Backward and Forward Linkages of Power Tiller Technology: Some Empirical Insights from an Area of Bangladesh

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1. INTRODUCTION

In recent years, the use of power tiller (PT) for land preparation has risen significantly at farm level. In the year 1988, the government withdrew duties and sales taxes on PTs and also standardization restrictions were waived, opening the import of all makes and brands of diesel engines, which resulted in a rise in the number of PTs. In the meantime PTs were upgraded with operators' seat, rear wheels and adjustable multiple implements. All these modifications improved the acceptability of PTs to the farmers. As a result, the sales of PTs increased from 3,000 in 1988/89 to over 15,000 in 1989/90 (GOB, 1990). Private sector was importing PTs at a rate of over 20,000 per year and about 100,000 PTs were being used in the country by 1995. However, according to Sarker (1997) under the test relief provision, private sector had been importing over 25,000 PTs annually. The number of PTs in Bangladesh from 1988 to 1998 is shown in Table 1. The total number of PT in the field exceeded 175,000 (Sarker, 1997). A rough estimate shows that there are about 350,000 PTs currently operating in the country. In addition to tillage operation, PT utilization has also created diverse work opportunities through its backward and forward linkages.

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Table 1: Power tiller Number in Bangladesh (1988-1998)

Year	Number
1988	3000
1989	7000
1990	10000
1992	35000
1994	60000
1998	150000

Source: Adapted from Sarker (1997)

There are many actors involved in the PT service market. Generally, the importers act as wholesalers within the country. They sell it to retailers or agents who distribute these at the local market levels. The retailers sell PT to the farmers directly with some assurance/guarantee and after sale services. In some cases, they sell it against partial payment while they charge a little higher price than usual. A power tiller requires the service of a driver to operate it, mechanic to repair it and support services from workshop to repair and produce the necessary spare parts. Diesel, mobil shop/petrol pumps are also the actors in the power tiller service market. The main and ultimate actors of PT are the owners who are also the users of PT and those who are not the owner of PT but rent in PT services on payment. The present study mainly attempts to understand the business of PT service providers and assess the backward and forward linkages of the technology.

Keshabpur upazila of Jessore district, which experienced intensive use of PT, was selected purposively for the present study. The data were collected from a cluster of five villages of Keshabpur upazila. For selecting the sample, at first a complete list of 46 PT owners, 55 drivers and 11 mechanics from the selected villages were prepared by the author. Fifteen workshops were also listed from village markets and upazila markets of Keshabpur upazila. Then, 30 PT owners who were also the users of PT, 20 drivers, 10 mechanics and 10 workshops were selected randomly from the list for the present study. In addition, 30 PT user farmers who did not own PT but rented in PT services on payment were purposively selected from a para (sub-village). The data were collected from January to May, 2003. Many farmers of the sample especially PT users, mechanics and PT drivers cultivated very small area. Therefore, for meaningful presentation of data, farm sizes and other indicators were measured in terms of acres. Four case studies were conducted to understand the PT business more intensively.

2. CHARACTERISTICS OF PT SERVICES MARKET

In rural areas many farmers do not have the ability to buy PT but they buy and operate PT through mobilization of capital from bank and other sources. They generally operate and sell PT services for cropland cultivation on commercial interest. The main characteristics of PT services market for cropland preparation in the study area are given below.

2.1 No Fixed Command Area of PT

It was revealed from the study that PT had no fixed command area for its utilization. It varied from PT to PT. About 83% of PT owners reported that they went beyond their locality to cultivate others land in addition to ploughing land in their own locality. Average distance of places where an individual PT moved to cultivate land varied from 5 to 40 kilometers. The main reasons included maximizing utilization of PT, earning cash income and ploughing relative's land. It was observed that PTs command area could be quite extensive depending on communication facilities and density of PT in the area.

2.2 Small and Medium Farmers in PT Business

It is generally thought that those who buy and operate PT are the large farmers and that they get the maximum benefits from PT use. It is also argued that small farmers cannot buy PT due to their insolvency. It can be seen from Table 2 that about 30 per cent of PT owners were small farmers, 57 per cent medium farmers and only 13 per cent were large farmers. Thus, it is important to recognize that small and medium farmers got increased access to PT ownership through purchase and that they also benefited from PT service market.

