TARC Note

Land Leveling Guided by a Laser Machine Control System in Malaysia

Although direct seeding culture of rice is getting popular in the Muda irrigation area, there are some important problems associated with this technique. They are difficulty in weed control, water-shortage, and uneven germination. Herbicides are used for weed control, but the rate of application has been increasing remarkably. Partial land smoothing is also being practiced by the farmers to improve the plot water management and to reduce uneven germination. Although these steps are being done, the problems have still remained unsolved. Precise land leveling to improve the plot levelness seems to be effective for further refinement.

Benefits of the precise land leveling are anticipated as follows:

a) Uniform establishment of seedlings,

b) Saving irrigation water by reducing the depth of water inundated on paddy fields,

c) Saving herbicides by enabling shallow irrigation evenly over the whole field at proper timing,

d) More efficient operation in irrigation and drainage.

Therefore, we attempted to examine the performance of the precise land leveling operation guided by a laser machine control system in the ACRBD4 irrigation block in the Muda irrigation area (Fig. 1). In this note, the results of the trial are presented briefly.

The instrument and equipment used in the trial were two models of the laser machine control system (Table 1), a motor grader (Fig. 2), a rear bucket, a rear blade, and a niplo drive harrow. The laser machine control system was used for leveling work as well as for a land survey. The grid survey of 10 × 10 m was done throughout the area. The motor grader was a leveling machine used in this trial though it was found suitable only for shallow cutting per pass (2.5 cm) in very dry condition. For a deep cut and fill, repeated passes are required. Therefore, it was felt that the most suitable machine for the job was a bulldozer. However, the farmers concerned requested us not to use the bulldozer because they were afraid of the risk of disturbing the subsoil layer, so that the motor grader was used. The rear bucket was used for major scraping work (in the plot 3) as well as for the finishing touches in dry condition, with or without (in the plot 14) the laser machine control system in the area inaccessible for the motor grader. The modifying work done by the rear bucket with-

