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IMPACT OF FARM MECHANIZATION ON LABOUR USE FOR WHEAT CULTIVATION IN NORTHERN BANGLADESH

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ABSTRACT

The study was conducted 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. The findings revealed that less number of labour per hectare is required to complete the production process by mechanized farm compared to traditional farm. Family labour is mostly affected by the mechanization. Animal power and output have positive effect on labour requirement, while power tiller and input costs have adverse effect on labour requirement for wheat cultivation. The yield of wheat under mechanization (2.65 t/ha) is higher than that of traditional farms (2.57 t/ha). Total variable cost is significantly higher for traditional farms. Gross margin is found to be higher for mechanized farm (Tk. 14,168) compared to traditional farm (Tk. 10,102). High price of power tiller parts is mentioned as a major problem of mechanization in the study areas. The study concludes that mechanization has adverse effects on family labour and more research need to be conducted to develop appropriate technology to increase the production of wheat without substituting labour.

Key words: Mechanization, labour requirement, profitability, labour type, wheat.

INTRODUCTION

Agriculture of Bangladesh is characterized by overwhelmingly small holdings due to higher population density and nearly 80 per cent of its population residing in the rural areas coupled with unabated land fragmentation due to the inheritance laws of the country. With the introduction of small-scale mechanization the nature of using cultivation power has changed significantly and it appeared that the use of power tiller (PT) for tillage has increased rapidly and draught power (DP) to some extent has been replaced by PT in some areas of Bangladesh. Mechanization may be defined as the process of injecting power and machinery between man and materials in a production system (Khalequzzaman and Karim, 2007). Some other agricultural activities have already been mechanized and the most important one is water pumping through STW and DTW. Moreover, most of the farmers have started using weeder, sprayer, thresher and other small tools and equipment in small farm practices. The technological improvements in Bangladesh agriculture have brought about revolutionary increase in agricultural production. The increased use of purchased inputs in agriculture necessitated to raise their use efficiencies though mechanization.

In terms of employment agriculture is the largest sector of Bangladesh. This sector meets the demand of increasing food requirement and raw materials for the manufacturing units. Mechanization of this sector implies the use of various power sources and improved farm tools and equipment, with a view to reduce the drudgery of the human beings and draught animals. Application of farm mechanization will adversely affect the labour requirement, which will adversely affect the exiting unemployment situation. However, at the same time it is argued that the application of mechanization will boost up the overall productivity and production with the lowest cost of production (Aurangzeb *et al.*, 2007). There have been some studies (FFYP, 1973; Gill, 1984; Miah *et al*., 2002) conducted on the impacts of mechanization on overall livelihood of the rural population. These studies indicated that the increased use of PTs and to some extent, mechanization seriously affected the income of small farmers and landless labourers while contributing little to the overall productivity of farming system. Besides, a number of studies (Roy *et al*., 1978; Duft 1986; Agarwal, 1981; Aurangzeb and Blase, 2007) were conducted outside the country regarding this issue. Most of these studies only considered the effect (principally of tractors) on total farm employment; failing to take account of the fact that mechanization is essentially a mixed package. Different operations and crops allow different mechanization alternatives. A disaggregation by operations becomes particularly important in the case of a multi-purpose technique. Similarly, disaggregation by crops becomes important because different crops lend themselves to different levels of tractor use. It is not possible to identify the operations where mechanization is likely to have the maximum impact by only considering aggregate effect. For these reasons the present study is dealing with disaggregation in terms of operation and crop. Wheat is the second most important cereal crop in Bangladesh with an area and production of

399984 ha and 737 thousand metric ton respectively (BBS, 2007). The choice of wheat for crop specific analysis is determined by two considerations. First wheat is the main cereal crop grown in the study areas among the BARI mandated crops and secondly the highest level of mechanization is found in wheat cultivation among BARI mandated crops. Keeping all this factors in consideration the present study was undertaken with the objectives;

To assess the impact of farm mechanization on labour use for wheat cultivation and profitability.

METERIALS AND METHODS

Study area: Based on area and production of wheat three major wheat growing northern districts of Bangladesh namely Thakurgaon, Panchagarh and Dinajpur were purposively selected for this study.

