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Design and Development of a Pedal Wheat Thresher

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Abstract

Due to problems of threshing a considerable amount of grain crops, particularly those which are harvested during rainy season, are damaged each year in Bangladesh. This threshing problem is particularly acute in the case of wheat crops. Due to the reasons of small holdings and poor economic eonditions most of the farmers in Bangladesh can not afford to purchase engine powered threshers. To suit the farmers', conditions a low-cost pedal wheat thersher was designed and developed in the Agricultural Engineering Division of Bangladesh Agricultural Research Institute (BARI). By changing the spike-bars of threshing drum, this thresher can also be used for paddy threshing. The performance of the thresher was evaluated with paddy and wheat crops and was found satisfactory.

Introduction

Paddy and wheat are the two major cereal crops in Bangladesh. Paddy contributes 9o% and wheat contributes 8% of the national food grain production. However, wheat accounts for 20% of the cereal supply indicating that substantial amounts are still imported (1). Further, there is not enough irrigation water available during the rabi season to grow HYV rice on much area, emphasis is given on wheat cultivation to overcome the food deficiency and thus to stop food import. Howevr, a review of the constraints to increase wheat production in Bangladesh has revealed that due to difficulties at the time of harvest and threshing, wheat cultivation is not expanding as rapidly as it could be. A solution to the problems associated with threshing wheat will pay off not only in promoting increased wheat production but in giving better timeliness to the following crops resulting in higher yields. In Bangladesh every option for an increase in food production must be taken.

Threshing of paddy and wheat crops in Bangladesh are generally accomplished by beating ears on hard floors or with sticks and/or trampling by bullocks. Broadcast Aus and Aman in Bangladesh are mostly threshed by trampling by

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bullocks. Timely threshing by this method is critical due to the high risk of rains during the normal harvesting months of May and June. On the other hand it is a general complaint by the wheat growers that wheat is difficult to thresh manually as well as by bullocks, in comparison to rice. What output by beating is about 20kg/hr while rice output by beating is about 40kg/hr (2). The high demand of the animals for land preparation for kharif crops while the wheat threshing is in progress discourages the use of animals for threshing. Timely threshing of wheat in the outdoor in Bangladesh is also critical due to the high risk of rains during the normal harvesting months of March and April. Since holdings are small, farmers, at least individually, are unable to obtain engine powered threshers. There is some scope for farmers in co-operative associations to bay locally produced engine powered threshers as has happened in the case of Deep Tube-Wells (DTW). However, the co-operative associations are found difficult to organize and manage, and it did not work well in Bangladesh in the past. What is of particular interest to us, then is the possibility of manually powered threshers which are less expensive and simple technogy.

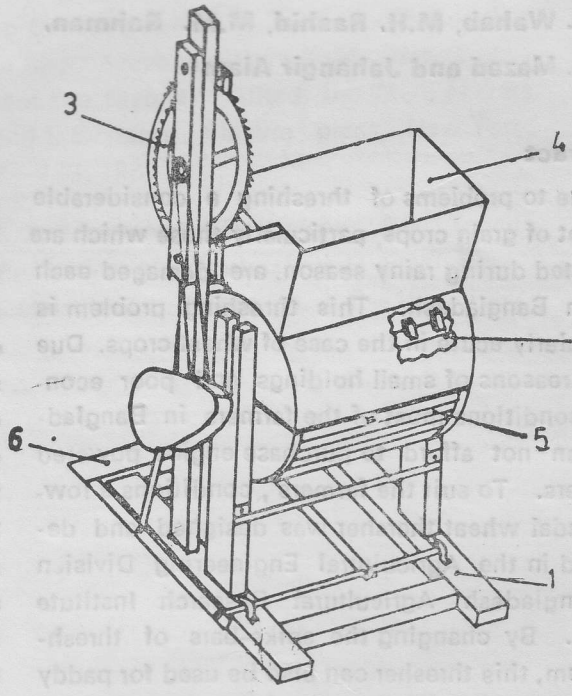
Some studies have been conducted and several prototypes of both manual and engine powered models have been constructed, most notably by the comilla co-operative Karkhana (3). However, except for the large axial flow types (output about 300-500 kg/hr,) none have been particularly successful (1). BARI and Canadian International Development Agency (CIDA) staff tested a bicycle-powered prototype constructed by Karkhana and found that, the physical energy required to accomplish the task was excessive with no significant advantage over the conventional methods. (1).

