

Technical Report
on
Combine Harvester ((Model: DR150A; S M World)
(Marketing Company: The Metal Private Ltd.)

Reported by

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Executive Summary

Due to migration of agricultural labor in non-farm sectors and increasing climate vulnerability it is a great challenge to keep pace of food production for the exponential growth of population in Bangladesh. For following the traditional paddy harvesting methods, significant amount of field losses has been occurred in every year. The study was conducted to evaluate performance of combine harvester (Model: DR150A) in comparison to manual harvesting of paddy and identify the impact on agricultural production system in Bangladesh. The experiment was conducted at *Wazirpur* Upazila of *Barisal* district during *Aman-2018* paddy harvesting using a combine harvester and also, manual harvesting was conducted at the same location. Financial analysis of combine harvester over manual method was carried out for the comparison. Cost savings in mechanical harvesting of paddy were found 57.61% for using combine harvester over manual harvesting. Similarly, labor savings for using combine harvester was found 70% over manual harvesting. The estimated BCR of combine harvester is found 1.55. The break-even use of combine harvester is 35 ha/yr which indicates a combine harvester must operate above 35 ha/yr to have profit. The combine harvester will run on fully profit basis if it could be used after that minimum hectare. The average total harvesting losses (including harvesting, threshing and cleaning) were also found 1.61% and 6.08% for using combine harvester and manual harvesting, respectively. The losses of paddy will be reduced 4.47% using combine harvester over manual harvesting. The above results revealed that manual harvesting is a labor and cost involving system. On the other hand, mechanical harvester like combine harvester is a time, labor and cost saving system along with reducing harvesting losses. As a result, total paddy production might be increased, and which will help to contribute significantly to the development of livelihood status of rural community of Bangladesh.

Selected combine harvester

A combine harvester (Model: DR150A) was selected and used for harvesting of paddy at the experimental site. The harvester is manufactured by Suzhou Wude Mechanical Parts Co., Ltd, China. Pictorial view of combine harvester is shown in Fig.1 and technical specifications of the combine harvester are presented in Table 1.



Fig.1 Pictorial view of combine harvester

Table 1 Technical Specifications of combine harvester

Testing Item	Designed Value
Model	DR150A
Overall dimension (L×W×H) mm	4250×2400×2350
Weight (kg)	2600
Header width (mm)	1500
Forward Speed (km/hr)	0~9.72
Fuel consumption (L/hr)	10~12
Engine Power (hp)	70
Engine type	Diesel Engine
Engine Speed (rpm)	2700
Working Efficiency (ha/h)	0.27-0.47
Country of origin	China
Importer in Bangladesh	The Metal Pvt. Ltd.

Technical performance of combine harvester

After mechanical harvesting using a combine harvester during *Aman/2018* at *Wazirpur*, Barisal of Bangladesh, average values of forward speed, fuel consumption and effective field capacity were determined as presented in Table 2. Total area was 0.28 ha for conducting the experiment with mechanical harvester. Small variations of these parameters in three plots are mainly due to the variation of operator's skill, soil condition and plot size.

Table 2 Technical performance of combine harvester

Plot	Forward speed	Fuel Consumption		Effective Field Capacity
	(km/h)	(L/ha)	(L/h)	(ha/h)
1	6.48	29.63	10.37	0.35
2	6.98	34.09	11.25	0.33
3	6.66	34.39	10.66	0.31
Average	6.71	32.70	10.76	0.33

Identifications of usable conditions of combine and mini-combine harvesters are also necessary to know for providing information to farmers and extensions service holders. Average effective field capacity of the combine harvester (Model: DR150A) was found 0.33 ha/h. Due to higher field capacity of combine harvester, it will definitely be appropriate to harvest large area within short time. In addition to this, 100% fallen crops are possible to harvest without any hazard by using the combine harvester which is not possible by mini-combine harvester or reaper. Southern region of Bangladesh is vulnerable area. Crops fall on the field at the matured stage is common phenomena in the region. Due

to climate vulnerability, it is also necessary to harvest large area of paddy within short time. All the mentioned issues are possible to resolve using only combine harvester. So, the combine harvester will be very much suitable in the southern delta of Bangladesh which area is affected severely by the natural calamities like *Sidr*, *Aila*, flood, cyclone, tidal, etc.

