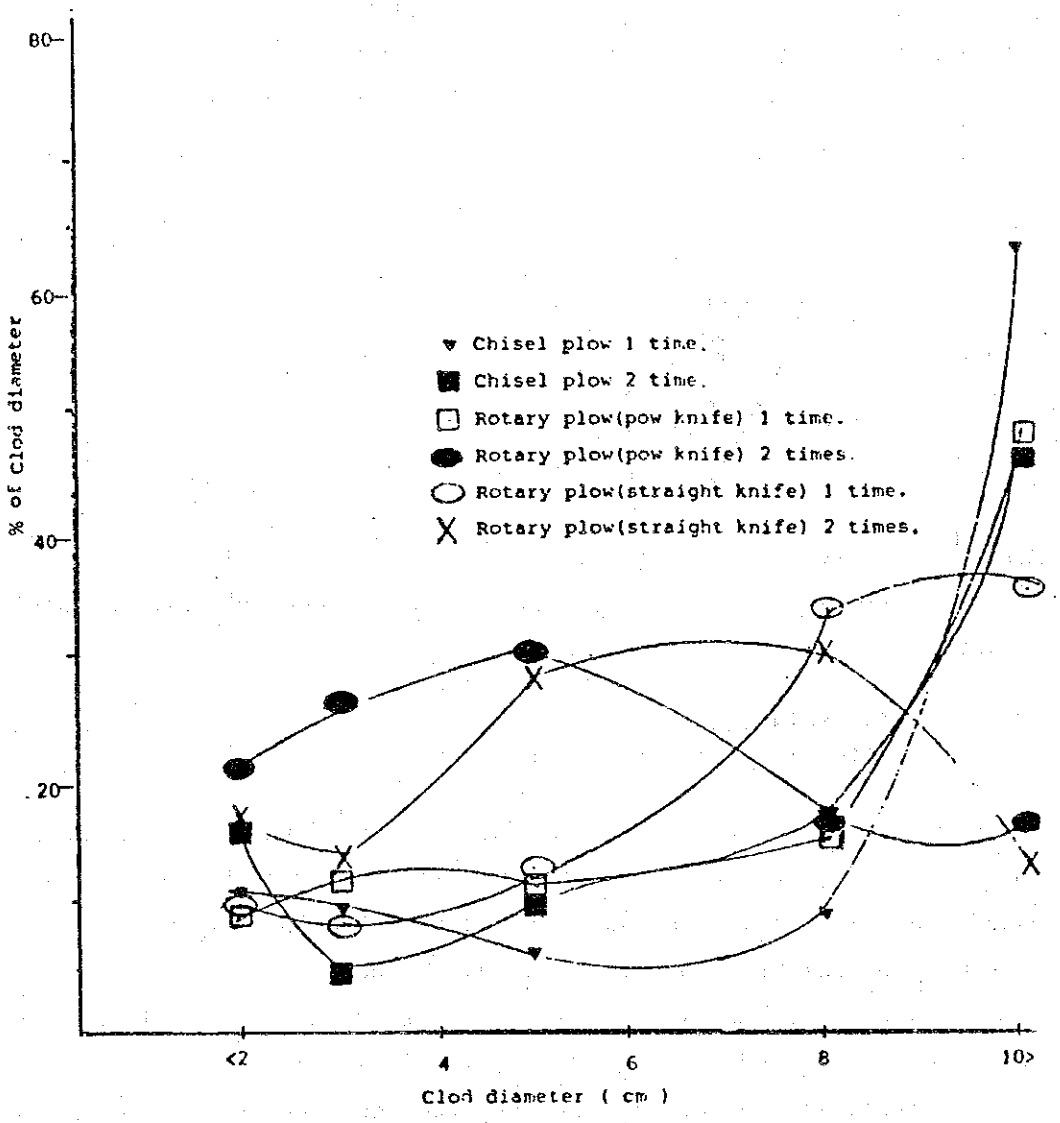


Fig. 4 The relationship between plowing system and variation of clod diameter after stop irrigation 45 days

II. Suitable Working Method of Walking Type Transplanter

Object

When Delta soil contains water, it shows a separation property and stickiness after being degraded. So, riding type of transplanter is preferred to walking type which causes more fatigue for workers.

However, there is much difference in price and selection of a suitable kind of machine is considered necessary according to the scale of operation. So, it has studied the suitable working method for walking type transplanter.

Method

1) Plowing depth: 15 cm, rotary plowing with tractor - 45 PS.
2) Puddling: Puddling rotary with tractor - 45 PS.
3) Measurement of cone index interpenetration: Dropped a cone index of 112 grs., 30° from 1 m height above ground to measure interpenetration.
4) Measurement of degree of worker's fatigue: As direct measurement of fatigue is difficult, wooden artificial footprints was made and rest the weight (60 kg), 300 grs/cm^2 to measure the depth of penetration into the soil and the strength to pull them out (kg).

Result

Fig. 5 shows relation between variation of cone index and days after puddling.

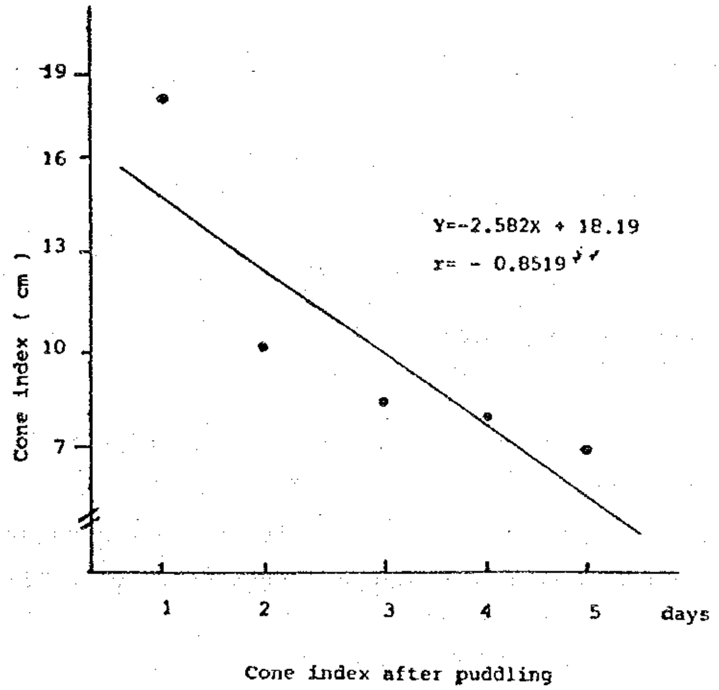


Fig. 5 Relation between variation of cone index and days after puddling

As indicated in the sketch, the cone index on the first day after puddling is very high and mechanized transplanting is impossible, but the cone index on the second day is 10.36 cm, which is within the limits of suitable mechanized transplanting.

Worker's fatigue relates with two elements; depth of interpenetration of foots into soil and soil's stickiness from which foots are withdrawn.

Therefore, the firstly investigated relation between days after puddling and depth of interpenetration of artificial footprints on Fig. 6.

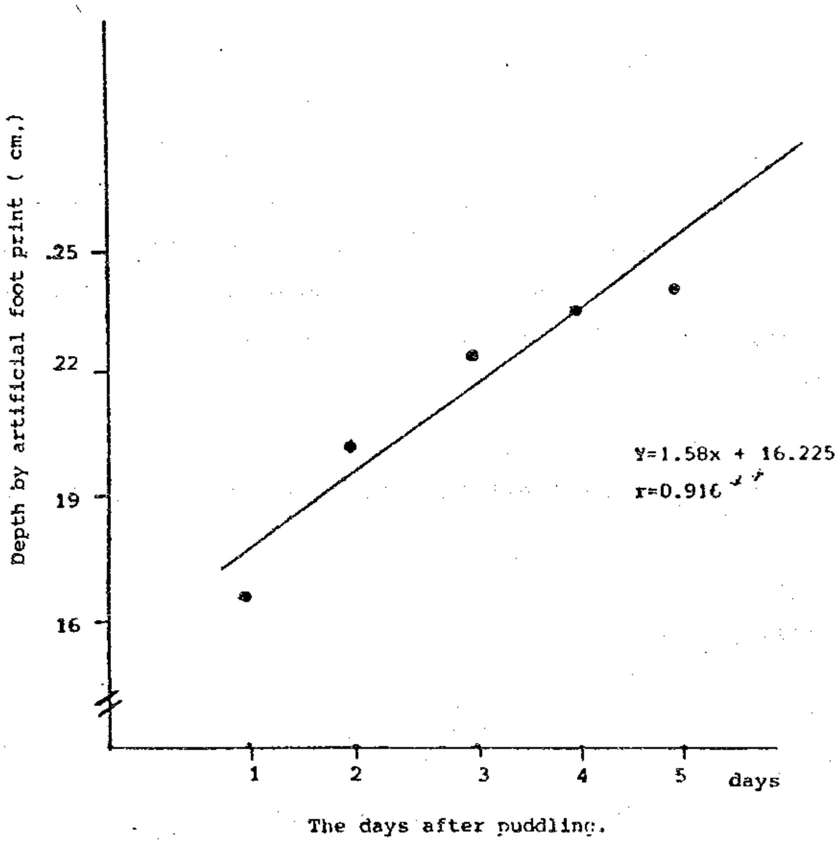


Fig. 6 The relationship between the days after puddling and depth by artificial footprint

According to it, the interpenetration depth tends to increase in a straight line with the lapse of time even for the plowing depth of 15 cm.

This means that the degree of fatigue by walking increases as irrigation water permeates lower layers and softens earth bearing power.

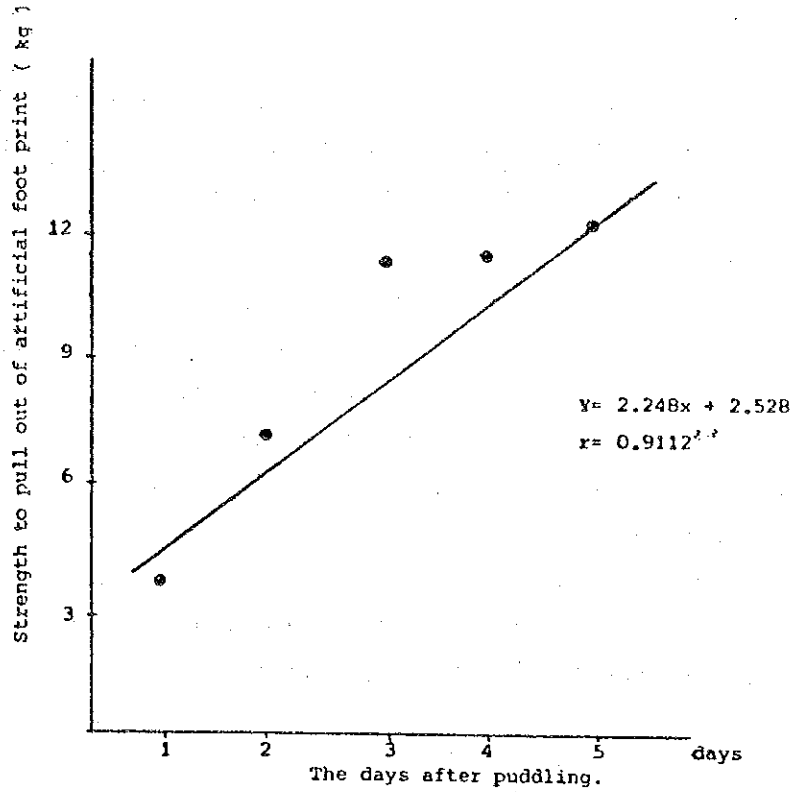


Fig. 7 Relations between pull out kg/foot and days after puddling

Fig. 7 shows relations between pull-out kg/foot and days after puddling. According to it, strength required for puddling out wooden footprints increases with the lapse of days after puddling, the strength of 3.29 kg required on the first day after puddling rises to 7.31 kg on the second day and to 11.65 kg on the third day. It is clear that require double the strength of the second day on the third day when compare the strength required to pull out footprints, which show the cone index within the most suitable transplanting limits.

In other words, it is assumed that the fatigue at the time of operation of a walking type transplanter relates to both the depth of penetration of feet into the soil and the strength required to pull them out, and conducted a trial demonstration using artificial wooden footprints.

As a result, the cone index shown on the second day was already within the limits of most suitable transplanting, with remarkably less fatigue as compared with the third day. Thus, it is considered the second day is the most suitable working time for walking type transplanter.

III. Improvement in Seedling Establishment in Mechanized Direct Sowing Culture on Dry Field

Object

Studied relationship between the plowing method and the seedling establishment in mechanized direct sowing culture on dry field with the purpose of cutting down expenses of nursing seedling and transplanting.

Method

1) Plowing method: 2 methods has employed. a) Chisel plowing with tractor - 50 PS, working width - 1.6 m, working speed per seond - 0.80 m/s.
   b) Rotary plowing (L-shaped type blade) with tractor - 35 PS, working width - 1.3 m, working speed per second - 0.58 m/s.
2) Plowing depth: ± 15 cm.
3) Frequency of plowing: 1, 2 and 3 plow.
4) Seed drill: Tractive type by 50 PS tractor, working width - 2 m.
5) Measurement of classified crushed soil: Classified clods per m^2 by size after plowing, and showed them in weight ratio.

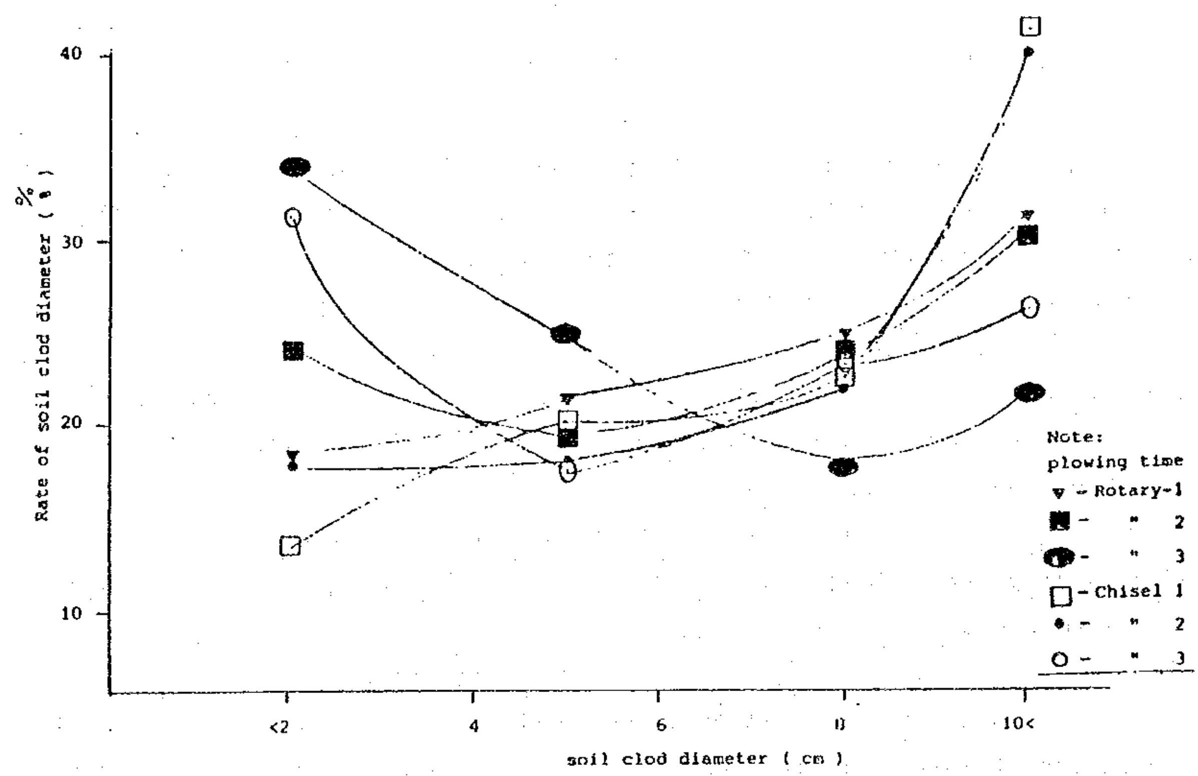


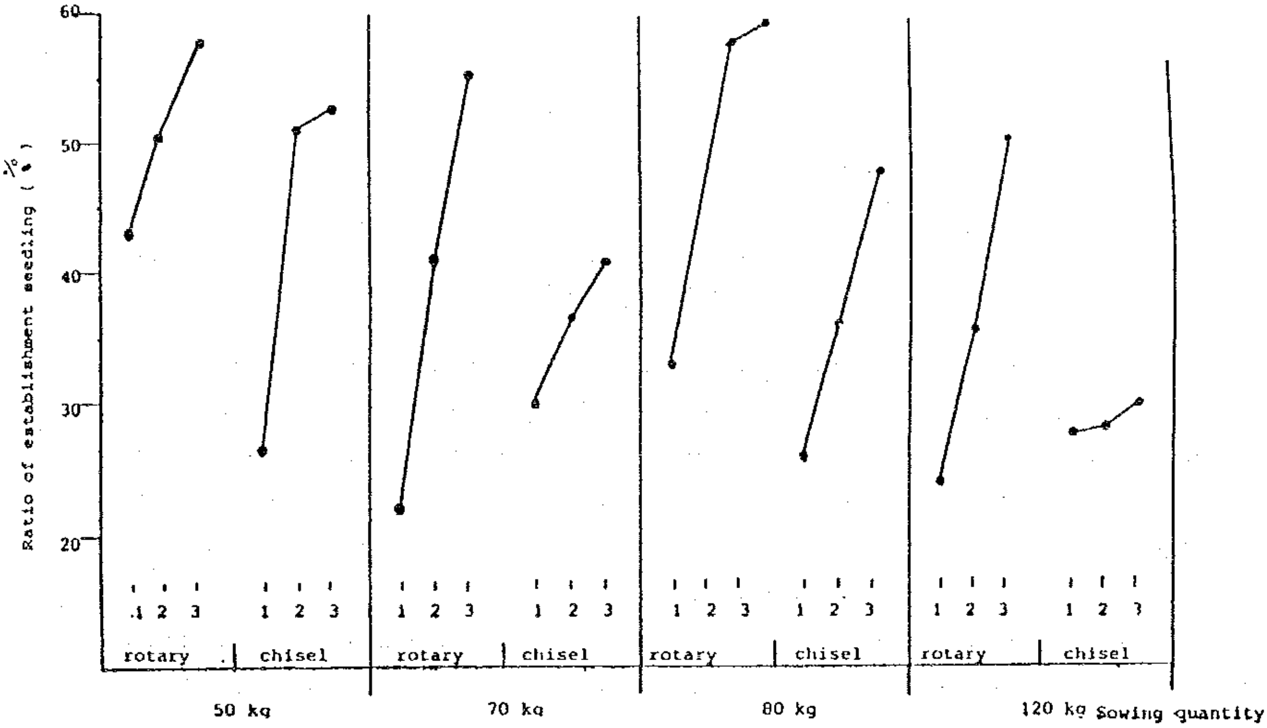
Fig. 8 The relation between rate of soil clod diameter and number of plowing

Result

Fig. 8 indicates the relation between rate of soil clod diameter and the number of plowing. According to it, as the number of plowing increases for both rotary and chisel plowing, the rate of soil clod with 2 cm diameter becomes larger.

Namely, the rate of 2 cm dia. clod is rotary 3 plow > chisel 3 plow > rotary 2 plow > rotary 1 plow > chisel 2 plow > chisel 1 plow.

Fig. 9 shows the relation between the number of plowing and seedling establishment ratio. According to it, as the number of plowing increases for both rotary and chisel plowing, seedling establishment improves under any sowing quantity. It was arranged the above in the relation between the ratio of 2 cm soil clod diameter in each experimental division and the ratio of seedling establishment in Fig. 10.



Notes: 1.2.3--- number of plowing by chisel and rotary.

Fig. 9 Relations between establishment of seedling and number of plowing

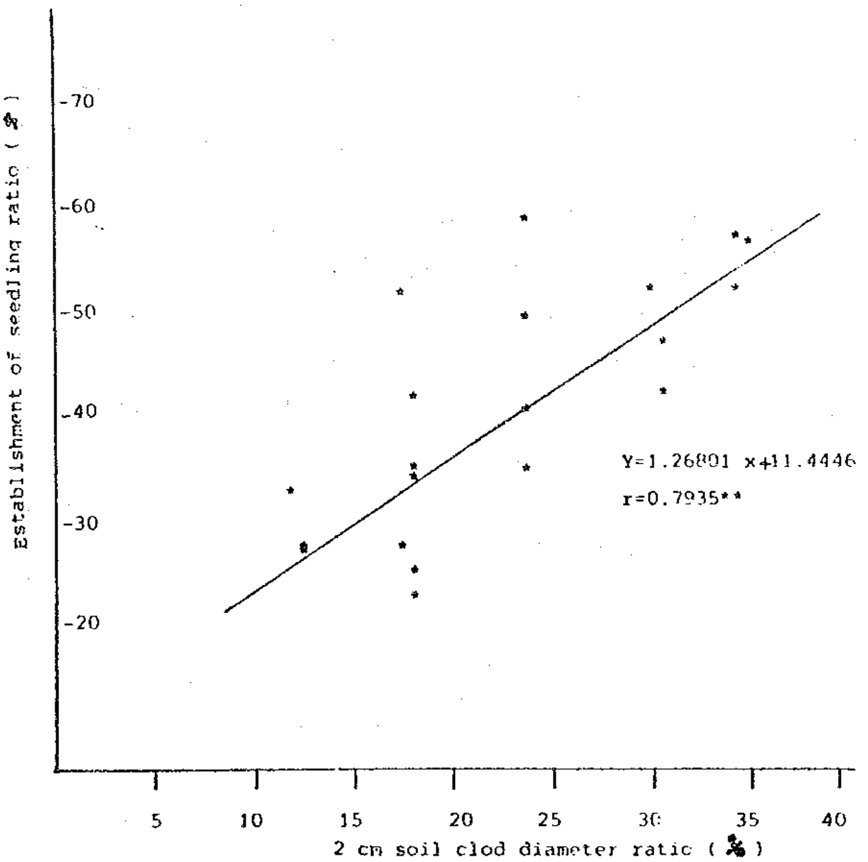


Fig. 10 Relationship between 2 cm soil clod diameter ratio and establishment of seedling ratio

According to it, a close positive correlation is recognized between the increase of 2 cm soil clods and seedling establishment. The plowing method with rotary or chisel - 3 plow shows higher seedling establishment rate. However, the chisel 3 plow method is considered more practical in view of the rate of work under the condition of remarkably low content of soil as stated in the preceding item.

The further studied the cause for the lower seedling establishment in soil clods over 2 cm diameter, and found out that the seeds sown in large soil clods considerably increased their sowing depth by crushing after irrigation and lowered seedling establishment ratio.

As shown in Fig. 11, sowing depth and establishment of seedling has a close negative correlation, a fact which indicates the absolute necessity of raising soil crushing ratio for stabilization and improvement of seedling establishment in the direct sowing in dry fields.

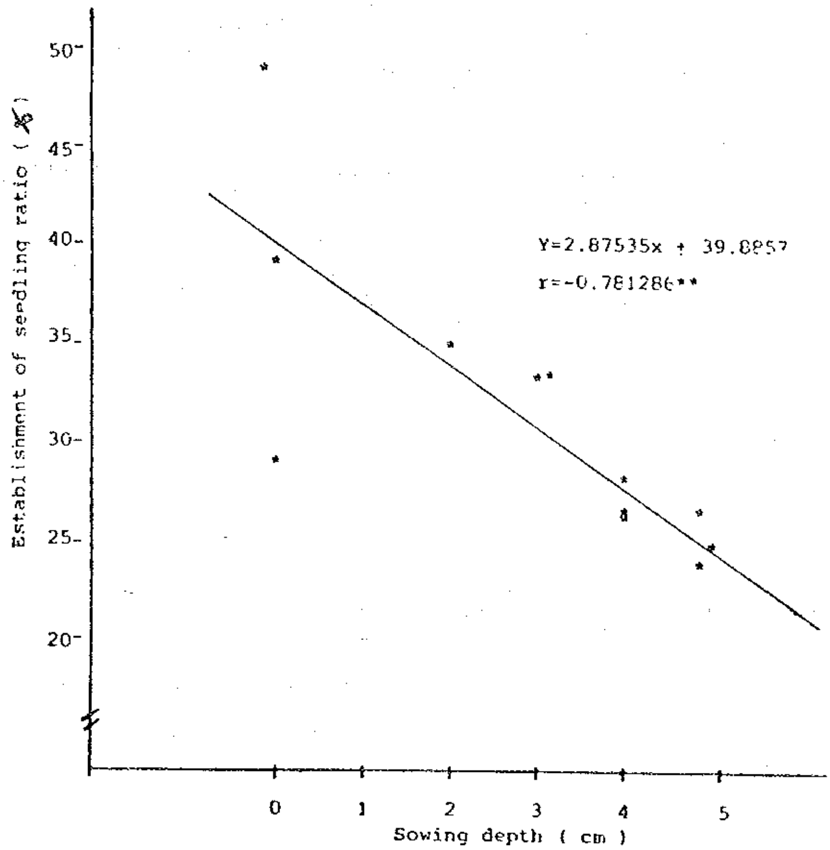


Fig. 11 Relationship between sowing depth and establishment of seedling ratio

IV. Mechanized Harvesting Technology

1. Reaper Harvesting Machine

Object

A reaper harvesting machine as one of the mechanized harvesting systems, which have studied the working rate and the operation accuracy of the reaper, assuming a system of combination of a reaper with a self-propelled automatic harvester.

Method

1) Date of harvesting: October 15
2) Name of variety: Giza 172 and 173
3) Length of experimental division: The machine operated 3 times on a 10 m division with an approach run of 5 m.
4) Grain losses: Head grain loss is indicates in the average value of 3 points, collecting falling grains in the experimental division after harvesting.

5) Soil hardness (ground contact): It is indicated in the average value at 3 points using the Yamanaka type hardness tester.

6) Plant lodging degree: An angle formed by vertical direction and culm.

7) Decleaning degree: An angle formed by culm and the surface of land as the base line.

Table 2. Specification of Reaper used for Trial

Model Name	AR-120
Dimensions	
Overall width (cm)	147
Overall length (cm)	239
Weight (kg)	116
Engine section	
Type	4-cycle, air cooled gasoline
Rated out put	3.3 ps/1800 r.p.m.
Drive section	
Shifting	Forward 1. Reverse 1. possible to
Speed (m/s)	0.80 adjust by acceleration
Dimensions of wheel	
Width (cm)	18
Diameter (cm)	43.5
Reaping	
Reaping System	Reciprocating
Reaping width (cm)	120

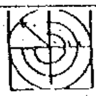
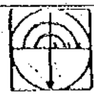
Result

Paddy rice plant lodging is the biggest bottleneck in mechanized harvesting.

In examining the reaping performance of this kind of machine, it was used a variety which is the most easily lodged - Giza-172, and conducted reaping experiment on groups of different lodging degree. The results are mentioned in Table 3 and 4. According to Table 3, the reaper can mow from any direction for the group of plant lodging degree of 44.4°, and head grain loss shows no change for mowing from any direction; an average loss of 0.23%. Table 4 indicates the case of higher plant lodging degree of 62°. In this case mowing from the opposite direction and right direction against lodging is impossible, but mowing from any other direction is possible with nearly the same grain losses as the case of 44.4° lodging.

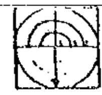
In conclusion, there is a close relation between establishment of seedling ratio and soil crushing ratio, and it is necessary to raise crushing ratio of soil so that the diameter of clod may become smaller than 2 cm, and under the conditions of Egypt, chisel 3-plow is more practical than rotary.

