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Performance of a Self-propelled Walking type Whole Stalk Green Sugarcane Harvester

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ABSTRACT

The NB-11 self propelled whole stalk green sugarcane harvester walking type of Bunmei Noki Company Limited was tested both in the laboratory and the field for its performance. The engine speed, travelling speed with various transmission gear operation pick-up chain, cutter blade and delivery chain speed with low and high PTO operation were measured and recorded as well as its operation with variety of the plant and field efficiency. Four varieties of sugarcane about 10 months old which were planted in the same field and treatment condition were harvested. The harvester performed the field efficiency of 0.82 rai/hr at low PTO operation and 1.3 rai/hr. at high PTO operation with tonnage of 7 t/hr. at low PTO operation and 14.5 t/hr. at high PTO operation respectively. The percentage of splitted stalk and remained stalk cut were determined.

INTRODUCTION

Sugar production in Thailand has been developed very fast. Starting as the importer in 1962, now she is the world third sugar exporter.

The sugarcane plantation area is about 4 million rai (640,000 ha.) yielding about 30 million ton of green sugarcane produce about 3 million ton of refine sugar. Therefore, this serves as an indicator of the sugar industry major role in development of the country economy.

At present, the growth of other industries is also high, thus it requires a large number of labor as well as in the sugar industry. The peak demand of labor for sugarcane industry is at the harvesting period lasting about 3-4 months yearly. Since there is a large amount of plantation acreage and limiting time of harvesting season due to the operating period of sugar refinery factory, a large number of labor is needed for harvesting. However, the labor shortage of sugar industry is also aggravating as the other industries grow.

Mechanization could minimize the labor shortage problem in harvesting. Quite recently, there have been many types of harvester introduced to this industry. They have not been applicable to the local harvesting condition due to the size which is too large and causes problem in trafficability under local soil condition. They are also too expensive for operation and maintenance.

MATERIALS AND METHODS

A self propelled whole stalk green sugarcane harvester walking type model NB-11 of Bunmei Company was tested both in the laboratory and field condition. The basic mechanism of the tested harvester is shown in Figure 1. and its specification is in Table 1.

It is a small windrower harvester with single row operation. The sugarcane is cut close to the ground by rotating multi blade and windrowed to the right side of the harvester. The harvester comprises six main functions : power source, transmission to the wheel, pick-up mechanism, cutter blade, side delivery mechanism and control level mechanism.

In laboratory test, the travelling speed and engine speed with various gear operation were re-

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corded as shown in Figure 2. The pick-up chain and delivery chain speed with low and high PTO operation were recorded as shown in Figure 3 and 4 respectively. The cutter blade speed VS engine speed with low and high PTO operation shown in Figure 5.

Four varieties of sugarcane about 10 months old namely Kwang Tung, U-Tong 1, F 140 and F 156 which were planted in the same field and treatment were harvested. The plant condition is shown in Table 2 and the profiles of row in the field of four varieties of sugarcane are shown in Figure 6. The testing condition was recorded as shown in Table 3. The records of performance test are shown in Figure 7,8 and 9.