Table 3 Performance comparison between combine and mini-combine harvesters

Technology	Avg. effective field capacity (ha/h)
Combine harvester (Model: DR150A)	0.33
Mini-combine harvester (Model: 4LBZ-110) (Ali <i>et al.</i> , 2017)	0.09

Economic analysis of combine harvester

Economic analysis was carried out and all results are presented in Table 4. The results supported that investment on a combine harvester is highly profitable. Cost saved during mechanical harvesting over manual harvesting was found 57.61%, on the other hand, the BCR for the combine harvester is 1.55 that is higher than unity with an initial investment of BDT. 18,00,000.

Table 4 Different financial features of combine harvester operation business

Item	Unit*	Amount
Purchase price of combine (P)	BDT	1,800,000.00
Working life (L)	yr	10
Fixed cost per hectare	BDT/ha	2803.98
Variable cost per hectare	BDT/ha	7538.26
Operating cost per hectare	BDT/ha	10,342.24
Average working area	ha/yr	105.60
Total fixed cost	BDT/yr	296,100.00
Total variable cost	BDT/yr	796,040.72
Manual harvesting cost	BDT/ha	24400.00
Cost saved	%	57.61
Rent out charge	BDT/ha	16,000.00
Benefit-cost ratio (BCR)	-	1.55
Break-even use	ha/yr	35

* BDT: Bangladeshi Taka (Approximately 84 Taka = 1 US \$), Average effective field capacity = 0.33 ha/h, Average daily working hour = 8h; Yearly use = 40 days.

Manual harvesting cost

During paddy harvesting to cleaning, all operations were done manually. Average cost of manual reaping, straw binding and carry to home, threshing and cleaning of paddy were estimated as presented in Table 5. Total manual harvesting to cleaning cost was found 24400 BDT/ha.

Table 5 Total manual paddy harvesting cost

Type of work	No of man-day/ha	BDT/man-day	Total cost, BDT/ha
Paddy reaping	23	400	9200
Straw binding & carry to home	15	400	6000
Paddy threshing	15	400	6000
Paddy cleaning	8	400	3200
Total manual paddy harvesting cost			24400

Break-even use

The break-even use of the combine harvester was found about to be 35 ha/yr as shown in Fig.2. It indicates that a combine harvester should operate above 35 ha/yr to have profit. The combine harvester will run on fully profit basis if it can be used more than 35 ha/yr. For getting break-even use, rent-out charge was considered 16,000 BDT/ha on the basis of field survey and total cost was estimated from the summation of annual fixed cost and variable cost. Annual fixed cost will not vary but total variable cost will vary along with the annual area coverage.

