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Identification of Hindrances to Adapt Agricultural Machinery in Selected Areas of Bangladesh

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ABSTRACT

Mechanization plays a significant role in modern agriculture. The decreasing number of labor and increasing population makes agricultural production harder. So mechanization is needed to cope up with this situation. This study was conducted to identify major drawback behind mechanization of Bangladesh. The study was a surveyed analysis and conducted in 8 villages in Sylhet, Cumilla and Gaibandha district in 2017-2018. The result shows that 95.71%, 100%, 85.71%, 78.58%, 71.42%, 92.85%, 97.14% farmers were thinking that fragmented land, high machinery price, lack of maintenance, inadequate extension service, poor transportation, lack of loan service and big machinery size is the main drawback for mechanization respectively. The result also shows that farmers' financial, social and cropping system condition does not suit properly. The current study was found that a healthy agricultural mechanization policy must be formulated immediately including machine development and manufacturing, quality protection by standardization of machines, skill development of researchers, farmers, mechanics and machine operators and marketing system improvement. In this study, a theoretical model was recommended for resolving these problems. It is recommended that government should set up agricultural machinery industries which should be developed or purchase and hired out to small-scale farmers at a subsidized rate to increase the level of mechanization of certain farm operations in the middle belt states of the country. If the production process can be stimulated by modern farming techniques and mechanical aids the goal of sustainable agriculture can be achieved and ensure food security.

Keyword: Adaptation, drawback, farmer, policy, model, mechanization.
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INTRODUCTION

Human race depends upon agriculture from the very beginning of the civilization. As that consequence, agriculture is developing day by day. The crucial part of this extension is agricultural mechanization. Mechanization is the way or process to stimulate the agricultural production, reduce labor cost as well as drudgery and optimum utilization of resources. In the 21st century, agriculture remains an essential sector for sustainable development,but at the same time, is facing major challenges and risks. Indeed, while the natural resources that sustain agriculture are becoming increasingly scarce, degraded, and vulnerable to the effects of climate change, the world's demand for food is expected to double within the next 50 years. In several developing countries, agriculture accounts for at least 40% of GDP and 80% of employment. And about 70 percent of the world's poor live in rural areas and most depend on agriculture for their livelihoods (WDR, 2008).

Table 1. Amount of farm machinery use in Bangladesh.

Farm machinery	
Name of the machine	**Amount**
Power tiller	3,50,000
Tractor	>25,000
High speed rotary tiller	30
Weeder	2,00,000
Seed-cum fertilizer distributor	About 60
Sprayer	1,250,000
Combine harvester	About 30
Reaper	About 40
Open dram thresher	150,000
Closed dram thresher	About 35,00
Winnower	About 500

Source: Bidhan et al. (2017)

