

Status and Constrain for Mechanization of Rice Harvesting System in Bangladesh

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Abstract

To know the position, problems and suggestion of harvest mechanization of rice, the study conducted in 21 upzillas under seven regions (Dhaka, Mymensingh, Sylhet, Comilla, Bogra, Rajshahi and Rangpur) based on different agro-climatic condition and cropping intensity and 126 farmers participated in the interview. For collecting data, a structured questionnaire was used and statistical analysis of the collected data was carried out. In study area, the average cultivable area was 225 to 1239 decimal (1 decimal = 40 m²) and 97.60% farmer reaping by sickle and only 0.80% used combine harvester. Cut paddy transported by head (13.49%), shoulders (12.7%) or both of them of 11.11% farmer and 44.44% of farmers used small truck or field thresher. Threshing was mainly done using (49.21%) closed drum thresher and open drum thresher (26.20%), likewise 1 of 126 farmer use head-feed combine harvester. The study area, most farmers (37.3%) used *kula* for the cleaning of rice, but only 8.74% of farmers used winnower. In considerable amount, 80.95% of farmers had machinery, while the remaining (19.05%) did not have machines. Farmers agreed that harvesting was a labor-intensive method (35.71%) and time consuming (28.57%). Transporting of harvested paddy was dangerous and painful for head, shoulder, hand, waist, backbone, leg, etc. With mechanization and the introduction of machinery, 40.48% of farmers identified the main ceiling as the price of the machine and information/lack of credit system (21.43%). In survey area, most farmers (36.51%) identified the vital advantage of mechanized harvesting as lower labor requirement, while 21.43% of farmers said that a lower loss of rice. All farmers who participated in the interview expressed their need for machinery and mentioned agricultural credit with easy terms and conditions, subsidy for buying machinery and the ensuring of a fair market price for their rice.

Keywords

Crop, Harvesting, Mechanization

1. Introduction

1.1. Current Status for Agriculture in Bangladesh

Rice in Bangladesh is an important cereal crop for national food security, and accounts for 93 percent of all food produced, 70% of average calorie intake and 35% of household expenditure [1]. Rice production in Bangladesh for FY 2011/12 was 33.88 million MT [2]. There are three rice growing seasons, which are called Boro, Aus and Aman. Of these, the two dominant seasons are Boro and Aman. Boro rice is grown completely under the irrigated ecosystem during the dry period (November to July) while Aman (July to December), Aus (April to August) and Upland rice (March to July) is grown under the rainfed ecosystem. Boro covers the largest land area, followed by Aman and Aus. During 1985, the post-harvest loss of rice in Bangladesh was estimated as 13.84% when mechanical intervention in some of the activities, particularly tilling, spraying, and threshing, was absent. The manual rice harvesting (cutting to winnowing) caused an average loss of about 4.44% [3]. After 1998, the wide scale adoption of power tillers for tilling led tremendous changes in the crop production sector in Bangladesh.

The most common harvesting system was to cut crops using sickle, and make a bundle with rope and then carry the bundle by balancing it on one's head, although some farmers use bamboo/wooden stick to carry the bundle upon their shoulders. In wet season (Aman) most of the farmers' dried paddy in the field (Figure 1) and carried them to the threshing yard. Some farmers threshed their paddy in the field or road side. In some areas, farmer used paddle threshers,



Figure 1. Harvesting, bundling, field drying and transporting system.

open drum threshers (ODT) or close drum threshers (CDT) for threshing the paddy (Figure 2). Farmers in Bangladesh winnowed the harvested crops using *kula*, and this activity was mostly done by women. However, some progressive farmers used mechanical winnower for cleaning the paddy (Figure 3).

In the contemporary context, the mechanization of harvest and post harvest work has become very important in Bangladesh because of the high rate of labor movement from rural to urban and industrial zones due to changes in the economy. Various research institutes (BRRI, BARI) and government institutes (BADC, DAE) have been working with the dissemination of modern harvesting machinery (hand reaper, power tiller operated reaper, self-propelled reaper and head feed combine harvester) and providing subsidy in the range of 25% to 60% of the original product price to the farmers (Figure 4).



Figure 2. Threshing practices and tools.



Figure 3. Cleaning practices and tools.



Figure 4. Modern harvesting machinery.

