Mechanization and Improved Efficiency of Lowland Rice Breeding Experiment

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Introduction

A rapid growth which the Japanese industry has recently achieved has induced an outflow of rural population into urban areas and subsequently made it difficult to procure hired labor in rural areas. As a result, a breeding experiment project which requires a vast amount of farm area and labor has been forced to shrink. In order to save labor in preparation of nursery and transplanting that requires labor most among processes for rice culture, therefore, a drastic reform has been introduced into the system of breeding experiment. It was to adopt direct sowing for cultivation of filial generations from F_3 to F_5, to devise and make for trial some special equipments and to improve both imported and home-made machinery for advancing mechanization and efficiency of the breeding project. How it has been developed will be roughly explained as below.

Breeding project through direct sowing (on dried field)

Table 1 shows an outline of a breeding project which has adopted direct sowing of rice.

Table 1. Breeding Processes of Lowland Rice through Dirct Sowing Cultivation

Generation	Planting	Planting method by strains	Density of plants	Machine applied
F_1	Transplanting	Transplanted one plant per hill	30cm×18cm	
F_2	Transplanting	Transplanted one plant per hill	30cm×18cm	
F_3	Directsowing	Hill Plot	30cm×30cm	Hand planter, Sowing marker
F_4	Directsowing	Micro Plot	Spacing of hills: 30cm	Hand seeder, Sowing marker
F_5	Directsowing	Three ridged Micro Plot	Length of ridge: 100cm	Hand seeder, Sowing marker
AfterF_6	Transplanting	Transplanted one plant per hill	30cm×18cm	

F_1 and F_2 are grown as usual through transplanting. In F_2 a panicle is taken from each of selected individuals for F_3 next year, seeds from the selected panicle are directly sown as a hill by a hand planter in F_3 cultivation. A plot with seeds sown in this way is called "hill plot". In F_3, therefore, a hill represents a strain. In F_3 a panicle is taken out from each of selected hills (or selected strains) for growing F_4 next year, seeds from the selected panicle are sown in a straight ridge, 1 meter long by a hand seeder in F_4 cultivation. A plot with seeds thus sown is called "micro plot". In F_4 three panicles are taken from each of selceted strains for F_5 next year, seeds from the selected panicle are sown in a straight ridge 1 meter long as in the case of F_4 cultivation. As three panicles were taken from each strain of F_4, a strain-group of F_5 includes three strains. A plot for this group, therefore, is called as "micro plot with three ridges".

For generations after F_6, rice plants are again grown through transplanting in order to secure their fixation and to test productivity under transplanting. Growing of strain groups is thus continued through transplanting thereafter.

Implements used for direct sowing

There are various implements which have been developed in Japan or imported from foreign countries in order to grow various strains of rice through direct sowing. They are as follows:

1. **Sowing marker (manufactured for trial. See** Fig. 1.)

This implement marks a position of ditch for direct sowing of rice strain. It has a cylinder with many perforations, through which lime is dropped from within on the field to mark the position for sowing.

2. **Hand planter (American made. See** Fig. 2.)

This implement is used for hill plot for the generation F_3. It is inserted into soil and seeds are put in its sowing cylinder. When the cylinder is slanted frontward, seeds are sown and covered with soil at the same time. Besides, it marks the position for next sowing.

3. **Hand Seeder (manufactured for trial. See** Fig. 3.)

This is used for micro plot for F[illegible], micro plot with three ridges for F_5 and for the productivity test in direct sowing. It is operated by 2 persons with one driving the machine along a ditch for direct sowing while another dropping seeds from a cone-shaped funnel. The machine cuts a ditch, sows seeds, covers them with soil and presses the cover soil all at once. Its efficiency is estimated to be twice as much as manual work.

Post-harvest processing implement

Implements as mentioned below are used for post-harvest processing works to improve rice breeding practice regardless of rice plants being grown through direct sowing or transplanting.

1. **Mobile thresher (manufactured for trial. See** Fig. 4.)

This machine consists of a amall thresher with gasoline engine and a trailer attached to it. Rice plants harvested for surveying their rice yields are threshed and weighed before they are dried Thus it dispenses with carrying whole rice plants into a room for surveying their yield. The machine is used for preliminary measurement of rice yield of various strains.