Table 2: Categories of PT owners and users according to farm size

Categories of farmers	No. of respondent	PT owners Percent	No. of respondent	PT users Percent
Small	9	30	19	63
Medium	17	57	11	37
Large	4	13	—	—
All	30	100	30	100

Source: Alam, 2003

On the other hand it can also be seen from the same Table that among the PT users about 63 per cent were small farmers and 37 per cent were medium farmers and

there was no large farmer. The findings indicated that although some small and medium farmers in the society had no financial ability to buy and use their own PT, they hired the services of it. Details of costs and returns from PT operation are given in Case Study 1.

Case Study 1: Power Tiller Owner (Ganob Mollah)

Md. Gonab Mollah (40) is a PT owner. He lives at Mongolkote under Keshabpure upazila in Jessore. His family consists of 4 members and possesses 125 decimal lands. In 2003 Boro season, he alone bought a new PT with the help of an agent on condition that he (Mollah) has to pay the full price of PT in 15 installments within the 2003 Boro season. He provided about 50 percent of purchase price of PT from his own source and with loan from local Shamiti and relatives. He mortgaged out his 42 decimals of land to buy diesel and mobil in cash at a time. He collected the service charge of PT from the farmers after the harvest of paddy. For this reason, most of the farmers in his area used the services of PT from him. Although he can drive his PT, he has hired a driver to assist. According to him, he bought the PT mainly for commercial purpose. In 2003 Boro season, he ploughed about 106.26 acres of land (two times) of which 1.26 acres was his own land and 63 decimals were rented from others. His annual income earned from crops plus vegetables plus poultry was Tk. 12500.00. The gross margin for PT operation in 2003 Boro season was Tk. 47075.00. Costs saved from own use of PT for tillage operations have been considered in calculation of total variable cost. Again costs saved from own driving of PT have been considered in calculating total cost. The usual rate charged for ploughing is Tk. 476.00 and for laddering Tk. 143.00 per acre (two times) of which 10 per cent goes to PT driver. In this Boro season, he did not require any repair charge and spare parts for his PT.

Cost and return of PT operation in 2003 Boro season

Land type	Area (acres) (Tk.)	Earnings (Tk.)	Diesel cost (Tk.)	Mobil cost (Tk.)	Driver cost (Tk.)	Total cost (Tk.)
Owned land	1.26	779.94	126	110	78	314
Others land	105.00	64995	10496	1390	6499.5	18385.5
All	106.26	65774.94	10622	1500	6577.5	18699.5

Source: Alam, 2003

Total returns, variable costs and gross margin of PT

Item	Amount (Tk.)
Total Return	65774.94
Variable Cost	18699.50
Gross Margin	47075.44

Source: Alam, 2003

Case Study 2: Contract Farmer (Rafiqual)

Md. Rafiqual Alam (30) is a contract farmer from the village Kalagachi under Keshabpure. His family consists of five members. His main occupation is farming/day labourer. In 2003 Boro season, he contracted a PT owner in Mongolkote. The name of the PT owner is Md. Mohasin Golder,who lived about 20 km. from the residence of Rafiqual Alam. The contractual arrangement was that Rafiqual would pay the PT owner Tk. 170.00 per bighas (42 decimals) for two cross ploughings. How much he could collect from the PT user farmers was not the concern of PT owner. He collected money from the farmers at the rate of Tk. 200.00 and Tk. 195.00 per bigha for two cross ploughings. He provided meal and accommodation to the driver who was paid by the PT owners. He would be responsible for protecting the PT or any parts of PT from theft or any damage to PT. His duty was to collect money from the user farmers and negotiate with other farmers for cultivating their land by his contracted PT. In 2002 Boro season, he also contracted the same PT owner on the same conditions and cultivated about 70 acres land. In 2003 Boro season, his contracted PT ploughed 15 days and cultivated about 125 bighas (52.50 acres land) including his 4 bighas rented-in land for which the charge was the same. The reason for ploughing less land area this year was that few other farmers also hired/contracted PT in his area, meaning increased competition. His income was about Tk. 9500.00 by this activity.