Sampling procedure: The data are classified into two groups such as mechanized and traditional farms to quantify the effect of farm mechanization. Mechanized farms are those where the farmers generally used agricultural machineries such as power tiller, thresher for farm operation. On the other hand traditional farms are those who did not use farm machinery mentioned above. They generally carry out the activities by using animal power and human labour. A total of 150 sample taking 25 from each group of each location is selected randomly to fulfill the objectives of the study.

Data collection: This study is mainly based on primary data collected through sample survey. Regarding information on mechanization, Rao (1974) and Aurangzeb (2007) use data on the input of tractor power (tractor-hours) per farm. Thus, information on the use of tractor is gathered in the form of tractor-hour use per farm. Both animal power and labour is also measured in animal hour and labour hours (8 hours equivalent to 1 man-days) use per farm The costs incurred on inputs are measured in terms of the prices paid by respondents for each input.

Analytical technique: In this study tabular method of analysis is used to present the result of field survey and to determine the impact of farm mechanization on labour use and profitability for wheat cultivation. Independent sample t-test was also used to test the differences between the means of two groups. The following multiple regression model is used to identify the factors effecting the labour requirement for wheat cultivation.

$$Y = a + b_1X_1 + b_2 X_2 + b_3X_3 + b_4 X_4 + b_5 X_5$$

Where,

Y = Labour time (hrs/ha)

X_1 = Power tiller time (hrs/ha)

X_2 = Output (Tk/ha)

X_3 = Input (Tk/ha)

X_4 = Animal time (hrs/ha)

X_5 = Dummy (1 for mechanized, 0 otherwise)

b_1---- b_5 = Coefficients to be estimated

RESULTS AND DISCUSSION

Impact on Labour Requirement

Labour time required for different categories of farm by type of operation: The labour time required for a specific operation is found to differ considerably between different farm categories. Table 1 gives the mean use of labour for each operation in hours per hectare. To test the statistical significance of the differences in the mean human labour hours used for each operation, t values are also computed. It is clear from the tables that for plouging and threshing, the traditional farms use substantially more human labour hours per hectare (L/H) than the mechanized farms in all the selected areas. In ploughing the decrease in labour hours per hectare from exclusively bullock to exclusively power tiller is found highest in Thakurgaon (169 L/H) followed by Panchagarh (145 L/H). On an average, the mean difference is found 136 L/H which is significant at 1% level of significance. In case of threshing, much less labour hours per hectare is needed when a thresher alone perform the operation instead of the traditional one of bullock or drum threshing. On an average, mean difference for threshing is found 145 L/H which is significant at 1% level. In case of other operation i.e, drying and winnowing mechanized farms need less L/H compared to traditional farms. This is due to the fact that when the farmers use drum for threshing, the grains are scattered all over the place and requires more labour hours to accumulate the grains but in case of a thresher farmers can collect the grains from a place and not much winnowing is necessary. As the farmers used similar type of methods for sowing, inter culture and irrigation, there is no significant difference of labour hours used per hectare between mechanized and traditional farms.

Type of labour affected by mechanization: Table 2 indicates that the type of labour likely to be affected by mechanization is depends on which agricultural operation is mechanized. Sowing and irrigation are done largely by family labour (100%). There is no use of hired labour for this purpose. Incase of intercultural operation and harvesting, traditional and mechanized farms used both hired and family labour. On an average 68 and 64% of total labour hours is hired for intercultures by traditional and mechanized farm respectively, rest of them are family supplied. For harvesting 77 and 70% of total labour hours is hired by traditional and mechanized farm respectively. The proportion of hired and family supplied labour hours is found more or less similar for above mentioned operations, this may be for using similar type of technique for intercultural operation and harvesting by

the two category of farms. On the other hand, family labour is mostly affected by the operation like ploughing and threshing where mechanized farms used mechanical power for this operation. Only 12% of total labour hours of ploughing is family supplied by mechanized farms while it is 52% for traditional farms. Similarly only 5% of total labour hours for threshing is family supplied and 95% is hired by mechanized farms. Mechanized farms used more hired labour than traditional farms for ploughing and threshing, this may be for the fact that these operations required skilled labour. For other operations like drying and winnowing, both category of farm used more family labour than hired labour.

