ESTABLISHMENT OF MECHANIZED RICE CULTIVATION SYSTEM IN EGYPT

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ABSTRACT

The Rice Mechanization Pilot Project being carried out jointly by the Egyptian Ministry of Agriculture and the Japan International Cooperation Agency at Meet El Dyba in Kafr El Sheikh Governorate aims at developing a mechanized rice cultivation system for the small farmers in the Nile Delta region. This system should be suitable for the agricultural land conditions peculiar to the region and should enable to achieve increased land and labor productivity. The presentation will focus on the following aspects:

(1) After carrying out a number of experiments by adopting the recommended cultivation practices in the early, middle and late growth periods, the yield increased appreciably.

(2) Efficient systems of mechanized plowing, puddling, transplanting, harvesting and grain drying, suitable for the conditions of the Nile Delta region, have been developed, and the advantages of mechanization have been revealed, as evidenced by both the yield increase and cost reduction.

Introduction

The objective of the Rice Mechanization Pilot Project is to establish a mechanized rice cultivation system in response to the national goals for attaining self-sufficiency in food and overcoming the labor shortage in the villages of Egypt. In other words, the system has been developed for the purpose of achieving increased land and labor productivity by mechanization as the pillars of the technical development program, as shown in Fig. 1.

Increase of yield per unit land area by mechanization

Paddy yield is determined by two factors: namely, yielding capacity (≒ the number of spikelets per square meter) and assimilation of photosynthesis products. Accordingly, the relation between the number of spikelets per square meter and paddy yield based on the data collected from the experiments carried out during the project are shown in Fig. 2 and Fig. 3.

It was revealed that rice cultivation in the Nile Delta region can be highly productive due to the high-yielding capacity promoted by abundant solar radiation.

In carrying out and assessing the experiments on mechanized rice cultivation, the growth period of rice plants was divided into three parts; namely, the early, middle and late growth periods. The early growth period extends from germination to approximately 43 days before heading, the middle growth period from approximately 43 to 20 days before heading, during which the plant type is definitely determined, while the late growth period extends from

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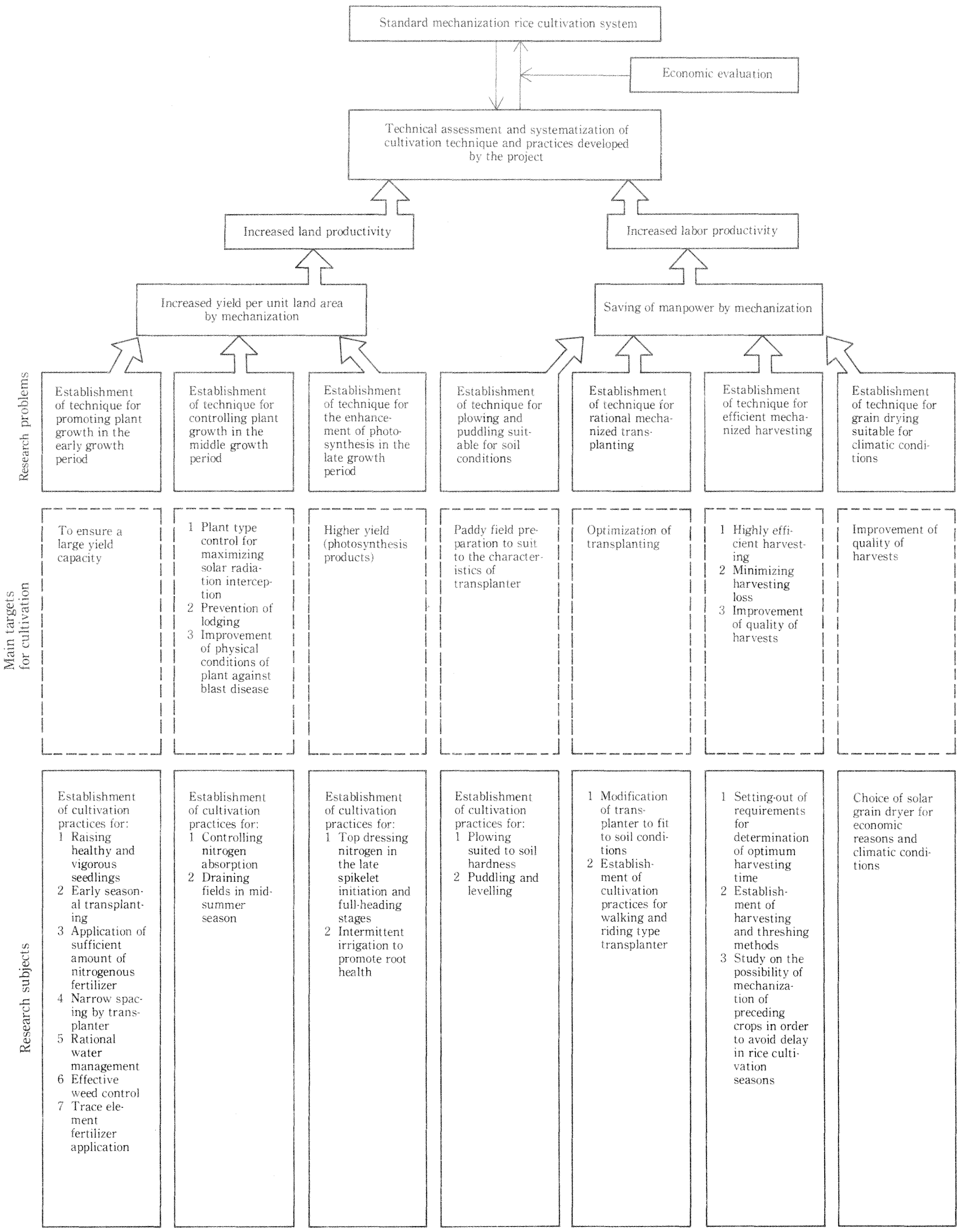