Mechanization is a process through which agricultural activities can be improved and optimum crop production can be achieved (Chowdhury et al, 2010). Mechanization is a crucial input for agricultural crop production which has been neglected in the context of developing countries. Factors that reduce the availability of farm power compromise the ability to cultivate sufficient land and have long been recognized as a source of poverty, especially in sub-Saharan Africa. Increasing the power supply to agriculture means that more tasks can be completed at the right time and greater areas can be farmed to produce greater quantities of crops while conserving natural resources. Applying new technologies that are environmentally friendly enables farmers to produce crops more efficiently by using less power. Bangladesh is still a developing country in Asia with an estimated population of 156.5 million (World Population Review, 2017). The population growth rate, at present, stands at 1.26% (BER, 2008-2009). Bangladesh has an area of about 50,000 square miles of which about 22.3 million acres (69 percent of total land area) are cultivated land. Agriculture plays a dominant role in the growth and stability of the economy of Bangladesh. More than three quarters of the total population in rural areas derive their livelihood from the agricultural sector. About 48 percent of the labour force is still employed in Agriculture (Hossain et al, 2017). Thus, to increase production and cropping intensity, the most important gain will be the faster development of agricultural mechanization as well as variety development. Replacing the traditional inefficient agricultural tools, efficient mechanized cultivation must be introduced and extended (Islam, 2011). To fulfill this requirement, the easiest way out is mechanization that can increase production per unit land as well as cropping intensity. To achieve the goal of becoming a developed country, there is a need for a faster extension of mechanization as well as a variety of developments. The good news is that the government has already attributed due importance to agricultural mechanization in the National Agricultural Policy. In the Policy, it is included that the government will encourage the production and manufacturing of agricultural machinery adaptive to our socioeconomic context (MoA, 2009). Virtually, mechanization in Bangladesh agriculture started in 1960s with the introduction of tractor, power tiller, deep tube well, shallow tube well and low lift pumps on some very limited quantities (BRRI (2009). Manufacturing workshops and industries engaged in agricultural mechanization activities will be provided with appropriate support. Until about the late 1950's, irrigation was basically through traditional method that included the use of swing baskets, done, hand tube wells and small gravity irrigation systems, low lift pumps for irrigation were used from 1950. In 1968, the activities were expanded to include deep tube wells and shallow tube wells were used for irrigation form 1971 (BBS, 1989). The production process in crop agriculture entails a number of strenuous field operations. The effectiveness of these operations determines the extent of production through changes in both yield and cropping intensity (Ahmed, 2001). In the year 2000, the land preparation was done almost 70% by mechanically (Farouk et al, 2007) this has now been raised to about 80%. But, bed makers, seeders, weeders, harvesters, and winnowers- all have limited uses. However, threshing of maize is accomplished almost 100% by power and hand maize shellers and those of paddy and wheat, over 80%, by both power and manual threshers. Efforts are being continued by researchers to improve the machine performance. The number of Power tiller was about 7, 00,000 until 2014 (Ahmmed, 2014). During the period, the associated mechanized equipment was used 10.13% higher than those of the previous year. About 80% of irrigation are done by groundwater and the rest of surface water (BADC, 2008). The present status of machinery use is shown in (Table 1). Improving this situation the first

Table 2. Classification of farmers (based on land distribution).

Basis of land ownership	Selected area		
	Gaibandha	Sylhet	Cumilla
Landless farmer (>0.405 hector)	9	7	2
Small land farmer (0.4-0.81 hector)	10	18	12
Medium land farmer (0.81-2.43 hector)	4	4	1
Large land farmer (> 2.43 hector)	0	2	1

priority is to focus the problems of mechanization. A survey was conducted at villag “Charia Kalibari” in the Hatikumrul Union Parishad No. 9 under Ullapara Upazila in Sirajganj District, Bangladesh during 2006 to know the status of agricultural mechanization and its impact on the rural environment (Khalequzzaman and Karim, 2007). Another study was conducted in Sindhanur and Manvi talukas of Raichur district by involving 120 paddy growers who come under the Tungabhadra Project Area. The specific objective of the study was to analyze the extent of knowledge possessed and adopted by the paddy growers about farm mechanization practices (Nagaraj et al, 2013). One other study carried out in three northern districts of Bangladesh during the period of 2009-10 to find out the effect of mechanization on labour use and profitability in wheat cultivation (Rahman et al, 2009-10). The purpose of this study is to detect the problems faced by farmers on the path of mechanization as well as an assessment of farmer’s demands for machinery use to meaningful mechanization.

MATERIALS AND METHODS

Study location

The study was conducted in 8 villages based on the different land type and cropping intensity. Sylhet, Chattragram and Rangpur regions were selected based on production.

The area of survey selected in this study has different climatic condition. In Rangpur region temperature is high during summer. The temperatures are higher on average in August, at around 29.0°C. The lowest average temperatures in the year occur in January when it is around 17.3°C. The variation in the precipitation between the driest and wettest months is 478 mm. Paddy, wheat, sugarcane, potato, mustard, corn, tobacco is common crops in that area.

Sylhet is located at 24.8917°N 91.8833°E, in the northeastern region of Bangladesh within the Sylhet Division, within the Sylhet District and Sylhet Sadar Upazila. Sylhet has a typical Bangladesh tropical monsoon climate bordering on a humid subtropical climate at higher elevations. The rainy season from April to October is hot and humid with very heavy showers and thunderstorms almost every day, while the short dry season from November to February is very warm and fairly clear. Nearly 80% of the annual average rainfall of 4,200 millimeters (170) occurs between May and September short dry season has little effect. The average annual temperature is 24.8°C in Sylhet. Paddy, tea, orange, pineapple, etc., are common crops grown. Paddy, tea, orange, pineapple, etc. are common crops grown.