1.2. Machinery Use Status

The serious scarcity of draft power necessitates the use of mechanical power for agricultural production activities. Labor shortage during peak harvesting period compelled the farmers to switch from traditional to mechanized cultivation. The government has, therefore, attached special importance to agricultural mechanization. To encourage the use of machines in agriculture, testing and standardization restrictions have already been withdrawn in the free market distribution system. As a result, the use of agricultural machinery has increased significantly and immense potential is created for further increase. More than 400,000 power tillers are present in the country [4]. In the year 2007, alone 62,000 power tillers have been imported and the number of 4-wheel tractor has been reported to 12,000 and it was found 5530 in 2002. Currently 2500 to 3000 tractors per year are being imported and used for agricultural purpose, mainly for tillage and transportation [5]. Currently manually operated grain threshers (numbering over 200,000), including close-drum thresher (safe for eyes), along with a power operated ones (estimated number: 12,000 - 15,000) are also in widespread use. These are all made in Bangladesh by local manufacturers using some imported raw materials. The low cost manual machines (Tk 1200 to 2500 each) are generally owned by individual farmers but the power driven ones (costing Tk 15,000 to 25,000) are usually hired [6]. The current statistics of farm machinery in Bangladesh is presented in **Table 1**.

Currently, 150 rice reapers and 100 combined harvesters are being used in Bangladesh. The mechanization of rice harvesting has only reached 15% of the rice planting area. The use of mechanical harvesters in rice production can avoid losses of about 3% per season [8]. To establish strategies for the successful mechanization of rice harvesting, it is necessary to assess the factors affecting the mechanization of these activities. Therefore, this study was undertaken with to understand the current status, problems, prospects and probable solutions for the harvesting system and also suggestion improvements to the harvesting system.

Now, the mechanization trend is increasing (**Table 2**) and day by day, users attitude change, so that the area coverage occupied by machinery.

2. Materials and Methods

The study was done under the Korean International cooperation Agency (KOICA)-

Bangladesh collaborative project titled “Development of Research Capacity of Bangladesh Rice Research Institute” and with the help of Department of Agricultural Extension (DAE).

2.1. Study Locations

The study was conducted in 21 villages in seven regions based on different agro-climatic condition and cropping intensity. Dhaka, Mymensingh, Sylhet, Comilla, Bogra, Rajshahi and Rangpur regions were selected based on production

Table 1. Current statistics on farm machinery available in Bangladesh.

Sl. No.	Farm Machinery	Number of Units
1	Power tiller	About 350,000
2	Tractor	>25,000
3	High speed rotary tiller	30
4	Weeder	>200,000
5	Seed-cum-fertilizer distributor	About 60
6	Sprayer	1,250,000
7	Combine harvester	About 30
8	Reaper	About 40
9	Open drum thresher	150,000
10	Closed drum thresher	About 35,000
11	Winnower	About 500
12	Dryer	About 500 (including rice mill dryer)
13	Hand maize sheller	12,000
14	Power maize sheller	2000

Source of data: [7].

Table 2. Area coverage through farm machinery for rice production.

Sl No.	Operation	Area Coverage
1	Tillage	70% power tiller, 28% tractor, 2% bullock
2	Transplanting	98% manual
3	Weeding	95% manual (by hand or manual weeder)
4	Spraying	>90% knapsack sprayer
5	Irrigation	>90% STW or DTW or LLP
6	Harvesting	97% manual (sickle)
7	Threshing	80% thresher
8	Winnowing	82% manual
9	Drying	Farmer’s level—100% sun drying
10	Milling	Village level Engleberg huller—100%
		Commercial level Engleberg huller—30%, Rubber roll huller—70%

Source: [9].

volume, weather conditions, accessibility, cropping patterns and production surplus. At least one village from each upzilla was selected after considering the intensity of rice cultivation. The sample households were randomly selected using a random sampling technique with arbitrary allocation (Table 3) and minimum 3 farmers from each place were selected randomly. The total number of respondents was 126.

2.2. Questionnaire Preparation

Farmers'/machinery users opinion was needed to establish the mechanization guidelines, as well as details on their wishes and needs. Structured questionnaire was used to collect the necessary information by interviewing the farmers. A draft survey questionnaire was prepared and pretested to refine the questionnaire.

Table 3. Study locations.

