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Original Article

An assessment on mechanization of rice production in Nabiganj, Sylhet

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A B S T R A C T

The study aimed to assess rice producers' modern agricultural machinery and develop statistical information about available farm machinery. The study was undertaken in Nabiganj Upazila, Sylhet, Bangladesh, to determine the current status of mechanization for rice production in terms of tillage practices, weeding, insect control practices, irrigation management system, harvesting, and post-harvesting drying and storage facilities. The mechanization of land preparation, irrigation, and threshing was nearly complete. According to the study, agriculture employed 63.31% of farmers, with the rest working in other industries. Power tiller, tractor, and draught animal are used to cultivate 64.32 percent, 29.73 %, and 5.95 % of the total projected land respectively. Shallow water pumps cover 97.31 % of complete irrigation due to surface irrigation water sources such as ponds and rivers are near the field. A thresher and combine harvester are used to mechanize the threshing process. According to the survey, the transplanting, harvesting, winnowing, and drying activities are not yet mechanized. Farmers still used the sun to dry their harvests. 100% of farmers use local labor for field preparation and weeding. The majority of farmers rely on migrant labor from Bangladesh's northern districts. As a result, Farmer's desire the most up-to-date machineries like a transplanter, harvester, and thresher. So, the government should formulate effective plan by evaluating the current state of mechanization and increasing the use of machinery equipment.

Introduction

Agricultural mechanization is the process of transferring energy in a farm production system using engines or motorized equipment. It simplifies and eliminates labor-intensive tasks, substitutes for labor shortages, and boosts productivity (Rahman *et al*., 2021). It is a scientific system for utilizing human and animal energy in agricultural production, storage, and processing in more effective, labor and time saving ways (Akdemir, 2013). Farm mechanization with the proper equipment helps to finish farm activities on time and also increases work production per unit time (Gurung *et al*., 2017). Mechanization is viewed as one of the greatest engineering accomplishments of the 20th century. It has direct economic effects on land and labor productivity to meet the living challenges and increase productivity in a sustainable way (Alam, 2019). Bangladesh began mechanization before independence, with the purchase of power tillers and pumps to speed up the modernization of agricultural operations (Hossen *et al*., 2020). Since the mid-1990s, when import rules were liberalized, over 150,000 power tillers have been imported annually into Bangladesh (Goodwin, 2015). Mechanization in agriculture is a critical component in enhancing farm worker productivity, timely planting, and low-cost production. Due to the persistent efforts of dedicated farmers technological advancement in agriculture has entered a prosperous level (Hossen *et al*., 2021). Farm mechanization embraces the production, distribution, and application of various instruments, machinery, and equipment for developing farmland, sowing, reaping, and primary processing (Diao *et al*., 2016). Bangladesh Agriculture is currently one of South Asia's most mechanized agricultural economies. Bangladesh's agriculture sector accounts for 19.29% of the country's gross domestic output (GDP), where the crop sector contributes alone 13.44%. But agricultural labors are decreased from 63% in 2007 to 47% in 2012. Moreover, the rural labor force