Table 3. Performance Test for Reaper

Item \ Standing direction		1	2	3	4
					
Testing condition	Variation of moisture content 1st day	16.1%	16.1%	16.1%	16.1%
	" 2nd day	14.9%	14.9%	14.9%	14.9%
	" 3rd day	14.7%	14.7%	14.7%	14.7%
	Harvesting time sec/10 m	12.8	12.5	12.5	13.3
	Harvesting speed m/s	0.78	0.80	0.60	0.75
	Plant lodging deg	44.4°	44.4°	44.4°	44.4°
	Decleaning deg	45.6°	45.6°	45.6°	45.6°
	Hardness kg/cm^2	5.6	5.6	5.6	5.6
	Cutting height cm	9.9	9.7	8.9	10.4
Performance	Straw weight (50% moisture) $kg/10\ m^2$	8.24	8.60	7.52	8.12
	Grain weight (14% moisture) $kg/10\ m^2$	4.764	4.971	4.439	4.692
	Losses weight by head $grs/10\ m^2$	14.8	7.2	5.6	18.5
	Percentage of head loss	0.30%	0.14%	0.12%	0.39%

Note: Variety - Giza-172

Table 4. Performance Test for Reaper

Item \ Standing direction		1	2	3	4
					
Testing condition	Variation of moisture content 1st day	Impossible	14.5	14.5	Impossible
	" 2nd day		14.2	14.2	
	" 3rd day		14.2	14.2	
	Harvesting time sec/10 m		12.5	12.5	
	Harvesting speed m/s		0.80	0.80	
	Plant lodging deg	62.00°	62.00°	62.00°	62.00°
	Decleaning deg	28.00°	28.00°	28.00°	28.00°
	Hardness kg/cm^2		2.8	2.8	
	Cutting height cm		18.42	10.30	
Performance	Straw weight (50% moisture) $kg/10\ m^2$		10.40	10.40	
	Grain weight (14% moisture) $kg/10\ m^2$		6.740	6.740	
	Losses weight by head $grs/10\ m^2$		22.22	12.73	
	Percentage of head loss		0.32	0.19	

Note: Variety - Giza-173

Table 5. Field Working Efficiency for Reaper

Variety: Giza-173
Area: 87 m x 380 m = 3306 m^2

Standing angle: 80
Time (20 m): 24.14 second

	Actual working time								Turning time								Adjusting time for trouble		
	1		2		3		4		1		2		3		4		Time		Items
	m	s	m	s	m	s	m	s	m	s	m	s	m	s	m	s	m	s	
1	1	45	–	36	1	50	–	35	–	5	–	–	–	–	–	15	1	20	Feeding over limit
2	1	45	–	36	1	45	–	35	–	5	–	–	–	–	–	5	–	40	"
3	1	43	–	35	–	45	–	35	–	–	–	–	–	–	–	–	5	–	"
4	1	48	–	35	1	48	–	35	–	3	–	–	–	2	–	–			
5	1	30	–	35	1	25	–	20	–	3	–	–	–	–	–	–			
6	1	50	–	12	1	42	–	15	–	2	–	–	–	2	–	–			
7	1	43	–	12	1	41	–	10	–	1.5	–	2	–	1.5	–	–			
8	1	41	–	10	1	42	–	8	–	1.5	–	10	–	1	–	–			
9	1	40	–	7	1	42	–	7	–	–	–	1	–	10	–	–			
10	1	45	–	5	1	55	1	45											Working efficiency
11	1	47	–	15	1	45	–	15											
12	1	55	–	7	1	45	–	10											88.24%
13	1	49	–	10	1	45	–	15											
14	1	45	–	7	1	43	–	7											
15	1	43	–	5	1	45	–	4											
16	1	40																	
Total	27	49	4	27	24	58	4	56	–	21	–	13	–	16.5	–	20	7	–	Total working hour 1 hr 10 min 84 se

Table 5 shows reaper's effective field capacity for Giza-173, which has no plant lodging. According to the Table, operation rate is 1.30 hours per feddan and working efficiency if 88.8%.

The reason for this high efficiency is the machine's simple operability for operators, being capable of a small sharp turn.

The machine can mow even field corners continuously, and this is one of the reasons for its high performance.

No problem was found in operability even under the condition of cone index (ground contact) of 5.6 kg/cm^2.

As explained above, investigation on the mowing performance of reaper assuming a harvesting system by combination of reaper and automatic harvester, showed a high efficiency of working rate of 1.30 hours per feddan and working efficiency of 88.8% for non-plant lodging field. Mowing is possible from any direction at the lodging degree of 44.4° and head grain loss is very low.

In the most difficult mechanized mowing for large plant lodging, mowing is possible from any direction except opposite and right direction, with no increases in grain losses.

In conclusion, reaper's performance is very high, and a combination system of reaper and self-propelled automatic harvester is very promising.

2. Harvester (Ear head threshing type mounted on auto-crawler)

<u>Object</u>

The trial test was carried out the rate of work and operation accuracy of this machine as a combination system with reaper.

<u>Method</u>

1) Name of variety: Giza-173
2) Method of reaping and drying: Natural drying on the ground for 2 days after reaping with reaper.
3) Method of feeding to harvester: After drying, collect paddy straws at a certain interval, and move the harvester there. Manually feeding rice plants to the threshing room from the top of panicle.
4) Grain losses: Unthreshed grain loss = measured unhulled rice sorted from waste straw. No. 3 chaff grain loss = measured unhulled rice in waste straw scattered from No. 3 chaff.

Table 6. Specification of Harvester used for Trial

Model Name	HH-701
Dimensions	
Overall width (cm)	243
Overall length (cm)	260
Weight	552
Engine section	
Type	4-cycle, water cooled
Rated out put	7 ps/2400 r.p.m.
Drive section	
Driving method	Rubber crawler in endless form
Shifting	Forward 3, Reverse 1
Crawler width (cm)	40
Threshing section	
Diameter of threshing	
Drum x width (mc)	42 x 51
Drum r.p.m.	480
Selection	Swing, winnower and suction in combination

Result

The collected paddy straw dried for 2 days after reaping with reaper at predetermined places and threshed them moving harvester.

Table 7 shows the rate of work of harvester. In the case of Table 7, the machine was rather old and had many mechanical troubles, requiring 7 hours 21 minutes per feddan.

Table 7. Field Working Efficiency for Harvester

Actual working time	Time for transfer harvester	Time for adjusting of troubles	Name of troubles
1 hour 16 min 55 sec	30 sec	2 min 00 sec	Grain conveyer obstructed
	25 sec	6 min 45 sec	Chaff outlet obstructed
	25 sec	5 min 30 sec	Grain conveyer obstructed
	50 sec	10 min 15 sec	Chaff outlet obstructed
	1 min 40 sec	14 min 30 sec	Chaff outlet obstructed
Total 1 hour 16 min 55 sec	3 min 50 sec	39 min 00 sec	
All total working hours			1 hour 59 min 45 sec

Notes: Variety: Giza-173

Field size: 38 m x 30 m (1140 m^2)

Grain moisture: 15.5%

Straw moisture: 51.0%

Total threshed grain weight: 749.84 kg

Field working efficiency: 46.9%

Convert to Feddan

Working hours: 7 hrs 21 minutes

Table 8. Performance Test for Harvester

Name of items for survey	Results	Convert to Feddan	Remarks
Working time (sec/10 m^2)	51	5 hours 57 minuts	
Weight of grain (gr/10 m^2)	6577.50	2.7526 ton/Feddan	7.735 kg/min.
Weight of straw (gr/10 m^2)	7000.00	2.9400 ton/Feddan	8.235 kg/min.
Weight of chaff (gr/10 m^2)	836.50	351.330 kg/Feddan	984.12 gr/min.
Moisture of grain %	15.50		
Moisture of chaff %	51.00		
Losses before threshing (gr/10 m^2)	156.33	65.659 kg/Feddan	From reaping up to just before threshing
Unthreshed loss (gr/10 m^2)	56.53	23.743 kg/Feddan	
Chaff loss (gr/10 m^2)	8.88	3.730 kg/Fed an	
Total grain weight (gr/10 m^2)	67799.24	2.856 ton/Feddan	
Total loss weight (gr/10 m^2)	221.74	93.131 kg/Feddan	
Losses before threshing %	2.30		
Unthreshed loss %	0.83		
Chaff loss %	0.13		
Total losses %	3.26		

Note: Variety - Giza-173

The rate of work without such troubles was 4 hours and 47 minutes. In this system, paddy straws were no binding due to mowing with reaper, and feed them truing up the top of panicles.

The feeding quantity of paddy straw was rather insufficient due to lack of practice.

Working hour would be reduced by increasing feeding quantity. Table 8 indicates operation accuracy. It is worth notice that No. 3 chaff grain loss (0.13%) and unthreshed loss (0.83) are very small.

As stated above, top of panicle were not trued up and unthreshed grains were left due to lack of practice. Therefore, it is considered possible to decrease the loss by getting skillful.

In conclusion, as a result of studies on the rate of work and operation accuracy of harvester as a combination system with reaper, it required 7 hours 21 minutes per feddan, but the rate of work and operation accuracy would be improved dramatically, increasing the feeding quantity by skilled labor and elimination mechanical trouble through maintenance.

Therefore, it is considered that this system is very promising as mechanized harvesting system for the studied farmers of medium/small scale.

3. Combine (Ear head threshing type of combine)

Object

The harvesting performance test had been conducted up to last year regarding this machine, and high rate of work as well as high operation efficiency was confirmed for the short-culmed variety of Japanese type. The standard variety of Egypt, however, is a long-culmed variety, Giza-172, and it was pointed out that machine are easily clogged with straws. Therefore, studied a suitable harvesting method for long-culmed variety this year.

Method

1) Time of harvesting: October 12
2) Variety: Giza-172
3) Length of experimental division: Operated the machine 3 times on a 10 m division with an approach run of 5 m.
4) Grain loss: Head grain loss, it is indicated in the average value at 3 points, collecting falling grains in the measured division after reaping. Unthreshed grain loss: measured grain sorted from waste straw from straws. No. 3 chaff grain loss: measured unhulled rice in waste straw scattered from No. 3 chaff.

Table 9. Specification of Combine

Model Name	TC-3500
Dimensions Overall width (cm) Overall length (cm) Overall height (cm) Weight (kg)	 167 400 197 2370
Engine section Type Rated output	 4-cycle, 3 cylinder, water cooled 32 ps/2600 r.p.m.
Drive section Crawler type Shifting Crawler width x length (cm)	 Rubber crawler in endless form Forward 12, Reverse 4 40 x 150
Reaping section Type Reaping width (cm) Reaping height control Threshing clepth control Reaping device	 Reciprocating 135 Hydraulic system (manual and automatic) Hydraulic system (manual and automatic) Chain with time
Threshing section Diameter of threshing Drum x width (cm) Drum r.p.m. Selection	 42 x 90 540 Swing, winnower and suction in combination

Result

The traditional variety, Giza-172, has a long culm length of 120 cm and it is easily lodging. So selected a period of experiment before plant lodging to study the rate of work and operation accuracy.

Table 10 and Fig. 12 show the results of performance test. According to these tables, losses of each part of paddy rice tend to increase as reaping speed grains, but the amount of losses differs according to the kinds of losses-head grain loss is the largest, unthreshed grain loss is the second and chaff loss is the third. As a result of this center's study on the cause for main losses: head grain loss and unthreshed grain loss, the following points became clear.

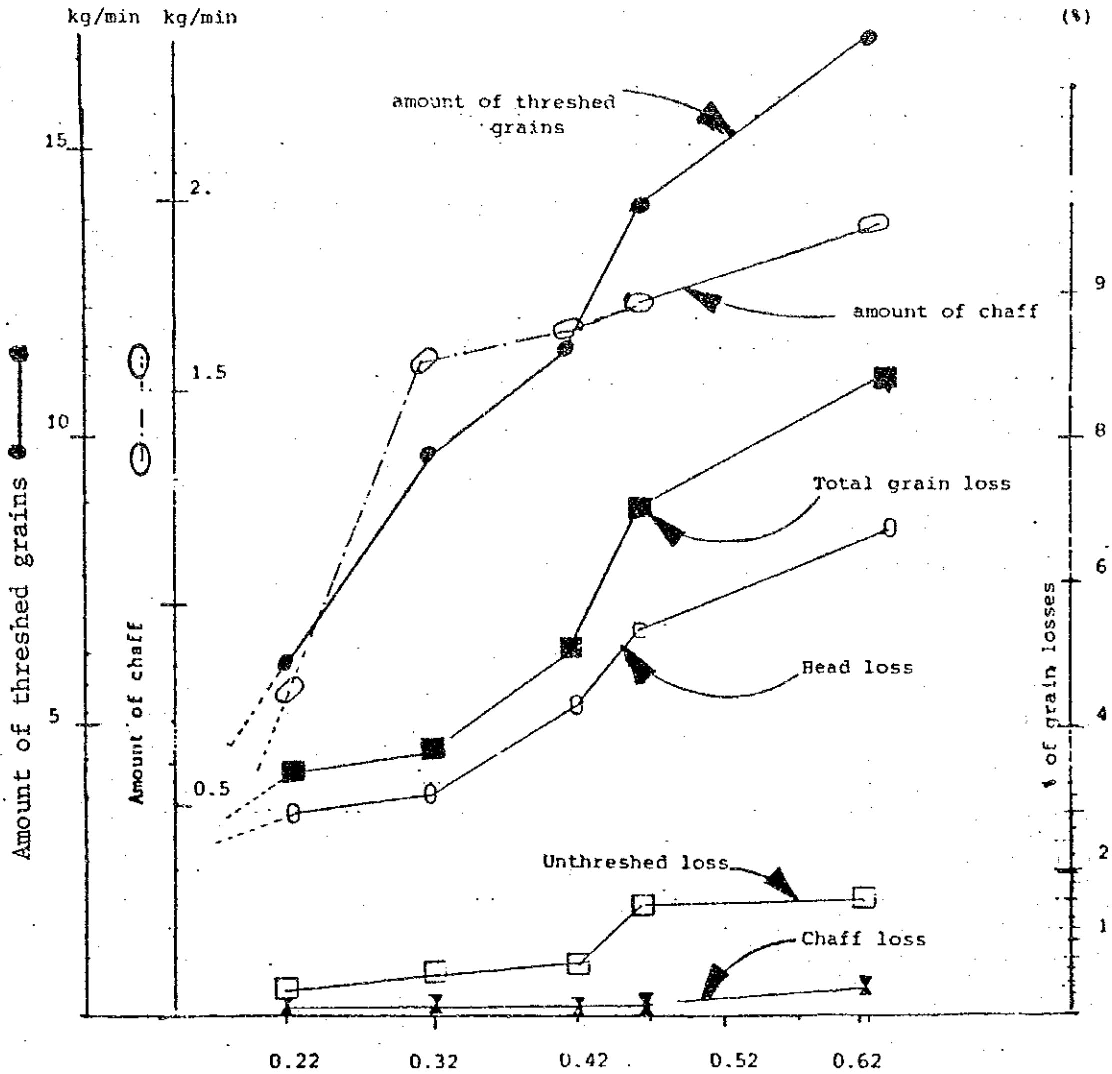
1) Head grain loss: Though the shattering nature of Giza-172 is moderate, the picking tines hit the top of panicles as reaping speed increases and its shattering nature is accelerated partly because of the drying degree. Therefore, judgement of suitable reaping time is considered to be very important in Egypt where climate is dry.

2) Unthreshed grain loss: This is caused by uneven culm length. In this case, top of panicle of short culm is not caught by the threshing drum. Giza-172 has long culm and its chaff quantity is large, so auto feeding depth adjustment causes clogging and stops machine. For this reason, manual feeding is employed, and adjustment of feeding depth is conducted on operator's judgement.

Table 10. Performance Test for Combine

Testing condition	Time for 10 m	sec	45	31.5	25	22	16
	Harvesting speed	m/s	0.22	0.32	0.40	0.46	0.63
	Sinkage of machine	cm	2.15	2.35	1.90	2.00	2.40
	Cutting height	cm	10.45	14.90	12.25	15.00	13.70
Performance	Harvested straw weight	kg/10 m^2	10.20	11.19	10.12	11.40	9.70
	Harvested grain weight	kg/10 m^2	4.700	5.250	4.750	5.350	4.550
	Chaff weight	gr/10 m^2	590	840	720	650	520
	Unthreshed loss	gr/10 m^2	12.65	28.15	31.30	76.25	65.00
	Chaff loss	gr/10 m^2	3.90	7.35	2.10	4.10	21
	Head loss	gr/10 m^2	155	175	215.5	310	319.5
	Total weight of grain	gr/10 m^2	4871.55	5460.50	4998.90	5740.35	4955.50
	Unthreshed loss	%	0.27	0.53	0.65	1.40	1.40
	Chaff loss	%	0.08	0.14	0.04	0.08	0.45
	Head loss	%	3.18	3.20	4.31	5.40	6.45
	Total loss	%	3.53	3.87	5.00	6.88	8.30

Notes: Variety: Giza-172
Moisture contents (chaff): 55.5%
Moisture contents (grains): 16.3%
Standing angle: 44.4°
Decleaning angle: 45.6
Plant height: 120 cm



Note: Variety: Giza-172 (panicle wieght type)
Moisture content: Grain is 16.3% straw is 55.5%

Fig. 12 Working speed (m/sec)

It became clear that the manual feeding caused unthreshed loss. There are the reasons for an unthreshed grain loss, which tends to increase as working speed is accelerated.

However, it has been revealed that it can cope with unthreshed loss due to an increase in chaff quantity for long culm variety by decreasing the speed of reaping.

As shown in Table 10 and Fig. 12, grain loss decreases at the speed of around 0.4 m/s without clogging, and reaping at a stable speed is possible.

Thus the suitable reaping speed of combine harvesting should be changed according to the variety's culm length.

The suitable speed for short culm variety (Giza-173, refer to the 1983 trial results) is around 0.68 m/s, and for the long culm variety (Giza-172), the speed should be reduced.

In conclusion, it has become clear that the long culm variety causes clogging of threshing drum in harvesting with a combine, making it impossible to carry out stable reaping, and that stable reaping with high operation accuracy is possible when reaping speed is reduced to 0.40 m/s as a result of our study.

4. Mechanized Harvest of Wheat

Object

A delay in the harvest of wheat defers rice planting period, which is one of the major reasons for a decrease in the harvest of paddy rice. The ripe period of wheat in Nile Delta in the ordinary year is from May 10 to 20, and there is enough time for the period suitable for planting paddy.

However, a delay in harvest due to manual labor defers paddy planting. Therefore, conducted a wheat harvesting experiment with a combine for paddy rice use with the purpose of paddy planting in suitable season.

Method

1) Harvesting period: May 20
2) Variety: Giza-155
3) Measured area: 2100 m^2
4) Condition of crops: Culm length 110 cm, seeding method: drill by seeder, plant lodging degree: 70°, moisture grain 12.5%, straw 30%, weed: none.
   Measurement of unthreshed grain was conducted in the same way as paddy rice.
   Combine TC-3500 for rice harvesting was used for the experiment.
   The number of revolution and adjustment of device were as follows:
   A) RPM of winnower: 1770 rpm. B) RPM of 2nd conveyor: 1640 rpm.
   C) Angle of dust discharge lever: No. 3, D) angle of riddle: 25°

Result

In harvesting wheat, utilization the combine used for rice harvesting there is a problem of clogging in No. 2 chaff return pipe due to the difference between rice and wheat in the 1000 grain weight. So each section of the combine should be adjusted to wheat harvesting first of all.

In addition, angle of riddle and selection ratio are in an inverse proportion. Therefore, it has studied optimum adjustment values in advance.

Table 11. The Adjustment of Discharge Lever and Angle of Riddle for Wheat Giza-155

Angle of riddle	Angle of discharge lever	Good grain		Unthreshed grain		Broken grain		Total of sample grains
		No. of grain	%	No. of grain	%	No. of grain	%	
20	3	972	97.2	19	1.9	9	0.9	1000
25*	3	980	98.0	12	1.2	8	0.8	1000
30	3	973	97.3	17	1.7	10	1.0	1000
35	3	971	97.1	19	1.9	10	1.0	1000
40	3	969	96.9	20	2.0	11	1.1	1000

Note: * The most suitable adjustment for harvest of wheat, Giza-155

The relation between adjustment of angle of riddle and harvested grains is indicated in Fig. 13 and Table 11. According to them, the values of adjustment for the least broken ratio and unthreshed ratio were 25° for the angle of riddle, and No. 3 for the angle of discharge lever. Therefore, the test was conducted the rate of work and operation efficiency based on the above adjustment.

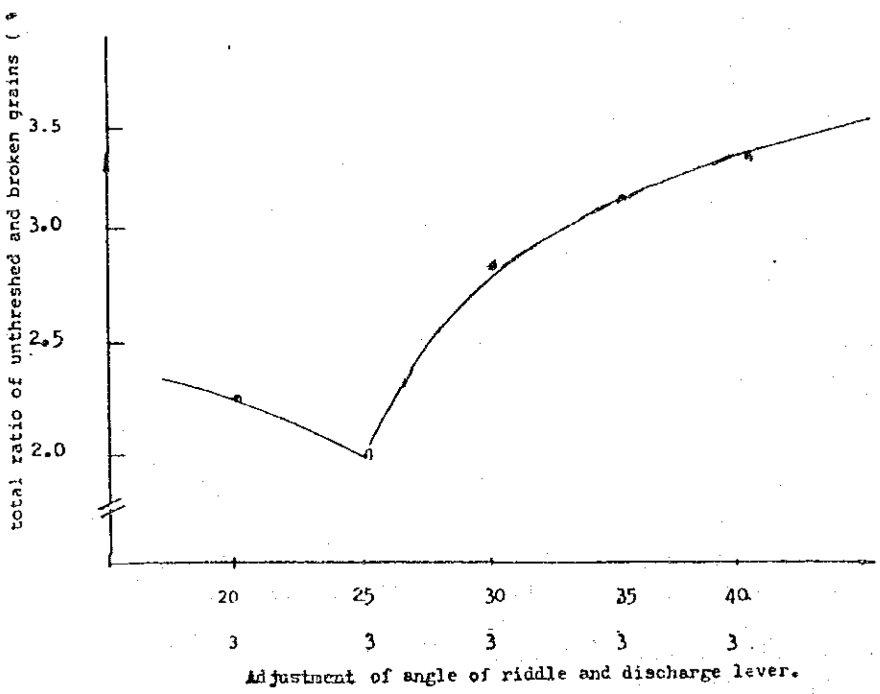


Fig. 13 Adjustment of device for suitable harvesting in wheat Giza-155

Table 12. Comparation of man/hour between traditional method and mechanical harvest in wheat per feddan

Item		Traditional method				Combine			
		Name of machine	Working hour per feddan			Name of machine	Working hour per feddan		
			Hrs of machiney	No. of men	Total man hrs		Hrs of machiney	No. of men	Total man hrs
Cutting		by hand	–	6	36		–	–	–
Binding	Middle size	"	–	–	–		–	–	–
	Larger size	"	–	6	12		–	–	–
Threshing	Transport of straw	by animal		4	24		–	–	–
	Threshing	by thresher	4	3	12	by combine	1.5	3	4.5
	Winnower	by motor winnower	2.5	3	7.5		–	–	–
Transport of threshed straw			–	–	–	by trailor	3	3	9
TOTAL					91.5				13.5

Notes: Working hour per day is 6 hours.

Table 12 shows a comparison of work from reaping to selection by traditional method with the work by the combine.

According to the Table, traditional method takes a lot of time, and this is the major reason for delaying planting of rice.

On the other hand, working speed and operation efficiency shows satisfactory results in the case of wheat harvesting using the combine for rice.

The climate at the time of reaping was very dry and the moisture of wheat was low, making it possible to perform ordinary reaping at a fast reaping speed of 1 m/s.

This was due to no chaff clogging as an advantage of dry climate. Operation efficiency was confirmed to be very high; 1.64 hours per feddan (42 a). Table 13 shows operation efficiency, which characterizes grain loss. Namely, unthreshed grain loss is a little high as compared with other losses.

Table 13. Ratio of Grain Loss Against Working Speed in Wheat, Giza-155

Items	Description		Working speed m/s
			1
Flow volume	Grain out let	kg/h	2115
	Straw flow	kg/h	1386
Grain losses	Head losses	%	0.227
	Chaff losses	%	0.262
	Unthreshed losses	%	0.431
	Sub total	%	0.920

Note: The above test was adjusted on 25° of angle of riddle and No. 3, of angle of dust discharge lever.

It has became clear that this phenomenon is closely related with the reaping period, i.e., the wheat culms are excessively dried up under high temperature and dryness, and culms are broken by picking tines. So culms are discharged without being caught by threshed drum.

However, the experiment proved that the total grain loss was below 1%, an extremely high operation efficiency.

In conclusion, the harvesting test of wheat using the combine for rice harvest showed a very high operation efficiency of 1.64 hours per feddan and operation accuracy of below 1% grain loss.

These results are significant in producting economic effect by improving the operation rate of rice harvesting combine and in making it possible to increase rice harvest by planting in a suitable season through speedy harvesting of wheat.

V. Utilization Conditions of Machines

Table 14 shows the utilization conditions of each machine in 1984. According to it, tractors with the capacity of 30 PS and 75 PS were most frequently used.

The 30 PS tractor was often used for plowing (when there was much water content), puddling and carrying because of its simple operability in spite of small type.

The 75 PS tractor was used mainly for chisel plowing in fields where rotary plowing was impossible due to increased soil hardness under dry climate conditions.

Regarding rice transplanter, the annual utilization time is as many as 100 - 200 hours, or the machine carried out transplanting of nearly 40 ha per machine.

The utilization hours indicated in Table 14 is rather limited, because the Agricultural Ministry of Egypt purchased 20 transplanters and the Center used some of them, so the utilization hours of furnished machine were limited.

When the walking type transplanter is compared with the riding type, the latter machine was used more than the former.

This reason is explained in the item concerning the suitable working method of walking type transplanter, so, please refer to it.

The plowing and puddling rotary having wide working width was used much in view of the broad field plot of the Center in the area of 40 ha and the proved high operation efficiency of this type of machine.

As for the harvester, the utilization rate of the binder is low in this country, because hymenium moisture and straw moisture respectively reach 14% and 50% even in decleaning conditions under the dry climate of Egypt, and binding with the binder for drying is unnecessary.

Furthermore, most of the planting varieties have long culms such as Giza-171 and Giza-172. Reaping of these varieties is very difficult. The combine can reduce working time from reaping to harvesting and its maximum utilization time is 396 hours in a year (harvesting period, late in Sep., late in Oct.).

The machine can reap nearly 40 ha a year per machine. Its traveling capacity has no problem in operation, making very efficient reaping work possible due to an increase in ground contact pressure after drainage.

Table 14.

Name of machine	Classification of utilization: Meet El Dyba Field	Classification of utilization: Demonstration	Total hrs.
Y Co. tractor 24 hP, No. 1	298		298
" , No. 2	129		129
K Co. tractor 30 hP, No. 1	298		298
" , No. 2	285		285
" , No. 3	81		81
" 45 hP	177		177
" 75 hP	461		461
Bulldozer	179		179
Transplanter, Y Co., 3 row	20		20
" , 6 row	60		60
No. 1, " K Co., 6 row	30		30
No. 2, " "	60	24	84
" , 8 row	6		6
Plower, rotary, RS-24	82		82
" , RL-1602	13		13
" , DC-1800	11		11
" , MX-2000	60		60
" , SX-1700	132		132
Puddler, rotary			
HY-182	44		44
P-241	86		86
No. 1 HB-2200	75		75
No. 2 HB-2200	100		100
HB-2800	27		27
Binder Y Co.	5		5
K Co.	7		7
Combine			
K Co. RX-2100	71		71
Y Co., No. 1 TC-3500	2	394	396
" No. 2 TC-3500	58		58
" No. 2 TC-3500	76		76
TC-1410	153		153
Harvester			
HH-701	112		112

VI. Troubleshooting and Maintenance

Routine check is conducted for the maintenance of the machine, but fuel filter and air cleaner often get clogging due to much dust in the dry air in Egypt. So these parts must be replaced much earlier that the time instructed in specifications.

There are cases of natural worn out of wires and seals. Egypt is dusty and highly basic water is used for work and washing machine after work. This causes rust on these parts and accelerates worn-out.

Out break troubles occurred due to unsatisfactory check after routine check and replacement of parts, and were partly caused by operator's carelessness during work.

Approximately 400 transplanters have been introduced in Egypt and are being used by farmers, and many out break troubles have occurred, mainly on steering part. This is due to the deep plowing depth at farmer's fields and soft deep soil layers caused by long irrigation time, making transplanter's traveling load heavier.

The Center eliminated these troubles by plowing of about 15 cm and, performing puddling immediately after irrigation.