Table 1. Distribution of labour hours used per hectare by operation

Item	Mechanized (A)	Traditional (B)	Mean difference	t-ratio
Dinajpur				
Plouging	30	125	-95	-11.55***
Sowing	8	9	-1	-0.51
Interculture	107	84	23	0.76
Irrigation	56	43	13	1.77**
Harvesting	177	185	-8	-1.39*
Threshing	27	165	-138	-13.64***
Others	60	74	-14	-2.99***
Panchagarh				
Plouging	30	175	-145	-21.29***
Sowing	11	11	0	-0.88
Interculture	256	233	23	0.70
Irrigation	29	36	-7	-1.60*
Harvesting	234	259	-25	-2.87***
Threshing	20	186	-166	-30.35***
Others	89	113	-24	-4.15***
Thakurgaon				
Plouging	36	205	-169	-26.45***
Sowing	6	7	-1	-1.87**
Interculture	75	88	-13	-1.42*
Irrigation	25	24	1	0.21
Harvesting	206	228	-22	2.32***
Threshing	27	159	-132	-22.56***
Others	83	97	-14	-2.06**
All areas				
Plouging	32	168	-136	-25.09***
Sowing	8	9	-1	-1.53*
Interculture	146	135	11	0.58
Irrigation	37	34	2	0.64
Harvesting	206	224	-18	-0.52
Threshing	25	170	-145	-32.09***
Others	77	95	-17	-1.81**

Intercultural operation includes application of manure, fertilizer, pesticides and weeding. Others include drying and winnowing.
***, ** and * indicates significant at 1, 5 and 10 per cent respectively.

Determinants of labour requirement: The labour requirements are related to the amount of time allocated to agricultural machinery, animal power and to inputs and outputs. The inputs and outputs are taken in money terms because they are measured in different units and cannot be taken quantitatively. According to the regression analysis the value of adjusted R^2 is found 53 which indicate that 53% of the variations in labour requirement are explained by the independent variables included in the model. F value is significant at 1% level implying that the variation depends mainly on the explanatory variables included in the model. The result reveals that the co-efficient of animal power is positive and significant. It indicates that holding all other factors as constant, animal power encourages the labour requirement. Because application of animal power needs labour and so its increases labour requirement. The coefficient of output is also positive and encourages the labour requirement. It is also observed that coefficient of input costs and tractor times have negative sign which indicates adverse effect

on labour requirements. The negative coefficient of input costs indicate that 1 unit increase in the cost of inputs, keeping other factor constant, will decrease the labour requirement by 0.02 unit. It is understood that with the increase in the cost of inputs their consumption quantity will reduced resulting a decrease in labour requirements. Similarly for tractor time, a unit use of tractor, keeping other factor constant, will reduce the labour requirement by over 3 times which is similar to the findings of Aurangzeb (2007).

Table 2. Type of labour affected by mechanization

Item	Dinajpur		Panchagarh		Thakurgaon		All areas	
	M	T	M	T	M	T	M	T
Plouging								
Family	2 (7)	55 (44)	5 (17)	85 (47)	5 (14)	123 (60)	4 (12)	88 (52)
Hired	28 (93)	70 (56)	25 (83)	95 (53)	31 (86)	82 (40)	28 (88)	82 (48)
Sowing								
Family	8 (100)	9 (100)	11 (100)	11 (100)	6 (100)	7 (100)	8 (100)	9 (100)
Hired	-	-	-	-	-	-	-	-
Interculture								
Family	37 (35)	30 (36)	91 (35)	63 (27)	30 (40)	35 (40)	53 (36)	43 (32)
Hired	70 (65)	54 (64)	165 (65)	170 (72)	45 (60)	53 (60)	93 (64)	92 (68)
Irrigation								
Family	56(100)	43 (100)	29 (100)	36 (100)	25 (100)	24 (100)	37 (100)	34 (100)
Hired	-	-	-	-	-	-	-	-
Harvesting								
Family	42 (24)	37 (20)	68 (29)	55 (21)	75 (36)	63 (27)	62 (30)	52 (23)
Hired	135 (76)	148 (80)	166 (71)	204 (79)	131 (64)	165 (73)	144 (70)	172 (77)
Threshing								
Family	3 (11)	68 (41)	1 (5)	68 (37)	0	52 (33)	1 (5)	63 (37)
Hired	24 (89)	97 (59)	19 (95)	118 (63)	27 (100)	107 (67)	23 (95)	107 (63)
Others								
Family	45 (61)	42 (70)	61 (69)	82 (73)	64 (77)	78 (80)	57 (69)	67 (75)
Hired	29 (39)	18 (30)	28 (31)	31 (27)	19 (23)	19 (20)	25 (31)	23 (25)