has shifted from agricultural to industrial and service sectors, creating an acute agricultural labor shortage during optimum sowing and gathering times. Due to workforce scarcity, consistency in operation cannot be ensured; leading to a decline in yield (Milon, 2015). Rice is a major national food safety cereal in Bangladesh, accounting for 70% of average calorie consumption and 35% of family spending on all food products. In Bangladesh, rice production amounted to 36 million metric tons in 2020 (USDA report, 2020). Mechanization in agriculture, along with better crop inputs, has increased yields by 10-15% (Chandra Nath *et al*., 2017). Other advantages of farm mechanization include converting non-cultivable land to cultivable land using sophisticated land development and tilling techniques. It also reduces the agricultural workforce's workload, improves farm comfort and safety (Gurung *et al*., 2017). Nowadays; farmers are forced to employ farm mechanization due to labor scarcity and a high labor wage rate. It is inevitable to increase agricultural output in the country, potentially transforming millions of rural families (Akter *et al*., 2019). Small farmers in undeveloped nations frequently lack access to capital goods such as farm machinery due to a lack of resources (Mottaleb *et al*., 2017). Mechanization in agriculture is one of the most important agricultural crop establishments, protection, harvesting, and processing inputs that have been overlooked in Bangladesh. In agriculture, a lack of farm power continually endangers faster and quicker land cultivation, labor efficiency, crop management, losses incurred after harvest, and yield (Saha *et al*., 2021). After China and India, Bangladesh is presently the world's third-largest producer of rice. The overall rice-growing area in Bangladesh is 11.90 million hectares, or around 75% of the total cultivable land (Asmaul *et al*., 2021). Bangladeshi farmers traditionally plowed their fields using traditional plows, but the usage of power tillers is rising in Bangladesh. In the beginning stage (1960), Bangladesh Agricultural Development Corporation imported and delivered power tillers experimentally to farmers (Khalequzzaman., 2015). Most farm tasks, such as field preparation, land leveling, tillage, planting, and spraying, are traditionally undertaken manually or with the help of various draught animals. As a result, agricultural yields are low due to the fact that the majority of crops are sown by hand (Khan & Rehman, 2019). The situation of mechanization of agriculture in Sylhet, Bangladesh, was assessed in 2018, where 83.23% of people were employed in farming, and applying the tractor, power tiller, and draught animals, the projected total land was 36.024%,59.678%, and 42.98% respectively; as well as 93.75% of total irrigation was covered by the shallow water pump (Rashed *et al*., 2018). Harvesting is the most crucial activity for maintaining rice yield and quality. This is a labor-intensive procedure in the rice growing process (Adam & El Pebrian, 2017). However, the transplantation, harvesting, weeding, and threshing operations are seen as work-intensive operations in rice farming in Bangladesh. Faster transplantation, weeding, and harvesting operations are necessary to improve crop safety (Islam, 2018). Production costs still increase at an extravagant rate because of inefficiency and waste at different levels of farm activity and high costs, and agricultural machinery insufficiency. Conversely, crops are smashed because of the bad climate effects and a lack of timely harvesting (Md. Anwar Hossen, 2021). Mechanization in agriculture is a crucial answer to all these difficulties. For instance, it will reduce operating time and costs, optimize the effective use of all agricultural inputs, including seeds, fertilizer, plant protection chemicals, water, and agricultural equipment; reduction of farm drudgery (Goyal *et al*., 2014). Therefore, this research attempt is made to evaluate the modern agricultural machinery used by rice producers and show an exact scenario of the ongoing mechanization status for better agricultural improvement of the locality.

Materials and Methods

Sampling and study design

A field survey was served as the basis for studying through which primary data was obtained systematically from individual actors using interview schedules and questionnaires and secondary data. Based on varied agro-climatic conditions, crop yield, the intensity of cropping, and agricultural practices, the research was conducted in villages of Nabiganj Upazila in Sylhet. The interview schedule and questions were created with active collaboration with the appropriate supervisor, experts from relevant disciplines, and secondary data. This study's sample units were farmers. The farmer survey was rooted in the current condition and mechanization level of farm practices. In this survey, the overall number of respondents was neat at 80. The interview aimed to know about the existing situation and farmers' inclination to employ machines in formulating a mechanized farming plan. Farmers are classified as demonstrated in the following table.

Table 1. Farmers land ownership pattern.

Sl. No.	Farmer's category	Criteria based on acquired lands (ha)	Total amount of lands (ha)	Farmers percentage (%)
1.	Landless farmer	(Less than 0.2 ha)	27.29	9.37
2.	Small farmer	(0.2-1.0 ha)	61.31	21.06
3.	Medium farmer	(1.0-3.0 ha)	85.23	29.28
4.	Large farmer	(3.0 ha and above)	117.27	40.29
Total amount			291.1	100

Note: Farmer's category Adapted from (Rashed *et al*., 2018).

Data was obtained through personal interviews based on sample units and an explanation of the study's objective. Each question was carefully explained to the interviewee, making an effort to get the requisite information. The interview schedule was written in Bengali for ease of communication with the responders. A pre-tested set of questionnaires was distributed to farmers to obtain input on the harvesting, threshing, cleaning system, and farm machinery and equipment operation. In the surveys, farmers answered their harvesting techniques and how they cut, transport, thresh and clean their crops. The information was gathered using a numerical approach to determine various agricultural machinery used in Nabiganj Upazila. The data was obtained conjointly by the farmer and the office to ensure data accuracy, as solely office data may not be reliable.

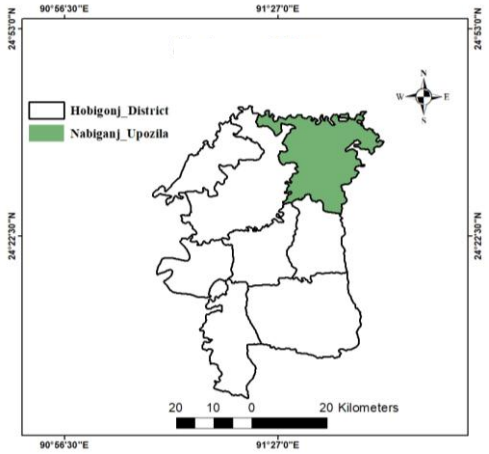

Figure 1. Map of the research area.