A part of out break troubles were repaired in small factories in town, but most of them were repaired and maintained by the Center's workshop. Most of the expendable supply parts were replaced by spare on hand, but were partly replaced through local purchase.

Table 15. Conditions of Troubles and Repair/Maintenance

No.	Name of Machine	Symptom	Ordinary Worn Out, Total used Hr.	Outbreak Trouble, Total used Hr.	Detail	Probable Cuase Selection of Cause	Solution
1.	K Co. Tractor No. 1, 30 HP	Tachometer wire	133		Wire itself damaged.	Life of parts	Replace
2.	K. Co. Tractor No. 2	Seal for cooling pump	309		Damage of seal	Life of parts	Replace
3.	K. Co. Tractor 45 HP	Tire rim bolt		134	Tire rim bolt hole enlarged.	Inferior check and maintenance	Repaired damaged parts.
4.	Y Co. Tractor 24 HP	Clutch spring		318	Return spring comes off automatically.	Mechanical cause.	Disassembled and repaired.
		Oil pressure			Oil leak from O ring	Life of parts	Replace
5.	Bulldozer	Oil pressure hose of		234	Contact between hose cover and hose broken and cut hose.	Mechanical product quality	Replace
6.	Y Co. 6 row trans-planter	Damage of each wire	290		Wire for accelerator and	Life of parts	Replace
		valve adjust.			Suction/discharge valves	Inferior check and repair	Cleaning
7.	K Co. Combine	Damage of caterpillar tred		650	Rubber part broken.	Bad operation	Replace
		Concave net in threshing drum	650		Net is pierced with holes.	Life of parts	Replace
8.	Y Co. Combine	Crank rod for cutter		409	Rod contacts with blade in part	Inferior check	Disassembled and repaired
9.	K Co Harvester	Vertical augar	220		Spiral augar worn out and grains do not come up	Life of parts	Replace

RESULT OF SURVEY AND VERIFICATION TRIAL
IN AGRONOMY DIVISION, 1984

Result of survey and verification trial in agronomy division, 1984

I. Mechanical Transplanting Cultivation Experiment

1. Selection of variety suitable for mechanical transplanting

2. Nursing seedling

   1) Effect of seedling of different seedling density on yield

   2) Effect of seedling of differetn nursing duration on yield

   3) Effect of nitrogen top-dressing in the latter half of nursing duration on yield

   4) Effect of zinc application seedling in nursing duration on yield

3. Planting density

   1) Effect of change in planting density on yield

   2) Effect of change in the number of seedling per hill on yield

4. Fertilizer application to main paddy field

   1) Three fertilizer elements experiment

   2) Effect of the amount of nitrogen application under different planting density on yield

   3) Effect of nitrogen split application method in later planting on yield

   4) Compost application experiment

II. Direct Seeding Cultivation

Cultivation trial of direct seeding method on dry condition

I. Mechanical Transplanting Cultivation Experiment

1. Selection of Variety suitable for Mechanical Transplanting.

Object

Variety comparison experiments on young seedling mechanical transplanting cultivation were conducted with the purpose of selecting varieties suitable for mechanized transplanting.

As a result, some varieties showed high yield as follows: Akihikari: 12.03 ton/ha, Nipponbare: 11.76 ton/ha, Giza-173: 11.28 ton/ha., Giza-172: 11.25 ton/ha. in 1982, and Nipponbare: 14.31 ton/ha, Akihikari: 10.54 ton/ha in 1983. As these varieties were considered promising, studies were developed aiming at higher and stable harvest.

Method

1) Trial varieties: Akihikari, Nipponbare, Giza-172 and Giza-173

2) Amount of fertilizer applied for main paddy field: N........159kg/ha
P_2O_5..... 80 "
K_2O...... 40 "

3) Split application method:

Basal dressing: 50% of total nitrogen and total basal dressing for phosphate and potassium.

1st top-dressing: Applied urea of total nitrogen 25% on the 10th day after transplanting.

2nd top-dressing: Applied the remaining 25% of total nitrogen to Akihikari, Nipponbare and Giza-173 seven days before panicle initiation stage, and for Giza-172, before reduction division.

4) Planting density: Mechanized transplanting adjusting to 30 cm x 12 cm (27.7 hill per m^2) with 4-6 seedlings per hill.

5) Date of seeding: All varieties were sown on 5th May.

6) Date of transplanting: All varieties were transplanted on 10th June.

7) Date of harvesting: Akihikari........10th Sept.
Nipponbare.......12th Sept.
Giza-173......... 6th Oct.
Giza-173......... 6th Oct.

Result

Yield and yield components are shown on Fig. 1 and Table 1.

The highest yield is 9.18 t/ha of Akihikari as in 1982, and the second is 8.06 t/ha of Nipponbare, and third and fourth are 6.84 t/ha of Giza-173 and 6.3 t/ha of Giza-172.

This year's yield is lower than '82 and '83, because the fertility of soil of the Meet El Dyba field is poor due to first planting with a lot of weeds, affected by salt injury. Though the yield remained on a low level on the whole, it showed the same tendency as in '82 and '83 namely, the early and medium maturing varieties such as Akihikari and Nipponbare produced higher yield than the late maturing varieties such as Giza-172 and 173.

As for the yield components, the panicle number per m^2 was 663.3 panicles for Nipponbare, which was the highest, 583.4 for Akihikari as the second, 547.3 for Giza-172, the third, and the lowest was 469.2 panicles for Giza-173. The results of analysis of variance concerning yield, panicle number per hill and per m^2 were on a 5% level for difference in varieties, and significance was recognized. As for spikelets number, no significant difference was recognized for both values per panicle and m^2, but high significant difference was recognized for ripening ratio and weight of 1000 grains on a 1% level. This displays the property of respective varieties very well.

Generally speaking, there exists negative relation between the spikelets number and ripening ratio per m^2 in Japan, and an extreme increase in the spikelets number decreases harvest due to lower ripening ratio. However, the relation between the panicle number and the yield per m^2 based on the consolidated results of variety comparison experiment in '82, '83 and '84, shows high positive correlation (Fig. 3). It is clear that high yield is obtained when many panicle are secured. Among them, however, Giza-172 has low ripening ratio in proportion to panicle number per m^2, producing low yield on many occasions. This is due to the degree of lodging, and considered to be a particular reaction in these varieties. Therefore, it was pointed out that the fertilization method should be changed for Giza-172, leaving a problem of mechanical planting suitability. Giza-173 had no blast disease in this experiment, but the variety had said disease in various locations in Kafr El Sheikh. It was also indicated that Giza-173 has a problem of mechanized planting suitability.

As stated above, comparison experiments had been conducted on promising varieties; 3 Japanese varieties and 1 Egyption variety. As a result, Akihikari and Nipponbare had high suitability for mechanical transplanting, but Giza-172 and Giza-173 had drawbacks of lodging resistance and blast disease resistance, respectively.

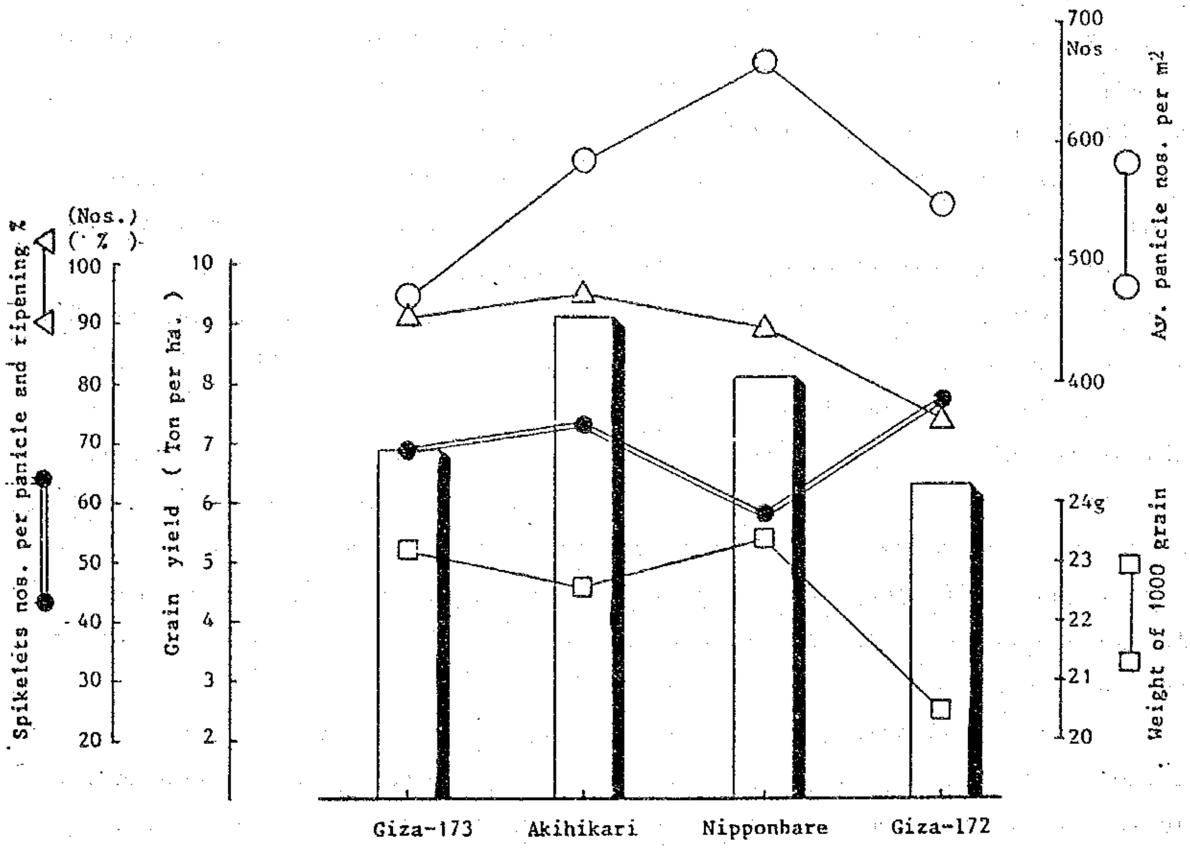


Fig. 1. Variety Trial in 1984 at Meet El Dyba

Table 1. Varietal trial

(Variety: Giza-173, Akihikari, Nipponbare and Giza-17-)

Treatment		Grain yield (Ton/ha.)	Nos. of panicles/ hill	Nos. of panicles/ m^2	Nos. of spikelets/ panicle	Nos. of spikelets/ m^2 (x 10^3)	Ripening ratio (%)	1000 grains weight (gm.)
Giza-173		6.84	17.32	448.6	70.5	31.61	91.40	22.50
		6.75	17.08	442.4	68.5	30.30	91.34	24.30
		6.94	19.94	516.5	63.8	32.95	90.20	22.70
	Av.	6.84	18.11	469.2	67.6	31.62	90.98	23.20
Akihikari		8.64	19.98	517.5	76.8	39.73	92.90	23.01
		9.92	23.00	595.7	73.7	43.93	97.4	22.57
		8.98	24.60	637.1	69.7	44.40	93.49	22.14
	Av.	9.18	22.53	583.4	73.4	42.69	94.60	22.57
Nipponbare		7.11	22.65	586.6	55.2	32.38	90.90	24.17
		9.75	26.04	674.4	69.2	46.67	88.20	23.20
		7.32	28.14	728.8	50.5	36.81	88.70	22.75
	Av.	8.06	25.61	663.3	58.3	38.62	89.27	23.37
Giza-172		5.15	21.30	551.7	63.7	35.15	71.60	20.87
		7.19	20.16	522.1	88.9	46.42	81.53	20.31
		6.57	21.94	568.2	79.1	44.94	70.08	20.24
	Av.	6.30	21.13	547.3	77.2	42.17	74.40	20.47
G. Mean ($\bar{X}$)		7.60	21.85	565.8	69.1	38.78	87.31	22.40
C.V. (%)		12.64	9.29	9.29	12.12	12.85	3.93	3.00
Statistical significance		5 %	5 %	5 %	NS	NS	1 %	1 %
LSD .05		1.57	3.31	85.79	–	–	5.59	1.09

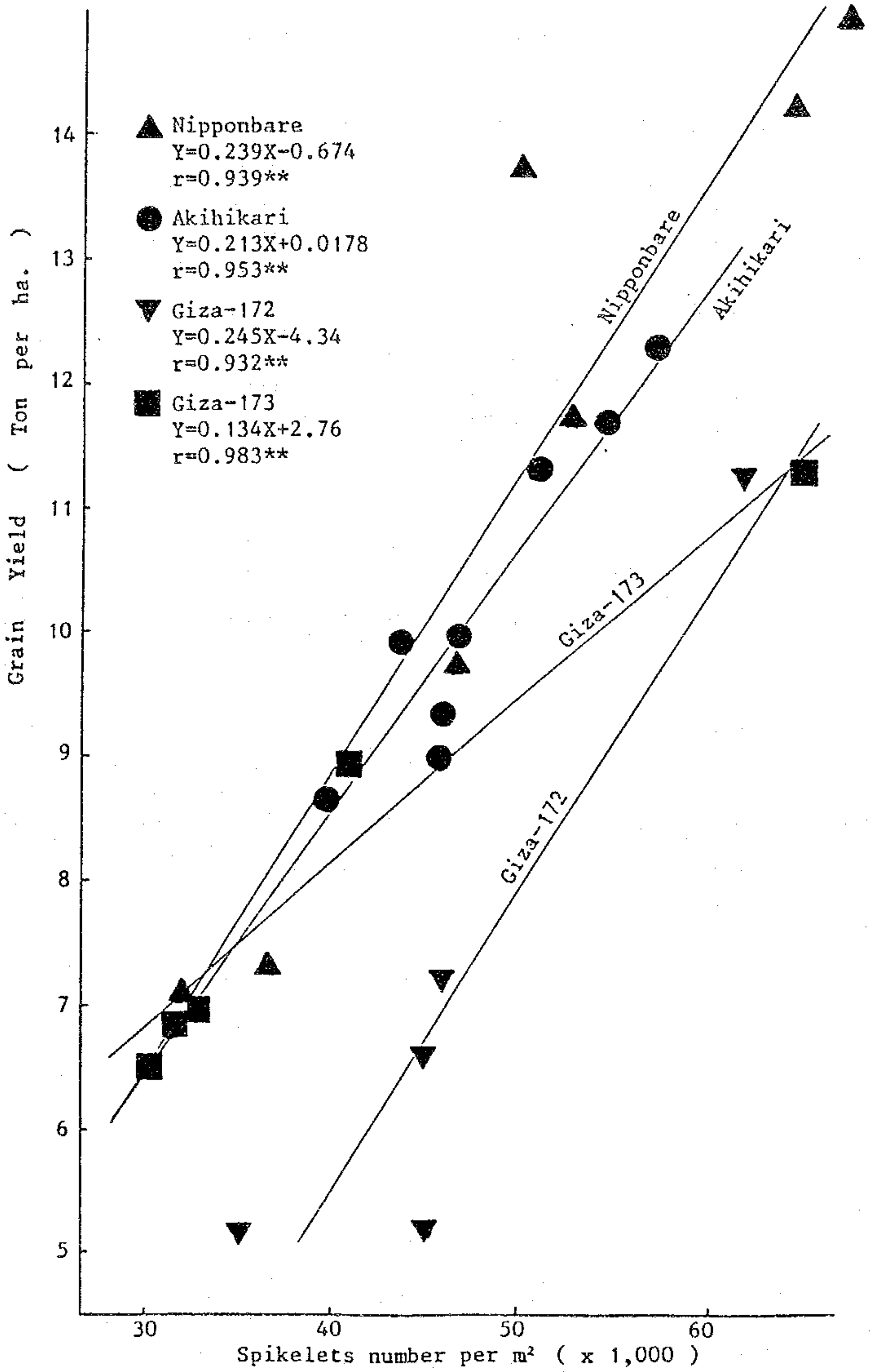


Fig. 2. Relationship between grain yield and spikelets nos. per m^2 among different variety during three years in RMP

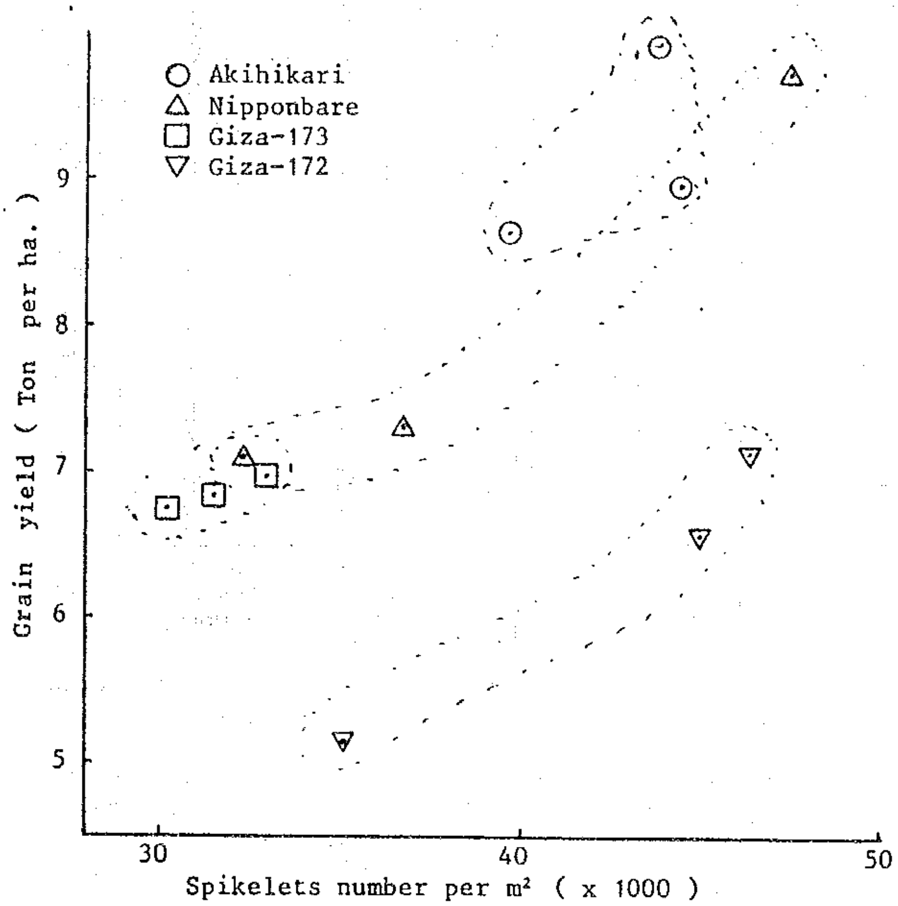


Fig. 3. Relationship between grain yield and spikelets number per m^2 among different variety

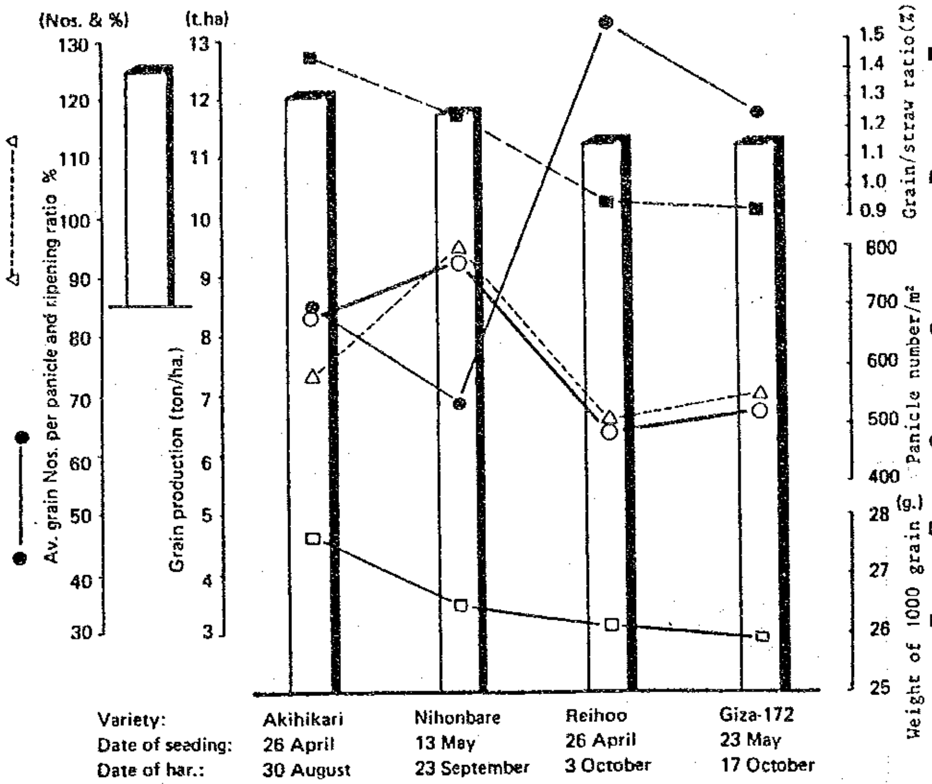


Fig. 4. Comparison of grain production and yield components in different variety on 1982 at RMP, Kallin.

Note: The grain production and yield components of each variety was selected from maximum grain produced plots in RMP, Kallin Station.

Table 2. Comparison of grain production and yield components in different varieties on 1982 at RMP, Kallin

Variety	Nos. of hill per sq.m.	Av. panicle Nos. per hill	Av. panicle Nos. per sq.m.	Nos. of grain per panicle (Av.)	Ripening ratio (%)	Weight of 1,000 grain (g.)	Grain/ straw ratio	Grain production (ton/ha.)
Akihikari	26.39	25.80	680.0	83.93	75.53	27.59	1.44	12.03
Nihonbare	23.38	29.32	773.5	68.41	94.90	26.46	1.24	11.76
Reihoo	21.11	23.13	488.3	113.90	66.04	26.13	0.94	11.28
Giza 172	21.11	24.79	523.3	117.88	70.21	25.98	0.92	11.25

Note: The grain production and yield components of each variety was selected from maximum grain produced plots in RMP, Kalin station.

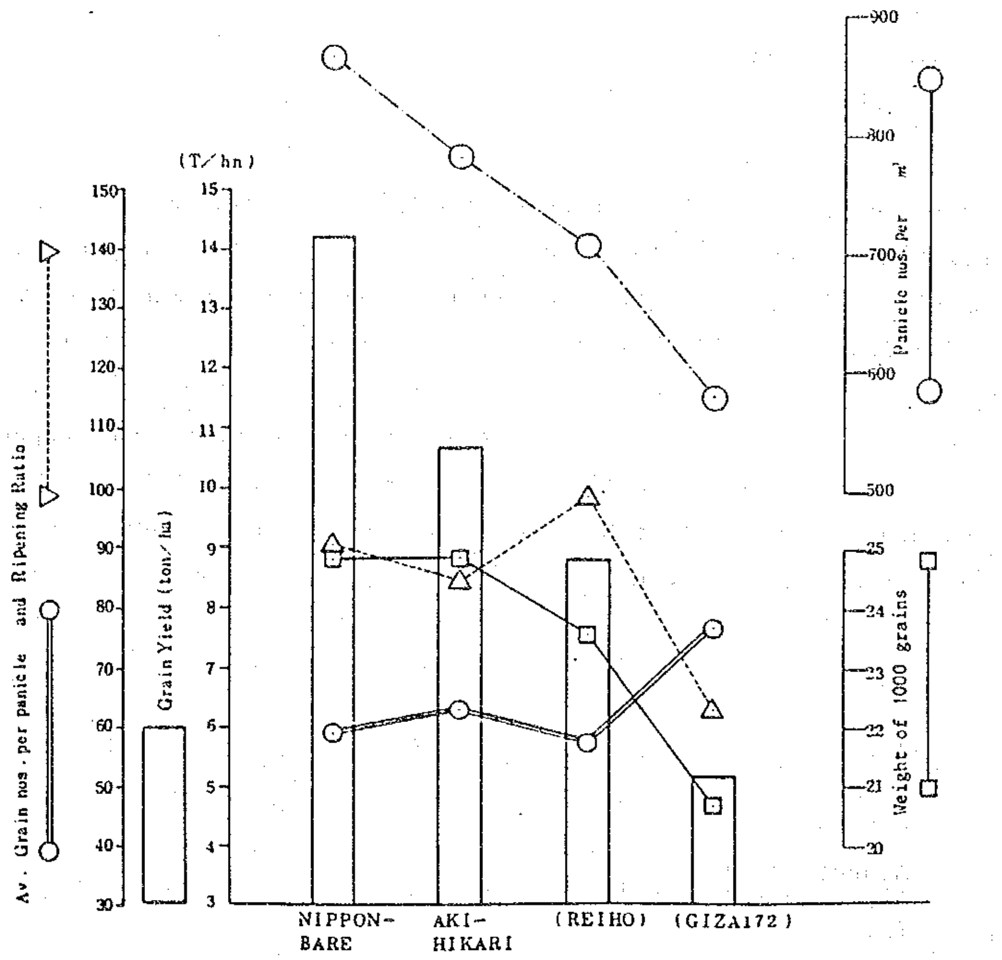


Fig. 5. Yield maximizing trial in 1983 at RMP, Kallin.

Table 3. Yield maximizing trial in 1983 at RMP, Kallin.

Test Plot		Nos. of hill per m²	Av. panicle nos. per hill	Av. panicle nos. per m²	Av. spikelets nos. per panicle	Ripening ratio (%)	Weight of 1000 grains (g.)	Grain yield (t/ha)
Akihikari	13	28.39	27.46	779.6	59.07	82.24	24.63	9.29
	14	28.39	27.02	767.1	66.47	88.63	25.05	11.32
	15	28.39	27.66	785.3	60.12	84.32	25.00	9.95
	16	28.39	28.50	809.1	67.44	86.20	24.89	11.71
	Av.	28.39	27.66	785.27	63.275	85.348	24.893	10.54
Nipponbare	17	27.65	31.38	867.66	73.91	90.13	24.49	14.23
	18	27.65	32.86	908.58	55.23	83.85	25.24	13.74
	19	27.65	30.32	838.35	80.24	88.99	25.03	14.98
	Av.	27.65	31.52	871.53	59.8	91.02	24.92	14.31
Giza 172	36	(28.49)	(20.57)	(586.04)	(76.86)	(63.38)	(20.71)	5.20
Reiho	37	(24.83)	(28.69)	(712.37)	(57.99)	(90.86)	(23.62)	8.88

2. Nursing Seedling

1) Effect of Seedling of Different Seeding Density on Yield

Object

In the case of seedling raising in box, it is assumed that the seeding rate per box has great influence on seedling quality and the percentage of missing plant, including grain yield. In other words, a low seeding rate results in less number per hill and more percentage of missing plant. On the other hand, a large seeding rate causes inferior seedling quality, transplanting injury, delay in rooting after transplanting and competition in hill due to the excessive number of seedling per hill.

Therefore, studies have been made on the relation between the seeding rate per box and grain yield.

Method

1) Treatment:

Treatment	T - 1	T - 2	T - 3	T - 4
Seeding rate per box (g.)	150	200	250	300
Amount after germination (c.c.)	315	420	520	630

2) Variety: Giza-172

3) Nursing duration: 26 days

4) Amount of fertilizer applied for main paddy field: N........120kg/ha
P_2O_5..... 60kg/ha
K_2O.......30kg/ha

5) Split application method:

Basal doses: 50% of total nitrogen and total amount of P_2O_5 and K_2O at just before the first plowing of main field.

1st Top-dressing: 25% of total nitrogen applied at 10 days after transplanting.

2nd Top-dressing: Remaining 25% of total nitrogen applied at just before the Reduction Division Stage.

6) Adjustment of picking amount of transplanter: 10 mm x 13 mm.

7) Planting density: 30 cm x 12 cm (27.7 hill per m^2)

8) Date of seeding: 25th May

9) Date of transplanting: 20th June

10) Date of harvesting: 20th Oct.

Result

The results of experiment are shown in Fig. 6 and Table 4.

In T-2 plot (seeding rate per box = 200 g.), the highest yield per ha. in the amount of 9.07 tons was obtained.

