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STUDY ON THE PERFORMANCES OF DIFFERENT WHEAT THRESHERS

M. Alam[1] M. A. Zaman[2] M. D. Hussain[2]

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ABSTRACT

The performances of four types of power threshers were tested for determining the grain output rate, threshing efficiency, losses, labor and power requirements of wheat threshing. The grain outputs varied from 43.17 kg/hr to 257.14 kg/hr. The threshing efficiencies were above 92.78 % for all the machines. Seed damages ranged from 2.7 to 3.5% of total grain intake. The labor performance was maximum, 64.29 kg/man-hr, for Spiral thresher and minimum, 21.8 kg/hr, for Kyowa thresher. The costs of wheat threshing varied between 0.43 to 1.07 Tk/kg depending on threshers. Among the power threshers, threshing cost was minimum for Spiral thresher; the cost was the lowest, Tk 0.09 per kg, for pedal thresher. The power thresher may be used in big farms but the pedal thresher is better for small scale threshing.

INTRODUCTION

Wheat is playing an important role to overcome the food deficiency in Bangladesh through increased production. The production of wheat in Bangladesh increased during the period from 1975 to 1995, at an average rate of 26% per year, (BBS, 1994). Traditional methods of wheat threshing are (i) beating ears against hard surface, (ii) threshing by feet and (iii) animal treading. Sarker (1989) reported that traditional methods of threshing in Bangladesh is costly, time consuming and laborious. These methods enhance appreciable grain loss and reduce quality of the grain. The required number of labor per acre for traditional method and mechanical method were 13 and 1.25 respectively (Peterson, 1985). BRRI (1990) reported that the additional labor requirement was higher for modern variety of crop instead of local variety. Besides, the agricultural labors in threshing period become shortage due to number of agricultural works : harvesting, transporting, threshing, cleaning, drying, storing etc. Therefore, the harvesting and threshing operations are sometimes staggered for a number of days that enhance losses of grain by rodents and deterioration of grain quality. BARI (1982) reported that wheat threshing must not be delayed after harvesting. Since, the grain quality deteriorates if the harvested crops are kept in stock for a longer period of time. Delayed harvesting by two weeks results in 4.1 % yield loss. The wheat must be harvested as soon as it is matured and the moisture content of grains remains in the range of 36% and 13% (w. b). Besides, the wheat threshing is required a complete dry day. If harvesting and threshing are delayed weather condition particu-larly rain may cause additional problems. Due to increased production, faster threshing by power threshers is necessary. Moreover, wheat threshing requires repeated squeezing or rubbing action which is very difficult to achieve by traditional methods.

[1] Associate Professor and [2] Professor
Department of Farm Power and Machinery, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh

The primary performance of a thresher is the percentage of seed detached from the non-grain parts of the plant i.e. threshing efficiency. Two additional parameters are separating loss and damage of seed. Power requirement is not a functional performance parameter of threshing unit, (Kepner, et al. 1982). Wienekel (1964) reported that the threshing efficiency is decreased with the increase of cylinder diameter, cylinder-concave clearance, feed rate and moisture content. The grain damage is increased sharply with the increase of cylinder speed.

This paper presents some of the findings of a research work undertaken to investigate the performances of threshers for wheat threshing.

METHODOLOGY

The performance studies of four different types of power threshers namely (i) Spiral thresher, made in Germany, (ii) Kyowa thresher, made in Japan, (iii) Marumiya automatic thresher, made in Japan and (iv) Axial power thresher, made in Bangladesh by Comilla Cooperative Karkhana (CCK), were tested in the Bangladesh Agricultural University Farm. All the four machines were tested for determining the labour, power and machine performances for wheat threshing. Each thresher was run for several hours with three different feeding rates. During each test, samples of threshed grain, straw and chaff were taken from their respective outlets for determining the parameters under study.