Thus, there was a need to develop an improved low-cost manually operated multicrop thresher which can operate at least for wheat and paddy. Keeping this objective in view the Agricultural Engineering Division of BARI has designed and developed a pedal thresher.

Materials and Method

The thresher was fabricated out of locally available materials such as wood, M.S. flat bar, M.S. rod, G.P. sheet, gear, pinion, belt, bearing, nut-bolts etc. All efforts were made to keep the cost of the machine low and the operation and maintenance as simple as possible.

The machine has mainly three functional units, namely, 1) frame, 2) serrated round blade, and 3) threshing chamber (cylinder & concave) (Fig.1).



Fig, 1 B A. R Wheat and Paddy Pedal Thresher. 1-Frame, 2-Threshing Cylinder, 3-Serrated Round Blade, 4-Hopper, 5-Sieve, 6-Pedal.

Farme : It is made of pieces wood of sizes 100 mm x 50 mm bolted together. Its function is to support the machine and to keep it rigid.

Serrated round blade : This consists of a circular cutting blade made of steel flat plate, supporting structure, and a V-pulley. The diameter of the blade is 260 mm and it is serrated like sickle at the periphery. The thickness of the blade at the periphery is thinner than it is at the centre. The blade is centrally fitted on a shaft which is powered from the rotating cylinder through V-belt and pulley. This serrated blade separates the wheat panicle, from the straw and thus makes the threshing easier. This unit is removed when the machine is used for paddy.

Threshing chamber (Cylinder and Concave) : The threshing cyliner is made of 1.5 mm thick M.S. sheet (Fig.2). The diameter and width of the threshing cylinder are 200 mm and 390 mm, respectively. For threshing wheat, six rows of threshing spike-bars are equally spaced on the threshing cylinder. The size of spike is 35 mm long, 14 mm wide and 5.5 mm thick. The spikes are welded on evrey spike-bar at an equal distance. Five rows of spikes are also fitted on the lower concave. Concave sieve sieve (lower concave) is made of 3 mm drameter rod keeping a clearance of 8 mm between the rods. The upper concave contains a feeding hopper made of G.P. sheet. The ears after being cut enter into the threshing cylinder through this hopper. A reinforced cement concrete fly wheel is also fitted on the cylinder shaft to produce uniform torque to the rotating cylinder. While threshing paddy, both the concaves are removed from the thresher and the spikebars of the cylinder are replaced by wireloop-bar. The wooden bars are 285 mm long, 50 mm wide and 20 mm thick. Thirteen nos. of wireloops are fitted on every wooden bar at an equal distance. Thinner (1,5 mm diameter) wire produces better beating force on grains. The machine was operated pedally through gear and pinion. Gear-pinion ratio was 1:4.