Regarding yield components, T-2 plot also had the largest spikelets number per panicle and the heaviest weight of 1000 grains. In T-1 plot (150 g. per box), the average number of spikelets per panicle was small due supposedly to the strong compensatory effect of rice in view of the small seedling number per hill and the high ratio of missing plant, causing slowly continued weak tiller even in the later half of tillering period, resulting in small panicle. The seedling number of T-3 and T-4 is more than T-2 and worse transplanting injury delays recovery. This is considered to be the reason for the smaller spikelets number. The largest panicle number per m^2 was recognized in T-3 plot - 490.4 panicles. T-4 remained at 463.4 panicles due to delay in initial growth as competition in hill gets intensified. The number of panicles were almost the same as that in T-1. In this experiment, manual seeding was employed for each box to assure accuracy, but in the case of using seeding machine, scattering of sowing quantity should be minimized. For this purpose, it is important to strictly carry out awning, prevention of over hastening of germination and drainage before seeding. In the case of manual seeding machine, smooth operation of the machine is necessary, minimizing unequal revolution. Water shortage delayed the irrigation time for main paddy field in this experiment and the seedlings of 26 nursing days were used, but the seedlings of about 20 nursing days are considered suitable in the case of 200 g.

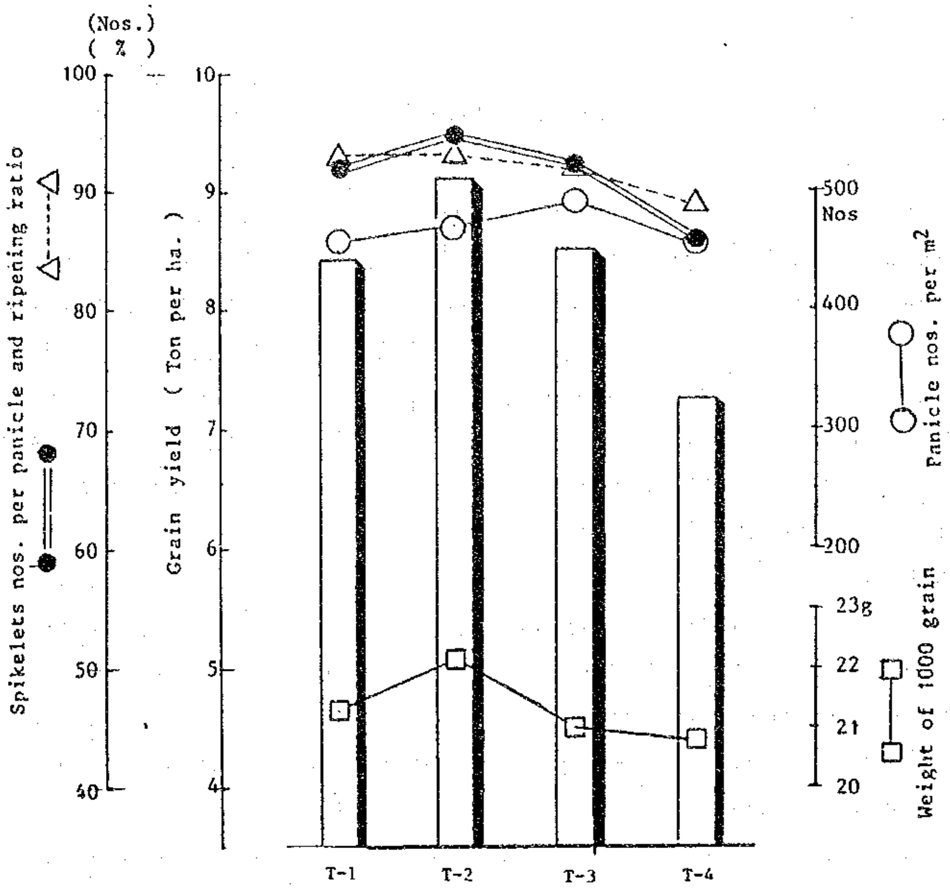


Fig. 6. Different seeding rate and its grain yield
(Variety: Giza-172)

Table 4. Different seeding rate to seedling tray and its grain yield (Variety: Giza-172)

Treatment		Grain yeild (Ton/ha.)	Nos. of panicles/ hill	Nos. of panicles/ m^2	Nos. of spikelets/ panicle	Nos. of spikelets/ m^2 (x 10^3)	Ripening ratio (%)	1000 grains weight (gm.)
T-1 150 g/tray		8.59	15.18	406.8	101.9	41.47	93.11	21.24
		6.89	18.12	485.6	71.4	34.67	94.56	20.65
		9.03	17.40	466.3	89.9	41.92	96.07	23.07
		9.11	17.88	479.2	103.2	49.43	88.42	20.61
	Av.	8.41	17.15	459.5	91.6	41.87	93.04	21.39
T-2 200 g/tray		9.69	16.85	451.6	106.5	48.11	95.60	21.52
		9.41	17.39	466.1	92.7	43.18	95.44	23.00
		8.83	17.15	459.6	89.6	41.18	95.80	22.15
		8.33	19.10	511.9	85.2	43.60	85.91	21.78
	Av.	9.07	17.62	472.3	93.5	44.02	93.19	22.11
T-3 250 g/tray		9.01	17.41	466.6	100.5	46.91	93.26	20.90
		8.89	17.70	474.4	97.0	46.01	94.90	20.33
		8.43	18.16	486.7	86.9	42.31	92.65	21.00
		7.55	16.93	453.7	84.0	38.11	89.50	21.59
	Av.	8.47	17.48	490.4	92.1	43.34	92.58	20.96
T-4 300 g/tray		7.31	17.47	468.2	81.8	38.28	88.39	21.11
		8.09	16.91	453.2	96.7	43.80	90.01	20.46
		6.11	15.36	411.6	72.1	29.69	92.95	21.56
		7.43	17.65	473.0	92.3	43.65	83.95	19.97
	Av.	7.24	16.85	451.5	85.7	38.86	88.83	20.78
G. Mean ($\bar{X}$)		8.30	17.28	463.4	90.7	42.02	91.91	21.31
C.V. (%)		9.64	5.91	5.91	12.15	12.19	3.98	3.71
Statistical significance		5 %	NS	NS	NS	NS	NS	NS
LSD .05		1.23	–	–	–	–	–	–

Note: Above seed quantity shown with dried seeds after seed selection.

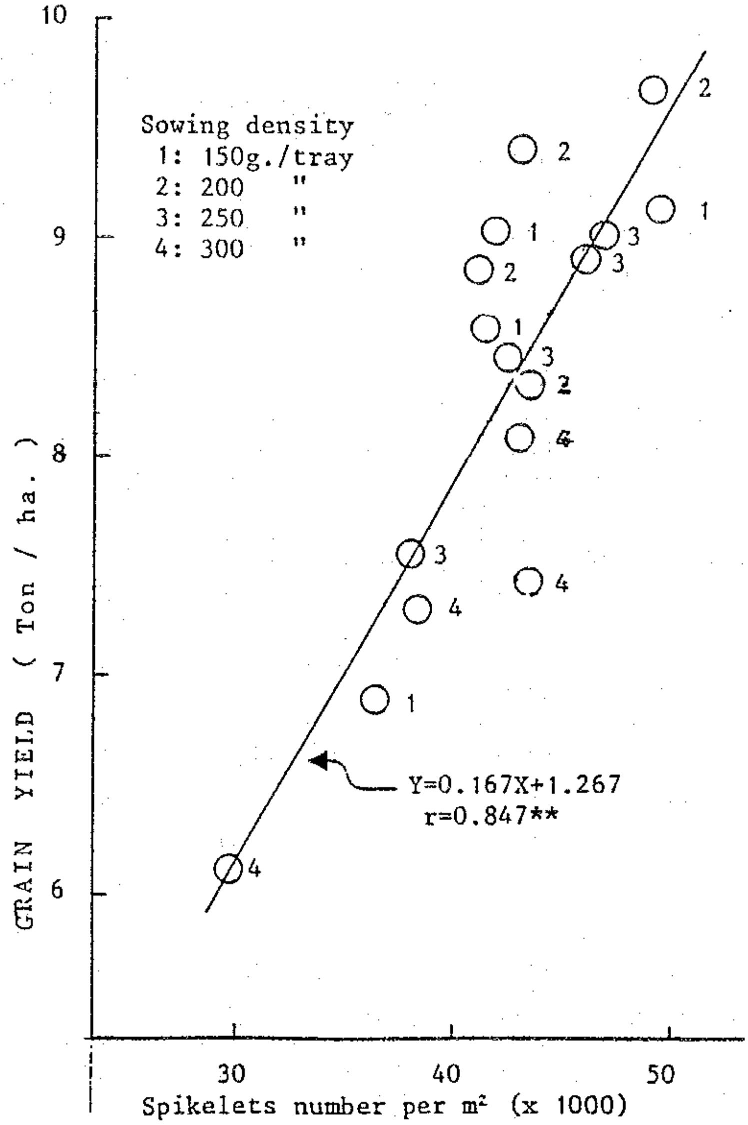


Fig. 7. Relationship between spikelets number and grain yield

2) Effect of Seedling of Different Nursing Duration on Yield

Object

A survey was conducted concerning examples of mechanized transplanting cultivation by farmers in Kafr El Sheikh, and many cases of transplanting of senescence seedling were observed.

Therefore, a study was made on the effect of different nursing days on yield.

Method

1) Treatment:

Treatment plot	Days after seeding	Leaf age
T - 1	20 days	3 - 4
T - 2	28 days	4 - 5
T - 3	35 days	over 5

2) Variety: Akihikari

3) Seeding quantity per box: 200 g.

4) Planting density: 30 cm. x 12 cm (27.7 hills/m^2)

5) Number of seedling per hill: 4-6 seedlings

6) Date of seeding: T - 1........ 7th May
T - 2........15th May
T - 3........22nd May

7) Date of transplanting: 12th June

8) Date of harvesting: T - 1........12 Sept.
T - 2........16 Sept.
T - 3........21 Sept.

Result

They are indicated on Fig. 8 and Table 5.

The results shows the highest yield of 8.13 t/ha in 20 nursing day plot, and a decline in yield in proportion to senescence of seedling. The panicle number per m^2 and spikelets number per m^2, which give the greatest influence on yield, were 541 panicles and 37,300 spikelets in T-1, the highest value, and gradually declined as the nursing seedling days became longer as for yield componetns.

Other yield components, ripening ratio, weight of 1000 grains and spikelets number per panicle showed no significant difference according to treatment. From these results, a significant relation can be noticed between nursing duration and initial growth, especially occurrence of tiller.

This is because of the excessively dense planting of seeding quantity of 200 g. per box, extending over a long period of 35 days, which causes excessive growth and obstruction to tiller, and finally a shortage of panicles. The same tendency was noticed for the 28 days nursing seedling as the 35 days nursing. Thus, the 200 g. seeding has poor free choice of transplanting time, and transplanting should be performed about 20 days after seeding. Therefore, when nursing days are expected to extend to 30 or 35 days for some reasons such as irrigation, the seeding quantity should be 150 g. or less.

In conclusion, the optimum transplanting at the seeding quantity of 200 g. per nursing box should be made i.e. 21 days of nursing duration, 3.5 leaf age.

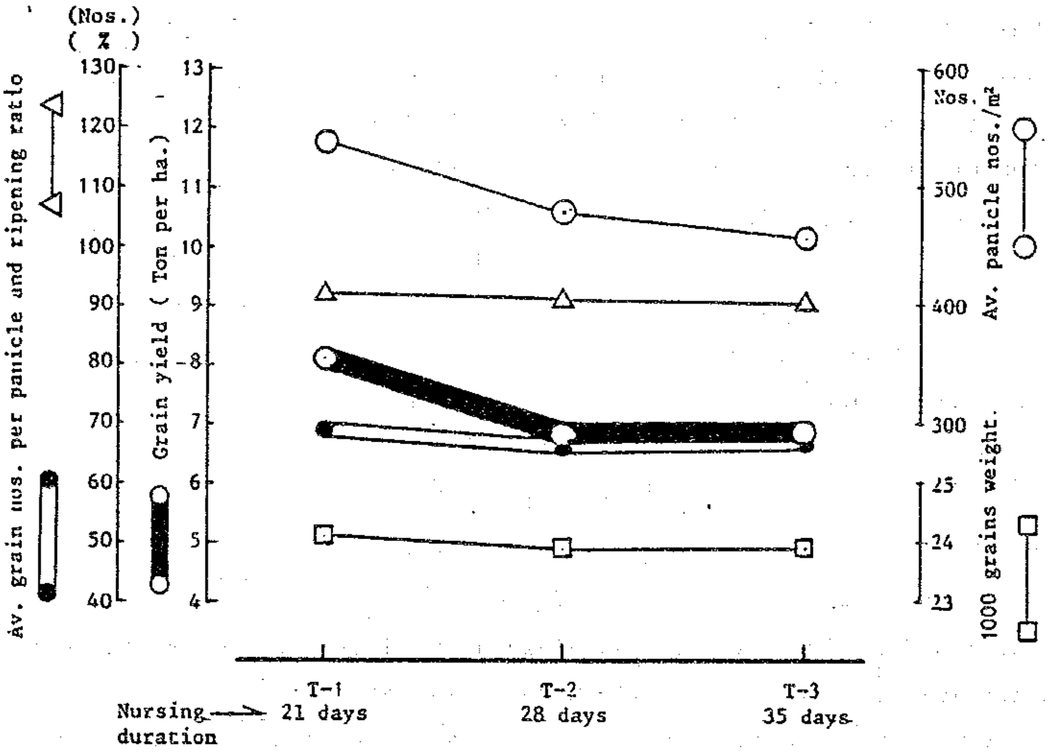


Fig. 8. Comparative trial of different nursing duration (Variety: Akihikari)

Table 5. Comparative trial of different nursing duration and its grain yield

Treatment		Grain yield (Ton/ha.)	Nos. of panicles/ hill	Nos. of panicles/ m^2	Nos. of spikelets/ panicle	Nos. of spikelets/ $m^2 (\times 10^3)$	Ripening ratio (%)	1000 grains weight (gm.)
T-1		7.48	19.38	501.9	67.74	34.00	87.98	24.17
		7.93	21.44	555.3	65.48	36.36	94.60	23.85
		8.97	21.82	565.1	73.59	41.59	92.68	24.25
	Av.	8.13	20.88	540.8	68.94	37.32	91.75	24.09
T-2		7.81	20.37	527.6	67.55	35.64	92.60	24.30
		5.79	17.81	461.3	61.76	28.49	84.51	23.64
		6.77	17.03	441.1	67.47	29.76	94.70	23.78
	Av.	6.79	18.40	476.7	65.59	31.30	90.60	23.91
T-3		6.34	18.92	490.0	59.76	29.28	89.21	23.90
		6.80	15.79	408.9	68.25	27.91	95.01	24.03
		7.15	17.89	463.4	72.06	33.39	86.60	23.79
	Av.	6.76	17.53	454.1	66.69	30.19	90.27	23.91
G. Mean		7.23	18.94	490.5	67.07	32.94	90.87	23.97

2) Effect of Nitrogen Top-dressing in the Latter Half of Nursing Duration on Yield

Object

Promotion of rooting and initial growth is one of the most important points of mechanized transplanting cultivation in view of expansion of yield capacity.

Therefore, studies were made on the effect of nitrogen top-dressing in the latter half of nursing duration on yield.

Method

1) Treatment:

Treatment plot	T - 0	T - 1	T - 2	T - 3	T - 4	T - 5	T - 6
Days before Transplanting	Cont.	Same day	2 day	4 day	6 day	8 day	10 day

2) Variety: Giza-173

3) Amount of fertilizer application for main paddy field:

N.......120kg/ha
P_2O_5..... 80kg/ha
K_2O...... 30kg/ha

4) Split application method: Basal fertilizer..... 50% of total nitrogen fertilizer and total quantity of P and K were applied.
1st top-dressing..... 25% of total nitrogen was applied 10 days after transplanting.
2nd top-dressing..... The remaining 25% of N applied 7 days before panicle initiation stage.

5) Transplanting density: 30 cm x 12 cm. (27.7 hill/m^2)
6) Number of seedling per hill: 4-6 seedlings
7) Date of seeding: 26th April
8) Date of transplanting: 24th May
9) Date of harvesting: 6th Oct.

Result

Fig. 9 and Table 6 shows the results of experiment.

The T-2 (2 days before transplanting) plot obtained the highest yield of 7.64 t/ha, the second was T-3 (4 days before transplanting) plot of 7.4 t/ha followed by T-5 and T-4. It became clear that there was not much difference in yield between T-1 (the same day as transplanting) and control plot (T-0), and that nitrogen application on the day of transplanting had no noticeable effect. In the case of fertilizer application on the day of transplanting, even seedlings with soil are transplanted in water asuming that no fertilizer would be absorbed, and nitrogen application supposedly disperses in water. As for T-4 through T-6 plot, the duration from nitrogen application to transplanting is too long and the effect is given while seedlings are in nursery bed before transplanting. This causes spindly growth seedling and weak seedling, and intensifies transplanting injury, making it difficult to get strong tiller in an early stage after transplant ing due to delayed rooting. This results in shortages of panicle number and spikelets number per panicle.

Regarding yield compoenetns, the panicle number per m^2 for T-0 and T-1 is 470 - 480, but the number increases to 550 - 600 for T-2 through T-5. However, the spikelets number per panicle is highest for T-2, 3 and declines for T-4 through T-6, probably because of transplanting injury and weak tiller. On the other hand, the effect of nitrogen applied for seedling in nursery box of T-2, 3 is great, producing strong tiller after transplanting.

The largest cause for an increase in yield is the nitrogen top-dressing 2 days before transplanting, which presumably secured spikelets number per m^2 through promotion of initial growth and no change in ripening ratio and weight of 1000 grains.

As a result, it has been clarified that top-dressing of 5 g. nitrogen per box at 2-4 days before transplanting is most effective for encourage the tiller development from just after setting period over.

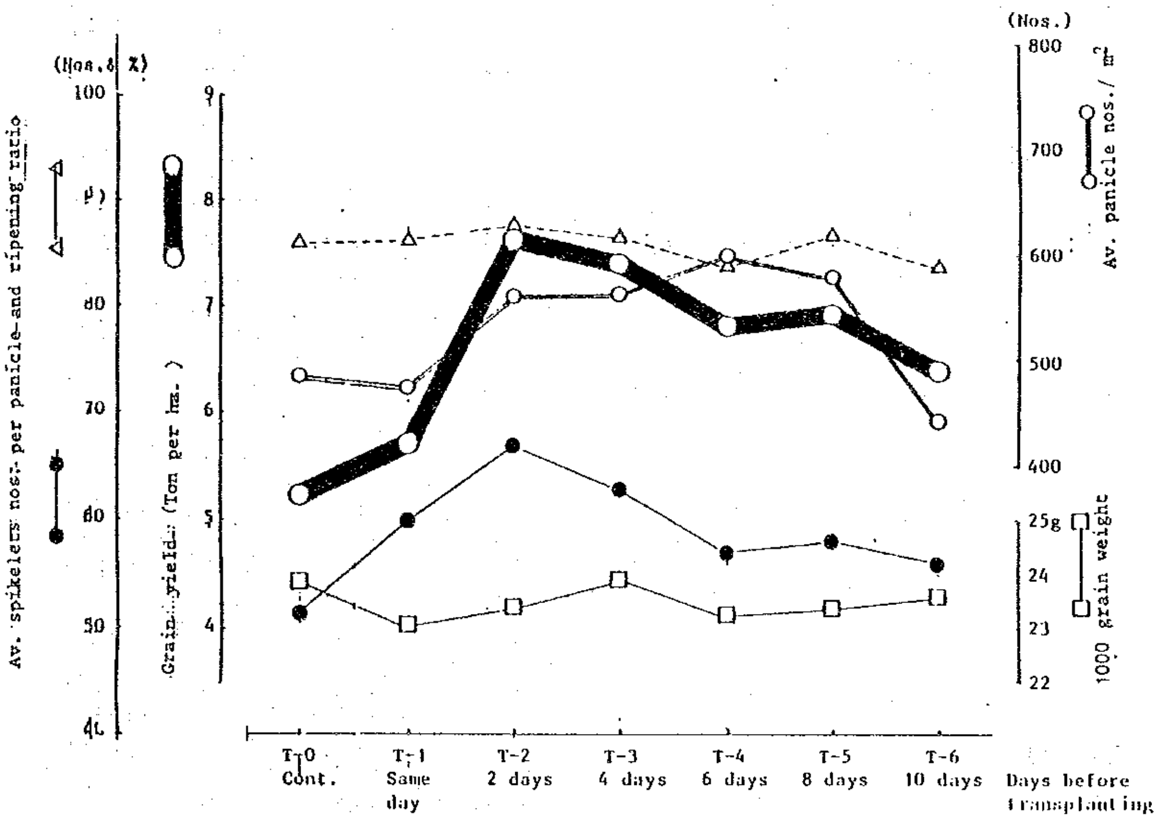


Fig. 9. Trial of carry over effect of nitrogen from nursery bed to main field (Variety: Giza-173)

Table 6. Trial of carry over effect of nitrogen from nursery bed to main field
(Variety: Giza-173)

Treatment		Grain yield (Ton/ha.)	Nos. of panicles/ hill	Nos. of panicles/ m²	Nos. of spikelets/ panicle	Nos. of spikelets/ m² (× 10³)	Ripening ratio (%)	1000 grains weight (gm.)
N-0		5.53	19.86	522.3	54.0	28.21	81.70	23.52
		4.61	16.74	440.3	48.7	21.44	87.52	24.16
		5.59	18.82	495.0	52.2	25.84	89.32	27.84
	Av.	5.24	18.47	485.9	51.6	25.16	86.18	23.84
N-1		6.29	19.52	513.4	58.2	29.85	89.20	23.83
		5.22	17.20	452.4	57.4	25.97	84.60	23.61
		5.59	17.14	450.8	67.7	30.52	85.92	21.73
	Av.	5.70	17.95	472.2	60.1	28.57	86.57	23.06
N-2		7.59	22.06	580.2	64.5	37.42	89.54	23.00
		6.78	20.42	537.1	64.9	34.84	83.36	23.14
		8.56	21.46	564.4	71.8	40.50	90.87	24.09
	Av.	7.64	21.31	560.6	67.0	37.59	87.92	23.41
N-3		6.81	19.96	524.9	63.7	33.41	81.82	24.41
		6.79	20.18	530.7	59.5	31.59	90.80	23.39
		8.59	23.92	629.1	66.6	44.91	87.70	23.74
	Av.	7.40	21.35	561.6	63.3	35.64	86.77	23.85
N-4		6.51	21.76	572.3	59.3	33.95	79.70	23.45
		5.98	24.26	638.0	44.6	28.44	88.78	22.51
		8.01	22.46	590.7	67.6	39.90	83.60	23.77
	Av.	6.83	22.83	600.3	57.1	34.09	84.03	23.24
N-5		6.53	21.86	574.9	55.6	31.94	89.01	22.89
		7.41	20.52	539.7	60.7	32.73	93.69	23.49
		6.89	24.44	642.8	58.4	37.52	79.08	23.72
	Av.	6.94	22.27	585.8	58.2	34.06	87.26	23.37
N-6		4.98	18.68	491.3	50.7	24.92	83.80	24.24
		6.63	18.04	474.5	68.6	32.55	84.44	23.85
		3.58	13.82	363.5	48.6	17.65	83.99	22.82
	Av.	5.06	16.85	443.1	56.0	25.04	84.08	23.64
G. Mean ($\bar{X}$)		6.40	20.15	529.9	59.7	31.48	86.12	23.49
C.V. (%)		14.57	8.91	8.92	11.54	14.88	5.09	4.70
Statistical significance		5 %	1 %	1 %	NS	5 %	5 %	NS
LSD .05		1.42	2.73	71.69	–	7.11	6.65	–

Note: T-0 [Cont.], T-1 [Same day of transplanting], T-2 [2 days before transplanting], T-3 [4 days before transplanting], T-5 [8 days before transplanting] and T-6 [10 days before transplanting]

4) Effect of Zinc Application to Seedling in Nursing Duration on Yield

Object

Nile Delta soil contains extremely scarce zinc and high pH and initial growth after transplanting is often obstructed by zinc dificiency. So, studies were conducted on the effect of zinc application to seedling in nursing duration on yield.

Method

1) Treatment: Z - 0 .... Control

Z - 1 .... 2.5 g. of zinc Sulfate per box.

Z - 2 .... 5 g. of zinc sulfate per box.

2) Application method: Zinc sulfate was dissolved in water 7 days before transplanting and applied.

3) Variety: Giza-173

4) Planting density: 30 cm. x 15 cm. (22.2 hil-1/m^2)

5) Seedling number per hill: 4-6 seedlings.

6) Total fertilizer doses: N .... 100 kg/ha

P_2O_5 ..... 60 kg/ha

K_2O ...... 30 kg/ha

7) Split application method: Basal .... 50% of total nitrogen and total quantity of P an K applied.

1st top-dressing ..... 25% of total nitrogen was applied on the 10th day after transplanting.

2nd top-dressing ..... The remaining 25% nitrogen was applied 7 days before panicle initiation stage.

8) Date of seeding: 20th May

9) Date of transplanting: 25th June

10) Date of harvesting: 19th Oct.

Result

They are shown in Fig. 10 and Table 7.

The highest yield was 5.77 t/ha for Z-2, the second was 5.36 t/ha for Z-1 and the third, 4.13 t/ha for Z-0. The effect of zinc application among yield components appeared in the number of panicle per m^2, which increased proportionately to the amount of fertilizer, in the order of Z-2, Z-1 and Z-0. As the trial field had water shortage, covered with a lot of weeds, and application of fertilizer at suitable time was difficult, the yield was generally low, but it was worth notice that zinc application to box seedlings had effect on yield, and that the nursing box application remarkable reduces the amount of application and labor as compared with a large amount of application for main field. Nursing box application is very economical.

In conclusion, Nile Delta soil contains high pH and absorption of zinc is restrained, causing delay in initial growth after transplanting. To cope with this problem, sprinkling of zinc sulfate of 5 g. per nursing box 5 days before transplanting was proved to be very effective, promoting initial growth and increasing harvest remarkably.

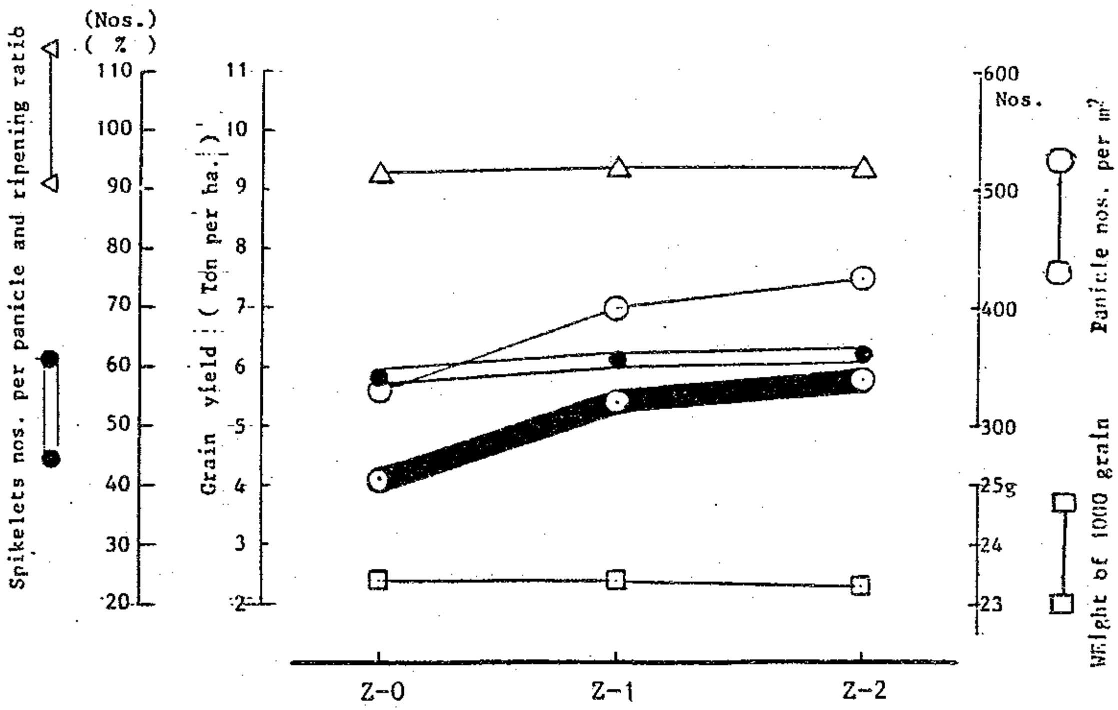


Fig. 10. Effect of zinc application to seedling tray
(Variety: Giza-173)

Table 7. Trial of zinc application to seedling tray (Variety: Giza-173)

Treatment		Grain yield (Ton/ha.)	Nos. of panicles/ hill	Nos. of panicles/ m^2	Nos. of spikelets/ panicle	Nos. of spikelets/ m^2 ($\times 10^3$)	Ripening ratio (%)	1000 grains weight (gm.)
Z-0		3.81	12.22	318.9	52.5	16.74	94.13	23.28
		4.29	12.55	327.6	61.7	20.21	93.02	23.25
		4.33	12.87	335.9	58.5	19.65	90.54	23.73
	Av.	4.13	12.55	327.5	57.6	18.87	92.56	23.42
Z-1		5.68	15.39	401.7	65.3	26.22	95.71	22.72
		5.21	15.04	392.5	59.4	23.32	92.25	23.66
		5.19	15.45	403.3	57.3	23.11	93.02	23.91
	Av.	5.36	15.29	399.2	60.7	24.22	93.66	23.43
Z-2		5.73	16.09	419.9	62.3	26.14	93.88	23.12
		5.59	17.35	452.8	54.7	24.78	94.56	23.46
		5.98	15.32	399.8	68.1	27.24	92.05	23.44
	Av.	5.77	16.25	424.2	61.7	26.05	93.50	23.34
G. Mean ($\bar{X}$)		5.09	14.69	383.6	60.0	23.05	93.24	23.40
C.V. (%)		5.06	4.31	4.32	8.82	7.09	1.79	1.75
Statistical significance		1 %	1 %	1 %	NS	1 %	NS	NS
LSD .05		0.45	1.10	28.64	–	2.83	–	–

Note: Zinc were applied to seedling tray just before the transplanting to seedling tray's seedlings mixed with water, and T-1 applied 2.5 g. per tray and T-2 were 5.0 g.