Crop type, variety, length, moisture content, and grain-straw ratio were recorded before starting a threshing test. The length of crop and penile were measured by a measuring tape. Three samples of 0.5 kg each were randomly taken in sealed plastic bag for determining the moisture content and grain-straw ratio. The grains were separated from each sample by hand. After weighing, the grains were dried in an oven at 130° C for 15 hours and then re-weighted. The moisture content of grain was determined by using the following formula.

$$MC = \frac{W_w - W_d}{W_w} \times 100 \qquad \text{...............} (1)$$

where MC = moisture content in wet basis, %
W_w = weight of wet grain, g
W_d = weight of oven dried grain, g

The grain straw ratio was calculated as follows :

$$K = \frac{W_d}{W_s} \qquad \text{...............} (2)$$

where W_s = Weight of dry straw, g

The test run and any stoppage time during the operation was recorded by a stop watch. The feed rate was varied in each run. At the end of each test, the machine was operated idle for 2 to 3 minutes to clear residues from the outlets. After each run, grains, straw and chaff were collected from their respective outlets for finding the amount of threshed grain and unthreshed grain. The separating loss was calculated by collecting threshed grains from straw and chaff. External broken seeds were separated from clean grain and weighed. The internal broken seed was identified by looking a seed over the light of a torch. A balance was used for measuring the amount of throughputs, straw and grains. The threshing efficiency, throughput capacity, material capacity, labour performance, power performance were calculated by using the following formulae :

$$\text{(a) Threshing efficiency, e (\%)} = \frac{G}{G+U} \times 100 \qquad \text{................} (3)$$

$$\text{(b) Throughput capacity, } C_t \text{ (kg / hr)} = M / t \qquad \text{................} (4)$$

$$\text{(c) Material capacity, } C_m \text{ (kg / hr)} = G / t \qquad \text{................} (5)$$

(d) Labor performance, P_{L1} (hr / kg) = $\frac{1}{C_m}$ .... (6)

(e) Labor performance, P_{L2} (man – hr / kg)

$= L / C_m$ .... (7)

(f) Labor performance, P_{L2} (kg / man – hr)

$= C_m / L$ .... (8)

(g) Power performance, P_p (hp – hr / kg)

$= hp / C_m$ .... (9)

where, t = time, hr
G = total amount of threshed grain, kg
U = total amount of unthreshed grain, kg
M = total amount of materials fed into thresher, kg
L = total number of labor required

The fuel consumption was recorded during each run for calculating the operating cost of the thresher. The cost of threshing was calculated by using the following formula :

$$C_{hr} = [\{(FC \times P) / A\} + (RMP + L + F + O)] \quad .... (10)$$

$$C_{kg} = [C_{hr} / T_g] \quad .... (11)$$

where C_{hr} = cost of threshing in Tk./hr
P = purchase price of the thresher, Tk.
FC = fixed cost, 0.15P, Tk/yr
A = annual use of thresher, hr/year
RMP = repair and maintenance payment, (0.02% of P), Tk./hr
L = labor cost, Tk./man-hr
F = fuel cost, Tk./hr
O = oil cost, 30% of fuel cost in Tk./hr
T_g = weight of total threshed grain in kg/hr
C_{kg} = cost of threshing in Tk./kg

The cylinder speed was measured at least 5 times during each test by a techometer and averaged to set the mean cylinder speed.

RESULTS AND DISCUSSION

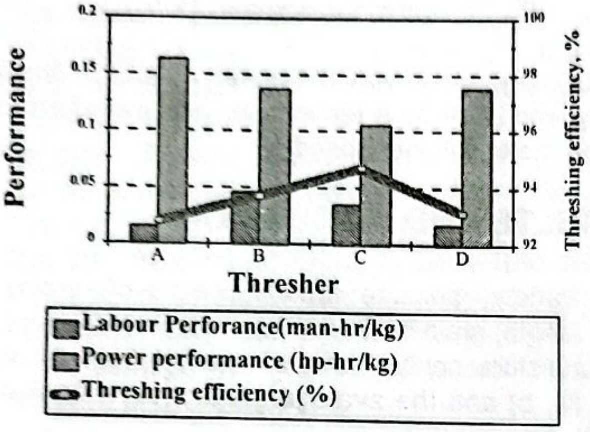
Crop variety, moisture content, weight of grains, plant length, grain-straw ratio are shown in Table 1. The moisture content of grain varied from 17 to 21% (w. b) and the average grain-straw ratio was 0.31%.

