Mechanized Direct-Seeding of Rice Adapted to Heavy Rainfall Condition in Southeastern Japan

By KYOJIRO INOUE*

Farm Operation Division, Central Agricultural Experiment Station

Sowing time in the direct-seeding rice cultivation in southeastern Japan has been adviced to be later than early June by taking into account the harvesting time of preceding crops mostly wheat or barley, and seasonal pattern of pest and disease occurrence. However, weather at that time is quite unstable because the rainy season so-called Baiu sets in about that time.

There are two types of direct-seeding of rice: direct-seeding in dry fields and that in puddled fields. In case of the former, a sequence of farm operations required for sowing, i.e. plowing-harrowing-seeding-fertilizer application etc., is often interrupted by rain, resulting in a delay of operation and hence a difficulty of completing whole practice in time. Even when the seeding was made in time, seedling emergence and establishment are frequently disturbed by heavy rainfall, which causes over-saturation of soil water or occasional submergence of field patches. Furthermore, in years of scarce rain, strong sunshine bakes soil, making soil pulverization difficult, and as a result seedling emergence is retarded. An additional labor is often required for hand-planting to replenish missing hills.

On the other hand, in case of the latter the seeding on pudded fields is less influenced by weather, unless there is a shortage of irrigation water. But, it is quite difficult to adopt large to medium size machines for sowing on puddled fields. Thus, these two methods have advantages as well as disadvantages.

The author developed a new techniques for direct-seeding of rice, that has advantages of both types, and is far better than either method, being more stable against weather influences. The method consists of two components: (a) the use of a multi-operational seeder, by which a series of farm operations required for seeding can be done at one time, and (b) preparation of the partially tilled and ridged seed-bed.

Partially tilled and ridged seed-bed

This particular type of seed-beds was found to be very effective in facilitating the run-off of rain water from the seed-beds and in draining excessive moisture absorbed by the seed-beds. Under a long spell of dry weather, it can preserve more moisture for longer period than any other seed-beds. Irrigation can also be practiced more easily and effectively because furrows already exist for distributing water. (Fig. 1)

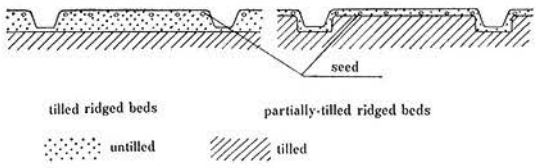

Fig. 1. Profile of seed beds

* The author carried out the study reported in this paper when he was in the Kyushu National Agricultural Experiment Station.

Multi-operational seeder

The machine is so designed that tilling, ridging, levelling, fertilizer application, seeding, soil covering and compacting can be made continuously by an operation of a single machine. Depending upon the stickiness of soil, modifications are made with regard to devices for furrowing, ridging and levelling. Type B is designed for the use on less sticky soils, and type C, which has a soil auger with differential diameter placed transversely to the travelling direction of the machine, is adapted to soils of moderate stickiness. Type D, equipped with an inversely rotating rotavating shaft with irregularly shaped tines is for very sticky soils. (Fig. 2 and Plate 1)

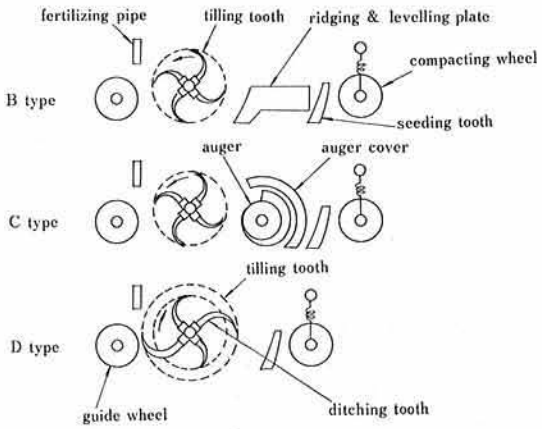

Fig. 2. Parts of multi-operational seeder

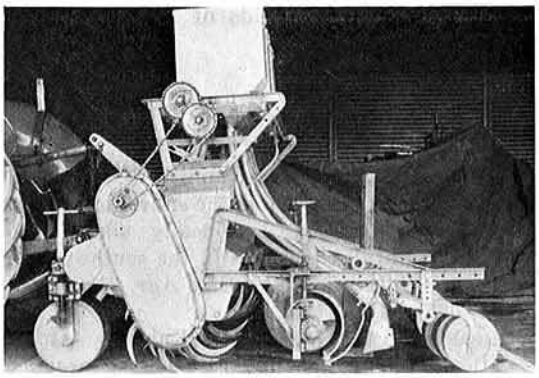

Plate 1. Multi-operational seeder of type C

Characteristics of the new seeding method

The new seeding method demonstrated that:

1) Rapid seedling emergence and good establishment can be obtained due to (a) good drainage at the time of heavy rain, (b) high moisture content of seed-bed under dry weather because of minimized evaporation loss during the seeding operation, (c) uniformity of seeding depth caused by the less vertical movement of the seeder during the operation, and (d) soil is easily crashed to small clods.
2) Even at unfavorable conditions of fields, such as that immediately after the heavy rainfall or the fields with stubbles (up to 20 cm long) left over after combine-harvesting, the seeding can be made with high accuracy of operation.
3) Because the power-unit (tractor) runs on the untilled portion of the fields, effect of weather on trafficability is reduced.
4) Soil is easily crashed to small clods, with low percentage of clods larger than 30 mm in diameter. Seedling emergence was found hardly affected by the size of clods, at least up to 30 mm in diameter, over a range of soil-moisture content from 50 to 100% of the maximum field capacity. This is because the seed-bed is consisted of untilled soil layer covered by a thin layer of soil clods.
5) Under a condition of the depth of soil covering less than 5 cm, size of soil clods less than 30 mm in diameter, and soil-moisture content close to the maximum field capacity, seedling emergence higher than 80% can be obtained without failure even with different kinds of soil. However, a problem of soil crust formation is not yet fully examined because the effects of soil clods were studied by pot experiment. For

Table 1. Excerpts from actual production tests

Items	years	1965	1966		1967	
	Locations*	A	A	B	A	B
Yields and components	Rough rice (ton/ha)	6.09	6.58	7.57	6.13	8.65
	Rough rice-straw ratios (%)	83.5	91.1	83.0	92.9	71.0
	No. panicles per unit area (m^2)	364	462	422	406	470
	No. grains per unit area (m^2)	30.43	30.97	34.06	28.65	36.1
	Yields on neighbouring transplanted rice fields (rough rice ton/ha)	—	—	7.44	—	7.02
Man-hours required	Seed processing	12.0	10.7		12.0	
	Seeding	14.2	12.4		6.7	
	Fertilization	14.4	27.6		22.8	
	Weeding	183.9	34.7		83.1	
	herbicides	11.4	6.7		3.5	
	manual	172.5	28.0		79.6	
	Pests control	14.8	37.1		32.8	
	Harvesting & processing	22.6	21.2		29.1	
	Total	261.9	143.7		186.4	

* A : Test plot on the Station premise, soil type ; loam, converted to paddy in 1963, high percolation rate (30-80 mm/day).
B : A local farmer's field in Ohki-machi, Fukuoka-ken, clay-soil, low percolation rate (6-8 mm/day).

a practical application of this principle, the effect of crust formation has to be examined at each place.

Weed control

In this method of direct-seeding rice cultivation, terrestrial as well as aquatic weeds emerge over a relatively long period. Herbicides of DCPA type are effective in controlling weeds at an initial stage of cultivation before the field is submerged. However, it was noted that the toxicity of herbicides to rice plants was increased by high temperature and low humidity. Heavy liming increased plant injury by increasing pH of soil. Nitrogen application reduced plant injury by causing a rapid recovery. Combined application with pesticides, NAC and Sumithione, caused a severe injury, particularly when the herbicide was used after the application of pesticides.

Field test on cultivation

Adopting this new method of seeding, the cultivation tests were carried out on 1 ha fields, using a 4-wheeled 25 Hp tractor and an ordinary combine harvester with 2 m cutting width, with a target of obtaining 8 ton/ha (brown rice) of yield at a labor input of 100 man-hours/ha.

The result are shown in Table 1. Due to the poor condition of field A (high percolation and low fertility), yields were only 6.1–6.6 ton/ha with labor consumption of 140–260 man-hours. Failure of timely application of herbicide caused by rainfall necessitated hand-weeding. However, yields at fertile fields (field B) was 7.6–8.7 ton/ha, similar to or slightly higher than yields of farmers' fields in that area.

References

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