3. Planting Density

1) Effect of Change in Planting Density of Yield

Object

The results of experiment in previous year made it clear that high yield over 8 ton per ha. is possible for the time of seeding from the last ten days of 20th May and the time of transplanting from 20th May to 10th June. Studies were made to grasp changes in yield according to the different transplanting density within the scope of adjustment of density by transplanters.

Result

1) Treatment:

	Between row to row	Between plant to plant	hill/m^2
T - 1	30 cm	18 cm	18.5
T - 2	30 cm	15 cm	22.2
T - 3	30 cm	12 cm	27.7

2) Variety: Giza-173

3) Amount of fertilizer applied for main field: N .... 100 kg/ha
P_2O_5 ..... 60kg/ha
K_2O ...... 30 kg/ha

4) Split application method:

Basal doses .... 50% of total nitrogen and total quantity of P and K.

1st top-dressing.... 25% of total nitrogen on the 10th day after transplanting.

2nd top-dressing.... Remaining 25% of nitrogen on just before the Reduction Division Stage.

5) Date of seeding: 3rd May

6) Date of transplanting: 26th May

7) Date of harvesting: 3rd Oct.

Result

Yield and yield components are mentioned in Fig. 11 and Table 8.

The fertility of soil of Meet El Dyba Experimental Field was poor this year, 1984, due to the first transplanting. In adiition, the field suffered from water shortage, a lot of weeds, salty injury and strong alkalinity, and the yield was very poor.

According to Fig. 11 and Table 8, there is not much difference in yield between treatment plot. Namely, the yield of T-3 plot was 3.06 ton per ha. as against 2.55 ton per ha. of T-1 plot. Assuming T-1 plot to be 100, T-3 is 119, only a small difference. In this experiment, shortage of irrigation water hit the field just after transplanting, rooting was obstructed considerably, inferior tiller mostly kept dormant and initial growth was very slow. Consequently, weak and high order tillering occurred frequently in and after the medium stage of growth and spikelets number per panicle sharply decreased, with less spikelets number per m^2. Therefore, it was impossible to make studies based on normal experiment.

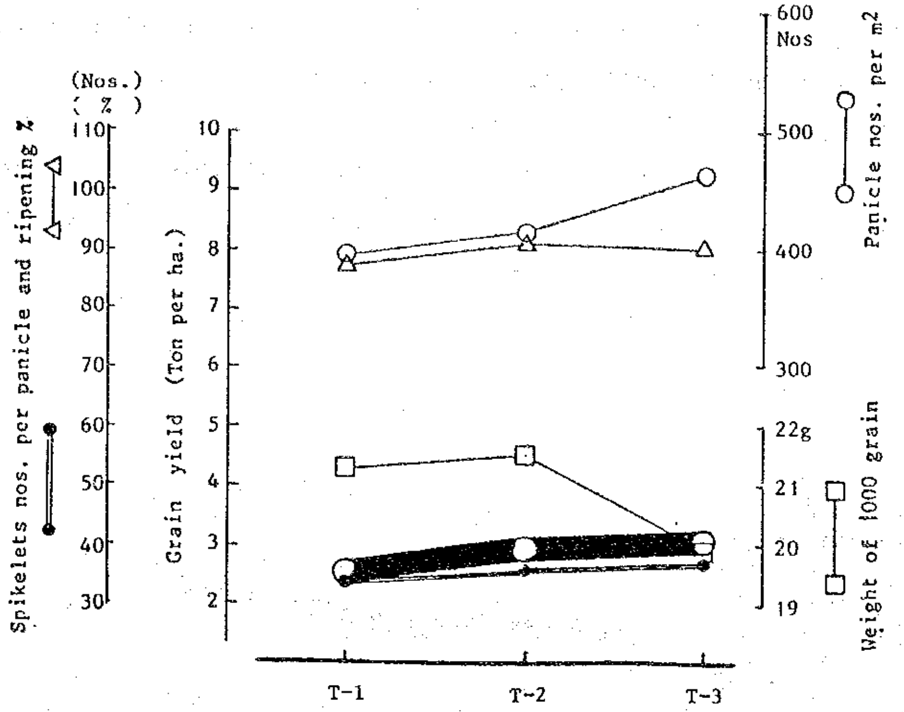


Fig. 11. Different planting density trial (Variety: Giza-173)

Table 8. Different planting density trial (Variety: Giza-173)

Treatment		Grain yield (Ton/ha.)	Nos. of panicles/ hill	Nos. of panicles/ m^2	Nos. of spikelets/ panicle	Nos. of spikelets/ m^2 (x 10^3)	Ripening ratio (%)	1000 grains weight (gm.)
T-1		2.69	20.32	392.2	37.6	14.75	88.3	21.2
		3.13	21.15	408.2	36.5	14.90	96.0	21.7
		1.83	19.63	378.9	27.9	10.57	78.2	21.1
	Av.	2.55	20.37	393.1	34.00	13.41	87.5	21.3
T-2		2.31	17.93	426.7	28.9	12.33	83.1	21.1
		2.91	15.17	360.0	42.1	15.20	93.3	20.8
		3.59	19.45	462.9	36.2	16.76	95.8	22.6
	Av.	2.94	17.52	416.9	35.73	14.76	90.73	21.5
T-3		3.03	17.86	509.0	33.4	17.00	91.0	19.5
		3.51	17.40	495.0	41.1	20.38	93.4	20.2
		2.63	13.80	393.3	36.6	14.39	86.9	19.9
	Av.	3.06	16.35	446.1	37.0	17.26	90.4	19.9
G. Mean ($\bar{X}$)		2.85	18.08	425.4	35.95	15.14	89.55	20.89
C.V. (%)		20.66	10.21	11.32	14.97	34.49	7.51	17.06
Statistical significance		NS	NS	NS	NS	NS	NS	NS

In conclusion, in the case of constant seeding quantity per box of 200 g., the number of seedlings per hill should be changed depending on the early or late maturing varieties, to 5-7 seedlings for the early and medium varieties, but in the case of a late maturing variety, a decrease in the number of seedlings per hill to a certain extent causes only minor decrease in harvest.

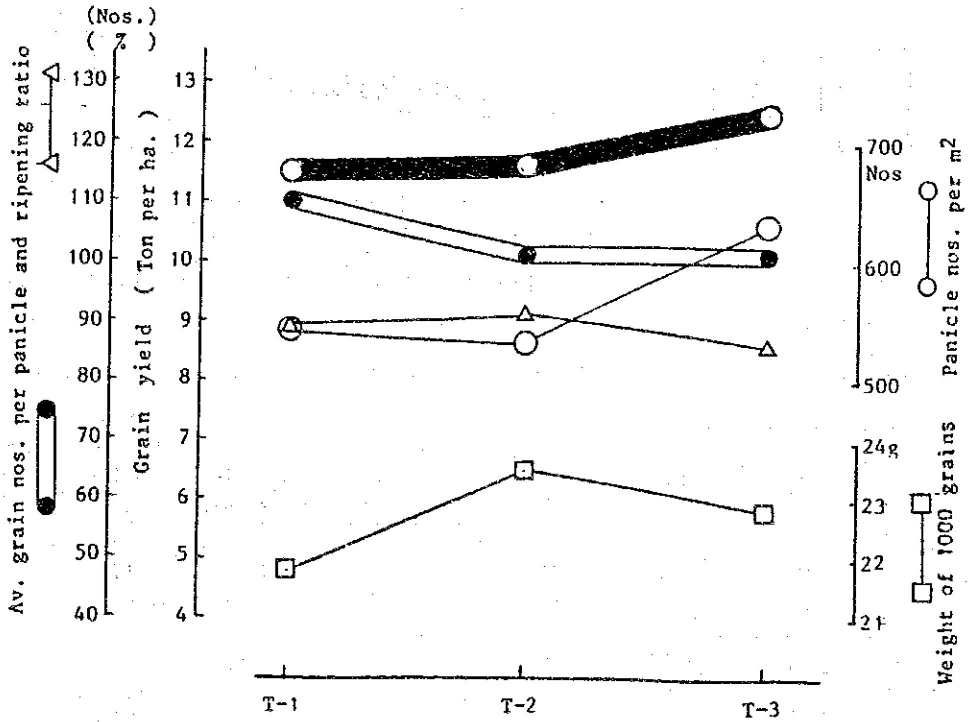


Fig. 12. Different seedling number per hill and grain yield (Variety: Giza-172)

2) Effect of Change in the Number of Seedling per Hill on Yield.

Object

As a result of seeding rate trial on seedling raising in box, the dry unhulled rice weight of 200 g. per box produced good result, with good seedling quality and extremely less missing planting percentage.

As a second step, the relation between the number of seedling per hill and yield was studied on condition of constant seeding rate and varied amount of picking of seedling by transplanting finger.

Method

1) Treatment:

Plot	Vertical feed	Horizontal feed	Nos. of seedling per hill
T - 1	10 mm	10 mm	2 - 3.5
T - 2	13 mm	14 mm	3.5 - 5
T - 3	16 mm	14 mm	5 - 7

2) Variety: Giza-172 and Nipponbare

3) Amount of fertilizer applied for main field: N .... 100 kg/ha
P_2O_5 ..... 60 kg/ha
K_2O ...... 30 kg/ha

4) Split application method:

Basal dose .... 50% of total nitrogen, total phosphate and potassium for both varieties.

1st top-dressing.... 25% of total nitrogen on the 10th day after transplanting for both varieties.

2nd top-dressing.... The remaining 25% in the beginning of reduction division stage for Giza-172 and on or about the 10th day before panicle initiation stage for Nipponbare.

5) Planting density: 30 cm x 12 cm (27.7 hills/m^2)

6) Seeding rate: 200 g. per box

7) Date of seeding: 26th April

8) Date of transplanting: 9th June

o) Date of harvesting: Giza-172 .... 1st Oct.
Nipponbare ...... 11th Sept.

Result

They are indicated on Fig. 12, 13 and Table 9, 10.

According to them, the yield of both Giza-172 and Nipponbare tends to increase in proportion of the larger number of seedling per hill as far as this trial concerns. As there are considerable variations in the palingenesis within the treatment, analysis of variance has been conducted. However, no significant difference was noticed.

It is considered that more seedlings per hill increase spikelets number per m^2 through an increase in panicle number, leading to more harvest. This tendency is especially marked in Nipponbare than Giza-172. In the case of T-1 plot, were the number of seedling per hill is limited to 2 - 3.5 seedlings, the ratio of missing hills naturally occurs in high percentage, but the difference in yield of Giza-172 between T-2 (3.5 - 5 seedlings per hill) and T-3 (5-7 seedlings per hill) is small, and T-1 plot-11.54 t/ha, T-2 plot-11.60 t/ha and T-3 obtained 12.45 t/ha in the order of yield.

In the case of Nipponbare, it is interesting that its yield variation due to difference in the number of seedlings per hill is large, showing the following order of yield: T-1 1.89 t/ha, T-2 8.08 t/ha and T-3 obtained 10.09 t/ha.

As already made clear, the yield of paddy rice in Egypt is regulated by the spikelets number per m^2, supported by the condition of solar radiation in ripening stage. As Giza-172 is a late maturing variety with long vegetative stage, the number of seedlings per hill is small, and the spikelets number per m^2 of different seedlings per hill is close together, showing no remarkable difference in yield. On the other hand, Nipponbare is a medium maturing panicle number type variety with short vegetative stage, and its panicle initiation stage comes earlier. So, difference in the number of seedlings per hill and the ratio of massing hill itself have influence on the number of panicles, and the more number of seedling per hill it has, the more spikelets per m^2 it puts forth, making great difference in yields as far as this experiment is concerned. It is therefore considered necessary to change the number of seedlings per hill according to the early or late maturing varieties in deciding the amount of picking of seedlings by transplanting finger. Namely, the number of seedlings per hill of early and medium maturing variety with short growth duration should be increased to 5-7 seedlings, but a late-maturing variety with long growth duration may decrease the number of seedlings per hill to a certain extent according to this experiment.

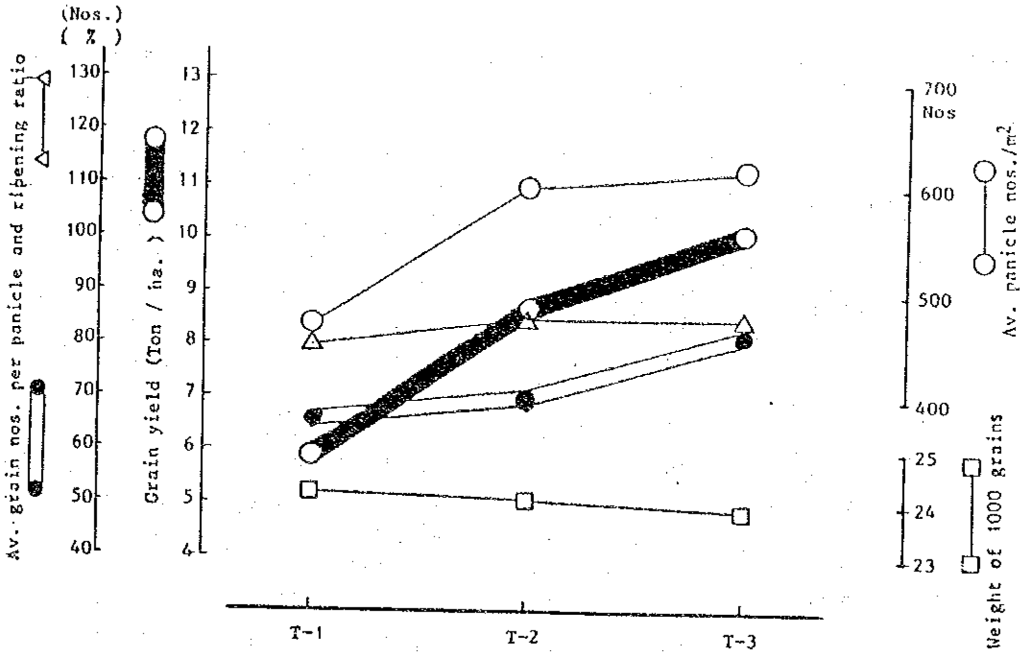


Fig. 13. Different seedling number per hill and its grain yield (Variety: Nipponbare)

Table 9. Different seedling number per hill and its grain yield (Variety: Giza-172)

Treatment		Grain yield (Ton/ha.)	Nos. of panicles/ hill	Nos. of panicles/ m^2	Nos. of spikelets/ panicle	Nos. of spikelets/ m^2 ($\times 10^3$)	Ripening ratio (%)	1000 grains weight (gm.)
T-1		12.18	21.6	557	107.6	59.9	93.4	22.67
		12.69	23.5	606	113.7	68.9	84.60	21.13
		9.76	17.9	462	107.2	49.5	89.62	21.56
	Av.	11.54	21.0	542	109.5	59.4	89.20	21.75
T-2		12.71	21.68	559	107.6	60.1	90.81	23.14
		9.51	19.20	459	97.3	44.7	89.07	23.63
		12.57	22.54	581	99.4	57.8	94.36	23.61
	Av.	11.60	21.14	533	101.4	54.2	91.41	23.46
T-3		12.05	22.70	587	98.9	58.1	89.12	23.29
		13.32	25.36	654	101.4	66.3	87.24	23.55
		11.99	24.98	644	103.8	66.8	82.28	21.64
	Av.	12.45	24.35	628	101.4	63.7	86.21	22.83
G. Mean ($\bar{X}$)		11.87	22.16	568	104.1	59.3	88.94	22.69
C.V. (%)		12.19	9.46	10.61	3.87	13.31	4.06	10.73
Statistical significance		NS	NS	NS	NS	NS	NS	NS
LSD .1		–	–	–	–	–	–	–

Note: T - 1 = 10mm. x 10mm. (2 – 3.5 seedlings per hill)
T - 2 = 13mm. x 10mm. (3.5 - 5 seedlings per hill)
T - 3 = 16mm. x 14mm. (5 - 7 seedlings per hill)

Table 10. Different seedling number per hill and its grain yield (Variety: Nipponbare)

Treatment		Grain yield (Ton/ha.)	Nos. of panicles/ hill	Nos. of panicles/ m^2	Nos. of spikelets/ panicle	Nos. of spikelets/ m^2 (x 10^3)	Ripening ratio (%)	1000 grains weight (gm.)
T-1		5.39	18.45	483.4	62.63	30.27	73.10	23.80
		4.92	18.30	479.5	47.48	22.76	87.60	24.50
		7.35	17.20	450.6	87.90	39.61	78.82	24.20
	Av.	5.89	17.98	471.2	66.00	30.87	79.84	24.17
T-2		9.45	21.46	562.3	79.62	44.77	85.89	24.40
		9.21	25.12	658.1	70.44	46.36	83.00	23.73
		7.37	21.90	573.8	60.36	34.63	86.63	24.03
	Av.	8.68	22.83	598.1	70.14	41.92	85.17	24.05
T-3		12.51	28.18	738.2	80.70	59.58	88.07	24.51
		9.11	20.96	549.2	87.22	47.90	85.14	23.14
		8.66	21.34	559.1	78.59	43.94	81.30	23.96
	Av.	10.09	23.49	615.5	82.17	50.47	84.84	23.87
G. Mean ($\bar{X}$)		8.22	21.43	561.6	72.77	41.09	83.28	24.03
C.V. (%)		19.05	12.33	12.33	18.26	18.73	5.73	2.02
Statistical significance		5 %	NS	NS	NS	10 %	NS	NS
LSD .05		2.71	–	–	–	13.32	–	–

Note : T - 1 = 10mm. x 10mm.
T - 2 = 13mm. x 14mm.
T - 3 = 16mm. x 14mm.

4. Fertilizer Application Method

1) Three Fertilizer Elements Trial

<u>Object</u>

As a result of the three fertilizer elements trial conducted at Kallin Experimental Field last year, the necessity for application of these three elements such as Nitorogen, Phosphate and Potassium was proved essential.

However, the soil condition of Meet El Dyba is different, so, a trial was conducted again.

<u>Method</u>

1) Treatment:

Plot	Nitrogen	Phosphate	Potassium
T - 0	0	0	0
T - 1	80	0	0
T - 2	80	60	0
T - 3	80	60	30
T - 4	0	60	30
T - 5	0	0	30

2) Split application method: Basal doses .... Applied 50% of total N as basal fertilizer and P and K applied total quantity as basal.

1st top-dressing.... 25% of total nitrogen on 7th day after transplanting.

2nd top-dressing.... The remaining 25% of nitrogen on the 7 days before the beginning of neck-node differentiation stage for Nipponbare, and just before the reduction division for Giza-173.

3) Variety: Giza-172 and Nipponbare

4) Planting density: 30 cm x 13 cm (25.6 hills/m^2)

5) Date of seeding: Giza-173 .... 20th June
Nipponbare ...... 7th May

6) Date of transplanting: Giza-173 .... 10th July
Nipponbare ...... 20th June

7) Date of harvest: Giza-173 .... 10th Nov.
Nipponbare ...... 22nd Sept.

Result

The effect of 3 elements on yield and yield components is shown in Fig. 14, 15 and Table 11, 12. In the case of Nipponbare, T-1 obtained more yield of about 2 tons, or 1.97 times as much as T-0 (Control). But, T-3 (applied N, P and K) produced the highest yield of 2.79 times as much as T-0 and 1.37 times as compared with T-1. There is little difference between T-4 (applied P, K) and T-5 (applied K only) in yield as between T-0.

Statistics show significant difference in yield, the number of panicles per hill, panicle number per m^2 and spikelets number per m^2 between treatment on a 1% level, and in spikelets number per panicle on a 5% level. However, no significant difference is recognized for ripening ratio and weight of 1000 grains.

In the case of Giza-173, T-1 and T-3 respectively produced more harvest of 1.97 and 2.22 times as much as T-1. The results of statistics show significant difference in yield due to treatments on 1% level. As for yield components, significant difference is also recognized on a 1% level, except ripening ratio and weight of 1000 grains, which are "Not significant".

The effect of nitrogen is conspicuous as stated above, and the absolute necessity of nitrogen for an increased yield as proved last year has been reconfirmed. In the rice crop season in '84, there was a large outbreak of blast disease in Kafr El Sheikh Governorate. The special features common to the districts which suffered great damage are boiled sown to (i) Remarkable delay in cropping season, (ii) Unskillful fertilizer application. No application of phosphate and potassium and unreasonable timing of nitrogen application can to the fore in particular. The importance of a balanced application of three elements is pointed up.

In conclusion, the necessity of application of three elements such as nitrogen, phosphate and potassium which had been made clear in and before previous year was reconfirmed, and it was clarified that any of the three elements is closely related to spikelets number, regulating yields.

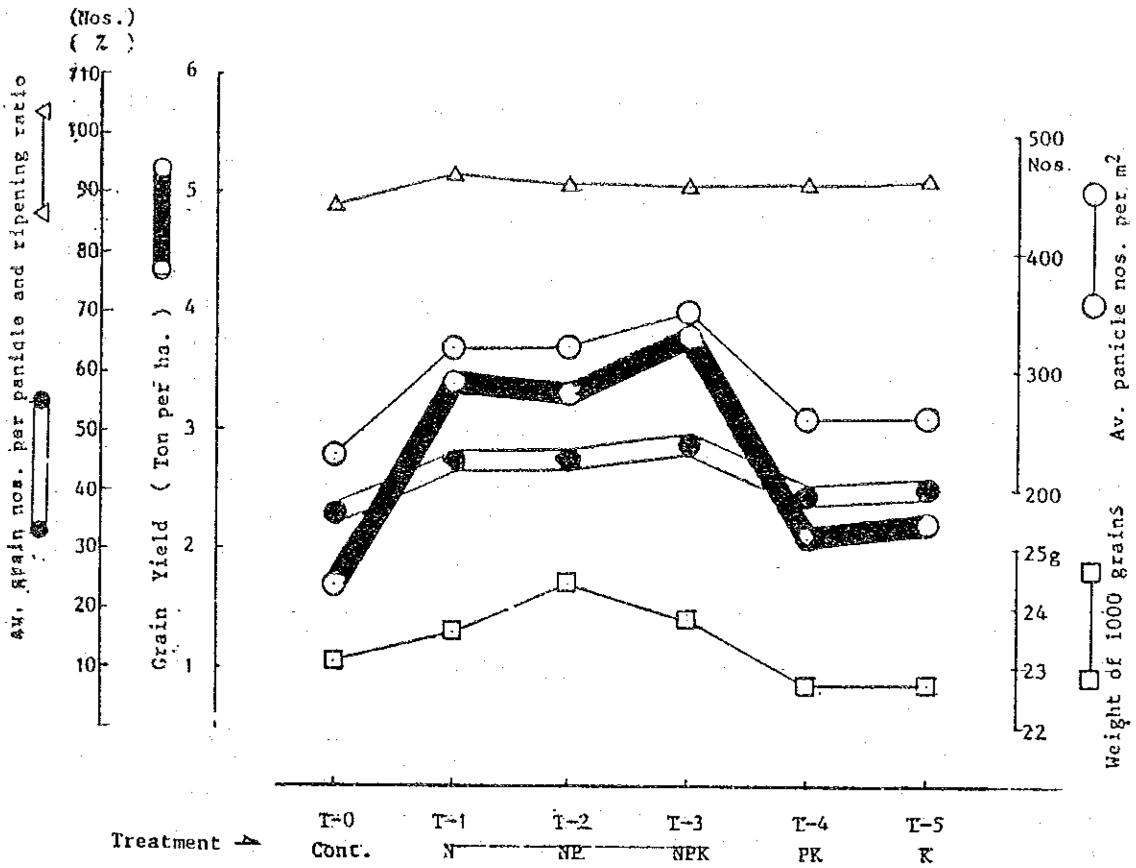


Fig. 14. Three fertilizer elements trial (Variety: Giza-173)

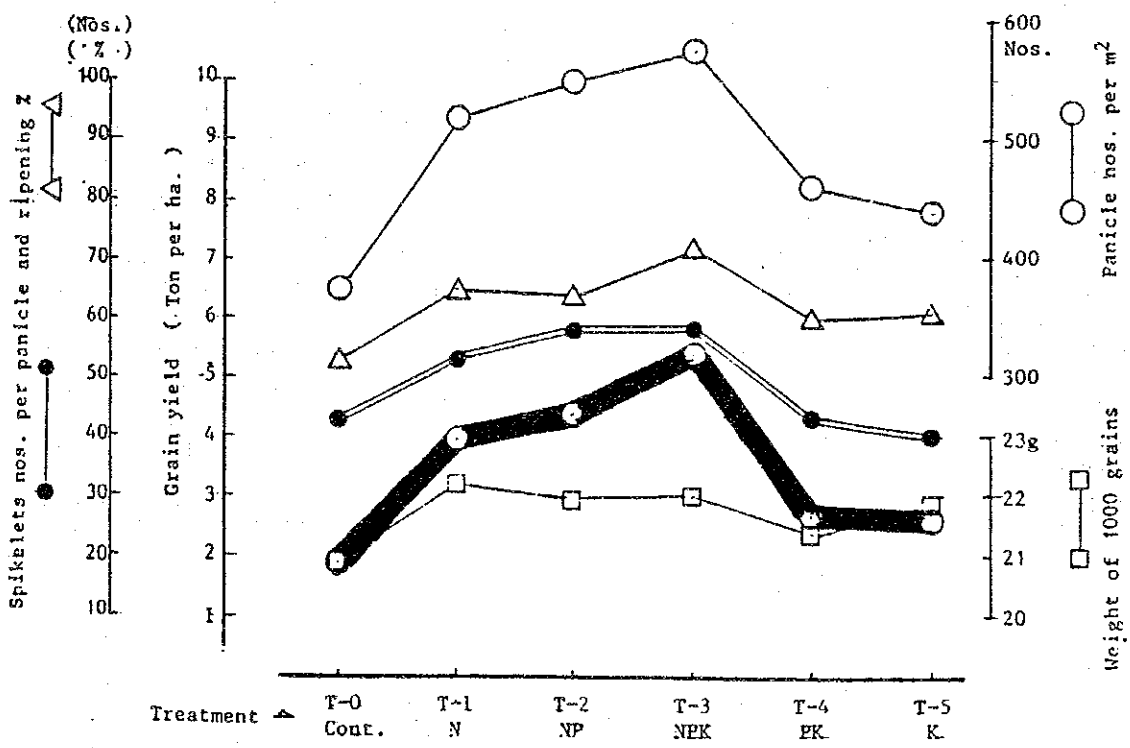


Fig. 15. Three fertilizer elements trial (Variety: Nipponbare)