Fig. 1 Technical development for mechanized rice cultivation system.

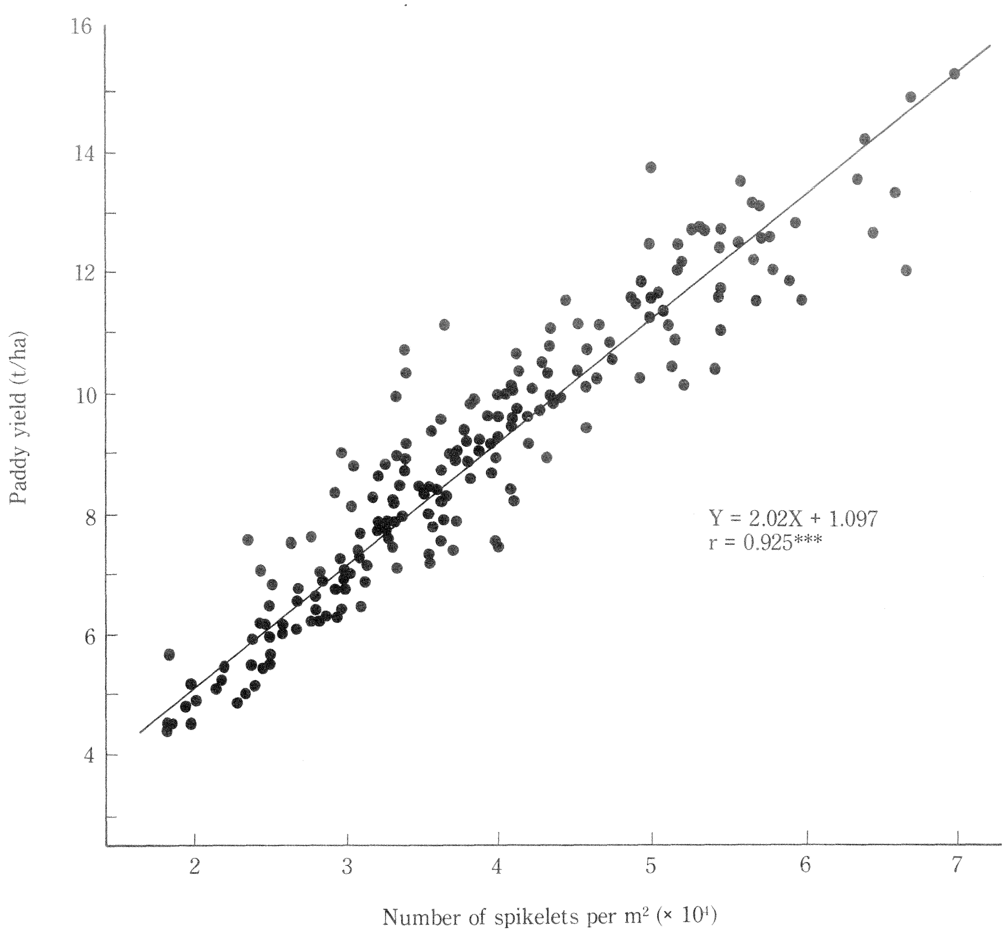

Fig. 2 Correlation between number of spikelets per m^2 and paddy yield in mechanized rice cultivation in Egypt (1982 - 1985).

approximately 20 days before heading to the time of maturity (MATSUSHIMA, 1976, 1980).

1 Recommended cultivation practices for the early growth period

In order to ensure the growth of a sufficient number of panicles in the early growth period, the seven following cultivation practices are recommended:

1) Raising of healthy and vigorous seedlings
2) Early seasonal transplanting