Region	District	Upazila	Union/Village	No. of Respondent
Mymensingh	Mymensingh	Sadar North	Shambogonj	3
		Barhatta	Chandrapur	3
	Netrokona	Netrokona Sadar	Shamgonj	3
Dhaka	Gazipur	Joydebpur	Harinal	3
		Joydebpur	Tarat Para	3
		Debirder	Kentment	3
Comilla	Comilla	Burichang	Rampur	3
		Comilla Sadar	Champak Nagar	3
	Chandpur	Hazigonj	Balakhil	3
Sylhet	Habigonj	Kachua	Hosenpur	3
		Habigonj	Duliakhil	6
		Madhabpur	North Surma	6
Bogra	Bogra	Sunamgonj Sadar	Bajra	6
		Bogra Sadar	Telihara	6
		Gabtol	Darial bazaar/Vuligari	6
Rajshahi	Rajshahi	Joypurhat Sadar	Bakila, Bakila	6
		Panchbibi	Naoda, Naoda	6
		Bagha	Arani, Shahapur	6
Rangpur	Dinajpur	Natore Sadar	Mazdighe	6
		Mirpur	Fulbaria	6
		Mithapukur	Pira bandh/Jaforpur	6
Thakurgoan	Thakurgoan	Pirganj	Fotapur/Tularampur	6
		Khansama	Satiangor/Vadusa	6
		Sadar	Mohanpur	6
Total	Total	Sadar	Kohor Para	6
		Pirgoanj	Joykun	6
		Total	Total	126

A pre-tested questionnaire was supplied to farmers to get feedback on the harvesting, threshing, cleaning system and operation-related machinery and the associated problems. Survey questionnaires were finalized after incorporating the feedback of the farmers. In the questionnaires, farmers provided relevant information on the harvesting systems what they are practicing for cutting, transporting, threshing, and cleaning.

2.3. Sample Size

The sample size of the interview was meaningful; but the present study sample was not reasonable and total respondent was 126. This interview focused on understanding the present condition and the tendency of farmers' prospects and needs in terms of harvesting machinery in order to formulate a strategy for mechanized harvesting. Machinery operation, advantages and disadvantages related to the harvesting system were considered. Farmers' opinion and desire regarding machinery for harvesting were also considered. To understand the drawback for the introduction of machinery, the most important points regarding mechanization were presented to the farmers and their comments were collected. A statistical analysis of the collected data was carried out and presented in this paper.

3. Results and Discussion

3.1. Machinery Use Status

3.1.1. Farm Size

In the survey area, the average farm size (cultivation area) was 225 to 1239 decimal (1 decimal = 40 m²), and maximum ownership was 2400 decimal while minimum ownership was 50 decimal (**Table 4**). Farm size is a key factor for introducing mechanized harvesting to allow machinery to enter, leave, and turn.

3.1.2. Harvesting

All the farmers harvested the crop manually using sickle, which indicated that mechanization in reaping was not yet started in the surveyed area (**Figure 5**).

3.1.3. Transportation System

The carrying of harvested paddy is painful work. Of the 126 farmers surveyed,

Table 4. Average cultivable farm size in surveyed area.

Region	Farm size (decimal)		
	Minimum	Maximum	Average
Mymensingh	70	2175	1122.5
Dhaka	50	400	225
Comilla	60	1000	530
Sylhet	150	1500	825
Bogra	400	1794	1097
Rajshahi	50	1780	915
Rangpur	78	2400	1239

13.49% transported cut paddy by balancing it on their head, and 12.7% used their shoulders. 11.11% of farmers carried harvested paddy on both head and shoulders. Only 18.25% of farmers sometimes used head carry and power tiller operated trolley or manual operated trolley. 44.44% of farmers reported that they threshed the paddy in the field and used small truck (pickup) for carrying harvested paddy (Figure 6). Most of the farmers' opinion, during the transported harvested paddy they feel pain in head, shoulder and waist.

3.1.4. Threshing

Threshing was mainly done using either close drum thresher (49.20%) or open drum thresher (26.20%), as shown in Figure 7, whereas 16.70% of farmers reported that they used paddle threshers. 7.14% of farmers reported that they performed threshing by beating, treading or other methods. In the survey area, only 0.97% farmers' use head-feed combine, but nobody use the whole feed combine harvesters and head feed thresher due to a lack of access.