Table 11. Three fertilizer application trial (Variety: Giza-173)

Treatment		Grain yield (Ton/ha.)	Nos. of panicles/ hill	Nos. of panicles/ m^2	Nos. of spikelets/ panicle	Nos. of spikelets/ m^2 (x 10^3)	Ripening ratio (%)	1000 grains weight (gm.)
T-0		1.70	9.50	228	36.07	8.22	91.94	22.95
Cont.		1.63	8.92	214	38.91	8.33	82.34	22.33
		1.84	10.50	252	33.97	8.56	89.90	23.95
	Av.	1.72	9.67	231	36.32	8.37	88.06	23.08
T-1		3.41	13.76	330	44.36	14.65	90.98	24.09
		3.89	14.82	356	46.93	16.69	95.02	23.95
		2.88	11.58	278	43.75	12.16	93.52	22.69
	Av.	3.39	13.39	321	45.01	14.50	93.17	23.58
T-2		2.91	12.76	306	41.33	12.67	90.32	23.71
		3.15	12.60	302	44.31	13.40	90.54	25.14
		3.96	14.52	345	50.13	17.29	91.50	24.40
	Av.	3.34	13.29	318	45.31	14.45	90.79	24.42
T-3		3.96	14.98	360	48.07	17.28	91.70	23.71
		3.87	14.86	357	49.00	17.48	89.82	24.05
		3.59	14.08	338	47.14	15.93	92.07	23.62
	Av.	3.81	14.64	352	48.07	16.90	91.20	23.79
T-4		2.00	10.18	244	38.30	9.36	91.12	23.50
		2.41	12.04	288	39.83	11.03	90.91	24.40
		2.09	10.28	247	39.71	9.80	92.19	23.14
	Av.	2.17	10.83	260	39.28	10.06	91.41	23.68
T-5		2.13	10.76	258	38.14	9.85	89.14	22.82
		1.99	9.91	238	39.67	9.44	94.32	22.05
		2.54	11.74	282	43.53	12.27	93.47	23.12
	Av.	2.22	10.80	259	40.44	10.52	92.31	22.66
G. Mean ($\bar{X}$)		2.78	12.10	290	42.41	12.47	91.16	23.36
C.V. (%)		39.8	8.72	8.61	5.96	12.74	–	–
Statistical significance		1 %	1 %	1 %	1 %	1 %	NS	NS
LSD .05		1.71	1.63	38.48	3.89	2.45	–	–

Table 12. Three fertilizer application trial (Variety: Nipponbare)

Treatment		Grain yield (Ton/ha.)	Nos. of panicles/ hill	Nos. of panicles/ m^2	Nos. of spikelets/ panicle	Nos. of spikelets/ m^2 (x 10^3)	Ripening ratio (%)	1000 grains weight (gm.)
T-0		1.82	12.70	325.1	44.6	14.50	56.97	21.42
Cont.		1.74	15.66	400.9	36.9	14.79	43.97	20.95
		2.26	15.52	399.3	47.3	18.79	58.75	20.48
	Av.	1.94	14.63	374.4	42.9	16.03	53.23	20.95
T-1		3.52	20.72	530.4	48.7	25.83	59.20	22.78
N		4.03	21.32	545.8	58.1	31.71	57.95	21.40
		4.32	18.68	478.2	51.3	24.53	76.94	22.37
	Av.	3.96	20.24	518.1	52.7	27.36	64.69	22.18
T-2		3.90	20.46	523.8	56.3	29.49	59.96	21.53
N & P		4.39	19.84	507.9	69.4	35.25	55.23	22.35
		4.98	23.80	609.3	49.1	29.92	77.68	21.97
	Av.	4.42	21.37	550.0	58.3	31.55	64.29	21.95
T-3		5.43	23.80	609.3	60.7	36.98	64.38	22.61
N, P & K		5.01	21.64	553.9	56.3	31.19	75.06	21.39
		5.83	21.71	555.8	55.7	30.96	77.48	22.12
	Av.	5.42	22.38	573.0	57.6	33.04	72.31	22.04
T-4		3.41	18.48	473.1	49.7	23.51	62.39	20.07
P & K		1.93	17.90	458.2	36.5	16.72	54.34	21.20
		2.74	17.78	455.2	42.8	19.48	62.65	22.24
	Av.	2.69	18.05	462.2	43.0	19.90	59.79	21.38
T-5		2.46	18.66	477.7	40.7	19.44	57.17	21.25
K		2.59	16.15	413.4	48.8	20.18	53.28	21.32
		2.69	17.10	437.8	30.9	13.53	71.23	22.79
	Av.	2.58	17.30	442.9	40.1	17.72	60.56	21.79
G. Mean ($\bar{X}$)		3.55	18.99	486.8	49.1	24.27	62.48	21.72
C.V. (%)		12.94	7.60	7.61	14.16	13.80	–	–
Statistical significance		1 %	1 %	1 %	5 %	1 %	NS	NS
LSD .05		0.71	2.22	57.4	xx.x	–	–	–

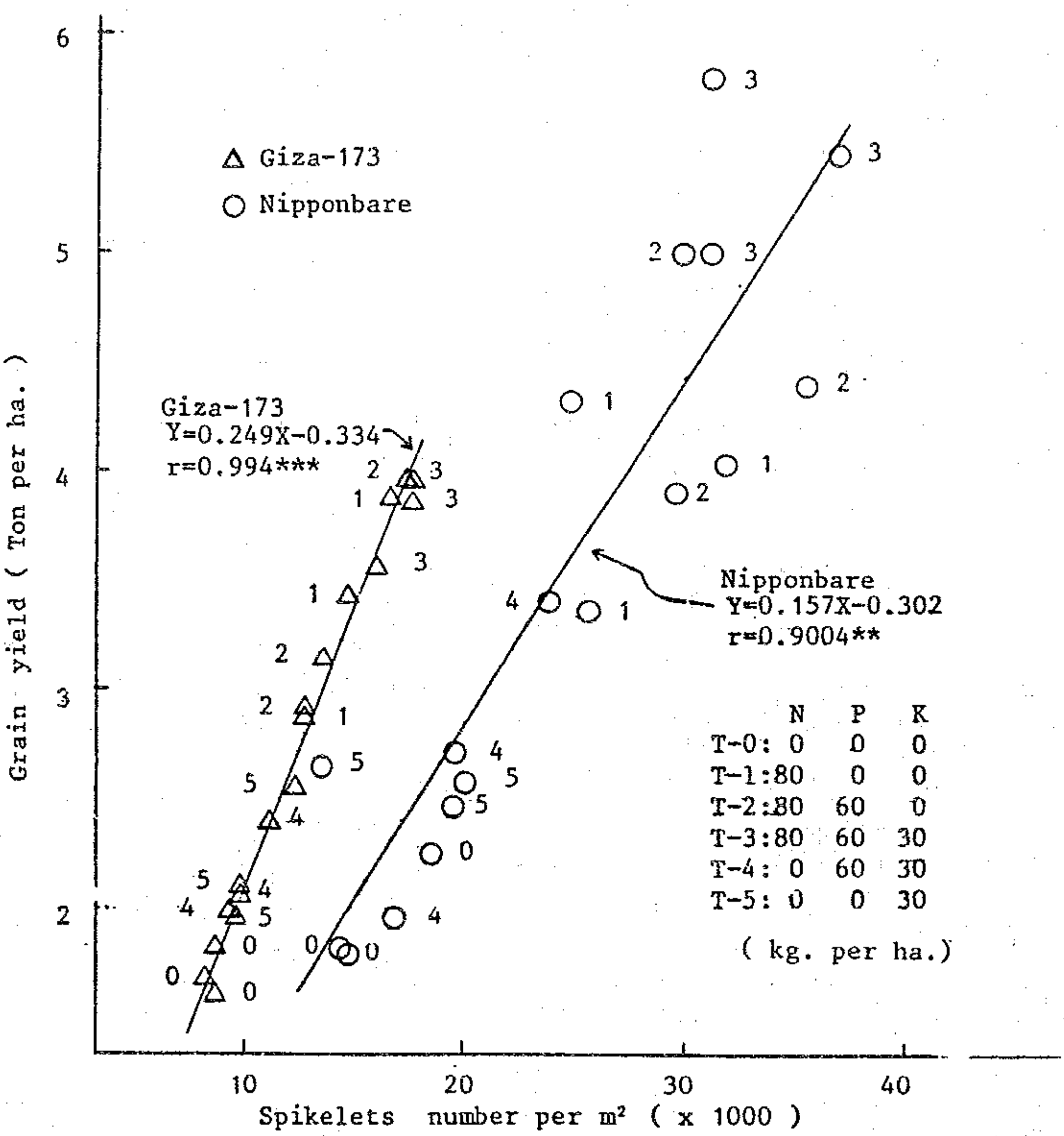


Fig. 16. Relationship between spikelets number and grain yield

2) Compost Application Experiment

Object

The soil of Nile Delta has characteristics of breaking very easily when fields are filled with water, but it becomes as hard as stone when dried up. This is supposedly because it is extremely lacking in organic matters. In the days when the Nile had flooding, a considerable amount of organic substances was spontaneously supplied together with floods, but the river is completely controled at present and the natural supply of organic matters has remarkably decreased. The complet control of water, however, created a problem of salty injury in various districts, and the government actively enforced drain works by culverts in the Nile Delta areas. Therefore, a considerable amount of chemical fertilizer is presumably carried away by leaching.

The effect of organic fertilizer application has been studied to cope with this problem.

Method

1) Treatment:

	T-1	T-2
Total quantity of fertilizer	N........120 kg/ha P_2O_5..... 80 kg/ha K_2O...... 30 kg/ha	N........120 kg/ha P_2O_5..... 80 kg/ha K_2O...... 30 kg/ha
Basal doses	Compost.. 6 t/ha N........ 30 kg/ha P_2O_5..... 80 kg/ha K_2O ..... 30 kg/ha	0 N........ 60 kg/ha P_2O_5..... 80 kg/ha K_2O ..... 30 kg/ha
Top-dressing	1st top-dressing: 7-10 days after transplanting N........ 30 kg/ha	N........ 30 kg/ha
	2nd top-dressing: 7-10 days before neck-node differentiation stage N........ 30 kg/ha	N........ 30 kg/ha

Remarks: The N content in compost is 0.5% for calculation purpose.

2) Variety: Giza-173

3) Transplanting density: 30 cm x 12 cm (27.7 hills per m^2)

4) Date of seeding: 20th May

5) Date of transplanting: 18th June.

6) Date of harvest: 22nd Oct.

Result

The effect of compost application on yield and yield components is indicated on Fig. 17 and Table 13. According to them, the treatment plot where compost was applied produced 7.11 t/ha of unhulled rice, an increased yield of 17% versus no application plot. As for yield components, all components are higher in the compost application plot. The stronger fertilizer storing capacity of soil due to compost application and the longer effect sustaining duration may have brought about an increased yield. Statistical process is omitted, because no control plot has been set up in this experiment.

In conclusion, studies on compost application for Delta soil proved that the said application is essential to increased yield.

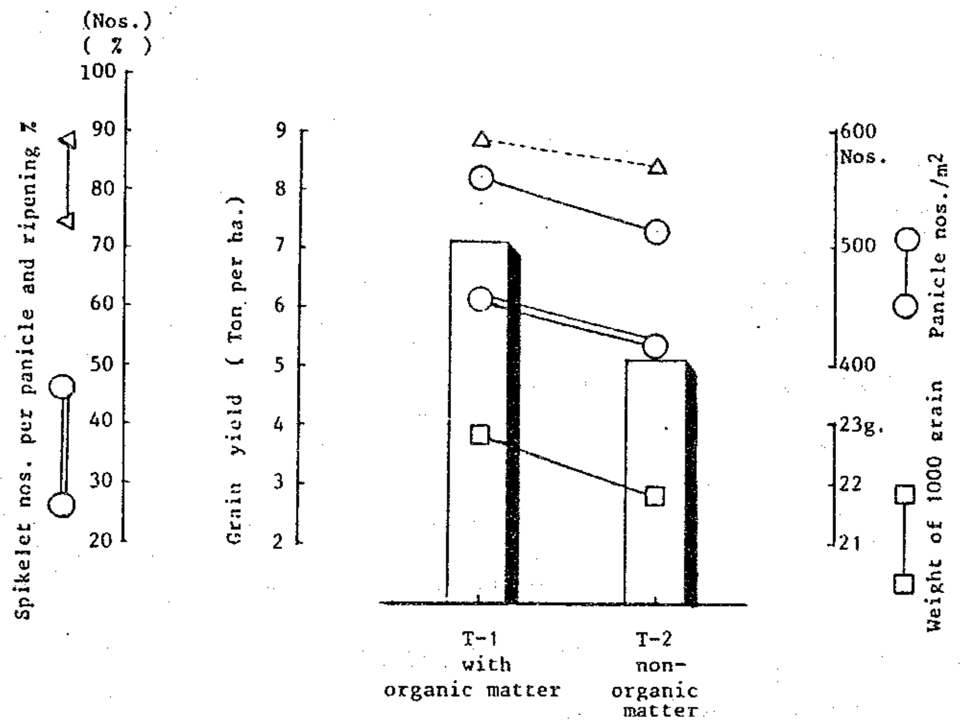


Fig. 17. Organic matter application trial (Variety: Giza-173)

Table 13. Organic matter application trial (Variety Giza-173)

Treatment		Grain yield (Ton/ha.)	Nos. of panicles/ hill	Nos. of panicles/ m^2	Nos. of spikelets/ panicle	Nos. of spikelets/ m^2 (x 10^3)	Ripening ratio (%)	1000 grains weight (gm.)
T-1 Organic matter applied		7.69	21.95	579.5	64.68	37.48	90.23	22.51
		7.83	23.10	609.8	61.35	37.41	88.80	23.23
		5.81	18.88	498.4	57.74	28.78	86.6	22.74
	Av.	7.11	21.31	562.6	61.26	34.56	88.54	22.83
T-2 Non-organic matter		4.21	20.24	534.3	53.18	28.42	70.94	20.54
		5.33	17.36	458.3	51.76	23.72	94.32	23.17
		5.59	21.18	559.2	54.14	30.27	86.72	21.54
	Av.	5.04	19.59	517.3	53.03	27.47	83.99	21.75
G. Mean		6.08	20.45	539.9	57.15	31.02	86.27	22.29

3) Effect of Different Planting Density on Yield

Object

As a result of studies in previous year, the optimum values for nitrogen application and planting density became clear. This year, two factor of experiment was conducted on planting density and the amount of nitrogen application.

Method

1) Treatment: N - 0......Control

N - 1......50 kg/ha P_2O_5..... 80 kg/ha K_2O..... 30 kg/ha

2) Nitrogen: N - 2.....100 kg/ha " " " "

N - 3.....150 kg/ha " " " "

N - 4.....200 kg/ha " " " "

3) Planting Density D - 1.....18.5 hills/m^2

D - 2.....27.7 hills/m^2

4) Variety: Giza-173

5) Split application method of fertilizer:

Basal dose ...... Excluding control plot, 50% of total nitrogen and total phosphate and potassium were applied.

1st top-dressing..25% of total nitrogen was applied 10 days after transplanting.

2nd top-dressing..The remaining 25% was applied the panicle initiation stage.

6) Number of seedling per hill: 4-6 nos.

7) Date of seeding: 10th May

8) Date of transplanting: 6 June

9) Date of harvesting: 10th Oct.

Result

The survey results of yield and yield components are shown in Fig. 18,12, 20(1) - (7) and Table 14.

According to Fig. 18, 19 and Fig. 20(1) regarding yield, both the planting density 18.5 and 27.7 hills/m^2 show nearly the same application reaction, i.e., the indicate a linear tendency toward increased yield up to 100 kg. of nitrogen and yield gradually increases as nitrogen application increases, reaching the peak at 150 kg. and sharply declining at 200 kg. As for the number of panicle per m^2, it keeps increasing up to 2-0 kg, in proportion to application increase in both the planting density as seen in Fig. 20(3). As regards spikelets number in both the planting density as seen in Fig. 20(3). As regards spikelets number per panicle shown in Fig. 20(4), both the planting density from the peak at 100 kg. of nitrogen, and the number clearly declines as nitrogen increases. So, spikelets number per m^2, which is the product of nitrogen application and planting density, continues to increase up to 150 kg. in line with an increase in nitrogen application as indicated in Fig. 20(5), showing a decline thereafter. Ripening ratio and weight of 1000 grains tend to decline with the increase of nitrogen application as shown in Fig. 20(6) and (7). In conducting this experiment, it was assumed that different planting density would cause different application reactions of yield components, but both factors showed nearly the same tendency. The highest yield positions in the range of 100 - 150 kg. of nitrogen application amount, and an excessive reaction appears when the amount overs 150 kg, resulting in a decreased yield.

In conclusion, the result of two factor experiment on planting density and nitrogen application amount indicates that the amount of nitrogen application of 100 - 150 kg. is optimum for both the planting density of 18.5 and 27.7 hills per m^2.

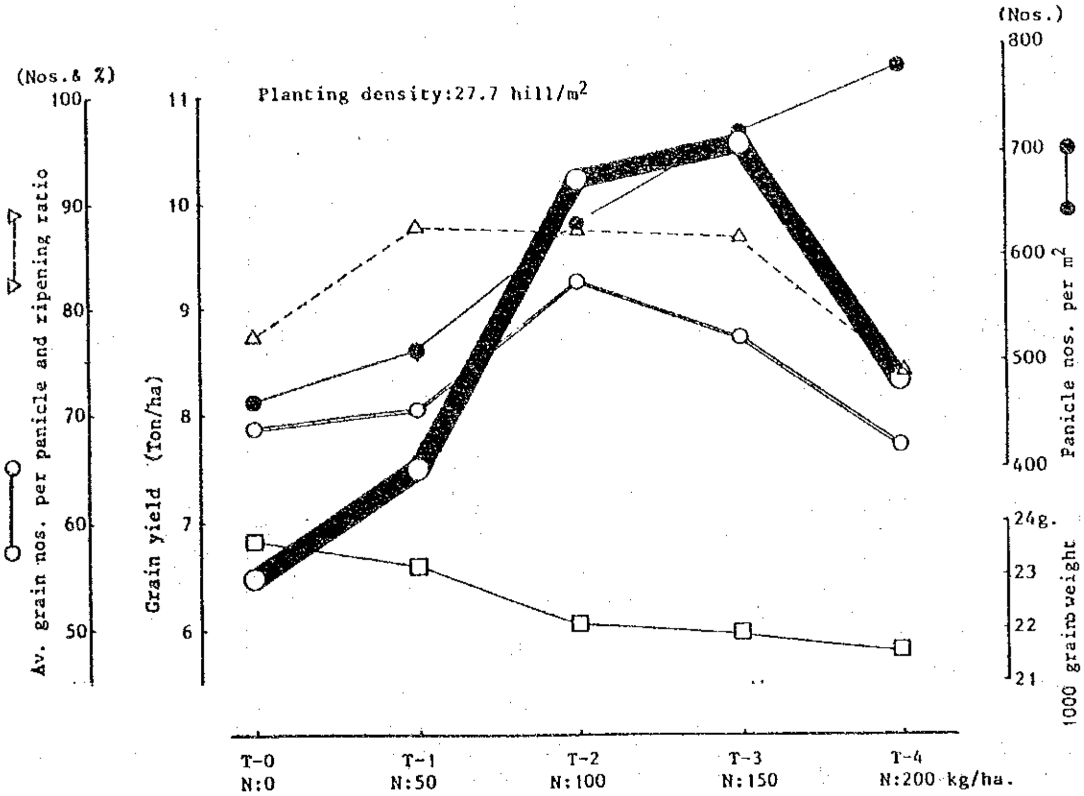


Fig. 18. Experiment of planting density and nitrogen level (Variety: Giza-173)

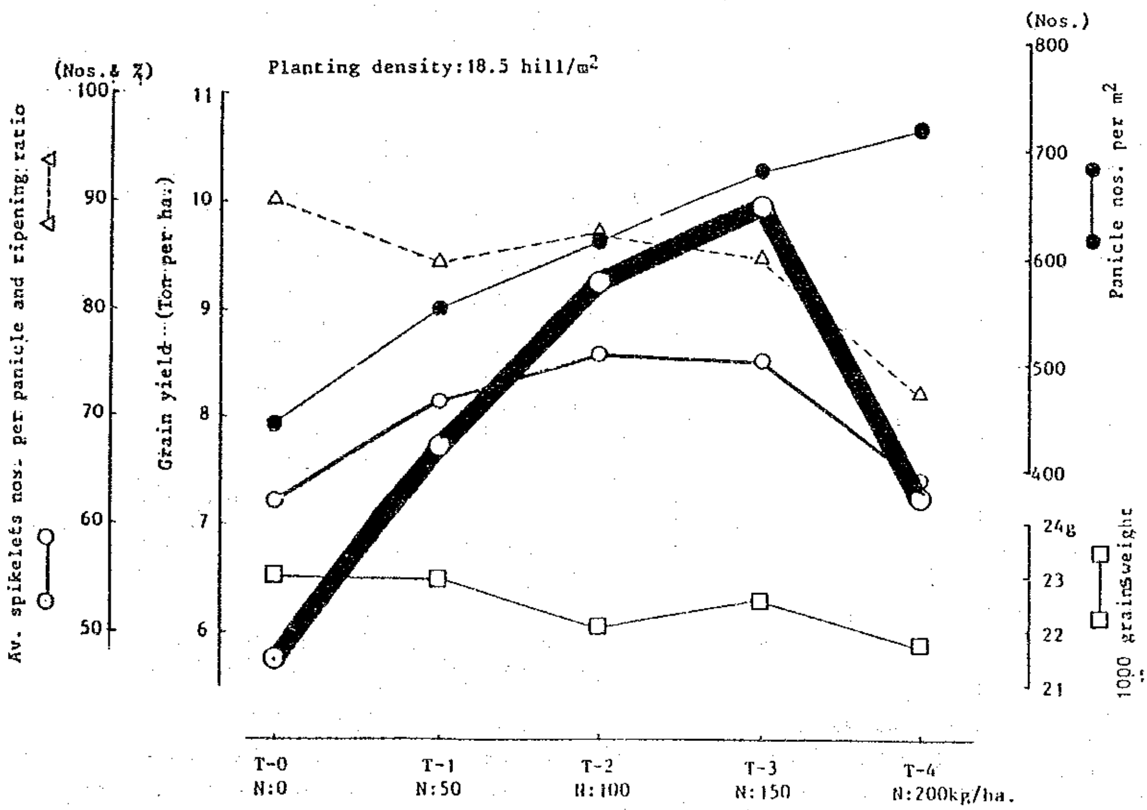


Fig. 19. Experiment of planting density and nitrogen level (Variety: Giza-173)

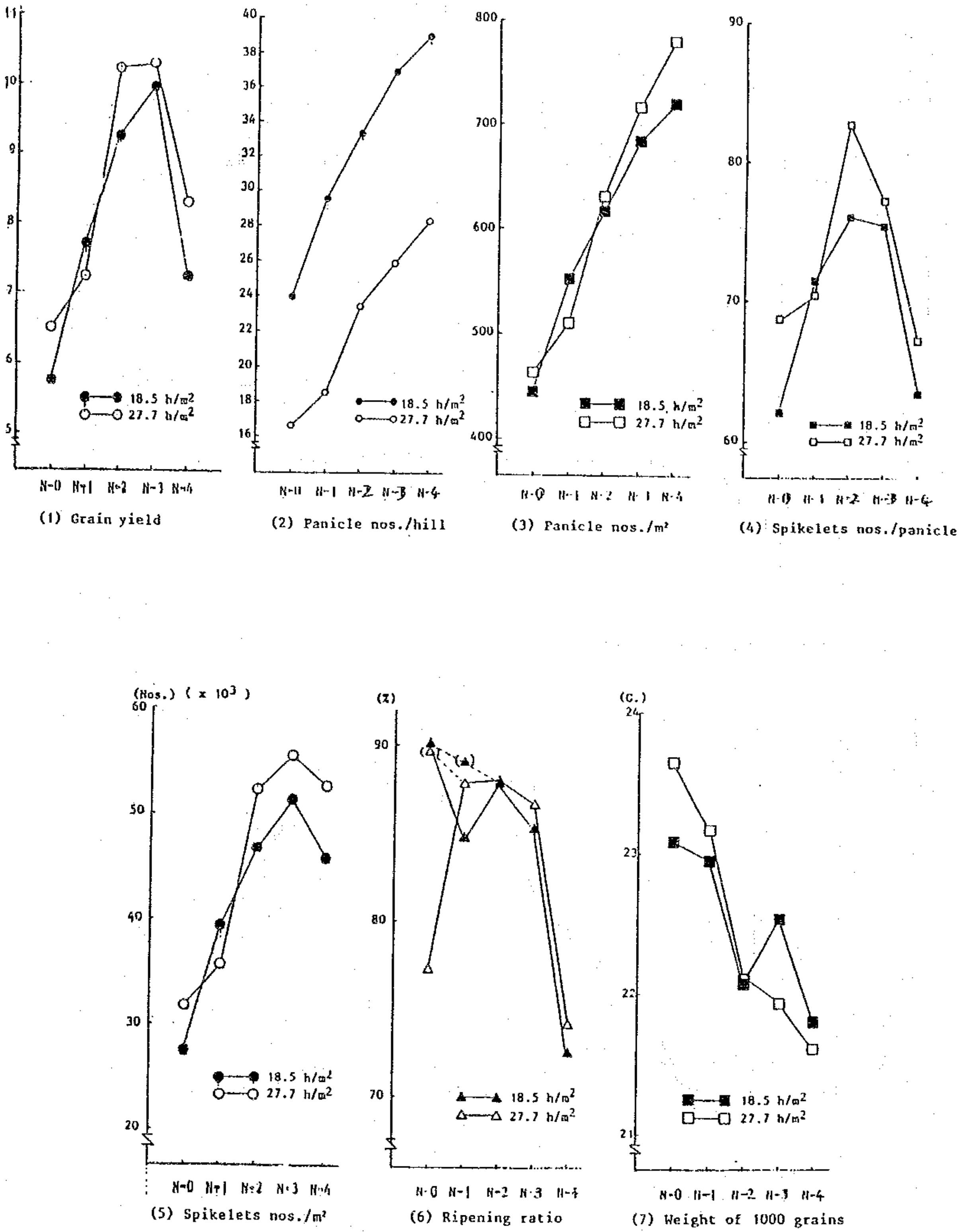


Fig. 20. Comparison of grain yield and yield components among density

Table 14. Experiment of planting density and nitrogen level (Variety: Giza-173)

Planting density	Treatment		Grain yield (Ton/ha.)	Nos. of panicles/ hill	Nos. of panicles/ m^2	Nos. of spikelets/ panicle	Nos. of spikelets/ m^2 ($\times 10^3$)	Ripening ratio (%)	1000 grains weight (gm.)
Planting density : 27.7 hill/m^2	T-0		5.74	15.42	427	62.2	26.56	91.53	24.25
			7.12	18.74	519	72.8	37.78	81.27	22.86
			6.59	15.85	439	71.1	31.21	59.38	23.81
		Av.	6.48	16.67	462	68.7	31.85	77.39	23.64
	T-1		7.84	17.09	473	75.2	35.57	88.90	23.22
			7.45	19.57	542	63.8	34.58	90.20	23.36
			7.12	18.66	517	71.9	37.17	84.55	22.98
		Av.	7.47	18.44	510	70.3	35.77	87.88	23.19
	T-2		9.28	23.59	604	79.7	48.14	86.12	22.27
			11.21	23.15	641	89.3	57.24	88.83	21.73
			10.21	23.42	649	78.9	51.21	89.18	22.35
		Av.	10.23	23.38	631	82.6	52.20	88.04	22.11
	T-3		11.58	26.56	736	83.3	61.31	89.10	21.13
			9.68	24.87	689	74.4	51.26	83.20	22.60
			10.51	26.32	729	73.9	53.87	88.00	22.09
		Av.	10.59	25.92	718	77.2	55.48	86.77	21.94
	T-4		9.59	26.48	738	81.3	59.99	72.60	22.56
			8.21	30.20	837	58.5	48.96	80.28	21.03
			7.16	27.76	769	61.9	47.60	70.04	21.29
		Av.	8.32	28.15	781	67.2	52.60	74.31	21.63
	G. Mean		8.62	22.51	621	73.2	45.50	82.88	22.50
Planting density : 18.5 hill/m^2	T-0		5.38	23.16	428.5	58.4	25.04	90.22	23.10
			5.97	24.48	452.8	65.1	29.46	91.36	22.67
			5.89	24.25	448.7	62.7	28.13	89.29	23.46
		Av.	5.75	23.96	443.3	62.1	27.54	90.29	23.08
	T-1		8.46	31.93	590.7	69.8	41.24	89.34	22.91
			7.70	28.35	524.4	73.4	38.49	87.90	22.90
			6.96	29.24	540.9	70.9	38.34	77.26	23.03
		Av.	7.71	29.63	552.0	71.4	39.36	84.83	22.95
	T-2		10.13	34.41	636.5	79.1	50.35	87.13	22.98
			8.53	33.27	615.5	68.8	42.35	89.93	21.28
			9.13	32.21	596.0	79.9	47.62	86.91	22.07
		Av.	9.26	33.30	616.0	75.9	46.77	87.99	22.11
	T-3		9.03	38.04	703.9	73.9	52.01	79.65	21.69
			9.57	34.97	646.9	72.7	47.03	86.50	23.17
			11.31	37.75	698.3	79.3	55.38	89.58	22.81
		Av.	9.97	36.92	683.0	75.3	51.47	85.24	22.56
	T-4		7.40	41.61	769.7	69.4	53.42	67.87	21.10
			7.90	37.79	699.1	62.3	43.52	76.51	22.67
			6.43	37.56	694.8	58.4	40.58	73.29	21.63
		Av.	7.24	38.98	721.2	63.4	45.84	72.56	21.80
	B. Mean		7.99	32.56	603.1	69.6	42.20	84.18	22.50
G. MEAN			8.31	27.54	612.1	71.4	43.85	83.53	22.5

Note: T-0[Cont.], T-1[N:50kg;ha.], T-2[N:100kg], T-3[150kg], T-4[N:200kg]

4) Effect of Nitrogen Split Application Method in Late Planting on Yield

Object

In Kafr El Sheikh Governorate, harvesting of wheat and clover for seed production is often delayed in many districts, subsequently deferring transplanting of rice, especially in Kafr El Sheikh and Kallin area. Therefore, studies were made on the split application of nitrogen under late-season cultivation.