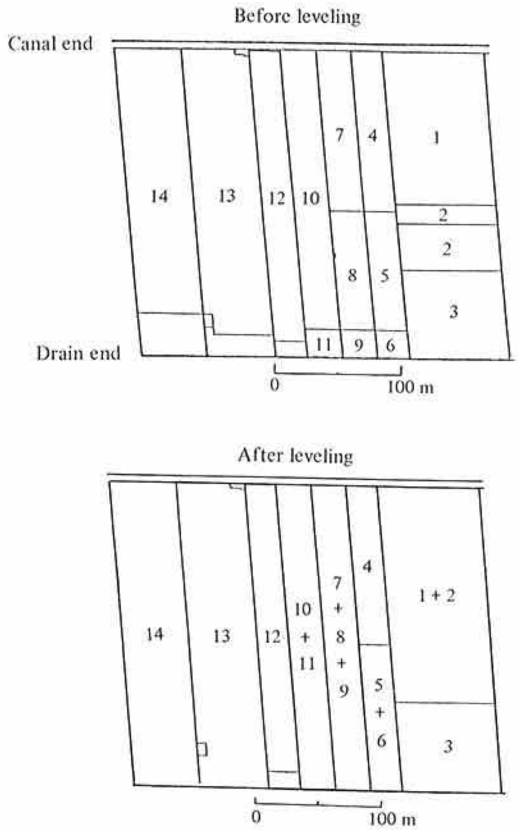

Fig. 1. Field plots used for the trial

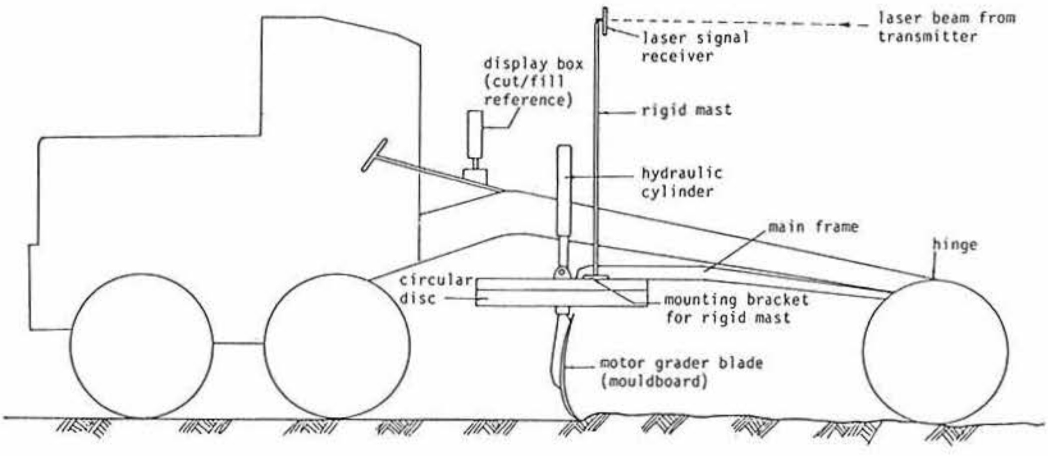

Fig. 2. Motor grader fitted with the laser plane system

Table 1. Laser machine control system adopted in this study

Name	Kind of laser	Operating radius	Grade control	Power	Automatic or maunal
1) Laser plane	Heliumneon gas	300 m	up to 10% (0.001%)	12V DC battery	Manual (Auto : available)
2) Laser beacon	Heliumneon gas	300 m	up to 10% (0.001%)	12V DC battery	Manual (Auto : available)

1): Used mainly for the control of motor grader and leveling survey.
2): Used mainly for the control of tractor and leveling survey.

Table 2. Field surface configuration before and after the land leveling operation with a motor grader, as expressed by the standard deviation from the average level of grid points in the 10×10 m grid

Plot	No. of grid points	Standard deviation(cm)			LI-5 (%)**			LI-2 (%)**			Acreage (ha)
		Before	After	Improvement	Before	After	Improvement	Before	After	Improvement	
1+2	135	4.2	3.6	0.6	84	87	3	45	42	−3	1.25
3*	55	4.2	2.6	1.6	86	98	12	64	60	−4	0.60
4+5+6	64	8.3	4.2	4.1	44	80	36	22	25	3	0.60
7+8+9	71	6.3	3.5	2.8	72	90	18	27	54	27	0.71
10+11	57	6.8	2.9	3.9	65	88	23	32	63	31	0.57
12	61	9.8	5.2	4.6	64	89	35	21	51	30	0.57
13	128	7.9	4.6	3.3	76	80	4	49	45	−4	1.33
14	127	7.4	3.5	3.9	63	88	25	28	47	19	1.26
Total	698	54.9	30.1	24.8	554	700	146	288	387	99	6.32
Mean	87	6.9	3.8	3.1	69	88	19	36	48	12	0.79

* Leveled by the rear bucket guided by the laser machine control system.
** LI-5: Percentage of grid points showing the deviation within ± 5 cm.
LI-2: Percentage of grid points showing the deviation within ± 2 cm.

out the laser control in the plot 14 made the configuration worse as shown in Table 5. Visual high patches were leveled with a rear blade in wet condition after smoothing done by a niplo drive harrow.

Since the plot surface sloped down toward the drain, the scraping of soil had to begin at the canal side. It caused the process of scraping in one direction. Small depressed plots were combined together to form a bigger plot (Fig. 1). Throughout the leveling work, the range of depth of cut was 2–5 cm.

The leveling work by the motor grader was done only once in this trial because of the tight operating schedule. As the result of the land leveling, the standard deviation of the plot configuration decreased from ±6.9 to ±3.8 cm (Table 2). The net improvement of ±3.1 cm was achieved.

The percentage of the grid points showing the deviation within ±5 cm and ±2 cm was 88% and 48%, respectively. For more precise land leveling, the higher percentage of the grid points within ±2 cm is required.

The configuration after smoothing done by the niplo drive harrow and rear blade was about ±3 cm (excluding the plot 14) in standard deviation as shown in Table 5.

The configuration in the plot 14 is shown in Fig. 3. It indicates discontinuously distributed depressed patches. They inhibit the smooth water flow, and cause standing water left on them. In direct seeding of rice, the standing water inhibits seed germination, be-

