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MECHANIZATION OF RICE DIRECT-SEEDING IN JAPAN AND THE U.S.

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ABSTRACT

Agriculture in Japan is generally characterized as a small scale and inefficient farming system with a diminishing number of young farmers. Labor productivity is very low. Farm incomes are not good with their living standard being very low. Farm land is abandoned in some areas. Costs of agricultural products are relatively very large. Production costs of rice in particular are enormously greater than the international standard. Because of costly domestic products, over 70 % of foods, which are consumed in Japan, are imported from the U.S., China, Thailand, Australia, and other countries. To improve productivity of rice production and to make the rice prices cheaper, it is indispensable to create large farms and make each stage of production process more labor-efficient. Therefore, we tried to introduce the no-tillage direct seeding system on rice production. The main results obtained in this research are as follows: A lot of labor time was cut and production cost was reduced by using the no-tillage direct seeding system. The growth of rice plant on the no-tillage direct seeding system was nearly equal to those on the tilled rice planting system. The grain yields on the no-tillage direct seeding system were slightly less than those on tilled rice planting system.

1. INTRODUCTION

The rice production system in Japan is quite inefficient because of small farm managing and farm incomes are not good with respect to the living standard in Japan. A great deal of paddy field in Japan are surrounded by mountains. Fields in mountainous and hilly areas account for about 40 % of Japanese total land. Farm size is around 0.7 hectares per farm and 0.06 hectares per field in average.

Small farms tend to use small machine; it would be very hard to use gigantic agricultural machines (for instance, tractor, combine and airplane) which are used in the U.S. and European countries. Therefore, labor productivity is low relative to the U.S. and European countries. Particularly, production costs of rice, which is the staple food in Japan, are quite high relative to other nations, and costs of machine account for a large share in total production costs. This causes expensive retail prices. Average retail price is 5,000 yen per 10 kg, milled rice, about 5 times to 20 times as expensive as those prices in Thailand, China and the U.S. respectively.

To improve the productivity of rice, in particular and to make the retail prices cheaper, it is indispensable to create large scale farms and make each stage of the production process more labor efficient.

In this research, we repeatedly studied the mechanization for rice production and focused on rice direct-seeding mechanization and we tested the efficiency of rice direct-seeding machine (airplane, R.C. helicopter, broadcaster and so forth). Our analysis was particularly focused on time length of operation using the machines in each working process, and we investigated germination percentage, growth and yield after seeding. We also compared the results with the situation in the U.S. Tests of each stage were done at two kinds of different condition fields (tilled and no-tillage field). The no-tillage system is the method in which the soil is not cultivated at all before flooding and seeding.

2. FIELD AND CLIMATE

The no-tillage rice direct seeding tests were done at 2 fields (field number : No.1 and No.2), in Hawai-Cho, Tottori Prefecture, Japan and 3 fields (No.3, No.4 and No.5), in Little Rock, Arkansas, the U.S. In No.1 field, seeding were transplanted after tilling and flooding. In No.3 fields, the direct seeding were done after tilling. In No.2, No.4 and No.5 fields, no-tillage direct seeding was conducted.

The characteristics of soils in those fields are shown in Table1 and soil textures are shown in Fig.1. Temperature and humidity in Tottori and Little Rock are shown in Fig.2 and Fig.3. There are not so much differences between Tottori and Little Rock.

Table 1 Atterberg limit and cation exchange capacity of tested field soil

Field number		Real specific gravity (g/100cc)	Liquid limit (%)	Plastic limit (%)	Cation exchange capacity (ml/100g)
No.1	Mean	252	44.2	30.5	16.7
	S.D.	3.6	1.6	1.2	1.1
No.2	Mean	249	42.8	33.6	17.3
	S.D.	2.6	3.2	1.9	1.2
No.4	Mean	259	46.5	28.46	20.1
	S.D.	2.1	2.12	0.5	1.6
No.5	Mean	266	40.3	27.2	19.5
	S.D.	2.9	1.8	0.95	0.9