Cumilla has a tropical savanna climate. The climate of Cumilla is generally marked with monsoons, high temperature, considerable humidity and heavy rainfall. The hot season commences early in April and continues till July. The average annual temperature in Cumilla is 25.5°C (77.9 °F). About 2,295 mm (90.35) of precipitation falls annually. Paddy, wheat, vegetables, corn, etc are common crops.

Preparation of interview schedule

Interview schedules were prepared according to the objectives of the study with active consultation with the key informants and secondary information. The draft schedules were corrected, modified and altered accordingly and printed for field data collection.

Sample size

In the present study, the amount of total respondent was 70. This interview focused on understanding the present condition and the tendency of farmers in terms of using machinery to formulate a strategy for mechanized agriculture. Machinery operation, advantages and disadvantages related to the system were considered. Farmers’ opinion and desire regarding machinery were also considered. To understand the drawback of the use of machinery, the most important points regarding mechanization was presented to the farmers and their comments were collected. The sampling units of this study are farmers. Farmers are categorized as shown in (Table 2).

Site of data collection

The primary data were collected from rural areas of Sylhet, Gaibandha and Cumilla as shown in (Table 3).

Table 3. Number of respondents in regions.

Region	District	Village	No. of respondents
Sylhet	Sylhet	Sylhet Sadar	6
	Sunamgonj	Derai	6
		South Gudabari	9
	Moulvibazar	Vanugacha	10
	Habiganj	Madhabpur	5
Chattragram	Cumilla	Muradnogor	9
		Sadar Cumilla	7
Rangpur	Gaibandha	Gobindaganj	18

Table 4. Respondents educational status.

Educational stage	Frequency	Percentage
Illiterate	11	15.71
Primary (1-5 Years)	23	32.85
Secondary (6-10 years)	27	38.58
Higher secondary (11-12 years)	10	14.28
Higher degree (12+)	0	0
Total	70	100

Data collection

The study was conducted by the sample survey method. Data were collected from 70 farmers to gather information from all the villages. Data were collected through personal interview. During interview of farmers, each question was explained to them clearly and tried to find out fact as much as possible. Before taking the interview, the whole purpose of the study was clearly explained to the respondents. Initially, many of the respondents used to be doubtful to answer the questions. When they were assured that the study was purely an academic one and was not likely to have an adverse effect on them, they tried to make good cooperation. Farmers are selected by random sampling technique. Primary and secondary data were collected. Primary data from the respondents were collected through semi-structured questionnaire following face-to-face interviewing method. Secondary data were obtained from published and unpublished research reports, manuals, articles, etc. After completion of data collection, analytical work which includes editing and tabulation were done software.

Data analysis

The data for the study was compiled and analyzed according to the objective of the study. Microsoft Excel 2013 and Microsoft Word were used for tabulation and organization of data. The relationship and graphs were also prepared by the above software.

RESULTS AND DISCUSSION

Educational level

The level of education of farmers is important for understanding their thinking towards new technology. Generally, the level of education of the farmers varies with different financial conditions. The average level of the educational period of farmers was selected in study areas with 5 years duration in each stage. In this study it was revealed that 84.29%, 32.85% and 15.71% farmer was literate, primary level and illiterate respectively (Table 4). It was also found that the percentage of secondary (38.58%) and higher secondary (14.28%) educated farmers mean total 52.86% educational level which is considerable for the selected areas. Although farmer received education at a certain level, drop out for financial limitation and uneager to continue further study.

Land ownership status

The land ownership affected the financial condition of farmers as well as adaptation behavior towards mechanical aids for production. The average farm area was considered in the range of 0.405 to 4.05 hector. The farm area is a very important concern for mechanization (Table 5) and showed that the small farmer was 57.14% which is higher than the other categories. The probable cause might be financial support and fragmented land inherited from generation to generation. In this case of the study investigated that landless and small farmers sometimes cultivates others land which was leased system (“Barga” in local language).

Machinery use status in different agricultural operation

Land preparation

Tillage practices play an important role in plant growth

Table 5. Land ownership patterns of respondents.

Farm size	Frequency	Percentage
Land less farmer (>0.405 hector)	18	25.71
Small farmer (0.4-0.81 hector)	40	57.14
Medium farmer (0.81-2.43 hector)	9	12.85
Large farmer (> 2.43 hector)	3	4.28
Total	70	100

Table 6. Utilization of tillage machinery.