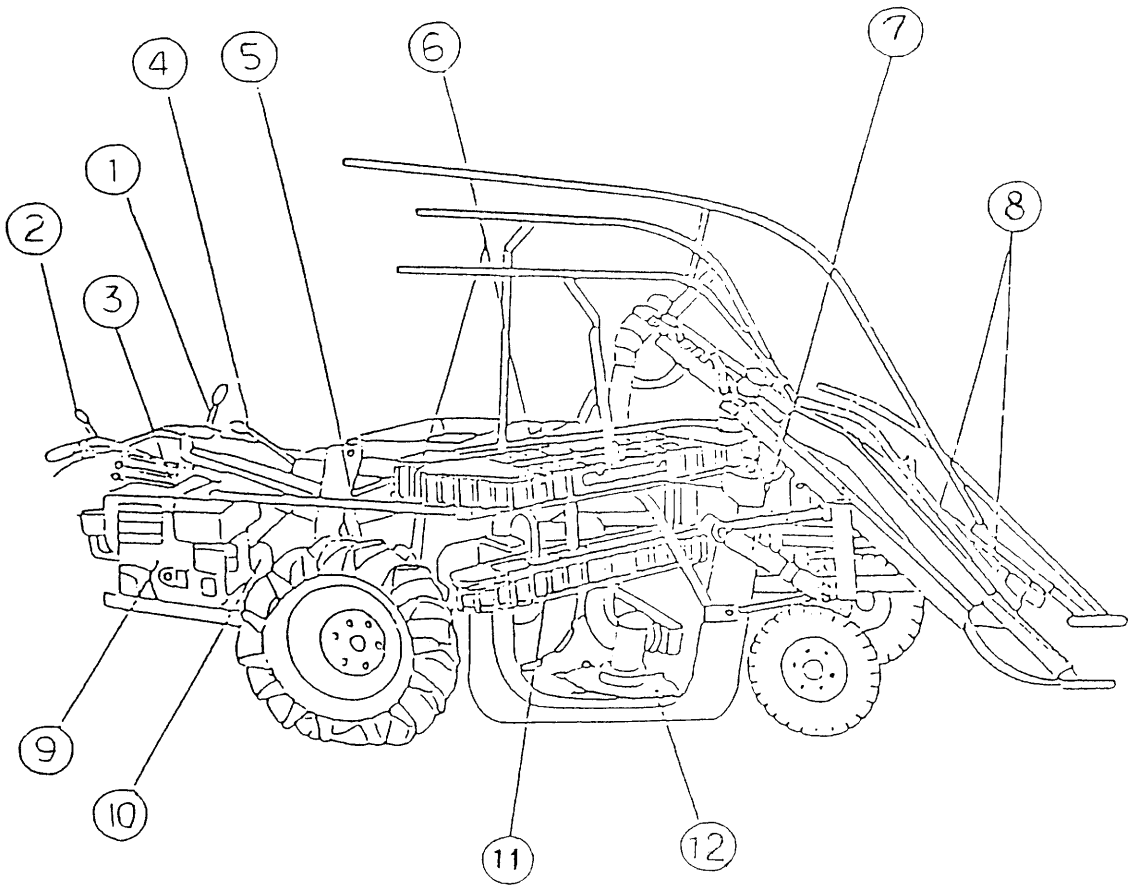
RESULTS AND DISCUSSIONS

Table 2 shows that the F-156 variety had the longest stalk with plenty of leaf still remain at the harvesting period but the diameter of stalk was the smallest as compared to the three other varieties. The speed of pick-up chain is faster than the delivery chain by about 30.5%. The speed of the cutter blade of the high PTO operation is faster than low PTO operation by about 58.3%. The profiles of row in Figure 6 indicates the place of stub and the condition of row ridge of four varieties of surgarcane. The ridge level varied row to row about 5-15 cm. In the test No.1-3, 7-9,13-15 and 19-21, the harvester was set the engine speed at about 1800 rpm., 1st running gear with low PTO operation. In the test No.4-6, 10-12, 16-18 and 22-24 the harvester was set the engine speed at about 1800 rpm., 2nd running gear with high PTO operation. The average of cutting height of harvested sugarcane was 3.2 cm. The average of travelling speed of harvester at 1st running gear was 0.26 m/s and 2nd running gear was 0.42 m/s.

The harvesting capacity at low PTO operation was about 0.82 rai/hr. (0.13 ha/hr.) and at high PTO operation was about 1.3 rai/hr. (0.21 ha/hr). In the field performance, the NB-11 could harvest average of 14.5 t/hr. As harvesting at low PTO operation F 156 had 38% of splitted stalk, while Kwang Tung had 28%, U-Tong 1 had 12% and F 140 had 17%. And at high PTO operation, F 140 had 27% of splitted stalk,

Table 1 The specifications of NB-11.

