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Consequences of Small-Farm Mechanization

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CAUSES AND CONSEQUENCES OF POWER TILLER UTILIZATION IN TWO AREAS OF BANGLADESH

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Causes and consequences of power tiller utilization were examined using data collected from 63 tiller owners and 56 nonowners. Timely and quick cultivation, difficulty in managing large numbers of animals, low cost and better quality tillage, and animal shortage were the main reasons for purchasing tillers. Costs were low because of distortions in the prices of tillers and fuel. Unavailability of spare parts and lack of repair facilities were major problems. Tiller use increased size of cultivated holding, decreased regular labor, evicted tenants, changed tenure status, increased cropping intensity, and increased machine orientation of farmers. The findings indicated that mechanization of tillage would greatly benefit rich farmers at the expense of small and marginal ones.

The level of tillage mechanization in Bangladesh is quite low, with more than 98% of the land cultivated by bullockdrawn plows. There is, however, a growing shortage of power because long-term neglect of the livestock sector has resulted in decreased availability of bullocks. Use of mechanical power has not increased fast enough to fill the gap. The power gap, along with other factors, has probably been responsible for the slow growth of output and employment, and unless that gap is immediately filled, growth of agriculture might be further constrained (Jabbar 1980). The use of mechanical power has grown very slowly. Causes of the slow growth need to be identified and eliminated before any rapid increase can take place. The consequences also need to be measured for appropriate policy making.

A survey of power tiller owners and nonowners was conducted in two selected areas to:

- Identify the reasons for buying or not buying tillers;
- Study the characteristics of the tillers and the process of their acquisition and operation;
- Identify factors affecting the nature and extent of tiller use; and
- Measure the consequences of tiller use on selected aspects of the farm business, particularly 1) ownership of animal power, 2) ownership of land, 3) cultivation

of land, 4) tenure status, 5) cropping pattern and intensity, 6) employment of labor, and 7) machine orientation.

SELECTION OF AREA AND SAMPLE

Since the early sixties, 6,362 power tillers have been imported, of which 4,278 were reportedly sold to the private sector on highly subsidized credit provided through the Bangladesh Krishi Bank (BKB). The actual number and geographical distribution were not known but it was believed that operational tillers were scattered throughout the country, with a few small pockets of higher concentration. Mymensingh District and a cluster of four villages in Munshigonj Thana of Dacca District were selected as areas of low and high tiller density, respectively. The four Munshigonj villages were about 3 miles south of Munshigonj Thana headquarters. Mymensingh District covered over 10,000 km² while the 4 Munshigonj villages covered about 7.7 km².

Preliminary fieldwork revealed that a large number of tillers had been sold by the original owners, some to buyers outside Mymensingh. A large number of tillers had been out of operation for a number of years, and some operating tillers had been purchased from sources other than BKB. Complete enumeration showed 34 operational and 26 nonoperational tillers. Apparently, more than 150 tillers sold by BKB had been resold outside Mymensingh. Subsequent analyses were based on data collected from these tiller owners plus data from 26 nonowners located in the same villages.

Of the 29 operational tillers found in the four Munshigonj villages, 73% were in 1 village, South Char Masura. Data were collected from all 29 owners plus 22 nonowners on 3 visits to each farm.

REASONS FOR BUYING AND NOT BUYING TILLERS

Reasons for buying tillers

Tiller owners were asked their reasons for purchasing tillers. Nonowners were asked whether they were interested in buying and, if so, why. Fifty-six percent of nonowners in Mymensingh and 82% in Munshigonj expressed interest in buying tillers. The relative importance of the reasons varied among owners and intending owners and also between the two areas. In general, frequently stated reasons included increased output, reduced costs, and reduced drudgery (Table 1).

The implications of some of the responses need explanation. First, 30% of both owners and intending owners reported a shortage of animal power. Only 8% of intending owners mentioned labor saving. This supports recent findings of a significant shortage of animal power, which machines would overcome (Jabbar 1980).

Second, 67% of the owners and 24% of intending owners expected tiller cultivation to be cheaper. At market prices, bullock cultivation was found to be 3-5 times more expensive than tiller or tractor cultivation (GOP 1970, Lawrence 1970, Mian and Hussain 1975) because the overvalued currency underpriced both tillers and fuel by 40-50%. At real prices, tractor or tiller cultivation was found to be 2-3 times more expensive than bullock cultivation (Lawrence 1970). Such distorted markets encourage substitution of animals by machines even in situations where labor is still plentiful and cheap.

Table 1. Distribution of reported reasons for purchase and intended purchase of a tiller.

Reported reasons	Owners (%)		Intending owners (%)	
	Mymensingh	Munshigonj	Mymensingh	Munshigonj
Timely/quick cultivation by tiller	100	100	45	16
Animal management difficult	50	100	10	17
Cheaper cultivation by tiller	82	48	25	22
Better land preparation	50	14	55	17
Animal power shortage	15	48	30	28
Multiple uses of tiller	18	10	-	-
Tiller custom service	-	13	5	33
Available on credit	12	3	-	-
Good for puddling dry hard soil	6	3	-	-
Labor saving	-	-	-	-
High death rate of weak animals	-	-	10	-
Sample size	34	29	18	18

Third, it has been argued there is a technical limit to the optimum size of a farm using animal and human labor. One reason is the management problem. Seventy-three percent of the owners and 14% of the intending owners indicated they had difficulty managing a large number of animals. Large landholders generally cultivate land up to that technical limit and rent out any excess. But engine power was expected to, and did, induce more self-cultivation (Jabbar 1977, 1980).

