J. Agril. Mach. & Mech. 3 (1 & 2), 1996 : 67-73 ISSN 1024-6290

ECONOMIC ASSESSMENT OF FARM POWER TECHNOLOGY WITH PARTICULAR REFERENCE TO POWER TILLER USE IN BANGLADESH

M. M. Alam[1] M. G. Hossain[2] M. A. Satter[1]

[Date Received : 10.12.1996]

Key words : Draught power, Power tiller, Technology

ABSTRACT

The study has been carried out to appraise the financial and economic impact of substitution of draught animal power (DAP) by power tiller (PT) in Bangladesh agriculture. The substitution of technology has been assessed under three main farm sizes namely small, medium and large, and the crops considered are rice, wheat and jute. Two on farm financial measurement techniques namely Gross Margin (GM) and Partial Budgeting (PB) are used for this purpose. The gross margins of DAP system at all three farm levels have been found marginally greater than that of PT system whereas the net margins of PT system at the same farm levels have ended with higher margins, The partial budgets conclude in favour of substituting DAP by PT.

INTRODUCTION

General Background

In recent years the government of Bangladesh has placed much emphasis on the role of agriculture within the overall development strategy, with a view to increasing food production, rural income, and employment opportunities. A number of measures have been undertaken to improve the economy of small farm holders. The purpose of such programmes is to improve small farm productivity, and the introduction of sustainable technology is one possible way of achieving this. But, the technology to be adopted must be appropriate and acceptable, not only in terms of technical suitability, but also to achieve financial and economical objectives that has impact upon the target groups.

Farming Systems in Bangladesh

The farm holdings in Bangladesh are classified as small (<1 ha), medium (≥1 and ≤3 ha) and large (>3 ha). Almost 95 percent of farm holdings in Bangladesh is below 5 hectares, and 80 percent is less than 2 hectares (Mettrick et al., 1981). These figures imply that the typical Bangladeshi farm is very small and often highly fragmented. The average farm size is too small to permit proper utilisation of a medium size machine or power source. To use such machines under these circumstances, the excess capacity of the machine would have to be hired out.

There are three distinct cropping seasons in Bangladesh namely *Aus* (mid-March to mid-June), *Aman* (mid-July - mid-Oct.) and *Boro* (mid-Nov. to mid-Feb.). Farmers usually grow rainfed paddy and

[1] Associate Professor, Department of Farm Power and Machinery, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh

[2] Associate Professor, Department of Physics, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh

jute as *Aus* crop, transplanted paddy (HYV) as *Aman* crop and irrigated paddy (HYV), wheat, pulses, chili, roots and tuber crops and vegetables as *Boro* crop. In the past, much effort has been given to modernise irrigation and water management along with introduction of chemical fertilisers, pesticides, HYV seeds, extension advice, agricultural credits and improve management practices. At present, the average cropping intensity in the country is 171 percent (BBS, 1990). Because of the increase in cropping intensity the turn around period between successive crops becomes very small and farmers are often unable to prepare their land for the next crop with available human and draught animal power (DAP). Therefore, in recent days much emphasis are being given to farm power issues in appropriate farm mechanisation.

Existing Farm Power Status

Most of the power used in Bangladesh agriculture is human and draught animal power. A survey on available agricultural power sources in Bangladesh (Gill, 1981) shows that the population of farms using permanent labour, draught animal power and power tillers are 100, 62.8 and 1.4 percent, respectively. The present estimation of average farm power available for cultivation is 0.364 kW/ha (Sarker, 1995). But, McColly (1971) has indicated that the farm power needed for a minimum increase in productivity should not be less than 0.373 kW/ha. The present power availability is 0.09 kW/ha less than the above minimum requirements. Therefore, a 1477 MW total power shortage exists in the country (at 171 percent cropping intensity).

The total number of draught animal in the country is about 11.2 million (BBS, 1986). An average output of a pair of draught animal is about 0.3 kW (Sarker, 1981). Therefore, to meet the power shortage an additional 4.92 million pairs of draught animals are needed. But, the draught animal population in Bangladesh is declining due to diseases, natural disasters, high price of fodder and other factors, thus making the draught power situation worse. In the prevailing situation, mechanical power source such as power tiller (PT) must be introduced in Bangladesh agriculture as additional animal popula-tion per farm is not feasible. Presently, the number of power tillers in the country is about 1,00,000. Additional power tillers might be imported from abroad. But, rigorous economic evaluation must be done, given that mechanical powered technology is sophisticated and capital intensive, to assess the full complication of such change upon the individual farm, the agricultural sector and the economy of Bangladesh.

The discussion in the previous sections has revealed that a substitution of animal draught power by power tiller is taking place in Bangladesh agriculture. But, the farmers are not aware of the financial and economic implications of this change. In view of the urgent need for proper understanding of the situation, a study has been carried out to appraise the financial and economic impacts of agricultural mechanisation in Bangladesh, with particular reference to the substitution of animal draught power by power tiller.