Analysis of Data

The data was collected, compiled, tabulated, and analyzed concerning the study's objectives. The descriptive statistical analysis was done using MS Excel software, and findings were presented in tabular and graphical forms. The map was prepared by ArcGIS software (10.5 stable version). Finally, the machinery in the area of research was identified, and the patterns of machinery in farm usage were checked.

Results and Discussion

Socio-economic condition of the farmers

Nabiganj Upazila has occupied around 439.6 sq. km area. The socio-economic status of the farmers of Nabiganj represents several characteristics such as age, literacy rate, primary occupation, and land ownership (Table 2). The majority of farmers (49.39%) belonged to the middle-aged group (36 to 50 years) and young-aged (up to 35 years), which are deemed as the prime working age. The illiteracy rate among farmers is 42.7 %, which is significantly higher than the national illiteracy rate of 25.62 % (BBS, 2019). The literacy rate among male and female farmers was 42.01% and 36.71%, respectively. Agriculture is the utmost significant occupation (63.25%) which suggested that the livelihood of the people mostly depended on agriculture. After agriculture; the most frequent occupations are business (8.83%) and non-farm workers (5.40%). Agricultural land ownership Landowners 42.59%, without land 57.41%, farm landowners 34.69% urban and 43.33% rural. Crops are Potato, jute, mustard, chili, tea. Main cultivation: Paddy.

Table 2. Socio-economic characteristics of the farmers.

Characteristics	Categories	Percentage of respondents
Age (years)	Young (up to 35)	45.79
	Middle (36 to 50)	49.39
	Old (above 50)	6.82
Literacy rate	Male	42.01
	Female	36.71
Main occupation	Agriculture	63.25
	Non-farm workers	5.40
	Business	8.83
	Industry	2.21
	Transport & communication	1.42
	Service	4.95
	Construction	2.98
	Religious service	1.53
	Others	9.43
Land ownership	Land owner	42.59
	Landless	57.41

Machinery Use Status

The severe shortage of draft power requires mechanical power to be deployed for agricultural productivity. During peak harvest time, a lack of labor obliged farmers to move from traditional farming to mechanical farming. Figure 2 shows the current statistics of farm machinery available in Nabiganj.

It is clearly visible from figure 2 that the farmer's most often used machinery is the tillage and threshing machines, such as the power tiller, tractor, and power thresher. Several harvesting machines are employed, such as the combine harvester and Reaper, whereas seeding devices, the rice transplanter, are rare.

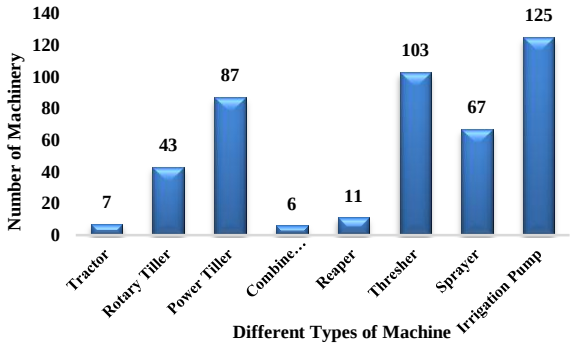

Figure 2. Number of machineries used by farmers.

After completing the data analysis, it was discovered that approximately 63.31% of people are still connected with agriculture, compared to about 83.23% in previous years (Rashed *et al.*, 2018). The rest are involved in other occupations, cultivating 291.1 hectares land of which 11.62%, 22.46%, 29.86%, and 36.07% land grown by landless, small, medium, and large farmers, respectively. The maximal of these lands are medium low lands, particularly well-suited to Boro Rice cultivation, with annual crop yields estimated to be around 735.24 metric tons.

Different farming practices and operations

Farming activities can be categorized into pre-harvest, harvest and post-harvest section. Pre-harvest operations contain tillage, seeding/transplanting, weeding, irrigation and plant protection. After pre-harvesting operations, the crops are yielded which is named as harvesting. Post-harvesting processes consist of threshing, winnowing, drying, transporting, milling etc. Several machineries are used in these operations at different region. Table 3 illustrates the use of different machineries at Nabiganj Upazila.

Table 3. Farming activity and Sources of machine used by the farmers.