3) Application of a sufficient amount of nitrogenous fertilizer in tillering to promote plant growth
4) Narrow spacing by transplanter
5) Prevention of rooting damage by rational water management after transplanting
6) Effective weed control
7) Application of zinc sulfate in the middle stage of the seedling raising period

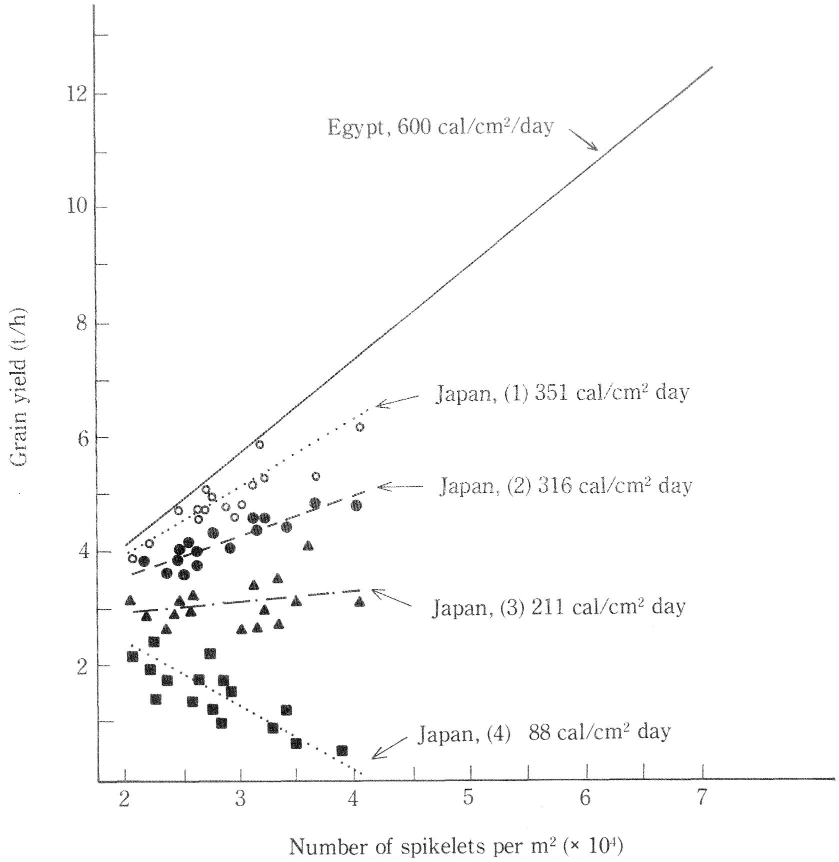

Fig. 3 Relation between the number of spikelets per m² for each level of solar radiation in the main ripening period 35 days after heading and grain yield.

Note: Egypt ... 1982 - 1985 at Kallin and Meet El Dyba, RMC
Japan (1) - (4) ... TANAKA, T., NAGAO, G. and NAMIOKA, M. (1975).