Type of harvester	Self propelled, whole stalk green cane harvester
Dimensions	Whole length : 3730 mm Whole width : 2260 mm Whole height : 1970 mm weight : 800 kg. wheel base : right 1320 - 1460 mm left 1260 - 1400 mm wheel tracks : front 1065 mm rear 1150 mm
Engine	water cooled, 4-stroke, diesel (YANMAR TS90CC) out put : rated 8 ps/2200 rpm max. 9 ps/2200 rpm fuel tank : 10 liter
Clutch	main clutch : dry type, multi blade
Brake	parking brake : drum
Transmission	forward : 6 speed, reverse : 3 speed PTO : 2 speed
Tyre	front : 4.00 - 8 - 6 ply rating rear : 7 - 16 - 4 ply rating
Base cutter	type : single blaed rotary cutter number of knives : 8 circular dia. of cutter : 504 mm cutting height control : +10 - 450 mm
Hydraulics	pump & tank : power package SHIMAZU PPL 3AC4L Cylinder : cutting height control--1 harvesting unit height control--4 (front 2, rear 2)



1. Main cluth lever
2. PTO clutch lever
3. Hydraulic lever
4. Travelling lever
5. Rear hydraulic cylinder
6. Upper delivery chain
7. Front hydraulic cylinder
8. Pick-up chain
9. Engine
10. Hydraulic pump and oil tank
11. Lower delivery chain
12. Cutter blade

Figure 1 The basic mechanism of whole stalk sugarcane harvester (NB-11)

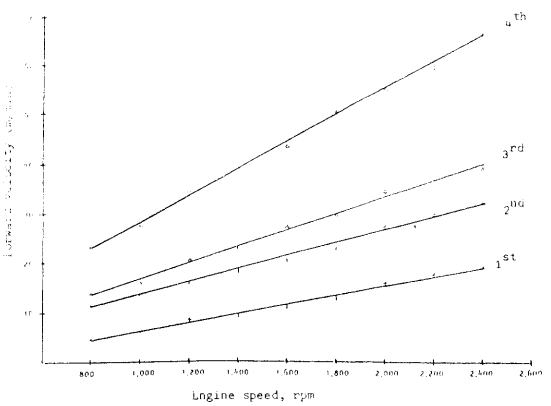


Figure 2 Shows the forward velocity VS engine speed with various gears operation.

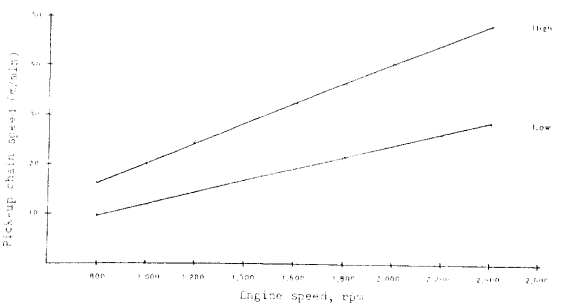


Figure 3 Shows the pick-up chain speed with running 1st and 2nd gear and set PTO at low and high operation.

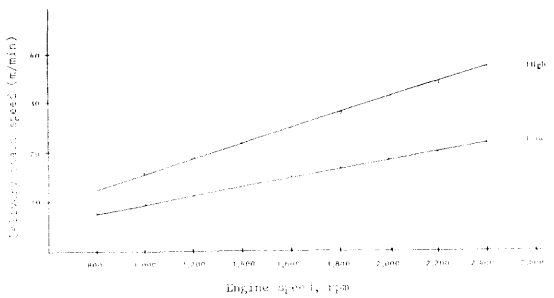


Figure 4 Show the delivery chain speed VS engine speed with running 1st and 2nd gear and set PTO at low and high opration.

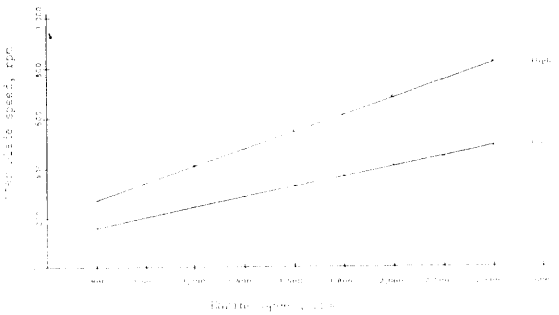


Figure 5 Shows the cutter blade speed VS engine speed with running 1st and 2nd gears and set PTO at low and high operation.

Table 2 Plant condition.