Tillage machineries	Frequency	Percentage
Tractor	4	5.71
Power tiller	57	81.42
Country plough	9	12.85
Total	70	100

Table 7. Water lifting techniques.

Water application technique	Frequency	Percentage
Low lift Pump	17	24.28
Deep tube well	8	11.42
Shallow tube well	45	64.28
Total	70	100

during seed germination, seedling emergence, easy transplanting, weed control, and water management even insect-pests and disease management. The farmers of the study areas used 81.42% and 5.71% by power tiller and tractor respectively, for land preparation in case of tillage operation as shown in (Table 6). It is seen that the use of power tiller is higher than a tractor because of small size and easy operation. It was also found that farmers pay an average of 5580 Tk/ha as hiring costs for land preparation.

Water application

Water is a fateful indication of crop production. It is the most important factor which can make a crop either a success or failure. Boro rice is fully dependent on irrigation and T. Aman rice needs supplemental irrigation. The farmers applied irrigation by shallow tube well or low lift pump and sometimes deep tube well in the study area. Among all the irrigation devices, deep tube well was mostly used on rental basis of approximately 5100 Tk./ha. About 64.28% of farmers used shallow tube well for artificial water application (Table 7) because of the available source of surface water and easy to operate. Although the discharge capacity of deep tube well is higher than other devices, it has gained less popularity due to high initial cost to install as well as repair and maintenance.

Intercultural operation

Presently, 31 diseases of rice are recorded in Bangladesh**.** Bacterial leaf blight was a common disease of rice in selected areas. 20-30% yield loss occurred depending on the severity of infection in subtropical countries. These diseases created a serious problem causing up to 70% yield loss (Sayed et al., 2015). It reported that farmers applied pesticides once or twice in a season and almost 100% farmer used the mechanical sprayer for spraying pesticide in the field. The result shows that hand weeding process was 87.14%, though it is very laborious and time-consuming process. It also reported that 4.28% farmers used mechanical weeding technique (Table 8), lack of technical skill and extension work.

Harvesting technique

This study shows farmers still preferred manual harvesting technique. Table 9 shows manual harvesting was 95.72% used by farmers' rather than mechanical harvesting techniques (Table 9). The reasons might be high cost, the small size of land and complex to operate.

Post-harvesting operation

From Table 10 maximum post-harvest operation done was 58.57% using pedal thresher/open dram thresher. It also found that the dram beating threshing technique is lower compared with pedal thresher/open dram thresher and followed by closed dram thresher. In general, all over

Table 8. Weeding operation.

Weeding technique	Frequency	Percentage
Hand weeding	61	87.14
Mechanical weeding	3	4.28
Hand and mechanical weeding	5	7.14
Herbicides	1	1.42
Total	70	100

Table 9. Harvesting Technology.

Harvesting machinery	Frequency	Percentage
Manually	67	95.71
Reaper	3	4.28
Combine harvester	0	0
Total	70	100

Table 10. Post harvesting techniques used by respondents.

Post harvesting machinery	Frequency	Percentage
Pedal thresher / Open dram thresher	41	58.57
Closed dram thresher	19	27.14
Dram beating	10	14.28
Total	70	100

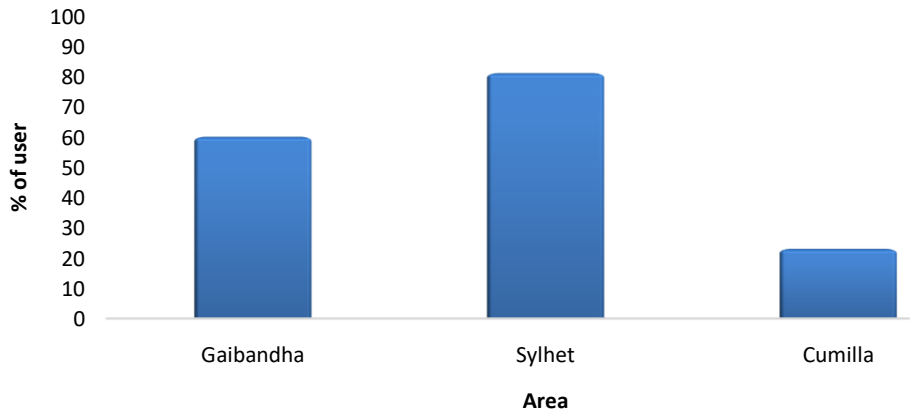

Figure 1.Use of power tiller.