S.D.: Standard deviation

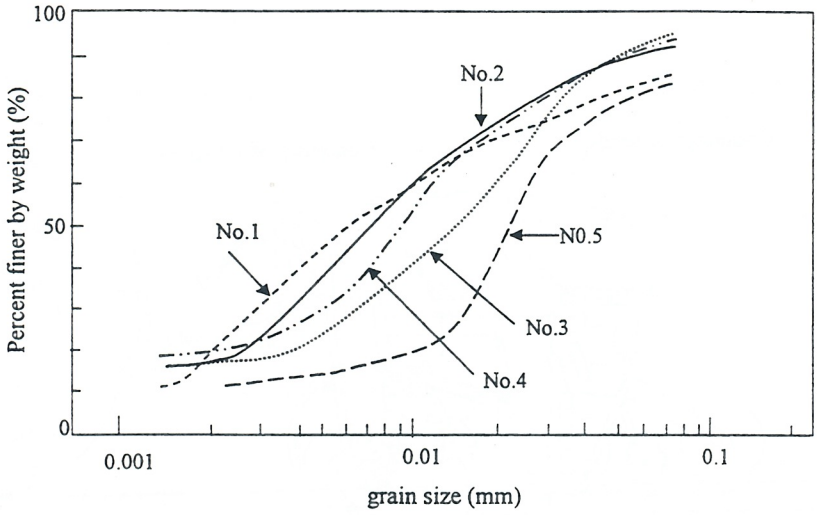

Fig.1 Grain-size accumulation curve of field soil

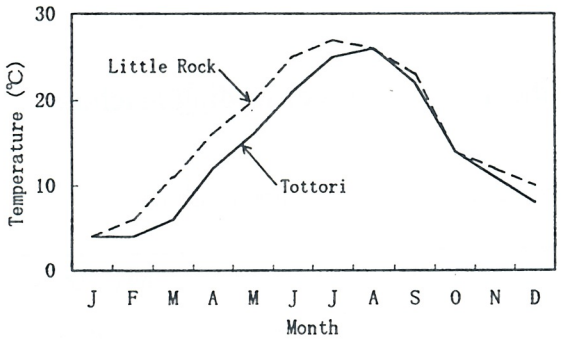

Fig. 2 Normal temperature

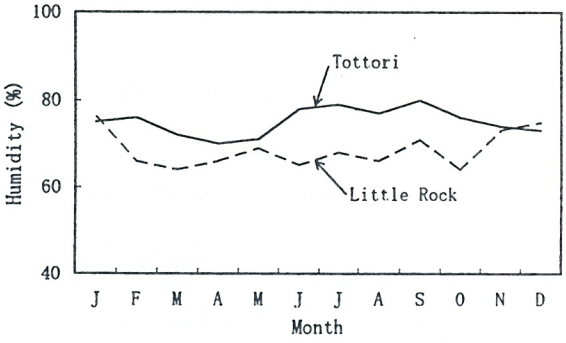

Fig. 3 Relative humidity

3. APPARATUS AND PROCEDURE

The rice direct seeding system and the no-tillage system have hardly been done in Japan up to now. On the other hand, 60 % of rice planting have been done by direct seeding by airplane in the U.S. Fig. 4 shows the outline of the no-tillage direct rice seeding tractor equipped with special device. The special device is composed of cultivating, land clearing, seeding, fertilizing and loading systems.

Table 2 shows the outline of dimension and the ability of the no-tillage direct rice seeding machine used in Japan. Operating efficiency of direct seeding using the no-tillage direct rice seeding machine and airplane, growth process of seeding, yield and soil hardness as time elapsed, were investigated.

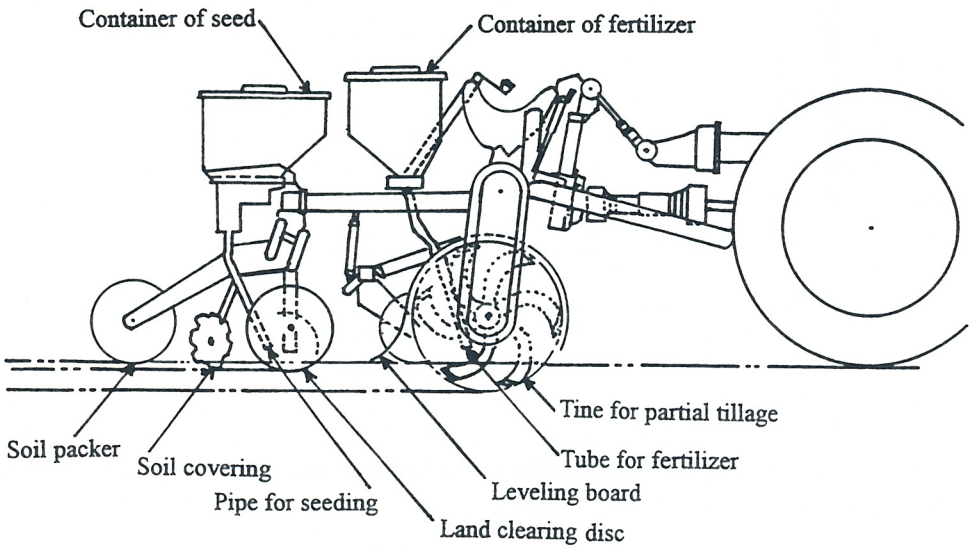

Fig 4. Schematic diagram of the no-tillage direct seeding machine

Table 2 Main specification of the no-tillage direct seeding machine

Tractor	Type		MT-306
	Out put	(kW)	30
	Wheal size Front		7.0-16.0
	Rear		12.4-24.0
	size Longth	(mm)	1550
	Width	(mm)	1800
	Height	(mm)	1100
Attachment (Seeding device)	number of rows		6
	interrow-space	(cm)	30
	Dia of rotary cutor	(mm)	450
	Depth of tillage	(cm)	6
	Plant of poputation	(kg/10a)	4.0-10.0
	Fertiliger	(kg/10a)	0-70.0
	Seed hopper capacity	(l)	27
	Efficiency	(mm/10a)	16-25