2.3 Emergence of Contract Ploughing in PT Services Market

The contract farmer emerged as a new actor in the PT services market for negotiating and organizing ploughing by PT. For going outside areas to cultivate others land depends on the availability of contract farmers. Contract farmers usually finds out the PT owners from distant places, sometimes even outside the districts. In this case he is paid cash or a share of total income from PT use (usually 10 %) or ploughing his own land free of cost. His duty is to collect money from the user farmers, keep the PT in his disposal, provide meal and accommodation to the driver. In absence of actual PT owner, he acts as the de facto owner of PT and negotiate with other farmers intending to cultivate their land by the PT (details of contract farmer is given in the Case Study 2).

2.4 Enabling role of different Institutions for the Expansion of PT

Table 3 shows that about 50 per cent farmers purchased the PTs by borrowing from NGOs (Grameen Bank, ASHA) and local Shamities. Findings indicated that local Shamities and agents were playing crucial role for the expansion of PT, because without their assistance small farmers would not be able to buy it. NGOs provide loan to the female members for business purpose. The NGOs had no concern about whether the farmer bought PT with the borrowed money or used it for other purposes. They tried to ensure regular weekly installment from the loan

receiver. Repayment system of borrowed capital varied from institution to institution. For local Shamities and agents the terms and conditions usually depend on the proportion of capital provided by the farmer. On the other hand, the percentage of total purchase price of PT borne by the owner largely depends on the goodwill and personal relation of the owner with the institution.

Table 3: Sources of capital for purchasing the PT

Source	Percentage of total purchase price borne by the owner and institution		Number	Percentage
	Own	Institution		
Own	100	—	9	30
NGOs	50	50	8	27
Local Shamities	40	60	6	20
Agents	45	55	7	23
Total		30	100	

Source: Alam, 2003

2.5 PT Owners Renting in others PT for Land Preparation

Not all the PT owners were able to cultivate their total Boro land by their own PT. They had to cultivate on an average 36 decimals of land (13% of their total cultivated Boro land) by other PT and the charge was the same as they would charge from others. About 80% of the PT owners reported that the reason for using other PT service were to catch up with the proper time of cultivation. About one-fifth PT owners reported that their land was too far and too small in size to justify using their own PT for tillage.

2.6 Poor Rural Youths as the PT Driver

The socioeconomic characteristics of PT drivers showed that little educated rural youth were getting the opportunity to become PT driver. They had no formal training on PT driving. They were the members of small and poorer farm families. They were playing crucial role to increase their family annual gross income by driving PT for only 48 days of which 65 per cent came during Boro season. Their family had got better access to rent in more land; about 51 per cent of their total cultivated land was rented in. PT driving was the extra sources of income of their family. (Details are given in Case Study 3).

Case Study 3: Power Tiller Driver (Suzzat)

Sazzat is one of the PT drivers in Mongolkote. He is a young man of 17 years and has primary schooling. His father's name was Oziar. Suzzat is a member of a large family consisting of 6 members. He is not the only earning member of his family. His main occupation is working as a day labourer. His family possesses 20 decimal lands. In this Boro season his family cultivated 84 decimal lands, renting in additional 54 decimals. Annual gross income of his family from crops plus vegetables plus poultry was TK. 13500.00. Although he did not receive any training on PT driving, he learnt it from other PT driver by his own efforts. In this Boro season he ploughed about 84 acres land (two times). He gets 10 per cent of the earnings. He could plough 336 decimal lands (two times) on an average in a day (12 hours). He ploughed about 28 days in this Boro season. PT owner bears all costs for his illness and accident. He enjoys PT driving because people call him a driver, a skilled technical person and he accepts it as a social honour. He also drives PT in other seasons of the year. From July to December 2002, he ploughed only 15 days. His earning from PT driving for a total of 43 days was Tk. 7269.00.

Income from PT driving from July 2002 to Boro season 2003

Period	Days ploughed	Earning of drivers
In Boro season 2003	28	5199
From July to December, 2002	15	2070
Total	43	7269

Source: Alam, 2003

If he were a farm labour, his income from 43 days would be at Tk. (50×43)= 2100.00. Extra income from PT driving was Tk.5109.00.As a day labourer his annual total income besides 43 days of PT driving was Tk.16,100 (365-43=322 × 50).