Figure in parentheses indicates the percentage of total; M = Mechanized farms, T = Tradition farms

Table 3. Labour requirement of wheat crop: regression estimates

Variable	Co-efficient	Standard error	t-value
Constant	404.56	94.70	4.27***
Tractor time (hrs)	-3.92	0.13	2.90***
Output (Tk)	0.03	0.001	0.98
Input (Tk)	-0.02	0.002	8.55***
Animal power time (hrs)	1.91	0.55	3.43***
Dummy	-361.11	76.55	4.71***
Adjusted R^2		0.53	
F-value		35.86***	

***, ** and * indicates significant at 1, 5 and 10 per cent respectively.

Impact of farm mechanization on profitability of wheat: According to the Table 4 the average yield of wheat is found higher for mechanized farm (2.65 t/ha) compared to traditional farm (2.57 t/ha). The mean difference is found to be 0.08 which is significant at 5% level. The yield is found to be higher for mechanized farm for all the selected areas compared to traditional farm. Although the statistical analysis indicated that mechanized farms realized higher levels of wheat output than traditional farms, these results are not conclusive as far as attributing the difference solely to mechanization. It may be concluded that yield differences between mechanized and traditional farms may also be attributable to other factors such as the intensity of fertilizer usage and proper water management. As the yield is found higher for mechanized farm, the mean difference of return is also significantly higher for mechanized farm. The total cost is found higher for traditional farms. This is due to the fact that substitution of farm machinery for manual power in certain operations such as ploughing and threshing has resulted in the reduction of labour requirements and subsequently reduces the total cost of wheat cultivation. The mean difference of gross margin and BCR is significant at 1% level for mechanized farm is all the selected areas respectively. On an average, gross margin is found to be Tk. 14,168 and Tk. 10,102 for mechanized and traditional farms respectively. The BCR are 1.48 and 1.31 for mechanized and traditional farm respectively.

Table 4. Profitability of wheat cultivation in different areas

Item	Mechanized (A)	Traditional (B)	Mean diff.	t-ratio
Dinajpur				
Yield (t/ha)	2.69	2.59	0.1	1.57*
Return (Tk/ha)	46275	44107	2168	1.30
Main product	43788	42208	1580	-
By product	2486	1898	588	-
Total cost (Tk/ha)	30423	33197	-2774	-2.82***
Gross margin (Tk/ha)	15852	10910	4942	7.25***
BCR	1.52	1.33	0.19	4.70***
Panchagarh				
Yield (t/ha)	2.56	2.51	0.05	0.80
Return (Tk/ha)	40900	40057	843	0.85
Main product	38434	37642	792	-
By product	2465	2415	50	-
Total cost (Tk/ha)	29415	32134	-2719	-2.75***
Gross margin (Tk/ha)	11485	7923	3562	5.80***
BCR	1.39	1.25	0.14	3.29***
Thakurgaon				
Yield (t/ha)	2.70	2.61	0.09	1.13
Return (Tk/ha)	43734	42713	1021	0.70
Main product	41456	39782	1674	-
By product	2278	2931	-653	-
Total cost (Tk/ha)	28566	31239	-2673	-2.60***
Gross margin (Tk/ha)	15168	11474	3694	6.72***
BCR	1.53	1.37	0.16	3.97***
All areas				
Yield (t/ha)	2.65	2.57	0.08	1.91**
Return (Tk/ha)	43636	42292	1344	1.56*
Main product	41226	39877	1349	-
By product	2410	2415	-5	-
Total cost (Tk/ha)	29468	32190	-2722	-2.76***
Gross margin (Tk/ha)	14168	10102	4066	6.54***
BCR	1.48	1.31	0.17	3.99***