2 Recommended cultivation practices for the middle growth period

The target for the middle growth period is to achieve a higher percentage of ripened grains. For this, the plant type should be considered in a way that each rice plant is best benefited by sunshine; rice plants should be prevented from lodging; and, at the same time, the physiological conditions of rice plants must also be improved.

The improvement of the physiological conditions of rice plants in this case consists mainly of the increase in the carbohydrate-nitrogen ratio (C/N ratio) in rice plants: that is to say, the larger the C/N ratio, the higher the percentage of ripened grains and the resistance against blast disease.

For the purpose of controlling the plant type, the prevention of lodging and improvement of the physiological conditions of rice plants, the absorption of nitrogen should be restricted to only the middle growth period. Methods for restricting nitrogen absorption are outlined below:

1) Fast and profuse absorption of nitrogen by rice plants in the early growth period enhanced by narrow-spaced transplanting of healthy seedlings results in a comparatively low content

of nitrogen in the soil in the middle growth period. That is to say, when the recommended seven cultivation practices are exactly followed in the early growth period, the restriction of nitrogen absorption becomes eventually possible in the middle growth period.

2) The main purpose of the mid-summer drainage practice is to protect the roots from various kinds of damage caused by the reductive condition of the soil and to make the roots healthy. Application of the drainage practice more intensively and for a longer period also contributes to the restriction of nitrogen absorption by rice plants. Rice plants in the middle growth period are most highly resistant to unfavorable external conditions in their whole life cycle. They can survive even if the field becomes so dry that large cracks appear on the soil surface.

3 Recommended cultivation practices in the late growth period

The main target for the cultivation practices in the late growth period is to maintain a higher level of photosynthesis. The soil is top-dressed with nitrogenous fertilizer twice: in the late spikelet initiation and the full heading stages. Then the field is irrigated intermittently to promote the health of plant roots.

4 Conclusion

After carrying out a number of experiments by adopting the recommended cultivation practices in the early, middle and late growth periods, marked increase in paddy yield was observed, as evidenced by the increased yielding capacity (≒ the number of spikelets per square meter) and a higher assimilation of the photosynthesis products.

Mechanized rice cultivation system
- machinery, equipment and techniques -

1 Selection of machinery and equipment

The machinery and equipment with appropriate capacity, type and size were selected, as shown in Table 1, taking into consideration their applicability and suitability to the soil and climatic conditions.

Table 1 Main agricultural machinery and ownership

Name of machine	Capacity/Type	Number	Ownership
Wheel tractor (4-wheel driven type)	50 ps	1	Rental
Chisel plow	1.75 m(w)	1	〃
PTO driven puddling rotary	3.6 m(w)	1	〃
Riding type rice transplanter	8-row	1	〃
Power sprayer (for seedlings)	600 l	1	〃
Head-feeding type combine	1.3 m(w)	1	〃
Irrigation pump	6 ϕ	1	〃
Solar grain dryer	25 m^2	1	Joint-ownership
Trailer	4-wheel	1	Rental

2 Method and period of cultivation and varieties selected for the experiments

- Method of cultivation : Mechanized transplanting of young seedlings
- Seeding period : April 22 to May 25
- Transplanting period : May 15 to June 15
- Variety : Giza-172 and others

3 Basic operational technique and standard methods of cultivation

1) Box nursing of young seedlings
2) Plowing - chisel plow attached to wheel tractor
3) Basal fertilizer application - tractor-drawn trailer, and manual
4) Puddling - puddling rotary harrow attached to tractor
5) Herbicide application - manual
6) Surface layer application of fertilizer - manual
7) Water management (including mid-summer drainage) - manual
8) Top dressing of nitrogenous fertilizer in the late spikelet initiation and full heading stages - manual
9) Harvesting and threshing - head-feeding type combine
10) Grain drying - solar grain dryer
11) Grain transportation - tractor-drawn trailer

4 Principal features of the mechanized rice cultivation system

A comparison between the mechanized rice cultivation system and the traditional rice cultivation system commonly adopted by Egyptian farmers at present is given in Table 2.