Bangladesh, tillage machinery are used mostly. But still, harvesting machinery such as combine harvester and planting machinery such as reaper is not used. Farmers often have prejudices about machinery use in crop cultivation. Most of them still prefer manual techniques rather than mechanical. The rice transplanter is now a day's quite popular invention. But still not so adapted by farmers for its high cost and complicated operation. Farmers still do the seedling grown in traditional ways. There are so many problems in field condition which make the mechanization process slower.

Status of adapted agricultural machinery

The present study found that power tiller, tractor and thresher were used in pre and post-harvest operation in selected areas. Farmers make use of agricultural machinery in two ways; one way is to give and rent own machine to other farmers and another way is cultivated own land as well as use for rental service. Figure 1 shows the percentage of power tiller use was 81%, 24% and 60% in Sylhet, Cumilla and Gaibandha areas respectively. The study observed that the power tiller was used minimally in Cumilla compared to other areas because of labor's low wages. Water is a vital element for crop production; inadequate rainfall pattern leads to the use of artificial application of water by means of irrigation

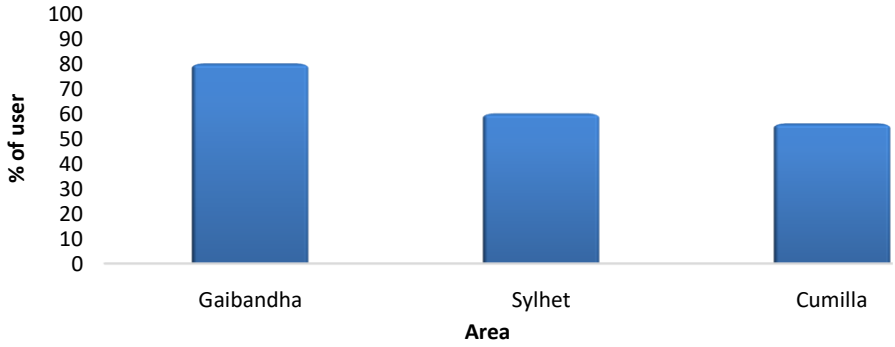

Figure 2. Use of irrigation pump.

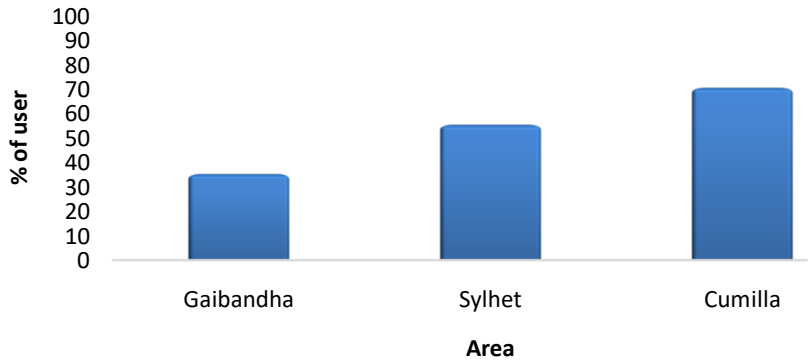

Figure 3.Use of thresher.

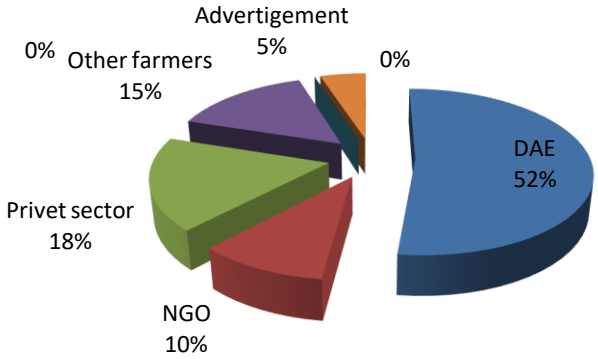

Figure 4. Different sources of information organization.

pump. The irrigation pump was used at 79%, 59% and 55% in Gaibandha, Sylhet, and Cumilla respectively (Figure 2). This result revealed that the highest number of irrigation pump was used in Gaibandha, as the command area under irrigation is greater than Cumilla followed by Sylhet. From Figure 3 is shown that the use of thresher was 35%, 56% and 69% in Gaibandha, Sylhet and Cumilla respectively. The use of thresher in Cumilla and Sylhet is greater than Gaibandha due to labor shortage.