2.7 Mechanics from Poor Households

Findings related to socioeconomic characteristics of mechanics showed that they came from poor households cultivating 1.18 acres of land. Most of them had no formal training on their job but had some form of education. About 26 per cent of annual gross income came from PT repairing services of which 60 per cent came from Boro season. Their owned and rented in land accounted for 45 per cent and 39 per cent, respectively of their total cultivated land. The system of rendering PT services was mainly by cash and sometimes by cash and credit. In addition to cash income, the mechanic had other benefits, i.e. preferential access to STW irrigation, PT hire services, etc. This actually allowed the mechanics to increase their cultivated land through renting in more land than before. (Details are given in Case Study 4).

Case Study 4: Rural Mechanic (Ayub Ali)

Ayub Ali (28) is an engine mechanic from Mongolkote village in Keshabure upazila. Ayub Ali's family consists of 4 members. Agriculture is the main occupation. He cultivated 84 decimals rented lands in this Boro season. He took up engine repairing work as a subsidiary occupation. He learnt engine-repairing work from a upazila workshop by working there as an apprentice for two years. Usually he has to go to owner's house or field for repairing work (PT, STW). He has contract with 3 STW owners that the STW owners will pay the repair charge in cash at the end of the Boro season. He has no contract with any PT owner. They usually pay the repair charge in cash. In this Boro season he repaired 5 PTs and earned about Tk 5000.00. The repairing charge varied from Tk. 250.00 to Tk. 600.00 per PT. He reported that repairing services varied from season to season, but were available throughout the year. According to Ayub Ali, he earned total of Tk. 30000.00 from repairing services last year, of which about 35 per cent came from PT repairing services. In this Boro season he earned less from PT repairing services due to his personal inconvenience. His annual income in 2002 was Tk. 71,530.00.

Annual incomes of rural mechanics

Items	Income (TK)	Percentage
Crops	10020	24
Vegetables	1510	4
Poultry	500	1
Repairing Services	30000	71
PT	10500	25
STW	19500	46
Total	71530	100

Source: Alam, 2003

2. 8 Competition in the PT Services Market

There was competition among the PT owners for cropland cultivation. Every PT owner tried to cultivate more land by his PT because they bought the PT for commercial purpose. They always tried to keep good relation with the farmers. In some cases they cultivated farmers' land on condition that the farmers would give him the service charges after the harvest of crop. This allowed him to cultivate more land. There was also competition among the contract farmers because they tried to cultivate more land by their contracted PTs. Sometimes they did not collect the services charge of PT from the farmers uniformly.

2.9 Profitability of PT Business

To assess profitability of PT owners for tillage operation gross margin (GM) analysis was used. Total variable cost per PT for selling services (own + others) were calculated at Tk. 20612.39 and total return was estimated Tk. 49427.00. Thus GM was estimated at Tk. 28815.00 per PT for Boro season and return per taka investment (variable cost basis) was Tk. 2.65. Driver cost and diesel cost were the main cost components which were 23 per cent and 26 per cent respectively (Alam, 2003). Case study 1 presented above illustrated cost and return of an individual PT owner.

3. BACKWARD LINKAGES

Different actors linked with PT technology in the study area create various backward linkages of the technology. Actors involved with PT technology in the study area are given in Figure 1.