METHODOLOGY

Methods of Economic Analysis

Agriculture is a dynamic industry. The changes in an agricultural enterprise take place largely because of economic reasons, together with other factors such as climatic conditions, technology, market development, government intervention etc. To face the challenge of adjustment to an ever changing financial and economic circumstances, one must be aware of profitability of the industry and the effective tool for measuring it. In this study two major on-farm financial measurement techniques have been considered. They are: i) Gross Margin (GM) analysis and ii) Partial Budgeting (PB).

Considerations for Economic Analysis

The farm holdings in Bangladesh are divided into small (Av. 0.37 ha), medium (Av. 1.25 ha) and large (Average 4.5 ha). All the farm holdings

grow similar crops in the three cropping seasons. Three main crops, namely rice, wheat and jute have been considered for present calculations. It has been assumed that farmers grow rice two-third of their land and the rest is shared by jute and wheat crop. Physical and financial data for rice, wheat and jute have been collected from the farmer of Mymensingh Sadar Thana (Table 1 and Table 2).

The operating costs for draught animal power (DAP) and power tiller (PT) have been calculated on the basis of collected data using standard procedures (Table 3).

Table 1 Physical and financial data for rice, wheat and jute crop

(I) Physical

	Unit	Rice	Wheat	Jute
Output, Yield	t/ha	1.7	1.68	1.4
Inputs :				
Seed	kg/ha	150	200	11
Fertilisers, N	kg/ha	160	120	75
P	kg/ha	60	50	25
K	kg/ha	90	70	35
Manure	t/ha	-	-	10
Chemicals	litres/ha	1.5	•1	2
Irrigation	hrs/ha	50	16.67	-
Casual labour :				
DAP system	days/ha	89	66	129
PT system	days/ha	84.5	57.5	127.5
DAP field operation	hrs/ha	180	216	136
PT field operation	hrs/ha	38	44	22

(ii) Financial (Prices)

		Rice	Wheat	Jute
Outputs: Yield	Tk/t	7000	6000	7500
Inputs:				
Seed	Tk/kg	10	8	100
Fertilisers, N	Tk/kg	8	8	8
P	Tk/kg	10	10	10
K	Tk/kg	5	5	5
Manure	Tk/t	-	-	75
Chemicals	Tk/litre	500	500	500
Irrigation	Tk/hr	30	30	-
Casual labour :		-		
DAP system	Tk/day	30	30	30
PT system	Tk/day	30	30	30
DAP field operation :				
Variable cost	Tk/hr	3.75	3.75	3.75
Fixed cost	Tk/hr	5.61	5.61	5.61
PT field operation :				
Variable cost	Tk/hr	25.57	25.57	25.57
Fixed cost	Tk/hr	16.89	16.89	16.89

Table 2 Labour and machinery requirements for selected crops

	Unit	Rice	Wheat	Jute
Common for both DAP & PT Systems :				
Seedling uprooting & carrying	days/ha	10	-	-
Transplanting	days/ha	20	-	-
Seeding	days/ha	-	2	2
Fertiliser application	days/ha	1	1	4
Weeding	days/ha	20	20	44
Spraying	days/ha	1	1	2
Harvesting	days/ha	30	30	30
Processing	days/ha	-	-	30
DAP system : Threshing	days/ha	5	10	-
Transport	days/ha	2	2	2
PT system : Threshing	days/ha	2	3	-
Transport	days/ha	0.5	0.5	0.5
Total labour requirements for DAP system (days/ha):		89	66	129
Total labour requirements for PT system (days/ha):		84.5	57.5	127.5
DAP field operation:				
Seedbed for seedling and Tilling	hrs/ha	124	120	120
Threshing	hrs/ha	40	80	-
Transport	hrs/ha	16	16	16
PT field operation:				
Seedbed for seedling and Tilling	hrs/ha	18	16	18
Threshing	hrs/ha	16	24	-
Transport	hrs/ha	4	4	4