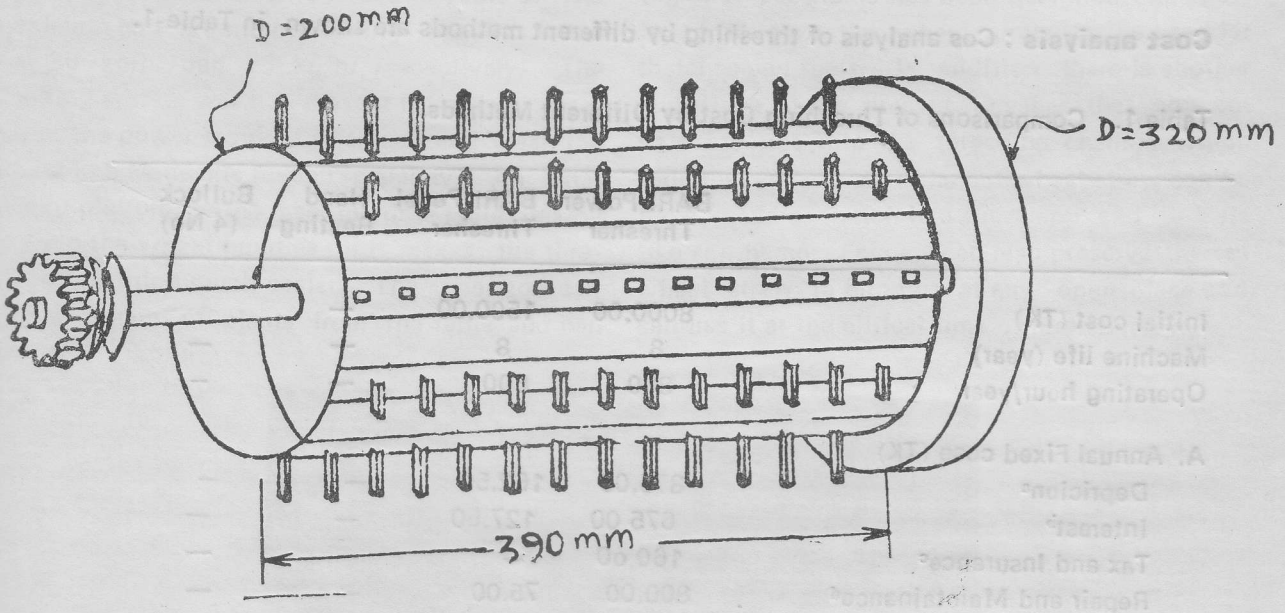


Fig. 2 Threshing Cylinder

The present design has advsntages over the traditional ones. The thresher can be used effectively for both wheat and paddy, and the thresh-

ing chamber can quickly be changed from wheat to paddy and viceversa. Due to the use of thinner wires, threshing is more complete and breakage percentage is reduced.

Machine Operation : Both wheat and paddy can be threshed by this machine. One person can operate the machine easily but it will be more efficient if it is operated by two person. The machine can also be operated by an electric motor of fractional horse power. The machine is operated at a speed between 200 and 250 rpm. In case of threshing wheat, plants in bunch are placed on the edge of rotating serrated ronnd blade. The blade rotates at a speed of 300 to 350 rpm. and cut the ears which automatomatically fall into the threshing chamber through feeding hopper. After threshing the grain pass through the sieve and fall on the ground. In case of paddy, hopper, concave, spike-bar and serrated round blade are removed and wire-loop-bars on the threshing cylinder are replaced. Paddy threshing is done by "hold on" system.

Cost analysis : Cos analysis of threshing by different methods are shown in Table-1.

Table 1. Comparisons of Threshing Cost by Different Methods.

	BARI Power Thresher	BARI Pedal Thresher	Hand Beating	Bullock (4 No)
Initial cost (TK)	8000.00	1500.00	—	
Machine life (year)	8	8	—	—
Operating hour/year	800	600	—	—
A. Annual Fixed cose (TK)				
Depricion[a]	875.00	162.50	—	—
Interest[b]	675.00	127.50	—	—
Tax and Insurance[c]	160.00	—	—	—
Repair and Maintainance[d]	800.00	75.00	—	—
Total Fixed cost	2510.60	365.00	—	—
Fixed cost TK./hr.	3.13	0.61	—	—
B. Operational cost, TK /hr.				
Fuel[e]	8.00	--	—	—
Lubrication oil[f]	1.00	—	—	—
Wages[g]	7.50	3.75	3.75	7.50
Bullock charge[h]	—	—	—	6.25
Total operational cost, TK./hr.	16.50	3.75	3.75	13.75
Total cos (A+B), TK./hr.	20.00	4.36	3.75	13.75

a. Salvage value 12 percent
b. Interest rate at 15 percent
c. Tax and Insurance 2 percent
d. Repair and Maintainance at 10 percent of initial cost.
e. Fuel at taka 6.91 per liter.
f. Lubrication oil taka 1.00 per hour.
g. Wages at taka 30.00 per person per day
h. Bullock charge taka 25.00/2 bullock– 8 hour.