3.1.5. Winnowing

In the survey area, most farmers (37.3%) used *kula* for the cleaning of rice, and followed by 32.54% of farmers used *kula* with an electric fan. In the survey area,

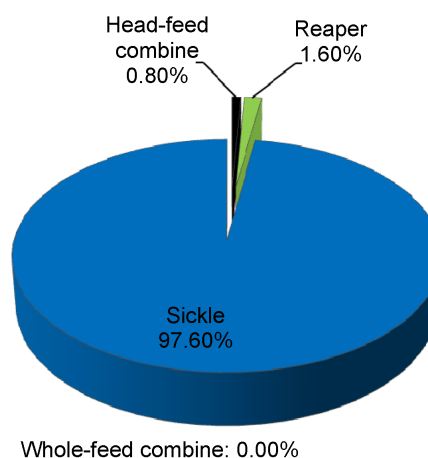


Figure 5 Rice cutting system by farmers.

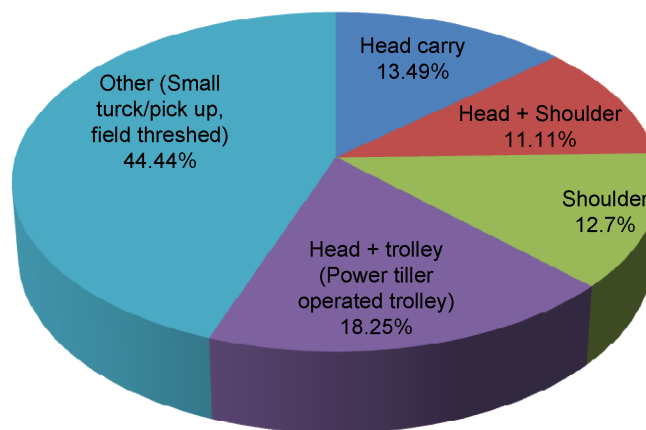


Figure 6 Carrying method of harvested paddy to threshing yard.

only 8.74% farmers used a winnower and 3.17% use other equipment for cleaning rice (Figure 8).

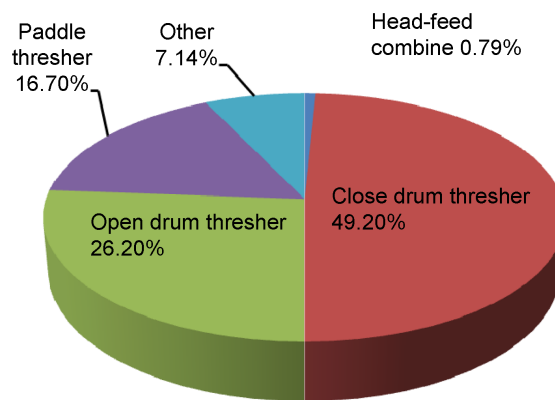
3.1.6. Machinery Use Status

The overall 80.95% of farmers had machinery, while the remainder (19.05%) did not have machines. Looking at the types of machinery, 50% of farmers used whole feed thresher (close drum thresher), 26.47% of farmers used open drum thresher, while 20.59% used other machinery (paddle thresher). In the project area, only 0.98% farmers using combine harvesters, 1.96% uses reapers but none use binders (Figure 9).

3.2. Problems of Harvesting System

3.2.1. Problems in Harvesting

About 35.71% of farmers agreed that harvesting by sickle was a labor-intensive method (Figure 10) while 28.57% of farmers described manual harvesting by sickle as time consuming. Of the respondents, 16.67% of farmers argued that manual harvesting by sickle affected the quantity of crops due to shattering.



Other: Beating by wooden/bamboople, steel/concrete frum beating

Figure 7 Rate of farmers using machine/tools for threshing of rice.

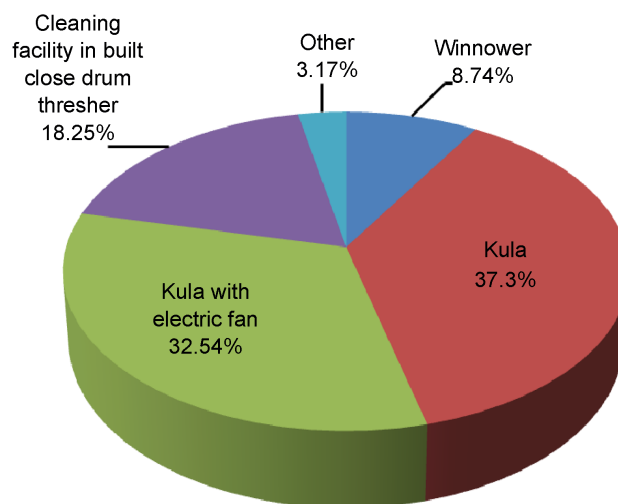


Figure 8 Rate of farmers using different tools for cleaning of rice.