Table 3 Operating costs of cultivation by bullock and power tiller

Operating Cost of Bullock Cultivation		Operating Cost of Power Tiller	
Purchase price of a pair of Bullock (P)	:Tk. 12,000	**Fixed cost data:**	
Salvage value (S)	:18% of P[1]	Purchase price of Power Tiller (P)	: Tk 55,000
Expected life (L)	:10 yrs[1]	Salvage value (S)	: 10% of P
Interest on Investment (I)	:5%	Working life (L)	: 5 yrs
Housing	:Tk 100/yr	Average working hours per year (WH)	: 720 hrs
Veterinary charges	:Tk 100/yr	Interest on Investment (I)	: 5%
Manure	:Tk 500/yr	Taxes and Insurance	: 1% of P[3]
Average working hours	:720 hrs/yr	Shelter	: Tk 200/yr
Daily labour rate	:Tk 30/day	**Variable cost data:**	
Daily working hours	:8 hrs/day	Fuel	: 1 litre/hr @ Tk 14/litre
		Lubricant	:1.5% of fuel consumption (in l/hr)[3] @ Tk 100/litre
Calculations:			
Fixed costs:		Repair and maintenance	: 5% of P per year
Depreciation : (P-S)/2	:Tk 984/yr	Operator	: Tk 6.25/hr
Interest on Investment : [(P+S)/2] x I	:Tk 354/yr		
Housing	:Tk 100/yr	**Fixed costs:**	
Veterinary charges	:Tk 100/yr	Depreciation : (P-S)/L Interest on	: Tk 9900/yr

(Table 3. contd..)

Operating Cost of Bullock Cultivation		Operating Cost of Power Tiller	
Feed	:Tk 3000/yr[2]	Investment : [(P+S)/2] x I	: Tk 1512.5/yr
Less (Manure)	:Tk 500/yr	Taxes and Insurance : 1% of P	: Tk 550/yr
Total fixed cost	:Tk 4038/yr	Shelter	: Tk 200/yr
Fixed cost/hr	:Tk 5.61	Fixed cost/hr:	
Variable costs :		(Fixed cost/yr)/working hrs/yr	: Tk 16.89
Labour cost per hour	:Tk 3.75	Variable costs:	
		Fuel : Consumption/hr x price/unit	: Tk 14/hr
		Lubricants : Consumption/hr x price/unit	: Tk 1.5/hr
		Repair & Maintenance : (5% of P)/WH	:Tk 3.82/hr
		Operator	:Tk 6.25/hr
		Variable cost/hr	: Tk 25.57

Source : [1] Mettrick, H. M. & D. P. James (1981). [2] Inflated due to annual inflation. [3] FAO (1990).

Calculation Procedure for Gross Margin (GM) and Net Margin (NM)

The gross margin of an agricultural enterprise is its output (yield) less its variable production costs. The enterprise output includes the market value of production retained on the farm. The variable costs must be specific to the enterprise and vary in proportion to the size of the enterprise, i.e. costs that vary directly in proportion to the level of output of the enterprise. The gross output is calculated as yield times unit price of crop. For crop production the variable cost items are identified as costs of seed, fertiliser, chemical, casual labour, variable machinery costs etc. Thus, gross margin has been calculated as gross output less total variable cost. The fixed cost items are identified as cost of machinery and permanent labour, and net margin (NM) has been calculated as gross margin less fixed costs (FC).

Calculation Procedure for Partial Budget (PB)

Partial budgeting is a marginal analysis which attempts to determine the changes in inputs, outputs, costs, revenues and profits associated with a proposed change in action, where this action does not affect the overall structure and performance of the enterprise. The effect of a partial budget is that it compares the costs of change with the benefits of change by examining the impact of that change as net income.

Considering changes in gross margin for DAP and PT systems and their fixed costs the net gain or loss incurred by the substitution of DAP by PT system have been calculated as follows :

Cost of change	Benefits of change
GM lost : Expected GM of the DAP system	**Extra GM :** Expected GM of the PT system
Extra Fixed Costs : Estimated fixed costs of PT system	**Fixed Costs Saved :** Estimated fixed costs of DAP system
Total Costs (X)	Total Benefits (Y)
NET GAIN (Y>X)	NET LOSS (X>Y)

RESULTS AND DISCUSSION

Gross Margin (GM) and Net Margin (NM) for Substitution of DAP by PT

After thorough calculation of gross margin and net margin with appropriate assumptions and considerations the results are shown in Table 4. It can be seen from Table 4 that the gross margin of the DAP system at all farm sizes are marginally greater than that of the gross margins of the PT system. As the output is the same for both systems, the differences in gross margins are because of differences in the variable costs. The work rate of DAP is much less than that of PT, thus DAP requires more hours for field operations. However, the products of unit operating cost of DAP and hours of field operation needed are still marginally less than that of PT. This is because, the unit operating cost of DAP is much less than that of PT

Table 4 Gross margins and net margins of farming systems in Bangladesh

Farm Size	Crop												Farm GM (Tk.)		Farm NM (Tk.)	
	Rice				Wheat				Jute							
	GM (Tk.)		NM (Tk.)		GM (Tk.)		NM (Tk.)		GM (Tk.)		NM (Tk.)					
	DAP	PT	DAP	PT	DAP	PT	DAP	PT	DAP	PT	DAP	PT	DAP	PT	DAP	PT
Small (0.37 ha)	610.5	570.6	361.4	412.3	208.5	204.4	133.7	158.6	138.4	138.0	91.4	115.1	957.4 (1637)	913.0 (1561)	586.5 (1003)	686.0 (1173)
Medium (1.25 ha)	2063	1928	1221	1393	707.2	689.2	451.7	535.8	467.7	466.2	308.8	388.7	3237 (5536)	3083 5272)	1981 (3388)	2317 (3963)
Large (4.5 ha)	7425	6940	4396	5015	2535	2486	1626	1929	1684	1678	1112	1399	11644 (19911)	11104 (18988)	7133 (12198)	8343 (14266)