Technical service provider

Farmers got information about machinery from DAE, NGO, Privet companies marketing personnel, Advertisement, etc. Figure 4 shows farmers got 52% information from the DAE and 5% from the media. Although DAE provided the highest percentage of service, the field extension officers are mainly major in Agriculture. Therefore, they lack technical knowledge

Table 11. Farmers view against machine adaptation.

Problem faced by farmers	Frequency	Percentage
Fragmented land pattern	67	95.71
High price of machinery	70	100
Poor maintenance	60	85.71
Lack of extension service	55	78.58
Poor transportation	50	71.42
Inadequate loan distribution	65	92.85
Big size of machinery	68	97.14
Total	70	100

about modern agricultural machinery and are unable to motivate farmers about new inventions.
From the study result, the following are hindrances for meaningful mechanization;

Fragmented land

The land used for agricultural purpose is not enough as per population growth. The land used for agricultural purpose is 69.5% compared to the total land of the country (Worldstat info, 2007). This percentage is decreasing day by day as a result of increasing urbanization.
Farmers, who inherited their land, become divided continuously. From the study result, 95.71% farmers stated that modern agricultural machinery is not suitable for land tenure system (Table 11). Therefore, farmers preferred labor than mechanical aids.

The high price of agricultural machinery

It was found that the farmers were mostly poor and hardly can afford costly machine individually. In this regard, almost 100% farmers pointed that modern machinery is expensive with respect to economic condition (Table 11). Only farmers having a large number of agricultural lands possess some farm machines like tractors, power tillers, operated seeders, combine harvester, etc. Farmer used these machines in own lands and also operate on hiring basis in others' farms and earn a substantial return. But, the number of such farmers is limited (Table 11).

Lack of knowledge and skill of users, manufacturers and traders

The machine users, manufacturers and traders are mostly illiterate and don't have substantial knowledge and skill about machine operation, repair and maintenance. The manufacturers do not often provide 'after sale service' to the users.
From investigation, it has been found that machines are left without working for minor and easily repairable faults. On the availability of a mechanic, the farmers get them repaired at the expense of high charges. But in other cases, where mechanics are not readily available, the user leaves the machine without operation (Table 11).

Lack of information

Information on new machine as well as maintenance of machinery is inadequate. Farmers or operators often do not know about proper maintenance and operational techniques (Table 11).

Credit and finance

The proper credit and financial system is very important in agricultural production. But in Bangladesh, the financial support from the bank and other financial institutions are not appropriate for poor farmer. The small farm holder often wants to buy machinery by taking a loan, but the interest rate is high. Some NGO such as Grameen Bank, ASA, BRAC, etc. provides loan for the entrepreneur, which is always enough (Table 11).

Farmer's opinion for meaningful mechanization

Meaningful mechanization means mechanization never creates unemployment; no labor displacement and also adaptability with the socio-economic condition. Selected farmers think mechanization only means tillage implement use. But the idea of mechanization is so far ahead of that. The need for mechanization must be communicated to farmers and convince to adopt more mechanical aids and modern technique of cultivation.
In this study, farmers' opinion towards mechanization was accessed. Figure 5 indicates that 87%, 5% and 8% farmers pointed yes, no and no comment respectively on the basis of high machinery price, large size machinery and lack of operational skills. Therefore, to ensure meaningful mechanization the above barriers should be addressed properly.
The current situation needs more focus on new and cheap technology for farmers all over Bangladesh. Farmers are aware of the situation that mechanization is needed for their production but there lie the problems such as land ownership pattern, lack of quality machinery, insufficient training regarding new machinery, deficiency of financial support as the main problems on the path of mechanization.
Figures 6-8 is the flow chain that shows the internal relationship and linkage between government, research institution, educational institution, manufacturer, trader