4. RESULT AND DISCUSSION

Table 3 shows the comparison of the results among the fields tilled-transplanted by tractor (field No.1), tillage direct seeding by tractor (No.2) , tilled direct seeding by airplane (No.3), and no-tillage direct seeding by airplane (No.4, No.5).

Fig.5 shows changes in soil hardness of paddy fields used in these tests over time. The soil hardness in clay loam soil field (No.4) was slightly harder than the one in sandy soil field (No.5) at the harvest season.

The detailed differences in yields were not clear in these tests.

Table 3 Growth of rice plant and yield

Field number		No.1	No.2	No.3	No.4	No.5
Plant height	(cm)	29.5	31.3	38.6	427	39.8
Root length	(cm)	11	13.2	12.5	11.9	12.3
Number of tillers		3.6	4.3	2.8	2.6	3.1
Yield	(kg/10a)			446	428	419

Investigated date of growth : 65days after seeding
Yield : Brown rice

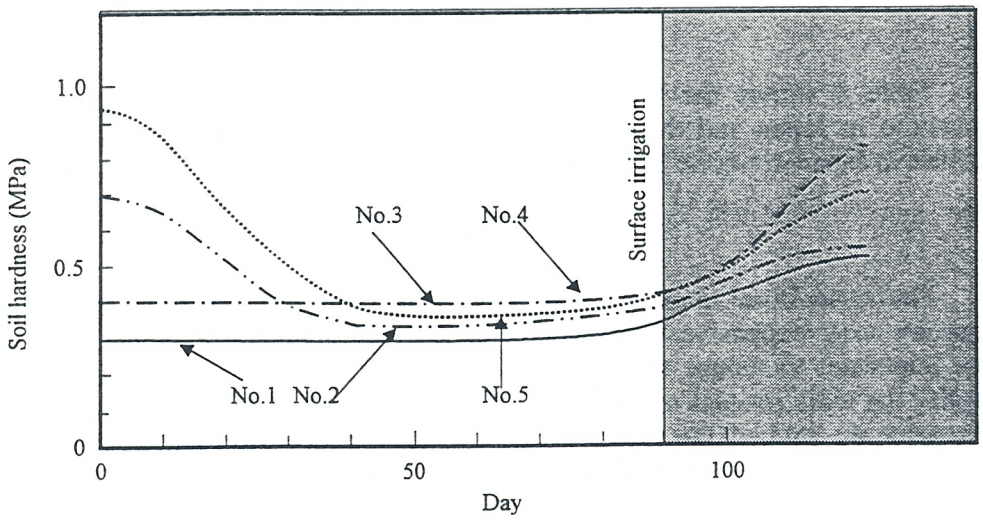

Fig.5 Changes in soil hardness of field

Table 4 Labor hour on japonica rice production

(h/ha)

Country	Japan			U.S.	
Field number	No.1	No.2	No.3	No.4	No.5
Seed Treatment	5	5	5	2	2
Nursery bed	42				
Tilling・Leveling・Puddling	35	28		8	
Basal application	16	16		1	1
Direct seeding		4	4	1	1
Transplanting	22				
Additional manure	10	10	10	1	1
Weeding	14	21	26	1	2
Watering・Drainage	58	58	58	3	3
Pest control	14	14	14	1	1
Harvesting Threshing	49	49	49	4	4
Transportation	8	8	8	2	2
Drysing・Hulling	24	24	24	10	10
Production control	10	10	10	2	2
Total	307	247	208	36	29

Table 4 shows the working items and each working hours on japonica rice production in Japan and the U.S. The working hours related to the direct seeding by machine in Japan are quite large relative to the ones done by airplane in the U.S.

5. CONCLUSION

The agricultural management scale in Japan is very small and the rice prices in Japan are very expensive comparing with the international standard. It is becoming more important to reduce the rice production cost and it is strongly recommended to simplify the work process of rice production to decrease the farmer's labor required. So, we repeatedly studied the mechanization for rice production and focused on the no-tillage direct rice seeding mechanization and tested the operating efficiency of it. The results indicated that the no-tillage direct rice seeding system might enable us to cut down labor time from 400 hours per hectare to 300 hours and the rice production cost would be considerably cheaper by using the direct-seeding and the no-tillage systems.

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