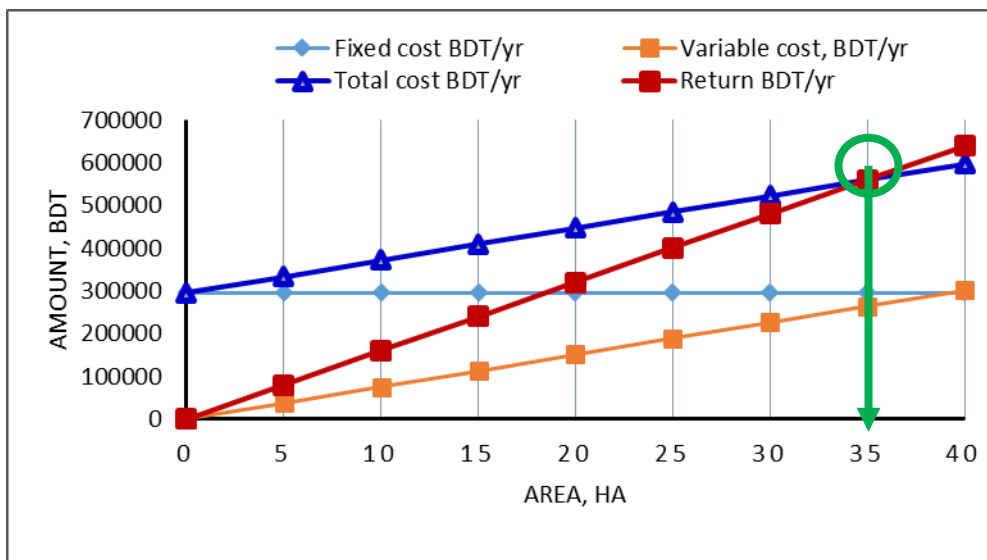


Fig. 2: Break-even analysis for a combine harvester

Manual paddy harvesting losses

Paddy harvesting losses (harvesting to cleaning) were determined during manual harvesting. All losses during *Aman*-2018 were summarized and presented in Table 6. Average total manual harvesting loss was found 6.08%.

Table 6 Average manual harvesting losses

Activities	Percentage, %			
	Plot-1	Plot-2	Plot-3	Average
Shatter loss	0.79	0.69	0.73	0.74
Cutting loss	0.77	0.55	0.72	0.68
Gathering loss	0.27	0.25	0.41	0.31
Carrying loss	0.14	0.20	0.34	0.23
Threshing loss	3.73	3.58	2.74	3.35
Cleaning loss	0.57	0.56	1.21	0.78
Total loss	6.27	5.84	6.15	6.08

Mechanical paddy harvesting losses from harvesting to cleaning operation

Measured total mechanical paddy harvesting losses (harvesting to cleaning operation) are presented in Table 7. Average total paddy harvesting losses was found 1.61% using a combine harvester. Harvesting loss of using the combine harvester is comparatively less than that of manual harvesting system.

Table 7 Grain losses during harvesting by combine harvester

Plot	Total loss, %	Average loss, %
Plot-1	1.66	1.61
Plot-1	1.55	
Plot-1	1.63	

Loss of paddy saved using mechanical harvesting

Loss of paddy saved using the combine harvester over manual harvesting system is presented in Table 8. Paddy loss could be saved 4.47% using combine harvester over manual harvesting. Paddy loss might vary with the operator's skill, soil condition, harvesting time and agronomic characteristics of the paddy. Generally early harvesting reduced pre-harvest and shattering loss in operation, on the other hand, delayed harvesting caused more loss due to low moisture content and faces natural calamities.

Table 8 Loss saved using mechanical harvesting over manual harvesting of paddy

Harvesting method	Total loss, % (From harvesting to cleaning operation)	Loss saved, %
Manual harvesting	6.08	4.47
Combine harvester	1.61	

Labor saved over manual harvesting

Labor requirement during paddy harvesting by combine harvester and manual system is shown in Table 9. Total labor required was found 18 man-day/ha and 61 man-day/ha for using combine harvester and manual system, respectively. Labor could be saved 70% for using the combine harvester over manual harvesting of paddy.

Table 9 Labor saved using mechanical harvesting over manual harvesting

Item	Labors involvement (man-day/ha)	
	Combine	Manually
Paddy harvesting	2	23
Paddy bag carry from field to home	8	-
Threshed straw binding and carrying from field to home	8	-
Straw with paddy carrying from field to home after reaping manually	-	15
Manual threshing	-	15
Cleaning	-	8
Total labor (from harvesting to cleaning)	18	61
Labor saved over manual harvesting (%)	70	-

Conclusions

Technical and financial performances indicating parameters of the combine harvester were determined carefully and all financial parameters were compared with manual harvesting system. From cost savings, labor savings and BCR in mechanical harvesting of paddy using combine harvester indicate that, investment for combine harvester is highly profitable. Harvesting cost and labor savings in combine harvester was found 57.61% and 70%, respectively over manual harvesting. The estimated BCR of combine harvester is found 1.55. The break-even use of combine harvester is also found 35 ha/yr which indicates the combine harvester must operate above 35 ha/yr to have profit. The losses of paddy can be reduced 4.47% using combine harvester over manual harvesting. Also, all results revealed that mechanical harvester like combine harvester is a time, labor and cost saving system

along with reducing harvesting losses, human drudgery and increasing cropping intensity and crop productivity. For that, total agricultural production might be increased, and which will contribute significantly to the development of livelihood status of rural community of Bangladesh.

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