Results and Discussion

The perfomance of the thresher was evaluated on wheat and paddy crops. The thresher was operated by a healthy young man.

Wheat threshing (Fig 3) : The test results of the thresher on wheat is recorded in Table 2. The maximum and minimun threshing capacity found was 30 kg/hr and 25 kg/hr, respectively. The cleaning system was not present in pedal thresher as the power reduired to thresh and clean the wheat is beyond the human capacity. An attachable platform to the machine or a table nearby to Keep the wheat bundles on it makes the threshing operation much easier. The operator can take a bunch of plants from the table and can make the ears more uniform by moving plants back and forth on the plane table.

Now a days the thatches of farmers' house and fuels for cooking are a great problems in this country. This process of cutting and threshing of wheat plants has been designed and devloped to save the wheat straw to be used for thatches and fuels. In addition there is another advantage in the present thresher that only cut ears are put into the threshing chamber which requires less power. The cut wheat straw can be nicely used as thatch like sun-hemp and it lasts like sun hemp. Farmers can also preserve the cut wheat straw in bundles at any open place and can use it at the critical time of fuel shortage.

Fig. 3 Thresher under wheat threshing

Table 2. Performance of BARI Pedal Thresher.

	Wheat				Paddy			
	Rep. 1	Rep. 2	Rep. 3	Average	Rep. 1	Rep, 2	Rep. 3	Average
Unthreshed grain, %	5.00	6 0 0	3.00	5.00	1.00	0.50	1.50	1.00
Cracked grain. %	—	—	—	—	—	—	—	—
Output, kg/hr,	25.00	30.00	28.00	27.66	55.00	60.00	61.00	59.00

Paddy threshing (**Fig.4**) : By removinghopper concave, spike-bars and replacing the poddy threshing wire loop bars on threshing cylinder, test on paddy was conducted, The maximum and minimum threshing capacity of the machine was found 61 kg/hr and 55 kg/hr, respectively (Table 2). As the diameter of wire (on bar) was minimum (1.5mm), the applied force on paddy grain was high and the machine threshed all the grains (even immature grains), within a short time. Thus the capacity was more than that of availabie common type of paddy thresher.

Fig. 4 Thresher under Paddy Threshing

Threshing Cost : Cost of threshing by the presesnt thresher is calculated and compared with those of other available methods shown in Table 3. It is apparent from the table that the threshing cost by BARI pedal thresher for both wheat and paddy, is less than that by the traditional methods. In case of paddy, the threshing cost by this thresher is about the same as that of the power thresher, but in case of wheat threshing cost by this thresher is slightly higher than that of power thresher. However, considering the price of the machine and the economic condition of farmers, this pedal thresher seems to be the most appropriate machine.

Conclusin

1. Post-harvest loss of wheat during threshing by traditional method can be prevanted and reduced by using this thresher.
2. Farmers will grow more wheat if this thresher is made available to the growers.
3. Since the price of this thresher and the cost of its repair and maintenace is very low it is anticipated that this thresher will be easily acceptable to the farmers.
4. This machine is advantageous & more economical as it can thresh both peddy and wheat most efficiently.

Table 3. Comparson of cost of Threshing by Different Methods.

Type of thresher	Average Threshing capacity (kg/hr.)		Threshing cost (TK./hr)	Threshing cost per 100 kg (TK,)	
	Wheat	Paddy		Wheat	Paddy
RARI power Thresher	190,00	259.50	20.00	10.53	7.51
BARI pedal Thresher	27.66	58.67	4.36	15.76	7.43
Hand beating	20.00[2]	40.00[2]	3.75	18.75	9.38
Builock (4 No)	25.00[4]	92.00[5]	13.75	55.00	14.95

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