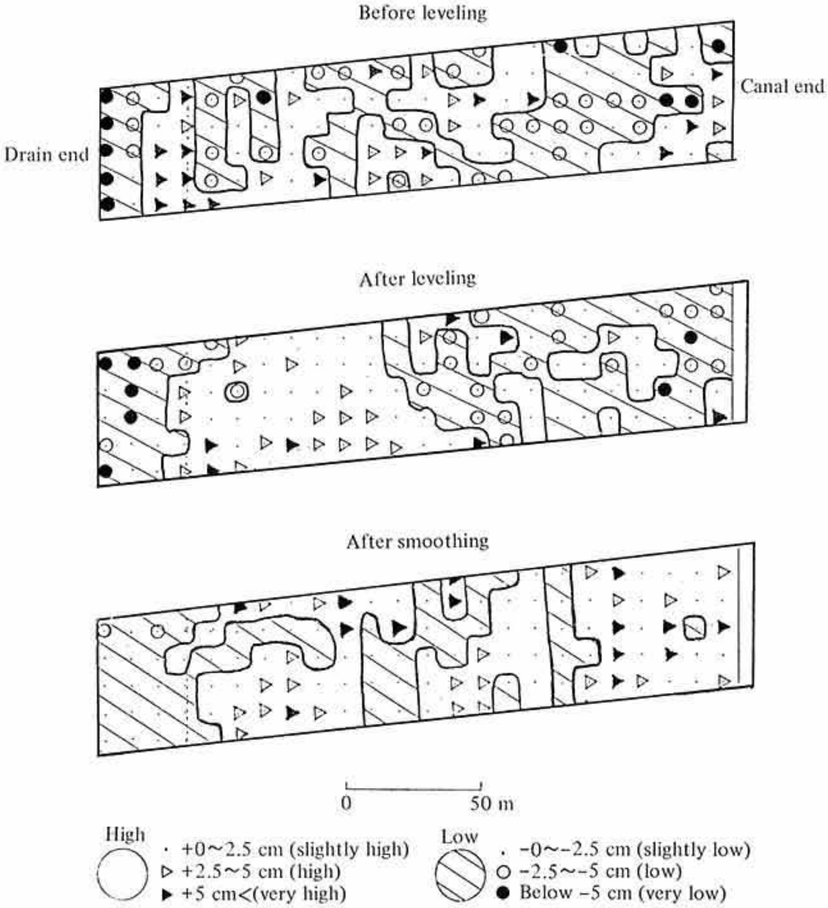

Fig. 3. The field surface configuration map (plot 14)

Table 3. Work-rate and time components of leveling operation with a motor grader

Parameters	Plot no. 12	13	14
1. Plot size (ha)	0.57	1.33	1.26
2. Component (in %) of the total time consumed			
Total working time (min)	106.9	234.7	243.9
a. Hauling/scraping (%)	53.47	52.70	58.56
b. Turning (%)	0	7.13	15.42
c. Gear change (%)	2.52	0.93	0.87
d. Reversing (%)	33.94	26.67	21.57
e. Adjustment (%)	8.39	7.59	1.95
f. Stopping (%)	1.67	4.64	1.62
Total	100.00	100.00	100.00
3. Work-rate (ha/hr)	0.32	0.34	0.31
4. Wheel slip (%)	25.8	7.25	21.68

cause the water temperature rises extremely under the scorching sun, and hence the content of dissolved oxygen is seriously reduced. To avoid this phenomenon, the depressed patches should be distributed continuously along the slope for easy removal of water.

Work rate and time components of the motor grader operation are shown in Table 3. The average work rate was 0.32 ha/hr. The performance of the motor grader could be improved further if the field trafficability becomes better and the system used becomes more familiar to us.

Total working time can be estimated by the following equation:

$$T=C\left(\frac{L}{V_n}+\frac{L}{V_r}+2G\right)\times NS\times B/b \quad \ldots(1)$$

T = Total working time (min.)
C = Coefficient. Total time/effective working time
L = Length of plot (m)
V_n = Hauling/scraping speed (m/min.)
V_r = Reversing speed (m/min.)
G = Time for gear change (min.)
NS = Ratio (coefficient) of actual number of haulding・scraping trips in a given plot/calculated number of trips as B/b. The value of NS is greater than 1.0, because some overlap of the blade width occurs in practice.
B = Width of plot (m)
b = Effective width of the blade (m)

C, G and NS were as shown in Table 4.

Table 4. Values of C, G and NS

Plot	C	G (min)	NS
12	1.11	0.11	1.99
13	1.24	0.04	1.70
14	1.23	0.04	1.89

Table 5. Comparison of the standard deviation before and after smoothing

Plot	Standard deviation (cm) Before	After	Improvement
1+2	3.6	2.8	0.8
12	5.2	3.0	2.2
13	4.6	3.2	1.4
14	3.5	4.4	−0.9

The operation cost of motor grader's work was about $200 (¥10,000)/ha in this trial.

The standard criteria for paddy field land leveling must be formulated to meet the minimum tolerance for uniform seed germination and efficiency of water control. In Japan, the standard for field surface configuration in paddy fields is "100% of grid points (10 × 10 m) must be within ±10 cm and more than 80% must be within ±5 cm". This standard is used for mechanical transplanters. But for direct seeding, a little more strict standard is needed. If systematic surface ditches for better surface drainage are formed by tractor wheels etc., it will be possible to make the standard more flexible. In addition, other factors, such as agronomy and farm mechanization, must be taken into consideration in formulating the standard.

On the other hand, it must be considered that, although the most refined standard can be formulated, the achievement depends on the maximum sensibility of the laser control system. The maximum sensibility of the laser control system used in this study was ±1.2 cm. Therefore, when the target range is greater than ±1.2 cm, it can be achieved with that system.

On the basis of the results obtained, further comprehensive study including selection of machinery for deep cutting in dry and wet conditions (eg. bulldozer), degree of preciseness, cost of the system, and performance of selected machines will be carried out.

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