Table 1 Different parameters of wheat crop related to threshing

Variety	Balaka
Average moisture content (w. b), %	17 - 21
Average plant height, cm	77.50
Average weight of 1000 grains, g	44.00
Grain-straw ratio	0.31
Penile-Straw ratio	0.17

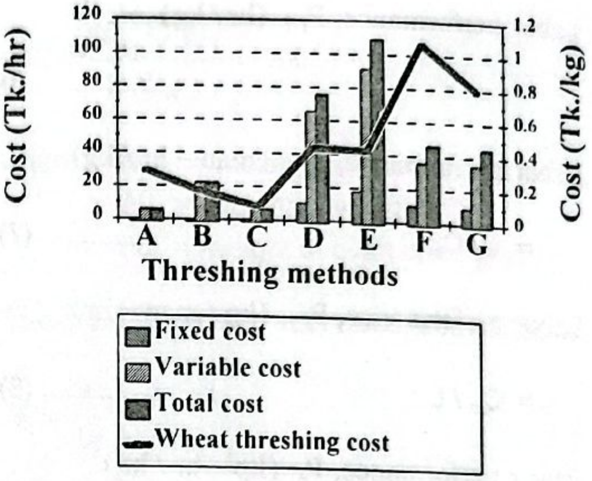
The threshing efficiency, labour and power performances of different threshers are presented in Fig. 1. The threshing efficiency of all the machines were above 92.80%; Marumiya thresher having the highest efficiency of 94.7 percent. The power performances of threshers varied between 0.11 to 0.16 hp-hr/kg; Spiral thresher required the highest power. The labor performance was highest, 0.05 man-hr/kg, for Kyowa thresher compared to that of other threshers.

The feeding rate, grain output rate, cylinder loss, separating loss, percentage of seed damage and labor performance are shown in Table 2. The grain output as well as the cylinder and separating losses were maximum for Spiral thresher. The cylinder speeds were varied from 700 to 950 rpm depending on the thresher type.



A = Spiral B = Kyowa
C = Marumiya D = CCK

Fig. 1. Threshing efficiency, labour performances, and power performances of different threshers



A = Manual B = Bullock C = Pedal
D = CCK E = Spiral F = Kyowa
G = Marumiya

Fig. 2. Comparative costs of wheat threshing by different threshing methods

Table 2 Feed rate, grain output, threshing losses and performances of different threshers

Threshers	Feed rate	Grain output	Cylinder loss	Separating loss	Seed Damage	Labour performance			Power performance
	kg/hr	kg/hr	%	%	%	hr/kg	m-hr/kg	kg/m-hr	hp-hr/kg
Spiral	734.69	257.14	7.20	5.20	3.50	--	0.02	64.29	0.16
Kyowa	132.74	43.71	6.30	4.00	4.20	0.02	0.05	21.86	0.14
Marumiya	245.20	56.86	5.30	3.00	2.70	0.02	0.04	28.43	0.11
CCK	550.00	173.55	6.88	3.34	3.29	0.01	0.02	57.85	0.14

The findings of the cost estimates (Fig. 2) show that the threshing cost by power threshers are comparatively higher than that by pedal thresher, animal treading and manual threshing due to higher initial cost, less annual use and high fuel cost of power threshers. However, threshing cost by Spiral thresher is the lowest among all power threshers. The threshing cost was the lowest (Tk 0.09 per kg) for pedal thresher. This cost might be reduced by increasing the annual use of a thresher.

CONCLUSION

It can be concluded that the power threshers should be introduced for higher threshing output and low labor requirement in a big farm where engine operator and technical know-how is available. However, pedal threshers can be introduced successfully to small farming household in the country for the low cost and simplicity. Replacing the traditional methods of wheat threshing by pedal or power threshers will minimize threshing losses and reduce the expensive labour requirement during peak hours of harvesting.

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