Method

1) Amount of fertilizer applied for main field: N........ 100 kg/ha
P_2O_5..... 60 kg/ha
K_2O ..... 30 kg/ha

2) Treatment method: T - 0 ..... Control
T - 1 ..... Total nitrogen as basal application
T - 2 ..... 50% of total nitrogen as basal, 25% at 7 days after transplanting, and remaining 25% applied 7 days before the beginning of neck-node differentiation stage.
T - 3 ..... Equally divide total nitrogen and apply in the same period as T-2.
T - 4 ..... 50% of total nitrogen applied 7 days after transplanting remaining 50% applied 7 days before the beginning of neck-node differentiation stage.

3) Variety: Giza-173

4) Planting density: 30 cm x 12 cm (27.7 hills/m^2)

5) Date of seeding: 19th June

6) Date of transplanting: 19th July

7) Date of harvesting: 21st Nov.

Result

Fig. 21 and Table 15 show the results of experiment.

According to these data, the highest yield is obtained in T-4 plot in the quantity of 6.81 t/ha when 50% of total nitrogen is applied 7 days after transplanting and the remaining 50% is applied 7 days before the beginning of nick-node differentiation stage. Other plots' yields are in the order of T-3>T-2>T-1>T-0. Namely, the more basal application, the less yield, apart from no treatment plot. In the case of transplanting, root system is small and absorption is possible only after roots have grown to a certain extemely short, and of late-season culture, duration of vegetative growth is extremely short, and it is most important to secure tiller in an early stage, making nitrogen fully effective. As for yield components, changes in the number of panicles completely correspond to the changes in yield. No treatment division is the lowest, and there is no big difference between T-1, 2 and 3, but T-4 shows a sharp increase in panicle number. This is considered to be due to the top-dressing of 50% total nitrogen 7 days after transplanting and strong tillering secured in an early stage. The number of spikelets per panicle also showed the highest value in T-4 and this is probably due to the effect of top-dressing of 50% nitrogen 7 days before the beginning of neck-node differentiation stage. In other words, basal application is unnecessary for late-season culture, and top-dressing just after rooting and just before the beginning of neck-node differentiation stage is like a powerful medicine. If it is performed in a good way, spikelets number increases and it is most effective in raising yield amount, in case of misapplication, seedlings become vulnerable to lodging and yields decline, causing damage of blast disease on many occasions. Therefore, attention should be paid to the following points in application:

1) The time of top-dressing in the beginning of neck-node differentiation should be later than the highest tiller season. If it is earlier, much ineffective tillering occur, resulting in what might have been least expected.

2) The top-dressing in the beginning of neck-node differentiation stage tends to produce excessive number of spikelets and aggravate seedling's light-intercepting characteristics.

So, it is safe to suspend the said top-dressing until the reduction division stage comes, excepting for a case where spikelets number is remarkably small.

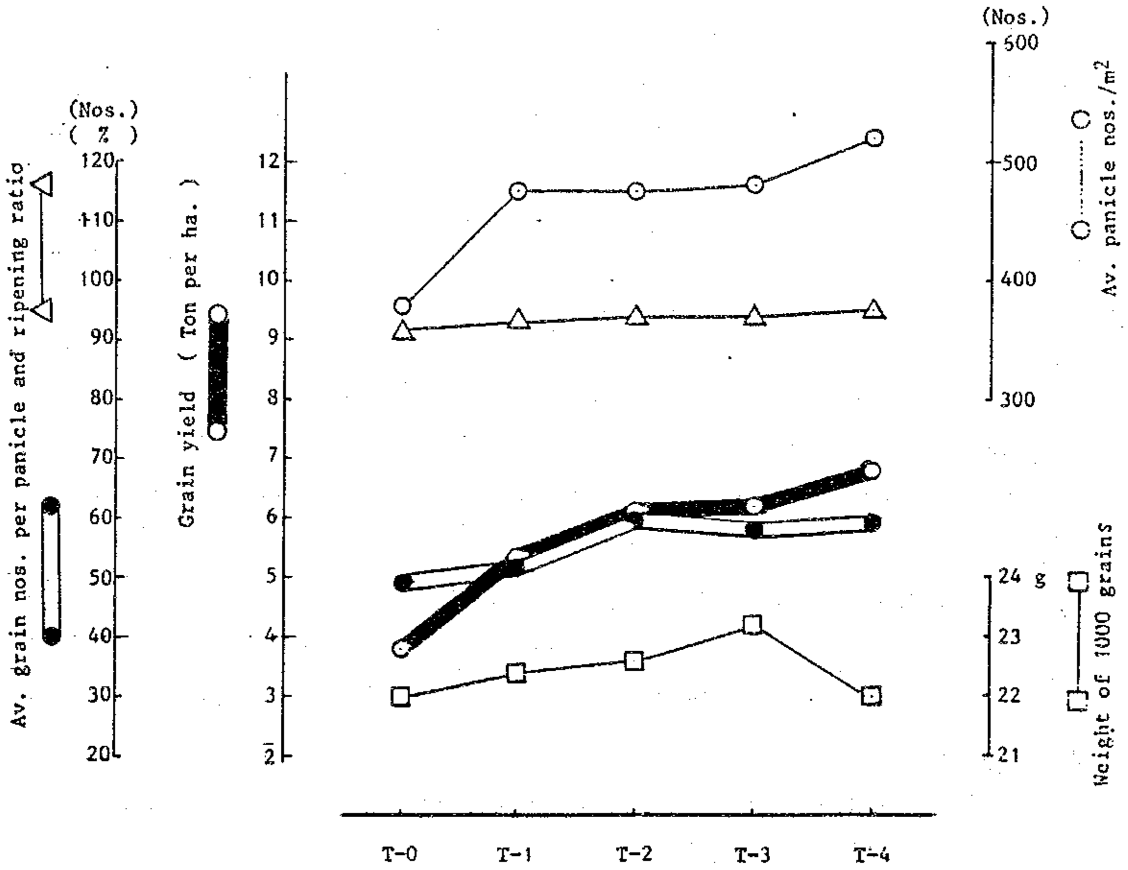


Fig. 21. Different nitrogen fertilizer split application method under the late transplanting condition (Variety: Giza-173)

Table 15. Different nitrogen fertilizer split application method under the late transplanting condition (Variety: Giza-173)

Treatment		Grain yield (Ton/ha.)	Nos. of panicles/ hill	Nos. of panicles/ m^2	Nos. of spikelets/ panicle	Nos. of spikelets/ m^2 (x 10^3)	Ripening ratio (%)	1000 grains weight (gm.)
T-0		3.77	14.20	379.1	48.57	18.41	93.47	22.47
		2.95	13.44	358.8	41.50	14.89	89.25	21.51
		3.73	13.82	368.9	45.00	16.60	94.86	22.99
		4.67	15.10	430.2	59.30	23.94	89.11	22.06
	Av.	3.77	14.14	377.5	48.62	18.46	91.67	22.01
T-1		5.61	1802	481.1	56.05	26.97	94.05	22.00
		5.05	16.80	448.6	57.29	25.70	95.89	21.11
		5.81	17.86	476.9	54.36	25.92	93.13	23.30
		4.72	18.56	495.6	43.68	21.65	89.91	23.05
	Av.	5.30	17.81	475.6	52.85	25.06	93.25	22.37
T-2		6.31	15.96	426.1	68.44	29.16	94.15	22.69
		5.59	18.52	494.5	53.00	26.21	94.89	21.98
		5.83	17.33	462.7	59.14	27.36	91.02	22.79
		6.83	19.54	521.7	61.25	31.96	94.36	22.91
	Av.	6.14	17.83	476.3	60.46	28.67	93.60	22.57
T-3		5.49	17.00	453.9	55.94	25.39	93.10	24.01
		7.13	18.92	505.2	61.71	31.18	95.82	23.50
		6.61	18.46	492.9	60.82	29.98	95.96	22.54
		5.57	17.66	471.5	54.06	25.49	91.09	22.81
	Av.	6.20	18.01	480.9	58.13	28.01	93.99	23.19
T-4		7.76	21.30	568.7	61.33	34.88	96.74	22.42
		6.91	19.08	509.4	60.44	30.79	94.19	24.24
		6.03	19.24	513.7	56.74	29.15	94.00	21.89
		6.53	18.32	489.1	58.78	28.75	94.79	23.52
	Av.	6.81	19.49	520.2	59.32	30.89	94.93	23.02
G. Mean		5.64	17.46	466.1	55.88	26.22	93.49	22.63
C.V. (%)		11.82	6.15	6.16	10.01	11.32	2.39	3.37
Statistical significance		1 %	1 %	1 %	5 %	1 %	NS	NS
LSD .05		1.01	1.62	43.28	8.43	4.47	–	–

Note : T-0 [Cont.], T-1 [100% nitrogen at Basal], T-2 [50% at Basal, 25% 7 days after transplanting as 1st To-dressing and 7 days befor the Panicle Initiation Stage as 2nd Top-dressing], T-3 [33.3% of nitrogen to each Basal, 1st TD and 2nd TD], T-4 [50% at 1st TD. and 50% at P.I. Stage]

II. Direct Seeding Cultivation

1. Cultivation Trial of Direct Seeding Method on Dry Condition

Object

The following two courses are requested to be taken by Egypt for its mechanical rice farming:

1) Mechanical transplanting cultivation technology,
2) Mechanical direct seeding technology.

These future courses aim to cope with shortage of labor and to increase yield. However, it causes cost increase to simply introduce technology. It is necessary to create technology of low cost through combination of the two technologies and improvement in the operation rate of machinery, expanding cropping season.

For this purpose, studies were made on the method for improving seedling establishment in cultivation of direct seeding on dry condition to reduce expenses of raising seedlings and transplanting.

Method

1) Treatment: T - 1 .... Rotary plowing (PTO: 620 rpm), two times plowing.
   T - 2 .... Rotary plowing, four times plowing (PTO: first two time with 620 rpm, and later two time with 810 rpm).
   T - 3 .... Rotary plowing (PTO: 620 rpm) two times and ratary harrow (PTO: 1400 rpm) two times plowing.
2) Variety: Giza-173
3) Amount of seed: 80 kg/ha of dry seeds
4) Amount of fertilizer applied: N .... 120 kg/ha
   P_2O_5...... 60 kg/ha
   K_2O....... 30 kg/ha
5) Date of seeding: 19th May
6) Date of harvesting: 20th Oct.

Result

1) Plowing Method and Clod:

Table 16 and Fig. 22 indicate plowing method and distribution of clod, respectively.

According to them, soil clods with the diamter of above 6 cm. account for 30% in T-1 and depth of seeding by seeder would be considerably deep. In T-2, soil clods of 2-4 cm and 4-6 cm account for over 70%. In both T-1 and T-2, soil clods of below 1 cm diameter account for only 10% or so.

As against T-1 and T-2, rotary plowing and rotary harrow of high rpm were used for treatment in T-3, so, more than 80% of soil clods were in the range of 2-4 cm. diameter.

2) The establishment of seedling under different soil clods and plowing conditions using direct seeder

Table 17(1) shows the number of established seedlings by plowing treatment.

According to it, T-1 is 22.6% and T-2 is 23.9%, showing little difference, but in T-3, the establishment ratio is 29.9%, showing a little improvement.

Though there was a considerable difference in the size of clod between treatment, the difference in seedling establishment was small.

This indicates that Nile Delta soil collapses in a short time by containing water regardless of the size of clod. Table 17(2) shows investigation results on the depth of established seedlings in each division. According to it, T-1 has an average depth of 3.05 cm and T-3, 2.4 cm, the latter being a little less deep. Distribution of established seedlings' depth is indicated in Table 17(2) and 17(3). In T-1, more than 50% of seedlings are distributed in the depth of 2-4 cm, but in T-3, most of them are distributed in the depth of 1-3 cm. due to the smaller clods, reflecting the size of clods. In T-1, 11% of seedlings are distributed in the depth of 5-6 cm. but no such distribution is noticed in T-3.

3) Irrigation method after direct seeding on dry field and establushment of seedling

Next Table 17(4) shows irrigation method after seeding and seedling establishment ratio.

According to the table, seedling establishment by flooding method was 14.66%, but in the case of digging small irrigation channels with a ditching machine in the field so that water gradually permeates into the soil, seedling establishment rose to 53.2%. In the case of flooding method, breaking of soil rapidly develops simultaneously with water filling and seeds are put in a non oxygen condition. Absorption method delays soil collapse and avoids a state of non oxygen. This is considered the cause for better establishment percentage.

In view of the above, the size of clod affects seedling establishment more or less, but irrigation method exerts a stronger influence on establishment.

In conclusion, studies on the method for improving seedling establishment in direct seeding on dry condition using drill seeder have made it clear that the higher crush ratio shows a tendency to bring about better establishment, and that the irrigation method after seeding has a greater influence on seedling establishment.

Namely, flooding just after seeding remarkably lowered seedling establishment percentage, but the highest percentage was obtained through gradual permeation of water in the soil, making irrigation channels in the field.

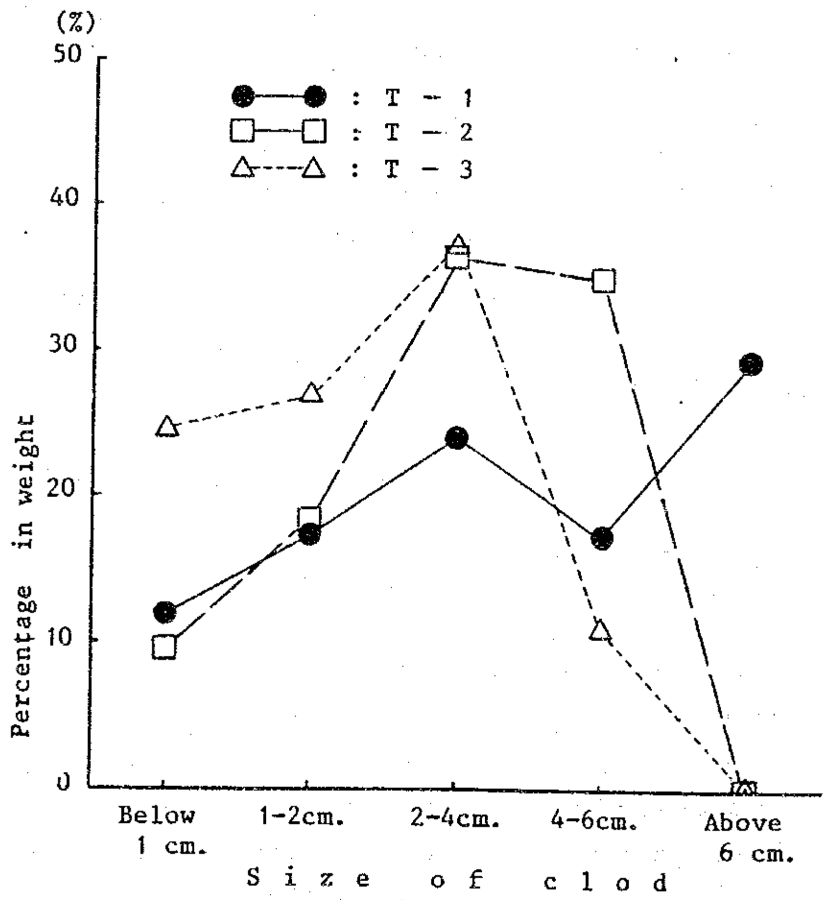


Fig. 22. Distribution of different size of clod under the different plowing condition

Table 16. Size of soil clod under the different plowing condition

(Agronomy Divi., RMP, 1984)

Size of soil cold (in diameter)	Treatment	T – 1			T – 2			T – 3		
		Number of cold	Weight of cold	Ratio in weight	Number of cold	Weight of cold	Ratio in weight	Number of cold	Weight of cold	Ratio in weight
		Nos.	gr.	%	Nos.	gr.	%	Nos.	gr.	%
Below 1 cm.	1	–	0.300	9.74	–	0.190	6.05	–	0.610	24.50
	2	–	0.410	14.34	–	0.340	16.59	–	0.590	27.76
	3	–	0.535	14.72	–	0.195	7.93	–	0.630	24.66
	4	–	0.330	8.96	–	0.235	8.12	–	0.815	21.50
	Av.	–	–	11.94	–	–	9.67	–	–	24.61
1 cm. – 2 cm.	1	156	0.460	14.94	114	0.450	14.33	224	0.715	28.71
	2	255	0.820	28.67	163	0.560	27.32	213	0.665	31.29
	3	177	0.515	14.17	127	0.430	17.48	156	0.560	21.92
	4	144	0.425	11.53	126	0.450	15.54	280	1.025	27.04
	Av.	–	–	17.33	–	–	18.67	–	–	37.75
2 cm. – 4.cm.	1	39	0.780	25.32	48	1.060	33.76	47	0.940	37.75
	2	50	1.030	36.01	49	0.920	44.88	44	0.770	36.24
	3	24	0.465	12.79	33	0.625	25.41	48	1.000	39.14
	4	33	0.825	22.39	61	1.230	42.49	58	1.350	35.62
	Av.	–	–	24.13	–	–	36.64	–	–	37.19
4 cm. – 6 cm.	1	6	0.430	13.96	16	1.440	45.86	3	0.225	9.04
	2	4	0.335	11.71	3	0.230	11.21	2	0.100	4.71
	3	10	0.955	26.27	3	1.210	49.10	4	0.365	14.28
	4	5	0.615	16.69	8	0.980	33.85	5	0.600	15.84
	Av.	–	–	17.16	–	–	35.03	–	–	10.97
Above 6 cm.	1	6	1.110	36.04	–	–	0	–	–	0
	2	1	0.265	9.27	–	–	0	–	–	0
	3	3	1.165	32.05	–	–	0	–	–	0
	4	5	1.490	40.43	–	–	0	–	–	0
	Av.	–	–	29.45	–	–	0	–	–	0

Note: T-1 [Two times plowing by rotary plow with 620 RPM of PTO]
T-2 [Four times plowing by rotary plow, and two times 620 RPM and two times 810 RPM of PTO]
T-3 [Two times by rotary plow with 620 RPM of PTO and two times by harrow with 1400 RPM of PTO]

Table 17(1). Establishment of seedling under the different plowing condition

Variety: Giza-173

Treatment	Number of established seedlings					Percentage of establishment
	1	2	3	4	Av.	
	nos.	nos.	nos.	nos.	nos.	%
T - 1	27	26	38	29	30.00	22.6
T - 2	29	23	34	41	31.75	23.9
T - 3	37	34	39	49	39.75	29.9

Note: Seeding quantity = 133 nos. of seeds per one meter.

Table 17(2). The established seedling depth on different plowing method

Treatment	Depth of established seedlings				Average
	1	2	3	4	
	cm.	cm.	cm.	cm.	cm.
T - 1	3.5	2.7	2.9	3.1	3.05
T - 2	3.6	3.1	2.9	2.6	3.05
T - 3	2.4	2.3	2.1	2.8	2.40

Table 17(3). Distribution of the established seedling depth under the plowing method

Treat-ment	Depth (cm.)					
	Below 1cm.	1cm.-2cm.	2cm.-3cm.	3cm.-4cm.	4cm.-5cm.	5cm.-6cm.
	%	%	%	%	%	%
T - 1	0	19.44	29.16	25.00	15.28	11.11
T - 2	0	17.65	23.53	35.29	20.59	2.94
T - 3	1.64	34.43	49.18	13.11	1.64	0

Table 17(4). Irrigation method for direct seeding field and its establishment of seedling

Treatment	Number of established seedlings					Percentage of establishment
	1	2	3	4	Av.	
	nos./m	nos./m	nos./m	nos./m	nos./m	%
Flooding method	11	21	18	28	19.50	14.66
Absorption method	74	69	71	69	70.75	53.20

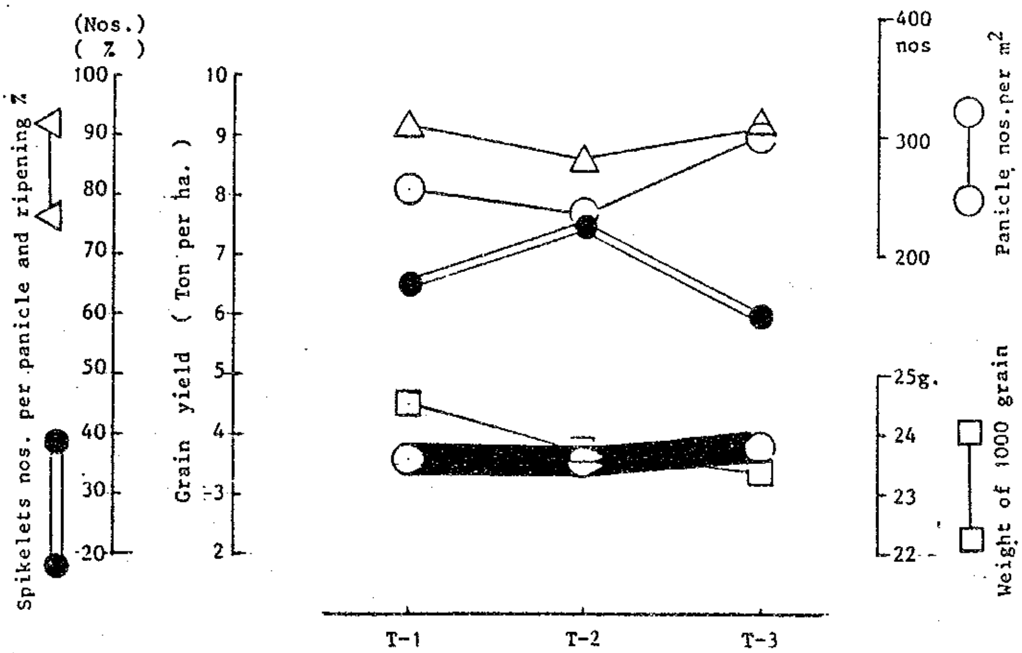


Fig. 23. Direct seeding trial with dry condition (Variety: Giza-173)

ECONOMIC ANALYSIS ON MECHANIZED RICE FARMING

I. Economic Analysis

Several interesting results were obtained by the collaborations with RMP Egyptian staff, two results are shown in the following pages.

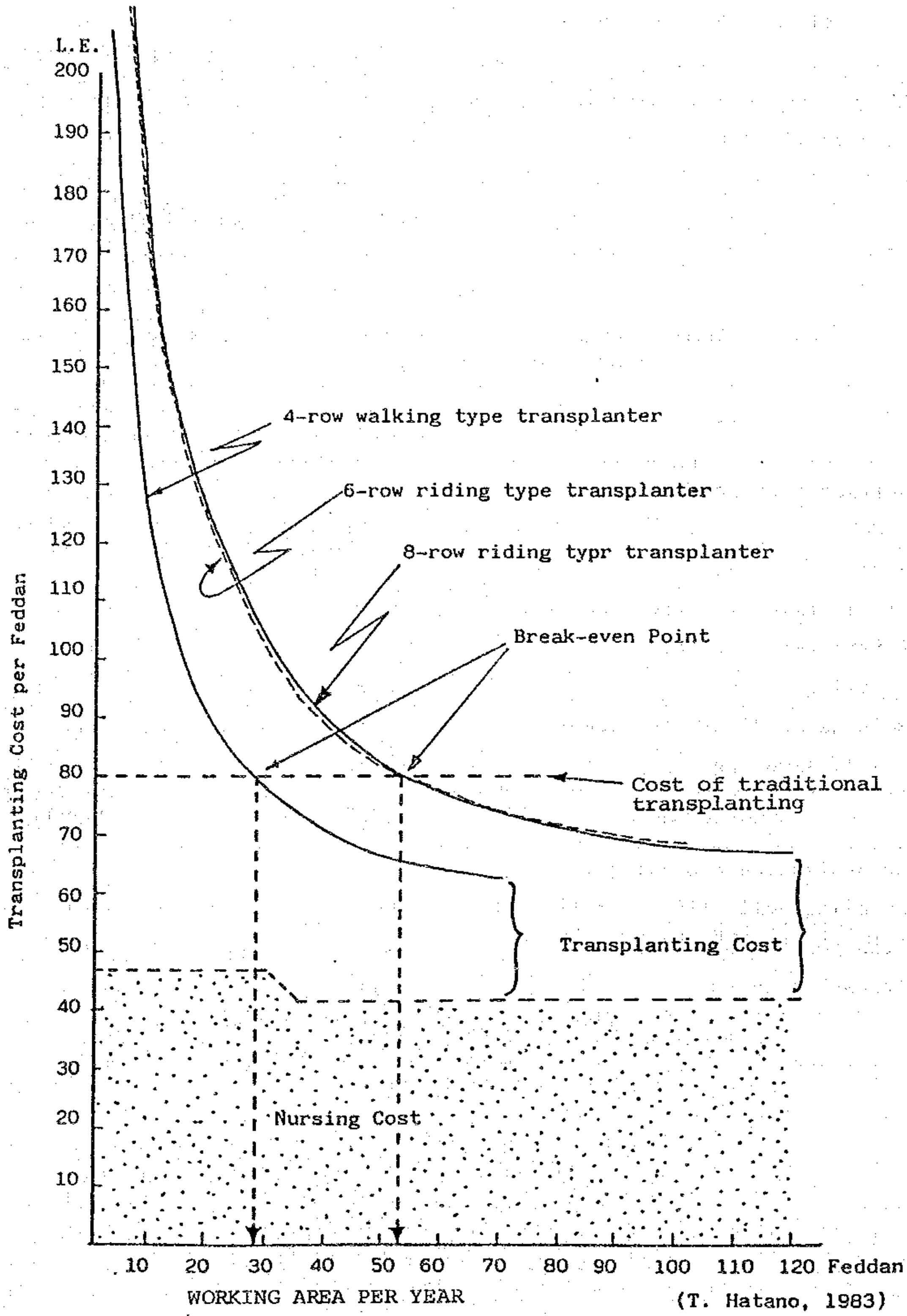
Table 1 explains the economic condition of rice farmers in Kafr El Sheikh (hereinafter referred to as KFS) Governorate in 1983. The comparison between mechanized transplanting and traditional manual transplanting was done, by visiting numerous farmers' home. The detailed explanation is written in the Arabic Text made for RMP trainees.