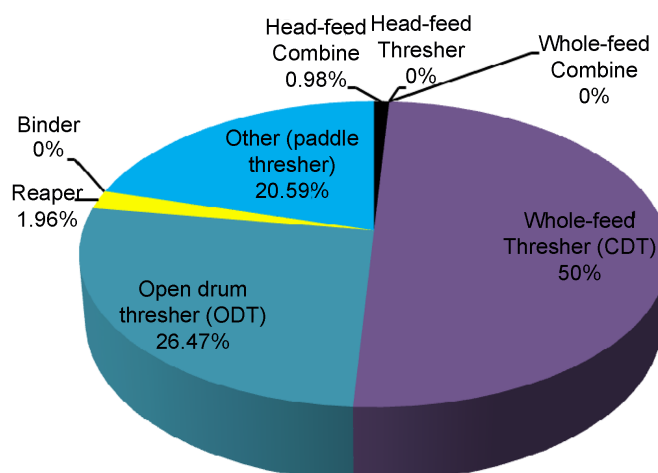


Figure 9 Rate of farmers having harvesting machines.

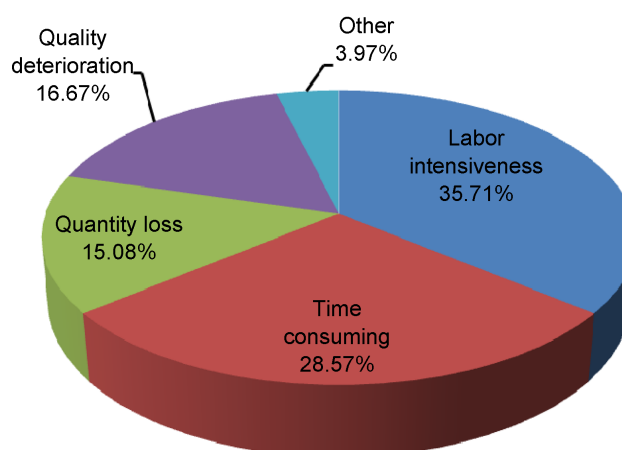


Figure 10. Disadvantages of current cutting method (by sickle) of rice according to farmers' comments.

However, 15.08% farmers considered that current cutting methods (sickle) resulted in a quality loss and 3.97% opinion has no alternatives.

3.2.2. Problems in Carrying

In the survey area, most of the farmers considered the carrying/transport method to be highly difficult. Transporting of harvested paddy was dangerous and painful for head, shoulder, hand, waist, backbone, leg, etc. The head carry caused pain in the head and neck, while shoulder carry caused pain in shoulder and arms. However, the common carrying system of head and shoulder has serious impacts for human health, even causing death. Farmers argued that they have no alternative way to carry the paddy.

3.2.3. Problems in Threshing

25.40% of farmers described farming as labor-intensive work, while 34.13% described it as time-consuming work. 18.25% of farmers said that the use of open drum thresher and close drum thresher resulted in quantity loss, though 13.49% of farmers complained that it resulted in quality loss (**Figure 11**).

3.2.4. Problems in Winnowing

Kula was commonly used for cleaning of paddy/rice, grain, etc. in Bangladesh. Cleaning by *kula* was labor-intensive and time consuming. The *kula* was held by hand, and sometimes its operation caused pain in the hands and arms. The dust created during cleaning is also harmful.

3.3. Investigation for Farmers' Opinion

3.3.1. Farmers' wanting about Mechanical Harvesting

Figure 12 shows the farmers' need and type of machinery use. 63% farmers want partial mechanization because of worry about un-employment; moreover rest (37%) of them essential full mechanized rice harvesting. The result indicated that 23.81% of farmers want to use reaper and thresher, while 14.29% of farmers are interested in head feed combine harvesters. 23.02% of farmers wanted a thresher and 5.56% of farmers desired a reaper. Only 0.79% farmers were interested in whole-feed combine, because its size made it impractical for their small fields, in contrary 26.19% farmers need winnower for cleaning rice after threshing.