Each farm grows 2/3 rice and 1/3 wheat and jute of total land. The number in parenthesis represent margins at 171% cropping intensity

Table 5 Partial budgets for substitution of DAP by PT at 171% cropping intensity

Farm Size	Benefits of change (Tk.)		Total benefits (Tk.)	Cost of change (Tk.)		Total costs (Tk.)	Net gain (Tk.)
	Extra GM (PT)	Fixed cost saved (DAP)		GM lost (Tk.)	Extra Fixed cost (Tk.)		
Small (0.37 ha)	1561	634	2195	1637	388	2025	170
Medium (1.25 ha)	5272	2148	7420	5536	1309	6845	575
Large (4.5 ha)	18988	7713	26701	19911	4722	24633	2068

(Table 3). Hence, despite faster work rates for PT operations, the unit costs associated make the variable cost of DAP less than those of PT and, therefore, the GM is found marginally greater.

However, the net margins of the PT system at all farm levels are found to be greater than that of the DAP system (Table 4). This is because of higher fixed cost incurred by the DAP. The fixed costs of each system (DAP and PT) have been calculated as the products of fixed cost per hour and the perating hours per hectare. The logic behind this calculation is that the farmers who own DAP or PT usually hire out the extra capacity of DAP or PT. The fixed costs are spread over the full capacity and unit fixed costs become less. It must be kept in mind that as long as the full capacity of the draught cattle and power tillers are utilised, the GMs and NMs appear to be positive, otherwise it might be negative at smaller farm levels. In Bangladesh, farmers do not consider their own labour and resources used as inputs in calculating margins. As a result, they may find better margins compared to this study. The low gross and net margins of different farms actually reflects the lower level of technology and energy input, and poor management practices in Bangladesh agriculture.

Partial Budgets for Substitution of DAP by PT

The GM and fixed cost data of DAP and PT systems obtained from previous calculations (Table 4) have been used in partial budget format and the results are presented in Table 5. Farm fixed costs are calculated from Table 4, as farm GM minus farm NM. It can be seen from Table 5 that for all three farm sizes, the substitution of DAP by PT has ended with net gains. The inclusion of timeliness of operations may also increase the net gain figures, especially in the case of larger farm holdings. So, the proposed change is worthwhile, as long as the situation remains unchanged.

CONCLUSIONS

The government of Bangladesh is no longer subsidising agricultural sectors but providing credits and extension advises to the farmers. Farmers are making decisions on their own to purchase new machines and put the technology into practice. In recent years, farmers have been buying power tillers and replacing their draught animal in tilling, threshing and transporting, and they are operating successfully with minor exceptions. The present study provides evidence of financial benefits in favour of substituting DAP by PT. PT net margins at all farm sizes have appeared better than that of DAP, and the partial budgets conclude that net gains can be made through this technology substitution decision. Moreover, a substantial power shortage in peak cropping seasons exists in the country, and unavailability of draught cattle to meet that shortage is a common phenomena. In this context, the adoption of PT might be successful if its full capacity is utilised and properly managed.

REFERENCES

BBS (1986). Report on the Livestock Survey, 178-84, Ministry of Planning, Govt. Of Bangladesh, Dhaka.

BBS (1990). Statistical Year Book of Bangladesh, Ministry of Planning, Dhaka, Bangladesh.

FAO (1990). Agricultural Engineering in Development : Selection of Mechanisation Inputs. Agricultural Service Bulletin No. 84, pp. 52.

Gill, G. J. (1981). Farm power in Bangladesh, A comparative analysis of animal and mechanical farm power in Bangladesh. Department of Agricultural Economics and Management, University of Reading, Development Study No. 19, Vol. I, pp. 37.

McColly. (1971). Proposal of agricultural mechanisation in the developing countries of South East Asia. Agric. Mech. Asia, Spring, pp. 21-25.

Mettrick, H. M. and D. P. James (1981). Farm power in Bangladesh. University of Reading, Department of Agricultural Economics and Management, Development Study No. 20. Vol. II, p. 90.

Sarker, R. I. (1981). Improved utilisation of animal draught power in Bangladesh. Proc. of Workshop on Maximum Livestock Production from Minimum Land, Bangladesh Agricultural University, Mymensingh, Bangladesh.

Sarker, R. I. (1995). Selection of farm power technology for small-farm systems in Bangladesh. Silsoe College, Bedford, England.