Fig. 1 indicates the Break-even Point of mechanized transplanting in KFS Governorate.

Table 1. Comparison of cost between mechanized transplanting and traditional transplanting

Item	Mechanized Transplanting	Traditional Transplanting
Nursing cost/feddan		
Land	1.50 LE	6.00 LE
Seed	3.75	8.40
Preparation of nursery be etc.	6.10	8.50
Fertilizer/chemicals	2.40	4.00
Seedling	5.00	1.00
Raising seedling management	3.50	9.00
Box of seedling	19.50	0
Sub-Total	41.75	36.90
Transplanting cost/feddan		
Seedling collection	0.50 LE	10.00 LE
Transport of seedling	1.75	10.00
Transplanting	26.90	25.00
Sub-Total	29.15	45.00
Total	70.90	81.90

Fig. 1. The cost and the break-even points of mechanized transplanting done by 4-row walking type transplanter, 6-row & 8-row riding type transplanters



(T. Hatano, 1983)

Table 2. A Ready Reckoner for the Yield of Paddy Grains (tons/ha or tons/feddan) based on the total number of fully ripened Grains per Hill and the Transplanting Density

- Effective for GIZA-172, REIHO and Similar Varieties -

Number of Grains per Hill	Number of Hills per m²								
	15	18	20	23	25	28	30	33	35
	t/ha(t/fed)	t/ha(t/fed)	t/ha(t/fed)	t/ha(t/fed)	t/ha(t/fed)	t/ha(t/fed)	t/ha(t/fed)	t/ha(t/fed)	t/ha(t/fed)
200	0.75 (0.32)	0.90 (0.38)	1.00 (0.42)	1.15 (0.48)	1.25 (0.53)	1.40 (0.59)	1.50 (0.63)	1.65 (0.69)	1.75 (0.74)
300	1.13 (0.47)	1.35 (0.57)	1.50 (0.63)	1.73 (0.73)	1.88 (0.79)	2.10 (0.88)	2.25 (0.95)	2.48 (1.04)	2.63 (1.10)
400	1.50 (0.63)	1.80 (0.76)	2.00 (0.84)	2.30 (0.97)	2.50 (1.05)	2.80 (1.18)	3.00 (1.26)	3.30 (1.39)	3.50 (1.47)
500	1.80 (0.76)	2.25 (0.95)	2.50 (1.05)	2.88 (1.21)	3.13 (1.31)	3.50 (1.47)	3.75 (1.58)	4.13 (1.73)	4.38 (1.84)
600	2.25 (0.95)	2.70 (1.13)	3.00 (1.26)	3.45 (1.45)	3.75 (1.58)	4.20 (1.76)	4.50 (1.89)	4.95 (2.80)	5.25 (2.21)
700	2.63 (1.10)	3.15 (1.32)	3.50 (1.47)	4.03 (1.06)	4.38 (1.84)	4.90 (2.06)	5.25 (2.21)	5.78 (2.43)	6.13 (2.57)
800	3.00 (1.26)	3.60 (1.51)	4.00 (1.68)	4.60 (1.93)	5.00 (2.10)	5.60 (2.35)	6.00 (2.52)	6.60 (2.77)	7.00 (2.94)
900	3.38 (1.42)	4.05 (1.70)	4.50 (1.89)	5.18 (2.18)	5.63 (2.36)	6.30 (2.65)	6.75 (2.84)	7.43 (3.12)	7.88 (3.31)
1000	3.75 (1.58)	4.50 (1.89)	5.00 (2.10)	5.75 (2.42)	6.25 (2.63)	7.00 (2.94)	7.50 (3.15)	8.25 (3.47)	8.75 (3.68)
1100	4.13 (1.73)	4.95 (2.08)	5.50 (2.31)	6.33 (2.66)	6.88 (2.89)	7.70 (3.23)	8.25 (3.47)	9.08 (3.81)	9.63 (4.04)
1200	4.50 (1.89)	5.40 (2.27)	6.00 (2.52)	6.90 (2.90)	7.50 (3.15)	8.40 (3.53)	9.00 (3.78)	9.90 (4.16)	10.50 (4.41)
1300	4.88 (2.05)	5.85 (2.46)	6.50 (2.73)	7.48 (3.14)	8.10 (3.40)	9.10 (3.82)	9.75 (4.10)	10.73 (4.51)	11.38 (4.78)
1400	5.25 (2.21)	6.30 (2.65)	7.00 (2.94)	8.05 (3.38)	8.70 (3.65)	9.80 (4.12)	10.50 (4.41)	11.55 (4.85)	12.25 (5.15)
1500	5.63 (2.36)	6.75 (2.84)	7.50 (3.15)	8.63 (3.62)	9.38 (3.94)	10.50 (4.11)	11.25 (4.73)	12.38 (5.20)	13.13 (5.51)
1600	6.00 (2.52)	7.20 (3.02)	8.00 (3.36)	9.20 (3.86)	10.00 (4.20)	11.20 (4.70)	12.00 (5.04)	13.20 (5.54)	14.00 (5.88)
1700	6.38 (2.68)	7.65 (3.21)	8.50 (3.57)	9.78 (4.11)	10.63 (4.46)	11.90 (5.00)	12.75 (5.36)	14.03 (5.89)	
1800	6.75 (2.84)	8.10 (3.40)	9.00 (3.78)	10.35 (4.35)	11.25 (4.73)	12.60 (5.29)	13.50 (5.67)		
1900	7.13 (2.99)	8.55 (3.59)	9.50 (3.99)	10.93 (4.59)	11.88 (4.99)	13.30 (5.59)	14.25 (5.99)		
2000	7.50 (3.15)	9.00 (3.78)	10.00 (4.20)	11.53 (4.84)	12.50 (5.25)	14.00 (5.88)			
2100	7.88 (3.31)	9.45 (3.97)	10.50 (4.41)	12.08 (5.07)	13.13 (5.51)				
2200	8.25 (3.47)	9.90 (4.16)	11.00 (4.62)	12.65 (5.31)	13.75 (5.78)				
2300	8.63 (3.62)	10.35 (4.35)	11.50 (4.83)	13.23 (5.56)					
2400	9.00 (3.78)	10.80 (4.54)	12.00 (5.04)	13.80 (5.80)					
2500	9.38 (3.94)	11.25 (4.73)	12.50 (5.25)						

Note: This table was preapred for the Yield Forecast and quick estimation of paddy yield of Japonica-type rice, such as GIZA-172 and REIHO, which have 25 gram in 1000 Grain Weight at 14% Moisutre Content.
If 1500 fully ripened grains were obtained per hill at the spacing of 30 hills per square meter, the yield of paddy (unhulled rice) per feddan comes to 4.73 tons.

Figuring out from the data in Table 1, the mechanized transplanting is cheaper than the traditional manual method at 11% level. As to the nursing cost, mechanized method is more expensive than traditional method (13%), because of the cost for purchasing of plastic trays. On the contrary, mechanized transplanting is much cheaper (35%) than manual transplanting.

The mechanized transplanting can be done at very low labor (18%), comparing with Egyptian traditional transplanting. Such labor saving is quite significant for farmers at this season.

According to Fig. 1, the break-even point of mechanized transplanting by 6 and 8 row transplanter was found around 50 feddans, and that of 4-row walking type was dropped around 30 feddans, as far as the cost per feddan is concerned. However, Fig. 1 was drawn based on the exchange rate of 1 US$ = 1.22 Egyptian pound as of October 1983. If the rate of 1 US$ = 0.82 LE were applied, the cost benefit would be much lighter than 11% as mentioned above. If the skill of machinery operators were improved and they were acquainted with mechanized method, the break-even point would be much lower than 50 feddans in case of 6-row or 8-row transplanter.

II. Economic Advantage of Rice Mechanization in Small and Middle Size Farmer

1. The object

There are three important viewpoints at least to make clear the ability of rice mechanization in this country.

1) What is the economic advantages of rice mechanization?

2) What is the technical problem to spread mechanized farming?

3) What is the government practice to spread the rice mechanization?

In this report I will put stress on the economic points as the followings.

1) To make clear the economic advantage of each mechanized system against each traditional system.

2) To calculate the total economic advantages of mechanized farming in farm management.

2. Economic Advantage in Each Mechanized Operation

(1) Plowing and Levelling

Recently many farmers use tractor for plowing & levelling instead of animal. But we should make sure which is more economical for small farmers to use tractor or animal?

1) Cost of animal keeping

The buffalo is used to plow and to make levelling in traditional system. The cost of plowing & levelling by buffalo is almost as same as the cost of keeping buffalo, and is nearly fixed cost. Cost of keeping buffalo is estimated the followings.

A) Winter feed (berseem) .... 105.6 LE
   Necessary area of berseem/buffalo .... 18 kerrat
   Production cost of berseem (/fed.) .... 70 LE
   Opportunity cost of berseem field (fed.) .... 70.8 LE
   Opportunity cost = net income of wheat detail data
   Berseem and wheat: Table 1-2

B) Summer feed (6 month: June - November) .... 123 LE
   Straw: 4 kg/day buffalo, price of straw: 0.132 LE/kg
   Dry food: 100 kg/month buffalo
   Price: 0.0466 LE/kg

C) Labor cost .... 300 LE
   A man can keep 3 buffalo wage: 75 LE/month man

D) Dereciation cost (buffaloshed and baffalo) .... 186.7 LE
   Buffaloshed (rental charge = 10 LE/month) .... 120 LE
   Buffalo .... 66.7 LE
   (Useful life = 6 years, price + 1,200 LE)
   (Remaining price = 800 LE)

The total cost of above case takes 715.3 LE/buffalo. But buffalo produces some milk & calf for meat. We can estimate these income as follows;

A) Milk .... 420 LE/year
   5 kg/day, milking period: 7 months
   Price: 0.4 LE/kg

B) Net income of 2 month age buffalo .... 200 LE
   Buffalo can produce one baby per year

Total income is 620 LE per year. In this case net cost is 101.9 LE.

2) Plowing & Levelling Cost by Tractor

If the farmer has a tractor, he must pay the cost as shown Table 3. For example, if the useful life of tractor is 7 years, fixed cost is 1227.6

LE/year and variable cost is 1.54 LE/hour. And total cost per hour is 3.26 LE. As the actual time to plow, one feddan may be 2.0 hours, machinery cost takes 6 - 7 LE/fed.

3) Which is more economical by buffalo or by tractor?

Judging only by above data, buffalo is more economical especially as if we calculate depreciation cost of buffalo.

But actually many small farmers practice plowing and levelling by tractor. Why?

I think one of the most important reasons is to loose more profitable chance by using animal instead of machinery.

Some times we call "opportunity cost" such as the following cost:

*Opportunity cost of animal using

A) Labor cost: It needs many hours to plow and to make level, estimately 10 hours/feddan by animal. There are about 6 or 7 hours loss against by tractor. And it's operation need 2 men at the same time. Therefore opportunity labor cost is estimated by 10 - 12 LE/fed. (Average wage = 3 LE/man.day)

B) Yield loss: As animal system takes long times to finish one cultivation process, sometimes farmers can't practice the cultivation within favorate working period. This is the one of causes to decrease the crop yield.

C) Healthy loss: The hard working under the burning sun causes to injure the health of human and animal some damage of animal take much cost by decrease of milk and early death.

But it is not so good for small farmers to own a tractor, because of too much wasteful of tractor utilities. Next, we consider the acceptable farm size to have tractor by oneself.

4) The economic farm size to own a tractor

Now, rental charge of tractor for plowing and levelling is 10 LE/hour. According to Table 3, 4 fixed cost and variable cost of tractor and chisel plow are the followings.

* Fixed cost (/year): Tractor + 1227.6 LE (7 years)

Chisel plow = 60.1 LE (7 years)

* Variable cost (/hour): Tractor = 1.55 LE
  Chisel plow = 0.02 LE

Under this condition, we can get the following break-even graph (No. 2). As graph shown, the economical point by owned is large size of farm. If plowing and levelling hours per feddan is 3, economical farm size to own a tractor is about 50.9 feddan. If 4 - 5 hours including transfer hours of tractor, economical size is about 34.0 feddan (Fig. 3).

Whenever it's true or not, I think sure that it isn't economical for a small farmer to have a tractor by himself. But if the farmer can lend another farmers as the water pump, economical size may be smaller.

(2) Nursery and Transplanting

Nursery and transplanting are one of the most important working process in rice cultivation. Because these are not only more hard but also more affective to yield of rice.

1) The advantage of mechanized system

Usually farmers make nursery bed on a part of berseem field at the day within the first half days of May.

The bed is necessary about 2 kerrats area to get young plants for a feddan. The traditional system is more expensive by the following reasons.

A) Traditional system takes long times for seedling and many seeds in spite of lower yield than mechanized system as followings.

	Traditional	Mechanized
Amount of seeds (/F)	60 - 80 kg	20 kg
Period of nursery	40 - 45 days	15 - 20 days
No. of plants (/hill)	30 - 40 stems	3 - 5 stems
No. of hills (/m)	16.08 hills	22.08 hills
No. of stems (/m) *	404.3 stems	84.4 stems
No. of stems (/m) **	529.4 stems	523.3 stems
Yields (ton/fed.)	3.0 t	4.5 t

* At the time of transplanting
** At the time of harvesting

This data is from Agronomy Division in R.M.C.

B) Traditional system takes more expensive cost than mechanized system. Let's see Table 5. Traditional system takes cost about 40 LE for nursery and 38 LE for transplanting per feddan. The difference of total cost between two systems is 20 LE. And main reason of high cost is the amount of labor and material cost.

C) Another actual advantages of mechanized system. There are another important advantages in actual mechanized farming.

The first one is that some farmers depend nursery and transplanting on cooperative branch. If the farmer commits the work both nursery and transplanting to cooperative association, he pays only 40 LE/feddan. If part of commission, for example only transplanting, the cost of commission is cheaper (24 LE/transplant). This charge is more economical than the cost of self practice.

The second one of commission to the cooperative decreases opportunity cost of self operation.

* By the commission, the farmers can avoid loss of the proceeding crop yield, for instance the last harvesting of berseem. The opportunity cost of the last yield of berseem estimates about 3 LE/kerrat. Because farmer can sell the last berseem to the keeper of cattle by 3 LE/kerrat.
* The farmer can save his family labors and get some wages by engaging another work.

2) How many size is economical when farmer owns transplanter?

According to the data from the R.M.C. transplanter (Yanmar, YP-6000), the fixed cost per year is 722 LE - 1421 LE, and variable cost per hour is 3.41 LE (see the Table 6).

Actual working capacity of transplanter is investigated in detail by Mechanization Division in R.M.C. (Table 7).

Actual working hours is rather bigger than performance test in R.M.C. That is, actual working hours attains 5 hours/fed. against test time 2.2 hours. At any rate, by this fact variable cost per feddan takes about 17.05 LE.

If a rental charge of transplanter is 40 LE, and other opportunity cost is ignored, the economic size is as the following Fig. 4.

In case of useful 5 hours, the economic size is more than 52 feddan. If farming size is less than 52 feddan, it is economical for farmers to choose the rental form.

(3) Harvesting

1) Harvesting cost by hand

Many farmers practice harvesting work by hand as the following example.

A) Reaping practice by employed man labor, usually 5 or 6 persons. And at the same time, binding and collecting by employed 5 or 6 women.

B) Transporting rice to the place where thresh rice by donkey or camel.

C) Arrangement rice for threshing named Sakka by employed labors, 2 or 3 persons.

D) Threshing by tractor moving on rice. This work takes 2 - 3 hours and cost may be 8 LE per feddan.

E) Separating straw by employed labor, may be 3 - 4 persons. This cost takes 6 - 8 LE/feddan.

F) Packing by employed 4 - 5 women. The farmer pays not only by cash but also by products. And it costs about 10 LE. In this case, total harvesting cost takes about 90 LE.

But harvesting cost is sometimes different by the conditions of farmers. And then, we show the average harvesting cost as the following Table 8. This table shows harvesting cost of 22 farmers in Disuk, Kallin, Kafr El She Sheikh. The range of cost is wide from 79 to 140 LE. And its average is 107.9 LE. And contents of cost is almost labor cost.

2) Harvesting cost by combine

Almost farmers don't use combine except large farmers. But if combine is used, its cost may be cheaper as the followings.

According to the report of R.M.P. Kallin Center (Table 9), harvesting cost per hour takes account to 19.67 - 23.0 LE. In this case, cost per feddan may be almost 88 - 103 LE (4.5 hours/fed.). Though this data is exact in practice of R.M.P., it's difficult to own combine for almost farmers because of high purchases price. Therefore it is natural for many farmers to rent the machine with cooperative operator.

Next we estimate actual harvesting cost in case of rental combine.

A) Rental charge of combine is 50 LE actually.

B) Labor cost with combine is 8 LE (2 men* 4 LE).

C) Transport baggages (30 - 40 baggages/feddan) takes about 10 LE.

D) Collecting straw takes cost by 9 LE (3 men* 3 LE).

E) Transport straw takes 18 LE (by camel).

Total cost is 95 LE in this case. But if the farmer will use straws for sale or feeding to cattle, he can decrease the cost at least 18 LE, by cutting collect and transport cost.

3) Which is more economical for the farmer, by rental or by owned?

Now we try to analyze the advantage of rental machine. According to Table 9, we determine the fixed cost and variable cost.

Fixed cost of owned machine .... 3305 LE (200 hours/year)

Variable cost per feddan .... 29.1 LE (4.5 hours)

Rental charge per feddan .... 50.0 LE

When we calculate of break-even point for rental and owned, we get the following graph (Fig. 5). Break-even point is 158.1 feddan. It is cheaper to choose rental combine within 158 feddan.

But the owner of combine may decrease the break-even point by joint use of his machine. Because he can reduce fixed cost by lending it to others.

3. Some Study for Effect of Rice Mechanization

Farmers usually have two most busy seasons in a year, in spring and autumn. In spring, especially the later of May & June, farmers have hard works of rice transplanting and wheat harvesting.

In autumn, especially the middle of October & November, he must harvest rice and cotton at same time.

Though rice mechanization is very useful to these hard works, but the economic effect of mechanization is rather different by the farmer's conditions.

Linear programming method is also useful to know the effectiveness under some different conditions. (See appendix, if you need the outline of L.P.)

And so I try to study the effect of rice mechanization according to some primitive linear programming model.

(1) The outline of L.P. model

The farmer has 5 feddans crop fields. And under this conditions, shown as table 10 - 12, he practices his farming.

I am afraid that we can't get reliable answers. Because these data are not so concrete. But I am glad if I can inform how to approach this problem.

A) Variables

X_1 : Transplanting area by traditional system

X_2 : Transplanting area by transplanter

X_3 : Over days than favorite transplanting period

X_4 : Total days to transplant seedlings of rice

X_5 : Total labors employed in spring

X_6 : The area of wheat harvesting

X_7 : The area of rice harvesting by traditional system

X_8 : The area of rice harvesting by combine

X_9 : Over days than favorite harvesting period of rice

X_{10}: Total days of rice harvesting

X_{11}: Total labors employed in autumn

X_{12}: The area of cotton harvesting

X_{13}: Other rice cost except of transplanting and harvesting cost by traditional system

X_{14}: Other rice cost except of transplanting and harvesting cost by machine

X_{15}: Total yield of rice

B) Constraint equations

i) Each crop area

Rice	$5.0 >= X_1 + X_2$	(1)
Wheat	$5.0 >= X_6$	(2)
Cotton	$5.0 >= X_{12}$	(3)
Total summer land	$5.0 >= X_1 + X_2 + X_{12}$	(4)

ii) The days for transplanting

Possible days	$10.0 >= X_1 + 0.33* X_2 - X_3$	(5)
Limit of over days	$20.0 >= X_3$	(6)
Total transplanting days ...	$0.0 >= X_1 + 0.33*$	(7)
	$X_4 + 4* X_6$	(8)

iii) Employed labors in spring

Total employed labors	$0.0 >= 14*X_1 + 4*X_2 - X_5 + 18*X_6$	(9)
Limit of employed labors ...	$300.0 >= X_5$	(10)

iv) Harvesting of rice

Harvesting area	$0.0 >= X_1 + X_2 - X_7 - X_8$	(11)

Possible days .... $10.0 >= 5*X_7 + 2*X_8 - X_9$ (12)

Limit of over days .... $20.0 >= X_9$ (13)

Total harvesting days ...... $0.0 >= 5*X_7 + 2*X_8 - X_{10}$ (14)

Available days in autumn ... $30.0 >= X_{10} + 3*X_{12}$ (15)

v) Employed labors in autumn

Total employed labors ...... $0.0 >= 24*X_7 + 10*X_8 - X_{10} + 79*X_{12}$ (16)

Limit of employed labor .... $300.0 >= X_{10}$ (17)

vi) Other cost and yield of rice

Other cost by traditional system ..... $0.0 >= X_1 - X_{13}$ (18)

Other cost by mechanized system ...... $0.0 >= X_2 - X_{14}$ (19)

Yield of rice .... $0.0 >= -3*X_1 - 4.5*X_2 + X_{15}$ (20)

C) Cost and net revenue of some variables, objective function

X_1 : Only labor cost

X_2 : Labor cost + rental charge of transplanter (40 LE/f)

X_5 : Average wage in spring (2 LE/labor)

X_6 : Net revenue + harvest labor cost of wheat (detail Table 10)

X_8 : Rental charge of combine with operator (50 LE/F)

X_{11}: Average wage in autumn (3 LE/labor)

X_{12}: Net revenue + harvest labor cost of cotton (detail Table 10)

X_{13}: Other rice cost (traditional) 149.0 LE/feddan

X_{14}: Other rice cost (mechanized) 125.0 LE/feddan

X_{15}: Average price of rice 120 LE/ton

* Objective function

$$R = -40*X_2 - 2*X_5 + 115*X_6 - 50*X_8 - 3*X_{11} + 330*X_{12} - 149*X_{13} - 125*X_{14} + 120*X_{15}$$

The object is to find the conbination of variables to maximize this R-value. We can make simplex table as Table 13, and calculate the following problems.

(2) Some solutions by linear programming calculation

A) Rental charge of machine depends on many conditions, but especially the effect of saving time and increasing yield by machine are important. And also wage of labor and price of rice may be important economically. So, it trys to study how much charge is economical on rice mechanization.

At first, we can get the optimum solution from simplex Table 13. The farmer makes choice only rice in summer crop, and mechanized operation both transplanting and harvesting of rice. (detail Table 14)

Why does the model get the above solution?

Cost items	Traditional	Mechanized
* Transplanting cost	28 LE	48 LE
* Harvesting cost	72 LE	80 LE
* Other cost	149 LE	125 LE
Total cost	249 LE	253 LE
* Gross revenue	360 LE	540 LE
* Net revenue	111 LE	287 LE

Mechanized model have advantage against traditional one. Because mechanized model takes much yield (4.5 ton) and more profitable revenue. On the other hand cotton profit is only 166 LE. Cotton has less profit than mechanized rice cropping. (See Table 10)

Next we consider how much rental charge of transplanter have the advantage against a traditional model.

This problem is solved by parametric linear programming as Table 14. Until rental charge of transplanter attains 224 LE/fed., mechanized model has advantage. It is a very surprized conclusion.

Is it true? I try to make clear what's mean of this conclusion. See the next table.

Difference of profit between Traditional and Mechanized

Items	Traditional	Mechanized	Advantage (machine)
Gross revenue	360 LE (3*120)	540 LE (4.5*120)	180 LE
Transplant cost	28 LE (14*2)	48 LE (40+4*2)	-20 LE
Other cost	149 LE	125 LE	24 LE
Difference			184 LE

As mechanized transplant has the advantage 184 LE/feddan, rental charge can increase until 224 LE (40 LE + 184 LE) by the effect of high yield. So, if there is no effect of increasing yield with transplanter, how to change the optimum solution? The solution is shown on Table 14. Machinery transplanting has the economic advantage only less than 44 LE. You can see the big effect of increasing yield by transplanter. At same time, when there is the effect of yield increasing, total income is shown the followings.

R = 2030.0 - 5.0*P (R = total net revenue, P = rental charge of machine)

By this formula, you may understand that 1 LE higher charge reduce income by 5 LE. So we can call this coefficient (5 LE), the elasticity of rental charge to income, and it is important for us to know the elasticity to judge the ability of rice mechanization.

Next, we try to study the same thing about combine. (See Table 14) If there is the effect of yield increasing, Mechanized harvesting is profitable until 161.4 LE charge price. And if no effect, profitable rental charge go down to 53.4 LE.

Another important information we can get, if rental charge is rising up, rice area reduce and cotton area increase rice. That is, cotton is the substitute crop of Rice in summer land. But high charge of combine decreases rice profitability against cotton.

B) The influence of wage

The wage level of employed labors is also important to judge the advantage of rice mechanization. Because, recently, agricultural worker get out to non-agricultural labor market. Therefore, farmers take much effort to get employer, and much money to employed labors.

So, in spring, if wage is rising higher, how change does the advantage of mechanized transplanting take?

We can get the solution by using parametric programming as the follow Table 15 (this solution is under the same condition of yield 3 tons). From the solution, we can get some important informations.

i) If there is no effect of increasing yield, traditional transplanting is more profitable than mechanized one until 1.6 LE wage. But the farmer have serious influence with rising wage, because the elasticity of wage to total income is very high, about 160 LE.

ii) Over than 1.6 LE wage, mechanized transplanting takes advantage against traditional one. And summer crop is only rice.

iii) Over than 3.42 LE to 6.39 LE wage, summer crop devide two crops. Rice is 2 feddan & cotton is 3 feddan. This conbination bring more profitable income to 5 feddan farmers.

iv) Wage more than 6.39 LE to 6.75 LE, wheat raising is not profitable. Because employed labor cost exceeds the profit of wheat. The wage level of 3.42 LE is very important for wheat raising.

v) When wage is rising over 6.75 LE, the area of rice is reducing gradually, and cotton area is increasing instead of rice area. And to avoid the hard work in autumn, mechanized harvesting become profitable again for enlarging cotton area.

We must pay careful attentions to the difference of mechanized meanings between two wage stages less than 3.42 wage and more than 14.6 wage.

At less than 3.42 wage, the mechanized harvesting contributes to rice cropping only, but at more than 14.6 wage, mechanization is useful to enlarge cotton area, and to get more money from cotton.

vi) At last, when the wage exceeds 25.71 LE, it is no sense to raise rice. In other words, the value of transplanting labor in spring is 25.71 LE at maximum level.

Next, if it can increase the yield of rice by mechanized transplanting, how influence does the change of wage gives to rice mechanization?

Speaking shortly, mechanization takes more advantages than the former solution, at expensive wage cost. (See the table No. 16)

Especially, the following informations are important.

i) At any rate wage, mechanized transplanting is more profitable than traditional one, because of increasing yield income.

ii) At 6.39 LE wage, wheat disappears by the reason of high labor cost

iii) Rice raising has labor value of 70.7 LE conclusionally. You can understand that rice mechanization with increasing yield takes much advantages.

Above all, we can have the following conclusion through parametric analysis. Under the short age of labor and rising of wage, the mechanization of transplanting may take advantage further.

Next, we consider about change of harvesting labor wage. By using same method, we can get the solution shown as table 17. Under condition of 3 ton yield, the table shows very interesting results.

i) As wage is rising up, rice cropping is taking a advantage against cotton. It seems some strange, but it has rational reason as the follow. In cheaper wage, traditional harvesting of rice is more profitable than mechanized one. But traditional harvesting needs many labors.

Generally speaking, the labor intense crop takes more benefits by decreasing wage of labor.

In this case, cotton is such crop, and traditional harvesting of rice is more beneficial than mechanized one.

ii) Gradually wage rising up, such advantage is disappeared. And at 2.93 LE wage, mechanized harvesting become benefitable. At the same time, cotton become unprofitable.

iii) At last, when wage attains 13.7 LE, rice harvesting has disadvantage to pay much money to workers exceeding income.

In other words, the value of harvesting labor can not overcome 13.7 LE.

Next, we try to calculate another case under 4.5 ton yield. The influence of wage changing is more sensitive, and the value of harvesting labor rise up until 31.7 LE.

Graph 1. Acceptable Size of buffalo