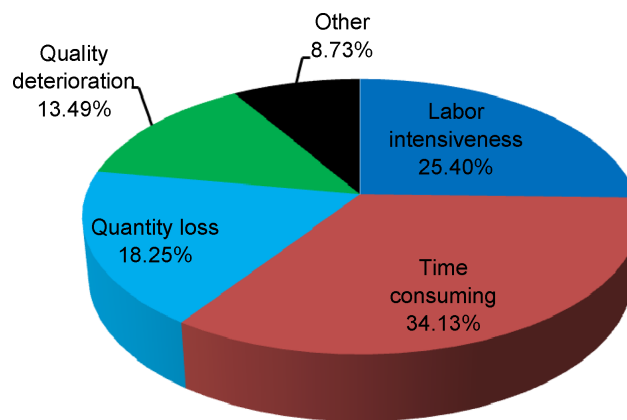


Figure 11. Disadvantages of current threshing method of rice according to farmers' comments.

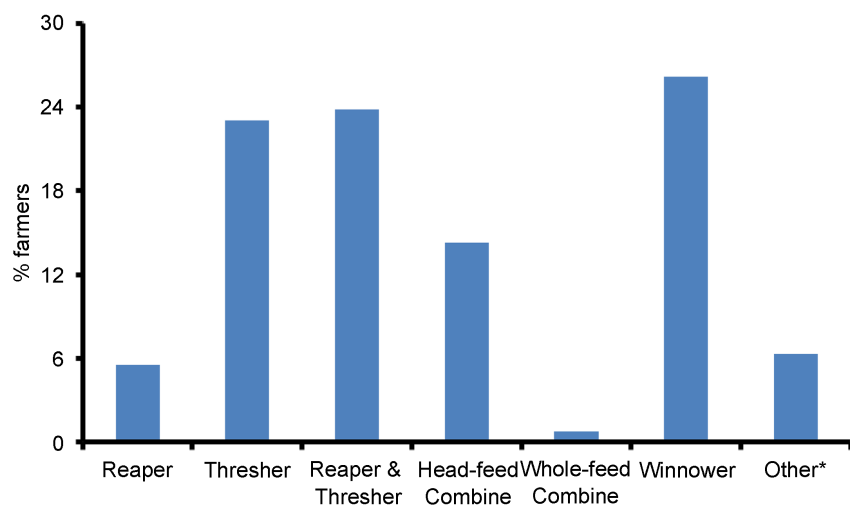


Figure 12. Rates of farmers need to use machines for mechanization of rice harvesting system.

3.3.2. Constraints of Harvest Mechanization

In mechanization and the introduction of machinery, 40.48% of farmers identified the main restriction as the price of the machine and 21.43% mention the information/awareness about machine, lack of credit (complicity) and government initiative is the main problem of harvest mechanization. Other minor restrictions identified were poor farm roads (6.35%) and small size of fields (5.56%) (Table 5).

3.3.3. Farmers' Opinions about Mechanized Harvesting

Table 6 shows that most farmers (36.51%) identified the vital advantage of mechanized harvesting as a lower labor requirement, while 21.43% of farmers said that lower loss of rice was another incentive for harvesting mechanization. Only 15.87% of farmers identified low cost of harvesting as the main purpose of harvest mechanization, moreover 14.29% farmers seems that harvesting machinery use increase the social status and better livelihood.

3.3.4. Suggestions for Improved Mechanized Harvesting

Farmers expressed the opinion that they would benefit in different ways by introducing the harvesting machinery, as they would get extra time for doing off-farm work during the lean period as rice harvesting starts, neighboring farmers could borrow the machinery, and the new generation would show a greater interest in modern agriculture. It would also create an employment opportunity. Poor and marginal farmers who did not have the ability to purchase machinery could borrow to meet the requirements.

In this interview, the similar needs of the farmers were disclosed in broad outlines. All farmers who participated in the interview expressed their need for

Table 5. Factors affecting the use of machine(s) for rice harvesting from farmers (%).

Disadvantages/Factor	Farmer (%)	Rank	Remarks
Price of machine	40.48	1	
Information/awareness about machine	21.43	2	
Lack of credit system and government initiative	21.43	2	Others: rental hire service, group of farmers
Poor farm road conditions	6.35	3	
Small size of fields	5.56	4	
Other	4.76	5	
Total	100		

Table 6. Advantages of harvest mechanization from farmers (%).