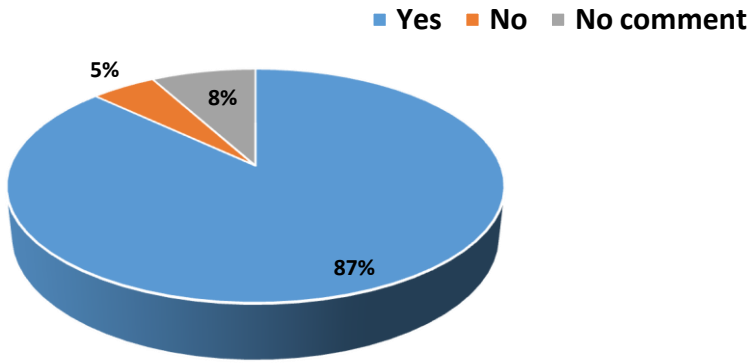

Figure 5. Farmers opionion about high machinery price, size and lack of operational skill.

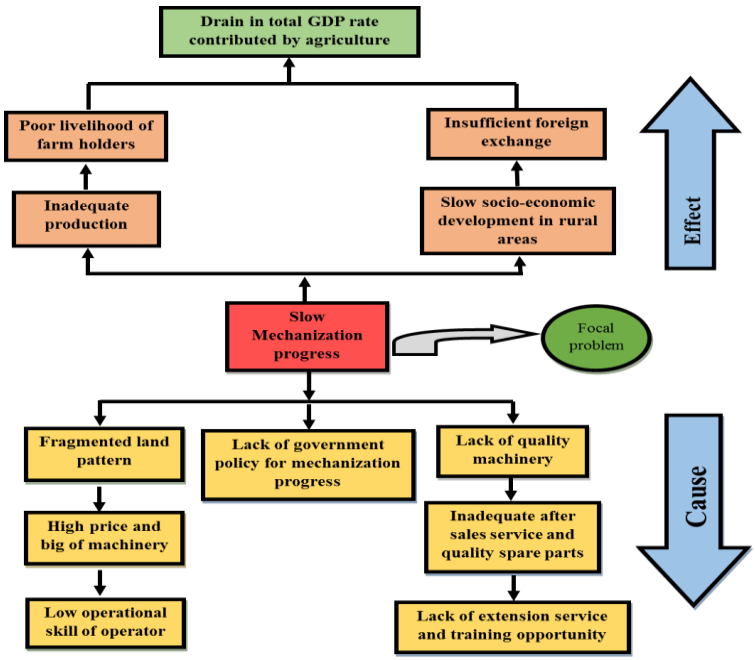

Figure 6. Problem tree.

and consumer that must be maintained properly. This is a long and time-consuming process which sometimes slows the speed of information transfers. The real farm problem became stuck in this process. Discovering a path for developing countries regarding the transfer of mechanization technology to the small farms would be faced with difficulties because of the added variability of socio-cultural, economic, and environmental conditions. Nevertheless, small farmers are in need of help. By sharing and learning from each other's problems, an alternative solution may be discovered, while trying to imitate the success of others in extending mechanization technologies to small farms. The commitment of all the stakeholders to increase the conditions in small farms through appropriate mechanization schemes can be a starting point. This will be a long ride, but from here on, we will only progress and realize our goal if we will all cooperate and accept the responsibilities and be accountable to the farmers who are in need of help. Despite all constraints and limitation, the agricultural sector has a great prospect. To overcome these problems, government, research institutions and educational institutions must work together and find the solution which best suits farmers.

Conclusion

Though mechanization is quite less in Bangladesh compared to other neighboring countries, it is gaining