Table 2 Comparison of main techniques between mechanized cultivation and traditional systems

	Mechanized system	Traditional system
Fertilizer application	Rational fertilizer application (50% as basal, 20% in the rooting stage, 20% and 10% in the late growth period)	No basal fertilizer application Top dressing in the middle growth period
Nursing of seedlings	Box nursery (young seedlings-average 2.5 to 3.0 leaves) Intensive management	Lowland rice nursery (fully grown seedlings-average 6.0 leaves) Extensive management
Trans-planting	Transplanter (8-row, riding type) Dense planting: 24 hills/m^2 (4 seedlings/hill)	Manual (at random and disorderly) Sparse planting: 15 hills/m^2 (20 seedlings/hill)
Water management	Water management according to different growing stages: with mid-summer drainage (in the middle growth period)	Successive irrigation
Harvesting and drying	Combine harvester (head-feeding type) Solar grain dryer	Manual repair Drying in the field and threshing by tractor

Cost analysis of traditional and mechanized rice cultivation systems

1 Ownership of agricultural machinery

In the mechanized rice cultivation system, nine kinds of farm machines, and in the traditional system, six kinds of farm machines are used.

For small and medium scale farmers, a rental system of agricultural machinery through an agricultural cooperative is recommended to reduce the investment by individual farmers. As an alternative, joint-ownership of machinery is also recommended. Rental and joint-ownership costs are analyzed in Table 3.

Table 3 Comparison of rental and joint-ownership costs of major agricultural machinery

Item	Rental fee*	Joint-ownership		
	(leasing by agricultural cooperative	Cost per farmer		No. of farmers in joint ownership
Machinery		Per crop season of rice cultivation	Annual**	
	£E/feddan	£E/feddan	£E/feddan	£E/feddan
Chisel plow (W. tractor)	8.00	8.42	76.27	51
Rotary puddling (W. tractor)	17.00	18.45	84.00	56
Transplanter (8-row, riding type)	15.00	78.61	36.38	24
Water pump	61.21 (50.21) (running hours per crop season)	29.88	25.20	17
Combine (head-feeding type)	50.00	60.92	78.01	52
Solar grain dryer	not available	27.47	12.18	8

Note: * Based on the fees charged by an agri-cooperative as of 1985/86.
** For all agricultural crops
(i.e. rice, cotton, birsim, maize, wheat, etc.).

2 Cost effect and increase in paddy yield associated with major cultivation practices in the mechanized rice cultivation system

Table 4 shows the ranking in the order of economic advantage as follows:

- Cost saving : C > B > A > D
- Paddy yield increase (as well as revenue) : C > A > D > B

Total effect : C > A > D > B

3 Conclusion

Comparisons of cost and price, and cost and revenue between traditional and mechanized rice cultivation systems are given in Fig. 4 and Fig. 5.

The mechanized rice cultivation system is associated with a comparatively higher machinery cost of £E180.20 per feddan (£E124.34 in the traditional system), although the labor cost of £E66.26 per feddan is lower (£E170.45 in the traditional system). That is to say, the total cultivation cost of both systems is almost identical.

After adding other expenditures including land rent and capital interest, the secondary cost