Parameter	Ratio (%)	Rank	Remarks
Lower loss of rice	21.43	2	
Lower labor requirement	36.51	1	
Lower cost in harvest	15.87	3	Others: better livelihood, social status
Save quality	11.90	5	
Other	14.29	4	
Total	100		

machinery such as USG applicator, transplanter, harvester and weeder to increase crop productivity and cropping intensity. The main problems identified in buying and using such machinery was high price and small scale of land. As suggestions to resolve the various constraints hindering the rice productivity, all participant farmers mentioned agricultural credit with easy terms and conditions, subsidy for buying machinery and the ensuring of a fair market price for their rice.

The participants urged the government to take effective initiatives via the local government or extension department to help the actual rice farmers to achieve greater rice productivity by using machinery. Finally, the participants mentioned that sustainable and field oriented suitable rice production technology needed to be introduced.

3.3.5. Suggestion for Mechanized Harvesting Policy

The following suggestions are made on mechanized harvesting policy based on field information.

- Farmers want have capital intensive machine on subsidized price and an easy credit facility.
- Extensive field demonstrations are needed for harvesting machinery. Meetings, farmers' workshops, training, field days and demonstrations can promote farmers knowledge on the benefit of using the machine, and learn how to operate and maintain it.
- The establishment of farmer groups for harvesting service is also important. As larger rice fields can be more productive, it is necessary to form cooperatives and merge small farms together.
- Development of entrepreneurship is urgently needed for providing custom hire service to the farmers.
- Research institute and extension agents can play vital role by providing demonstration and training on the operation and maintenance of the modern machine which ultimately enhance the farm productivity.

So, there is a broader avenue to introduce small to large machinery for enhancing the farm income in the study area. The key strategy in harvesting mechanization is to use machinery in every stage. The suggested ultimate destination of harvesting machinery is the combine harvester, as shown in **Figure 13**.

4. Conclusions

In the surveyed area, every farmer harvested crops manually using a sickle. Modern harvesting machines such as reapers and combine harvesters were negligible amount in the farmers' fields. Farmers were not so much familiar with the performance of combine harvester, or even with the reaper. Farmers described harvesting as labor-intensive and time-consuming work. Farmers used open drum thresher, close drum thresher and paddle thresher for threshing the paddy, either in the field or in the home yard. Mechanical winnowing units and traditional equipment *kula* were found in the surveyed area for cleaning the crop.

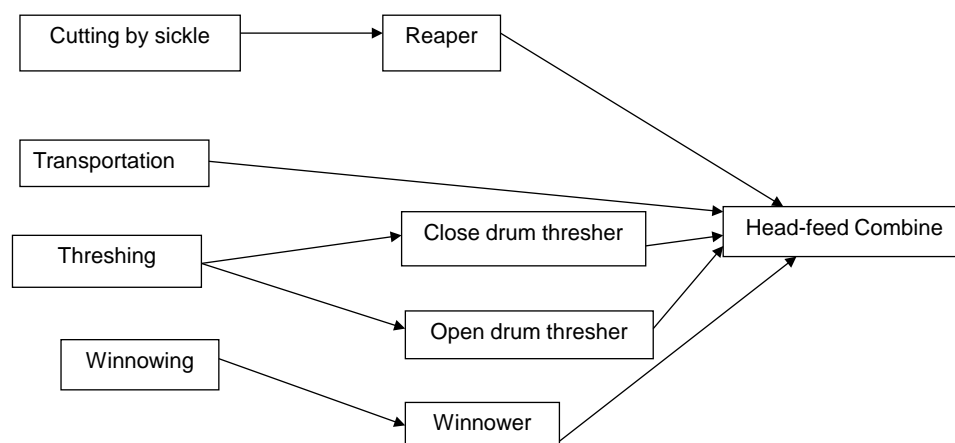


Figure 13. Diagram for suggested harvest mechanization.

Modern farm machinery need assessment was done in the surveyed area. Every farmer wanted modern harvesting machinery (reaper, thresher and combine harvester), but in initial investment was very high which was beyond the purchasing capacity of the farmers. Moreover, they wanted to buy the machinery for a subsidized price. The government should take an initiative to distribute such type of capital intensive machines on a subsidized basis. Demonstration and mass media publication is necessary to create faster awareness of harvesting technology. The important factors affecting farmers' use of rice harvesting machinery include farmer education, training, knowledge, perception on machinery and capital.

Conflicts of Interest

No potential conflict of interest relevant of this article was reported.

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