Farming activity/operations	Machine Type	Percentage (%)
Tillage	Tractor	29.27
	Power Tiller	64.32
	Draft animal	5.95
Seeding/ Transplanting	Seed Distributor, PT operated seeder and Transplanter	100% manually done by farmers
Weeding	Weeder	23.31
	Others	76.69
Irrigation	Low lift pump	97
Plant Protection (Pesticide & Herbicide)	Insecticidal sprayers	30

Farming activity/operations	Machine Type	Percentage (%)
Harvesting	Sickle	87.36
	Mini combine, Harvester	12.64
	Reaper	0
Threshing	Closed drum threshing	86.39
	Other Traditional ways	0.97
Winnowing	Winnower	0
Drying	Sun drying (chatal)	17.39
	Dryer	0
	Sun drying (On mud floor)	82.61
Transporting	Head load	7.49
	Shoulders	6.7
	By power tiller trolley	27.41
	Pickup	43.57
	Tractors	12.23
	Other's ways	2.6
Milling	Manually	0
	Mechanically	100

Tillage practices

In certain regions, buffaloes and oxen were employed to plough the lands for seedbed and rice field preparation at ancient times. However, with the introduction of the power tiller, the most of lands are now ploughed by power tiller, tractors and draft animals cultivated 187.23 hectors, or 64.32%, 86.53 hectors, or 29.27% and 17.34 hectors, or 5.95% of total land, respectively shown in figure 3, which indicates the state of advanced machineries in tillage practice is somewhat more than that mentioned by (Rashed *et al.*, 2018). These figures may appear to farmers to be adequate, but there is a strong potential of bringing 5.95% of lands under full cultivation by effective use of mechanical power sources, resulting in 100% mechanization of tillage operations.

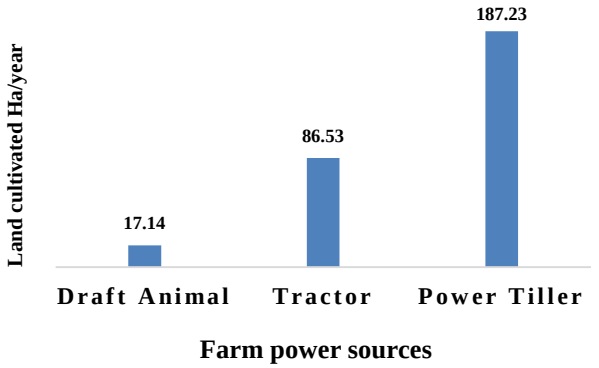

Figure 3. Different power sources used in land preparation.

Though tractors in tillage techniques provided a new dimension to mechanization in many rural parts of the nation, there are relatively little usage of tractors in ploughing compared to the use of power tillers for the following reasons. Most of the land are small and fragmented, lacking skills & experiences, high purchase costs, large repairs & maintenance costs, lack of spare part access, lack of adequate field mobility, lack of financial credits and assistance for buying and using. Only until these flaws are addressed can one expect tractors' acceleration to improve and crop productivity to meet expectations.

Weeding and insects control practices

According to collected data, farmers in older times were typically used to weaving by hand. Most used weeders and various pesticide kinds currently minimize labor costs in weaving operations, such as synergists, defoliants, desiccants herbicides, etc. The usage of insecticidal sprayers besides these fertilizers and pesticides are significantly enhanced in insect afflicted fields.

Crop irrigation management system

The research region chosen was not irrigated, so that the actual irrigation system situation could be identified. In the study area, earlier maximum cultivated land has been irrigated by shallow pumping water from water sources like as ponds and rivers. The land was watered completely using traditional irrigation technologies for example the swing basket and so on. While crops are produced more by increased usage of LLP pumps which has covered 97.31% of entire irrigation, 3.56% more than that mentioned by (Rashed *et al.*, 2018). Most of the water is wasted owing to poor irrigation management and irrigation surface selection, and soil holds less water in relation to demand than land, leaving farmers with challenges later on, such as a water shortage if there is no rain.

Harvesting and Threshing

Farmers manually harvested the paddy by sickle, which shows that harvesting in studied area examined have yet to commence. The usages of combine harvesters or even of the reapers are not so familiar to farmers. Farmers opined that harvesting time-consuming and labor-intensive. So, there is a great chance to introduce a harvester for harvesting the paddy. The threshing process is done in a significantly measured quantity using a close drum thresher of 86.39%, while the harvester is used by 12.64%, which is almost fully mechanized. Only 0.97% of farms employ the conventional method of threshing.