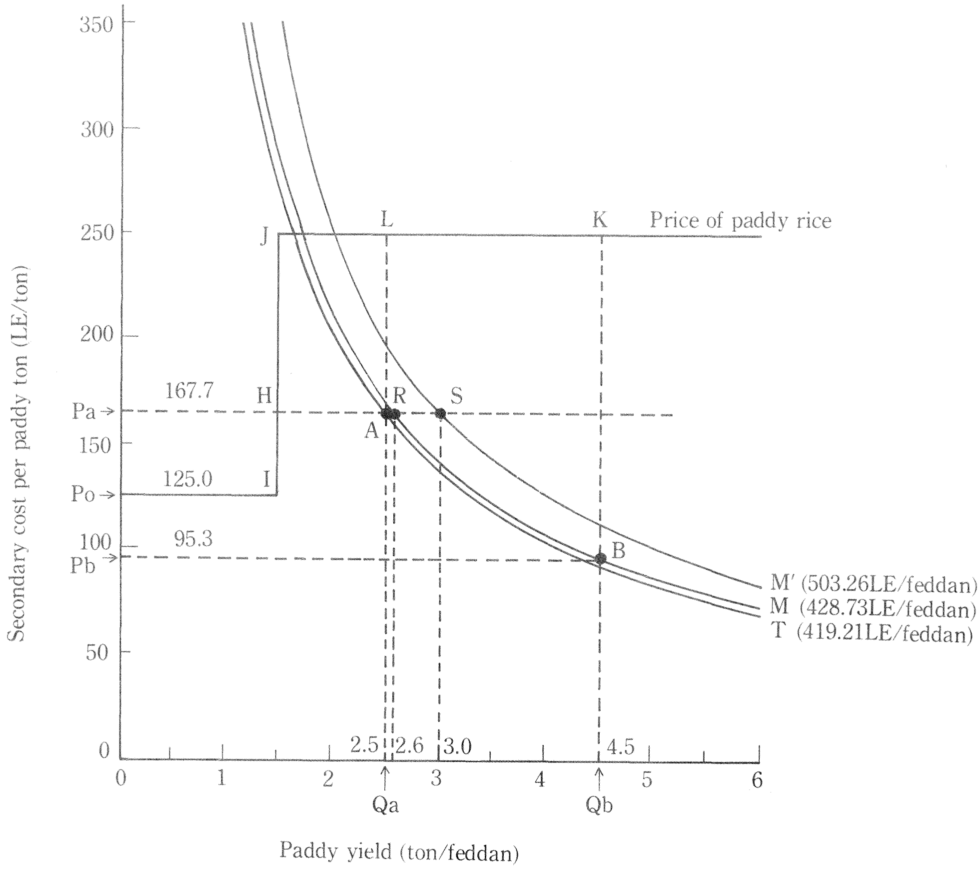

Fig. 4 Comparison of cost and price of paddy rice between the traditional system and mechanized system in rice cultivation.

Source: Horiuchi, H. (1986).

Note: T ... Traditional system
M ... Mechanized system depends on rental machinery
M′ ... Mechanized system depends on joint operation of machinery

Table 4 Cost effect and increase in paddy yield by major cultivation practices in mechanized rice cultivation system

Cultivation practice	Cost effect £E/feddan	Paddy yield increase: increase in weight ton/feddan	Paddy yield increase: increase in revenue £E/feddan* (*£E250/ton)
A Rational fertilizer application	+ 9.80	0.56	140.0
B Nursing of healthy seedlings	+ 4.85	0.13	32.5
C Mechanized transplanting	+ 15.85	0.63	157.5
D Mechanized harvesting	+ 14.61	0.53	125.0

Note: Based on data collected from various experiments carried out from 1981/82 to 1984/85.