2. **Integrated processing equipment for threshing, hulling and sorting (manufactured for trial. See** Fig. 5.)

This equipment is used for measuring weight and yield of hulled rice of various strains. A thresher, a huller, and a sorting apparatus are connected together with a blower successively to thresh, hull and sort rice which is then packed in a bag as brown rice and weighed. The equipment has the following devices: (1) a crimp below the drum of thresher can be drawn out for cleaning to prevent rice of various strains from mixing each other; (2) a box at the first entrance of sorted grain of thresher has been replaced by a funnel which enables unhulled rice to smoothly flow into the blower; (3) a net is applied to an opening at the bottom of blower so as not to let the wind sent by the blower blow backward into the thresher; (4) two hullers are connected together with one on top of another to carry out hulling process completely; (5) a hulling roller is made of iron rubber instead of rubber not to make hulled rice so black as to make rice quality inspection difficult; (6) switchboards of all motors are placed in front of the thresher so as to be operated by one man; (7) wind blown up by the blower must be let out completely from upper hopper in order to make hulls and hulled grains blown up into the hopper fall down naturally into other processing implement. Therefore, a cyclone is attached to the upper part of hopper.

This equipment can carry out all processes from threshing to weighing hulled grains of each striain and variety with only two men.

Its working efficiency is about 5 to 7 times higher than methods so far applied for the same processes. Although patent is pending, it is now on sale in the market [1] and several experiment stations have already adopted it. It can also be applied to the survey of rice yield in various experiments of rice cultivation.

3. Small thresher (modelled after Almaco small grain plant and head thresher made in America. See Fig. 6.)

This machine is to thresh each selected plant or panicle for the seeds of next year. As its drum is made of cast iron, unhulled grains move so smoothly inside it that no grains remain there. As seeds of different individuals do not mix up each other in the drum, the machine is very convenient for breeding practice. Compared with threshing plant by plant by Senba (comb type hand thresher) its efficiency is about 7 times higher. A machine of further improved type has been placed on the market. [2]

4. Small rice milling machine (modelled after automatic "Patent Mingetti" madein Italy, with some improvements. See Fig. 7.)

This is applied to a test milling of sample hulled rice in so small an amount as 50g. The Italian prototype is made so as to shave off rice bran from hulled rice with a grinder as illustrated in Fig. 8. As a result, milled white rice become very round, Consequently, the milling machine milles rice grains into round shape, not keeping their original shape while an ordinary Japanese machine does not. Therefore, the brass cone on which number of screws are fixed has beer replaced to the grinder of the Italian type of machine so as to mill rice, keeping their original shape. With this improvement it now takes only 2 or 3 minutes for milllng a test sample in so high an efficiency as 10 to 15 times more than the old milling machine. A machine of improved type is now placed on sale. [3]

5. Measurer of matured grain ratio (developed by the Genetics Section, National Institute of Agricultural Sciences. See page. 32)

Matured and immatured unhulled rice grains are separated first by sorting apparatus and each of their numbers is counted with transistor to obtain a ratio of matured grains to the immatured. It takes 6 or 7 minutes to count 1,000 grains. In this case, immatured grains mean to be completely immatured. Therefore, they can be used for genetical studyon sterility of rice. The counter separatly can be used for measuring the weight of 1,000 rice grains only. This measurer is also placed on the market. [4]

Future problems of mechanization and improvement of efficiency in rice breeding

As above mentioned, a substantial progress has been observed in mechanization in direct sowing of seed rice and treatment of harvested rice for breeding process. But mechanization has far lagged behind in harvesting of rice according to each of various strains and varieties. A higher efficiency, moreover, is looked forward in measurement of morphological features of rice plant such as length of stem, length of ear, and number of panicles, and recording and classification thereof.

Note : 1) Kiya Seisakusho, 350 Shinjuku-machi, Kawagoe-shi, Saitama Pref.
2) 4) Fujimoto Kagaku Kogyo K. K., 15 of 2, Uchikanda 3 Chome, Chiyodaku, Tokyo
3) Kett Kagaku Kenkyujo, 8 of 1, Minami-magome 1 Chome, Ota-ku, Tokyo

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1) Ryuji Ito et al., Mechanization and improvement of efficiency in rice plant breeding projects, 1-2, Agricuture and Horticulture, No. 10 and 11, vol. 39, 1964.
2) Ryuji Ito et al., Small and precise thresher for breeding experiments, Agriculture and Horticulture, No. 9, Vol. 41, 1966.
3) Ryuji Ito et al., Small rice milling machine for breeding experiments, Agriculture and Horticulture, No. 12, Vol. 41, 1966.