***, ** and * indicates significant at 1, 5 and 10 per cent respectively.

Table 5. Problems of mechanization in the study areas

Problems	% of farmers			
	Dinajpur	Panchagarh	Thakurgaon	All areas
High price of fuel for power tiller	80	80	60	73
Lack of PT for tillage operation	60	80	68	69
High price of PT parts	88	64	72	74
Lack of repair and replacement facilities	60	88	64	70

Conclusion: The findings suggested that mechanized farms received higher yield and return compared to traditional farms. Statistical analysis showed that the major effect of mechanical power adoption is the significant reduction in the labour input requirements of mechanized farm for ploughing and threshing. Family labour is mostly affected by the use of power tiller and thresher as these operations requires skilled labour. Animal power has positive effect on labour requirement whereas one unit use of power tiller reduces the labour requirement by over three times. Input price and tractor have inverse relation with labour requirement.

Policy implication: Mechanization in agriculture is the need of time but adoption of farm machinery in the small farms of Bangladesh will have differential impacts on family labour. In-depth analysis must be made not only in terms of how many man-machine hours have been substituted for man-animal hours but also in terms of which of the family household members have been relieved from farm work.

i) In the light of high fuel cost, more local research must be done to develop appropriate mechanical technology which improves wheat production efficiency without necessarily substituting for labour and is not dependent on petroleum base energy fuel for operation.
ii) The distribution of power tiller from area to area should be normalized. To solve this problem of mechanization, cooperative management of farm machinery and financing of second hand power tiller for small farmers may be effective.

REFERENCES

Agarwal, B. (1981). Agricultural mechanisation and labour use: a disaggregated approach. *International Labour Review*, 120(1): 115-127.

Annonymous (2006). Krishi Projukti Hat Boy. Forth edition, Vol. 1, BARI, Gazipur.

Aurangzeb, M., S. Nigar and M. Khan (2007). Labour requirement model for the wheat crop under mechanized and traditional farming systems in the NWFP: A case study of Peshwar districts. *Sarhad J. Agri.*, 23(1): 177-186.

BBS (2007). Bangladesh Bureau of Statistics, Mnistry of Planning, Dhaka, Bangladesh.

Duft, B. (1986). Some consequences of agricultural mechanizaiton in the Philippines, Thailand and Indonesia. In small Farm Equipment for Developing countries' Proceedings of the international conference on small farm equipment for developing countries: past experiences and future priorities. IRRI, Philippines.

FFYP (1973). The First Five Year Plan 1973-78. Ministry of Planning, Dhaka.

Gill, G.J. (1984). Tractorisation and rural employment in Bangladesh. In farm power and employment in Asia; performance and prospects. Proceedings of a regional seminar held at the Agrarian Research and Training Institute, Colombo, Srilanka. October 25-29, 1982. AGTI, Colombo and ADC, Bangkok.

Khalequzzaman, K. M and M. A. Karim. (2007). Study of agricultural mechanization and its impact on rural environment. *J. Innovative Development Strategy*, 1(1): 37-40.

Miah, M. A. Monayem, M. Serajul Islam and M. T. H. Miah. (2002). Socio-Economic Impacts of Farm Mechanization on the Livelihood of Rural Labourers in Bangladesh. *Farm Economy*, 12: 147-164.

Rao, H. C. H. (1974). Employment implication of the green revolution and mechanization: A case study of the Punjab. Agricultural policy in developing countries, Mcmillan, London.

Roy, S. and M. B. Blase. (1978). Farm tractorization, productivity and labour employment: A case study of the Indian Punjab. *J Development Study*, 14 (2): 193-209.