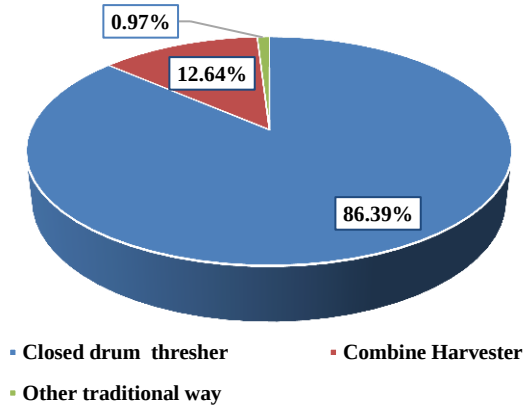

Figure 4. Threshing operation of crops.

The region studied needs an evaluation of modern agricultural gear such as reaper and combine harvester. All farmers desire the harvesters, but the first investments are quite costly, which exceeded farmers' purchasing capacities. The Government should take the initiative to support more such capital-intensive machinery. Farmers' education, training, knowledge, perceptions of machinery, and capital are also crucial variables impacting farmers' usage of such modern machines.

Transportation system

The paddy collection is a hard job of the 80 farmers questioned. From Figure 5 it is clearly visible that 7.49% of farmers carry harvested paddy by head load, and 6.7%

utilized their shoulders. 12.23% of farmers carry harvested paddy by tractor. Only 27.41% of farms employ trolley or manual trolley, occasionally with head carriage and power tiller. 47.43% of farmers reported they threshing the paddy in the field and picking the threshed paddy grain by pickup, and 2.6% in others way. Most farmers think they feel discomfort in the head and shoulder while they carry the harvested paddy.

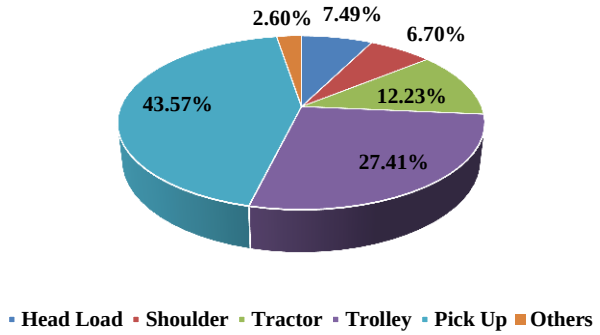

Figure 5. Crops transportation system.

Drying and Winnowing

In figure 6 it is shown that 48.27% of farmers use Kula for rice cleansing, 19.5% use Kula with an electric fan, and 32.23% utilized close drum thresher respectively; as a winnower after dying paddy a new local technique.

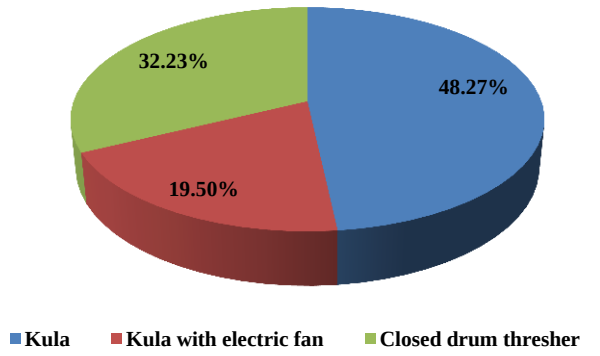

Figure 6. Winnowing operation of crops.

According to the survey, the drying process is not mechanized. Harvested rice still dried through sun drying on the mud floor (82.61%) and Chatal (17.39%) respectively. During land preparation and weeding, 100% of farmers rely on local labor. During transplanting, harvesting, and threshing, maximum farmers are reliant on migrant labor from Bangladesh's northern regions. Farmer's desire most modern agricultural technologies; so, the government should formulate effective plan for improving the situation by increasing the use of machineries.

Conclusion

The agriculture of Bangladesh is in the course of transitioning from subsistence to semi-commercial production. This assessment shows the progress in mechanical advancement in agricultural production system. Transplanting, harvesting, winnowing, and drying are not yet mechanized, according to the survey. Farmers continued to dry their harvests in the sun on the dirt floor (82.61%) and in the Chatal (17.39%). Most farmers employed migrant labor from Bangladesh's northern areas for transplanting, harvesting, and threshing activities, while 100% of farmers used local labor for land preparation, seedling, and weeding. Farmers want transplanters, harvesters, and threshers, among other modern agricultural technologies. As a result, the government should develop effective planning by assessing the current degree of mechanization and improving the situation by expanding the use of machines to boost crop productivity. Changes in farmer mindsets about adopting appropriate machines and technologies should be the primary concern for the government at this moment. Furthermore, ensure conducting adaptive research and demonstration efforts, institutional support, and networks of local service providers, farmer groups, and scientists. And ensuring availability and access to machinery are all important issues that must be addressed.

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