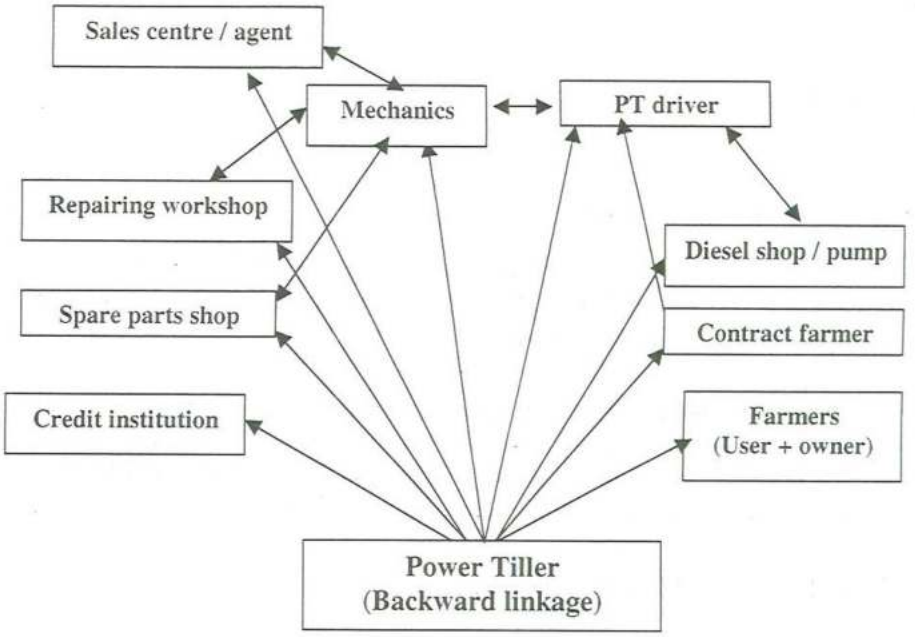

Figure 1 Actors involved with PT technology in the study area

3.1 Contractual Linkages

Number of PT owners, drivers, mechanics, diesel shops and spare parts shops were increasing significantly over the nineties (Table 4). PT owners are directly linked with sale centers, mechanics, repairing workshops, spare parts shops, credit institutions, drivers, diesel shops, contract farmers and farmers (user + owner) for

different purposes. Mechanics have a relation with sale centers, spare parts shops and repairing workshop because farmers often go to mechanics to get their help and advice to buy PT, spare parts and for repairing PT. In this case mechanics get benefit from both the parties. Some times contract farmers bridge with PT driver. It is not possible for PT owner to send PT in that area if PT owners do not have contract farmer. Contract farmer tried to convince PT drivers assuring good meal and accommodation. Sometimes PT driver helps the PT owners to decide about where to buy diesel and mobil from. So, the diesel shopkeepers try to keep good relations with PT drivers/mechanics.

Table 4: Comparison of growing PT owners, drivers, mechanics, diesel shops and spare parts shops in the study srea

Types	Number		
	Before (1990)	*In 2003*	*Change (%)*
PT owners	2	46	2200
Hired drivers	2	55	2650
Mechanics	1	11	1000
Diesel shops	3	9	200
Spare parts shops	0	3	300

Source : Alam, 2003

3.2 Growth of Local Workshop

With the increasing demand of agricultural machinery, especially PTs small workshops are rapidly growing (Table 5). An account of increasing agricultural workshops in the upazila market and study village market are given below:

Table 5: Comparison of growing agricultural workshops in the study area

Location of market	No. of workshops		Change %
	Before (1990)	In 2003	
Upazila market	3	8	166
Village market in the study area	0	1	100

Source: Alam, 2003

Most of the workshops were involved in manufacturing and repairing spare parts of PT, STW, threshing machines, etc. In the study area PT owners get the services of workshop within 1 to 2 km distance. To repair PT, the PT owners usually bought the following spare parts from the workshop: Injector nozzle, Cylinder head, Gasket, Piston ring, Cylinder liner, Piston and Fuel filter. The local workshop is now capable of fully servicing small diesel engines, PT etc. They can make major spare parts of PT.

Approximately 50 PTs were linked with the local workshops. The mechanics took 25 percent commission of their earnings from workshop. The owners of the workshop received the repairing costs of PTs in cash but in some cases in cash plus credit. It was observed that most of the workers in the local workshops had shifted from the traditional farm work. They were mostly illiterate and had no formal skill training at all. They had acquired knowledge and skill through apprenticeship at workshops. In the first year of apprenticeship they did not get any money from the workshop, but later on they got some income for their work in the workshops.

4. FORWARD LINKAGES

4.1 Growth of Agro-based Industries

It was revealed from different studies (Ahmed, 1992 and Gill, 1981) that PT had significant positive contribution to increasing production. Gill (1984) noted that PT can increase production by permitting timely planting and faster turn around between a crop, which in turn facilitates increased yield, greater cropping intensity and the possibility of introduction of new crop rotations. When production increases, more agro-based activities also are developed. As a result more opportunities for productive work are created. Figure 2 shows the growing small-scale agro-based industries in the study area. These small scale agro-based industries as a result of large-scale use of PT and other technology create forward linkages. It offers great scope for capital investment by the individual entrepreneurs, which will open up new employment avenues for the ever growing rural people. For the development of these growing agro-based industries continuous supply of raw materials should be ensured. To ensure the supply of raw materials we have to augment our production faster than before with our limited land resources. A list of growing agro-based industries in the study areas is given below (Table 6).