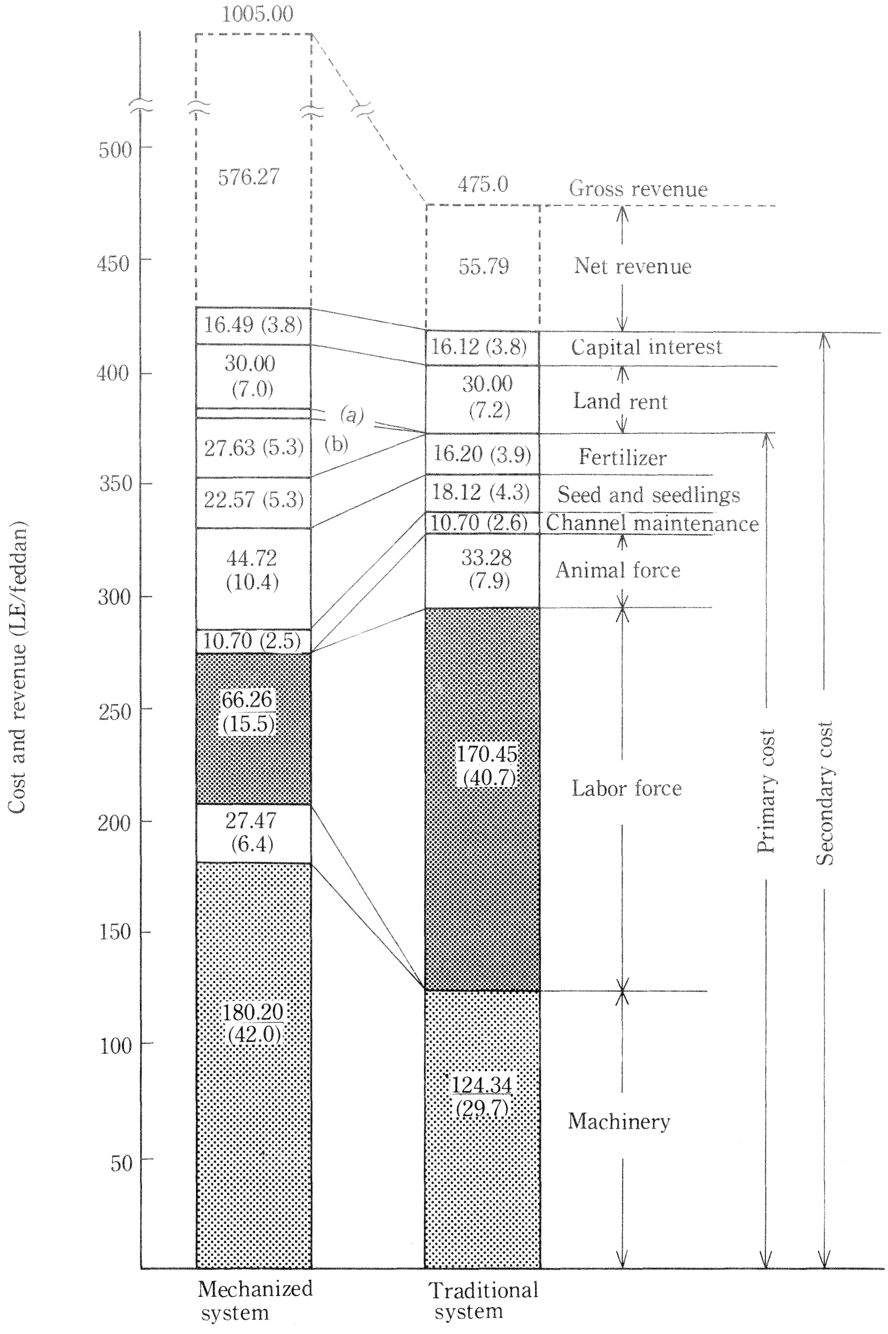

Fig. 5 Comparison of cost and revenue of paddy rice between the traditional system and mechanized system in rice cultivation.

Source: HORIUCHI, H. (1986).

Note: (a) ... Fuel, electricity
(b) ... Herbicides
(c) ... Facilities (solar grain dryer)

of mechanized rice cultivation and traditional systems is £E428.73 and £E419.21, respectively.

Experiments on mechanized rice cultivation showed that the average paddy yield was 4.5 metric tons per feddan, while in the traditional system it was 2.5 tons. Gross and net revenues of the mechanized rice cultivation system are £E1,005.00 and £E576.27 against £E475.00 and £E55.79 for the traditional system, respectively.

Hence, the secondary cost per paddy rice metric ton in the case of mechanized rice cultivation is as low as £E95.3 and that of the traditional system is £E167.7, showing a definite "cost-down effect" for the mechanized rice cultivation system. Furthermore, mechanized rice cultivation has an economic advantage over the traditional rice cultivation system as the paddy yield amounts to 2.6 metric tons per feddan (the equilibrium) or more.

Efficient systems of mechanized plowing, puddling, transplanting, harvesting and grain drying, suitable for the conditions of the Nile Delta region, have been developed and the advantages of mechanization have been revealed from the viewpoints of both yield increase and cost reduction.

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Discussion

Dat Van Tran: (FAO): 1. Did you use the same amount of inputs such as fertilizers, pesticides in the traditional and in the mechanized systems? 2. Did you compare the mechanized system and combined manual labor and animal draught?

Answer: 1. We used greater amounts of chemicals in the mechanized system than in the traditional system (twice as much fertilizers in the mechanized system and no herbicides inthe traditional system). 2. We have not compared these two systems yet.