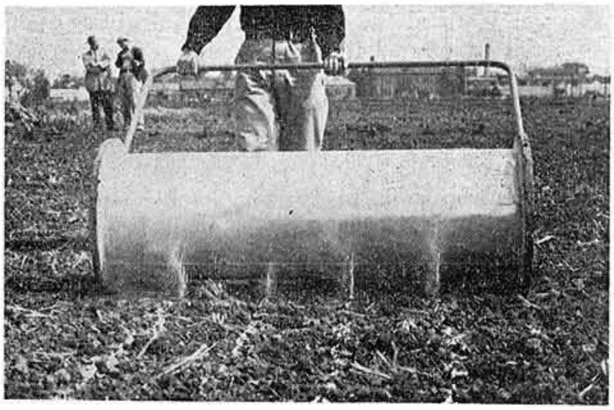

Fig. 1 Sowing marker at work

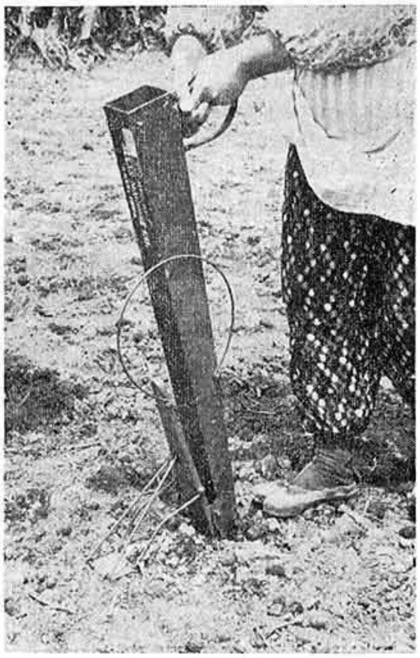

Fig. 2 Sowing by hand planter

Fig. 3 Sowing by hand seeder

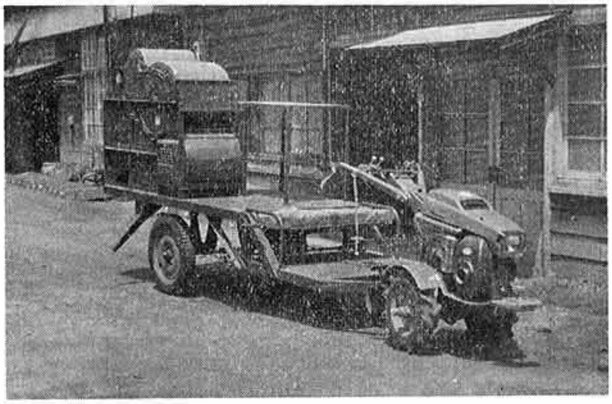

Fig. 4 Mobile thresher

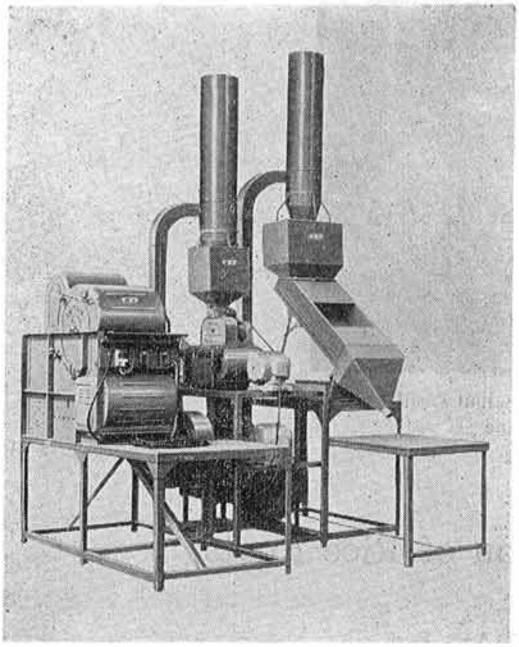

Fig. 5 Integrated processing equipment for threshing, hulling and sorting

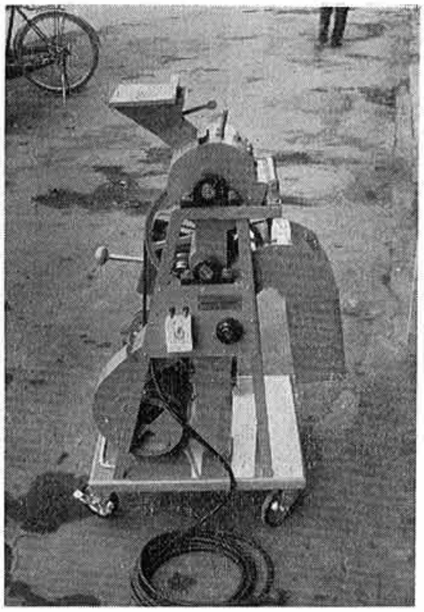

Fig. 6 Small thresher (Improved type)

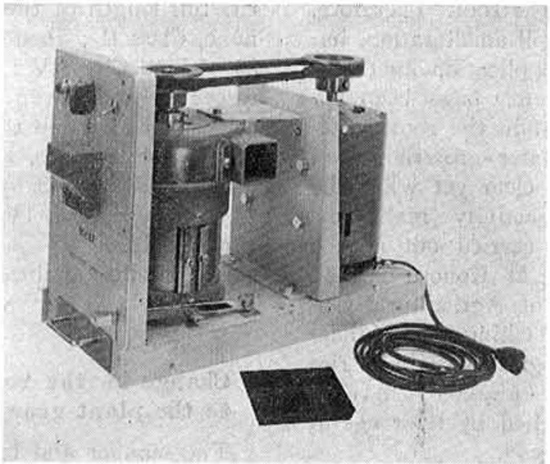

Fig. 7 Small milling machine (Improved type)

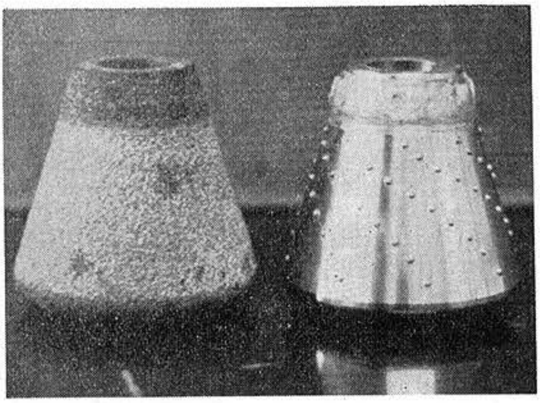

Fig. 8 Left : Cone of an Italian small sized milling machine
Right : Improved cone

Physiological Function of Rice Roots

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It is a well-known fact that the growth and yield of rice plant is much affected by the physiological function of the root. Therefore, various methods such as soil amelioration, improvement of fertilizer application methods, irrigation water control, etc. have been applied by cultivator to maintain the root activity, particularly for the later growth stages. However, it has not been clear yet what the root function or the root activity really is.

The present study was carried out in the period from 1957 to 1965 at Konosu branch of the National Institute of Agricultural Sciences for the purpose of making clear fundamental nature of physiological activity in rice roots by investigating the physiological char acteristics of roots classified by their age at various plant growth stages[3].

Rice plants (varieties used were mainly Nōrin no. 29 and Nōrin no. 25) were grown by soil- or solution-culture in pots or in the field. Classification of roots was made in relation to their age by a standard based on the length of the part on which rootlets occur to the full length of the root, that is, Class I: none, Class II : about 50 %, Class III : about 80 %, and Class IV : over 90 % in the ratio, respectively, as given in fig. 1. This standard corresponds well to the number of days after the root emergence, that is, Class I : within 3 days, Class II : 3 to 7 days, Class III : 7 to 14 days, and Class IV : more than 14 days, respectively.

The results obtained are summarized as follows.

Change in the root quantity according to the plant growth stage.

The number and fresh and dry weights of roots per plant increase with the growth of plant up to around the heading time, and then they decrease toward the late ripening stage as shown in fig. 2. According to the distri-