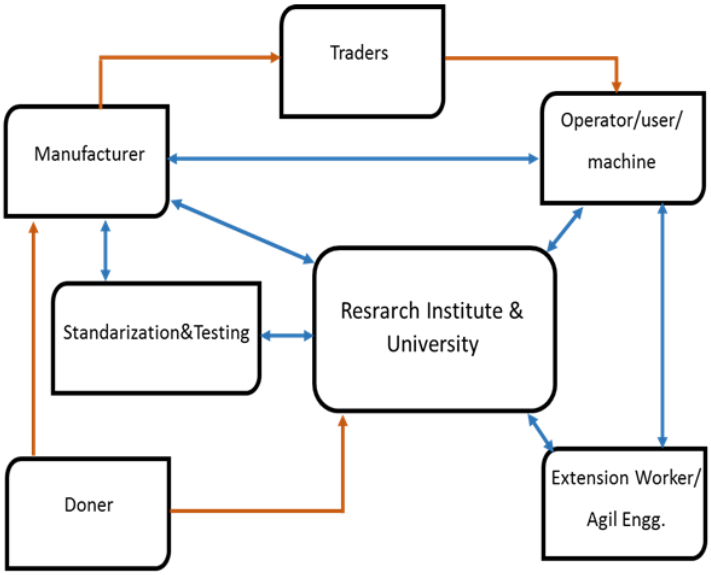

Figure 7. Recommanded institutonal relationship.

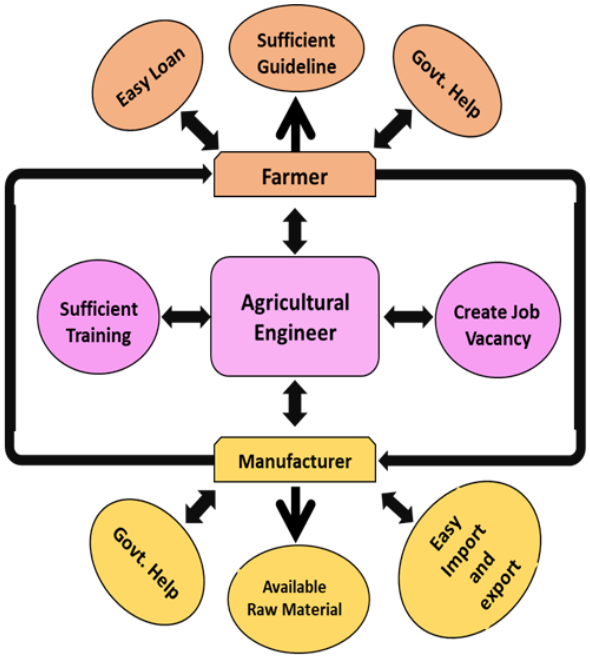

Figure 8. A theoretical model for increasing agricultural machinery adaptation behavior from manufacturer to farmer.

pace with time. Since Bangladesh is an agro-based country and a considerable share of GDP comes from agriculture, this sector is always given due importance. With the use of limited mechanization in crop production and other sub-sectors, the output from agriculture is increasing. The objective of this study is to find out the obstacles behind mechanization and assessment of the farmers' demand to fulfill meaningful mechanization. About 95.71%, 100%, 85.71%, 78.58%, 71.42%, 92.85%, 97.14% farmers thought that fragmented land, high machinery price, lack of maintenance, inadequate extension service, poor transportation, lack of loan service and big machinery size is the main drawback for mechanization. Most importantly, the farmers are coming

to the point of realization that to save time and cost of operation and to do profitable agriculture; there is no other better option than to go for mechanized agriculture. From the study result, the following recommendations are made;

1. Facilitate manufacturer of agricultural machinery with more tax relief/credit to ensure production of quality machinery and spare parts locally.
2. Training/demonstration and advisory programs should be carried out for farmers and local artisan as well as manufacturers in union level to enhance skill and enlighten them with recent invention and techniques.
3. Community farming group can be formed by farmers to purchase machinery which they are not able to adapt individually. With these facilities, all farmers of that area can be benefited.
4. Provides fund for research, development and extension. Increase educational level for agriculture in collaboration with Universities, BRRI, BARI, NGO and private sectors.
5. Review and rationalize the current tariff rates affecting the import of agricultural machine and spare parts and the raw materials so that the local manufacturer can be encouraged on a competitive basis.
6. Ensure subsidy for all kinds of machinery in farm level, in that way farmer becomes motivated to use own machines. Machinery that has complicated operation should be demonstrated by skilled technical personnel.
7. Since the power tiller and tractor is popular in the country, more tractor/power tiller drawn implement must be innovated. Consequently, farmers can make a choice and machinery price become more reasonable. The small farm machinery such as tractor mounted reaper, USG applicator, mechanical sprayer could be innovated locally for better adaptation by farmers.
8. The need for agricultural extension officer specialized in agricultural engineering is now an exigency. In field, engineers can help the farmer in any technical crisis and motivate them as well.

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