Variety		Kwang	U-tong 1	F-140	F-156
Length of whole stalk (cm)	Av.	384	390	421	483
	S.D	19	34	22	24
Length of Stalk without top(cm)	Av.	205	250	274	302
	S.D	19	30	28	26
Diameter of Stalk (mm)	Av.	32	29	28	27
	S.D.	4	2	2	4
Weight of whole stalk (kg)	Av.	1.86	1.76	1.95	2.17
	S.D.	0.30	0.36	0.20	0.61
Weight of top (kg)	Av.	0.74	0.18	0.05	0.20
	S.D.	0.87	0.03	1.51	0.04
Weight of stalk without trash(kg)	Av.	1.50	1.49	0.43	1.80
	S.D.	0.26	0.32	22.00	0.51
Number of leaf per one stalk	Av.	8	19	15	21
	S.D.	3	4	6	3
Hill space within row (cm)	Av.	87	67	63	68
	S.D.	16	8	10	13

while F 156 had 18%, Kwang Tung had 15% and U-Tong 1 had 11%.

In field test, the harvester was operated at engine speed of 1,800 rpm. conducting 6 test for one variety of sugarcane 3 test for low PTO speed and 3 test for high PTO speed. A length of one test in a row was about 10 meters.

CONCLUSIONS

The harvester can perform effectively in the good land preparation condition. Leaves and uneven of the row ridge are major obstacles to the harvester operation while the lodging and irregular shape of stalk produced more splitted stalk. The NB-11 harvester can do only cutting work but labor is still needed for getting rid of leaf and top cut. It is more difficult for the harvested stalkd to take leaf off and cut

Table 3 Testing condition or NB-11 harvester.

Test No.		1-3	4-6	7-9	10-12	13-15	16-18	19-21	22-24
Variety		Kwang		U-tong1		F-140		F-156	
Travelling speed(m/s)		0.24	0.43	0.28	0.42	0.25	0.41	0.25	0.40
Travelling speed(km/h)		0.9	1.5	1.0	1.5	0.9	1.5	0.9	1.4
Cutting height(cm)	Av.	4.4	4.2	0.5	2.8	3.3	2.4	6.0	1.7
	S.D.	1.4	2.3	0.5	1.7	2.8	2.5	3.0	1.9

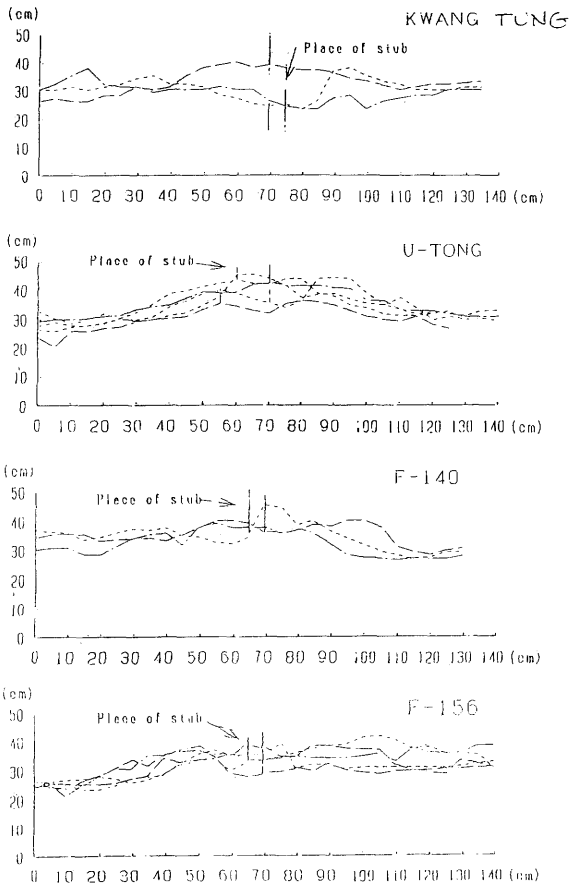


Figure 6 Profiles of row.

the top after they are windrowed, since the labor has to bend down to pick up stalk which sometimes buried in leaves and trashes. Moreover, it has to be held while removing the leaf which it is not a proper position and more time consuming operation than in the typical manual harvesting that sugarcane stalk stand still as the labor uses the harvesting knife to cut the top and leaf off, then cut the stalk near to the ground afterward.

Therefore, for sugarcane harvester machine development in Thailand can be thought of as the one which can cut the top and leaf off while harvesting. This can really minimize the labor shortage in the harvesting work of sugar industry.

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