Table 6: Comparison of growing agro-based industry in the study area

Activities	Number		Change (%)
	Before (1990)	In 2003	
Paddy & wheat milling	3	7	133
Paddy parboiling	2	4	100
Chira making mill	0	1	100
Oil seeds crushing mill	2	3	30
Total	7	15	—

Source: Alam, 2003

A number of people (men and woman) were employed (permanently and casually) in agro-based industries and earned more income than before (according to their opinion). The processing and marketing of primary agricultural products created forward linkages and enhanced profitability of crop production through value addition.

4.2 Growth of Rural Non-farm Activities

The growth of the rural economy is the key to support accelerated growth of agriculture. PT technology coupled with other technology has contributed to the growth of agriculture and linkage between agriculture and rural non-farm sector. The whole range of activities created by backward and forward linkages of power tiller technology are characterized as rural non-farm activities. These linkages increase the employment opportunity and income of the rural people, which in turn has contributed to the reduction of poverty. Nevertheless, at the present stage of development of Bangladesh agriculture and given the constraints in resource availability, the priority is to ensure productivity growth.

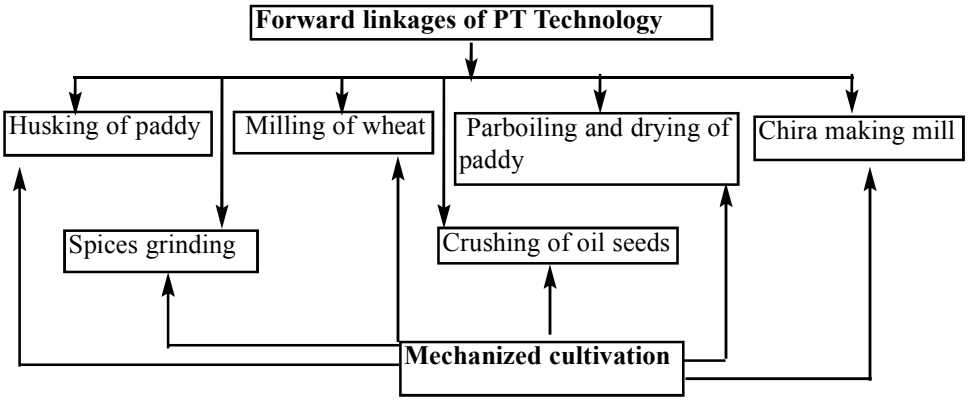

Figure 2: Growing small scale agro-based industries in the study area

5. CONCLUSIONS AND RECOMMENDATIONS

PT contributes to accelerating rice production by increasing cropping intensity and changing cropping patterns. It also increases demand for human labour in non-farm activities. From the study it can be seen that PT together with other technology has opened up new opportunities of non-farm activities for rural labourers through its backward and forward linkages. Hence, the present stage of farm mechanization along with irrigation, fertilizer and other technologies can be treated as complementary to employment generation. The people who have

initiatives, risk bearing ability and a reasonable entrepreneurship, are taking up PT technology as a business. So, the blame against PT for causing labour displacement, widening income distribution and imbalances in rural economy of Bangladesh does not stand up to empirical test. The government policy on selling PTs through the open market operation should be continued so that farmers can purchase PT from local markets at competitive price. Credit facility to the farmers should be provided on easy terms and conditions so that they can purchase PT on their own and make the business more competitive, which will eventually lead the operation cost to come down. Formal training arrangements on proper operation and maintenance of PTs can be made available for PT owner, driver and mechanics through private sector workshops. Therefore, steps could be taken in this regard by government and private organizations. Government should ensure enabling environment i.e. physical infrastructure, electricity, etc to ensure quality of locally manufactured spare parts. Private sector workshops should be encouraged to provide training on their job. Government should ensure necessary assistance and help to private entrepreneurs for capital investment in the new portfolios created by the backward and forward linkages of PT technology. Considering the impact of PTs, extension workers, NGOs and private sector should come forward to encourage farmers to adopt PT and go for mechanization.

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