Fourth, one-third of the intending owners, mostly in Munshigonj, wanted to buy a tiller so they could provide custom services. Custom operation was already booming in Munshigonj and intending buyers might have been influenced by the prospects.

Fifth, only 7% of the owners mentioned availability of credit as a cause for buying a tiller. Credit was available for purchase of all new tillers.

Reasons for not buying a tiller

The reasons nonowners did not buy a tiller are in Table 2. More than 50% of the nonowners were interested in buying when their neighbors bought, but they could not because of capital shortage or unavailability of tillers. Most nonowners not interested in a tiller were located in Mymensingh. Their primary reasons were related to repair and maintenance. Many of the current tiller owners already face this major problem.

Table 2. Distribution of nonowners' reported reasons for not purchasing a tractor.

Reported cause	All nonowners (%)		Unwilling nonowners (%)	
	Mymensingh	Munshigonj	Mymensingh	Munshigonj
Lack of capital	38	18	-	-
Not available	21	21	-	-
Could not manage to buy	-	14	-	-
Lack of knowledge or experience with machine	6	23	14	-
Had/have adequate bullocks	6	14	29	-
Operation, maintenance, repair problems	15	5	85	50
Did not like machine	12	5	-	-
Animal cheaper	6	5	36	50
Sample size	34	22	16	4

CHARACTERISTICS, PROCESS OF ACQUISITION, AND OPERATION OF TILLERS

Brand and capacity

Tillers were either received as grant aid or imported on credit from Japan. Of the sample, 48% were Yanmar, 40% Mitsubishi, and 6% Kubota and Isaki. However, 70% in Mymensingh were Mitsubishi and 83% in Munshigonj were Yanmar.

Tiller capacity was 6-10 hp. Ninety-two percent of the Mitsubishi tillers were 6-8 hp and 82% of the tillers in Mymensingh were 6-8 hp. In Munshigonj, 55% were 6-8 hp and 45% were 8-10 hp.

Additional equipment and tiller

In Mymensingh, 50% of the tillers were purchased with one or more attachment. Attachments reported were pump (25%), trolley (23%), hauler (6%), and furrower (6%). Nine percent of tillers were purchased without additional equipment, but the owners bought them later. In Munshigonj, only one tiller was purchased with a pump attachment and two other owners purchased threshing equipment later.

Most owners of tillers with no attachments wanted to buy and those with some wanted more. In Mymensingh, tiller owners wanted to buy a trolley (35%), pump (32%), hauler (24%), and equipment for threshing, seeding, and electric generation (12%). In Munshigonj, 34% wanted a trolley and 65% wanted a pump.

Source and time of purchase

The government first imported tillers for experimental purposes, but a few were subsequently sold to farmers. Later tillers were imported and distributed through the BKB and also through private dealers who generally sold on credit from BKB. During 1972-74, the Bangladesh Agricultural Development Corporation (BADC), the public corporation responsible for import and distribution of agricultural inputs, distributed tillers with BKB providing credit.

Acquisition dates suggest that tillers have been used longer in Mymensingh than Munshigonj. In Mymensingh, 32% of the tillers were purchased during 1963-68, 41% in 1969-74, and 27% in 1975-80. For Munshigonj, the corresponding figures were 7%, 24%, and 69%, respectively. Sources for purchase of tillers are in Table 3.

Secondhand purchases from other farmers have increased consistently. In Mymensingh, secondhand tillers were 44% compared to 55% in Munshigonj. Six percent were more than 6 years old at the time of purchase, 39% were 5-6 years old, and 39% were 3-4 years old. The main reasons for selling were repair, maintenance, and operational problems.

Tiller price and sources of capital

Tiller prices varied with time of purchase, machine condition, brand and capacity, number and type of accessories included, type of payment, and supply source. For new tillers brand and capacity and supply source had minimal effect. An index of average price by time of purchase, and tiller condition is in Table 4. Up to 1974, prices were quite low, and secondhand tillers were sometimes more expensive than new ones. After 1974, the price of new tillers increased about 300%, but prices of secondhand tillers remained fairly constant.

All tillers purchased on full cash were secondhand and those purchased on full credit were new. Although they were purchased from BKB, BADC, and private dealers, BKB provided the credit in all cases. With part cash payments, 38% of the price was paid in cash. Most tillers purchased with part cash were new and supplied

Table 3. Percentage of tillers purchased from different sources by period.^a

Period	sources (%) of supply			
	Dealer	BKB	Other farmers	Others ^b
1963-65	33	67	-	-
1966-68	50	40	10	-
1969-74	14	58	14	14
1972-74	7	7	29	57
1975-77	-	50	38	12
1978-80	10	19	71	-
All periods	16	31	38	15

^aSource: Field survey 1980. ^bInclude tiller mechanics, Foreign Voluntary Agency, and Bangladesh Agricultural Development Corporation.

Table 4. Index of average price by time of purchase and condition of tiller.

Period purchased	Index of av price			
	Mymensingh		Munshigonj	
	New	Used	New	Used
1963-65	1.00	-	-	-
1966-68	0.90	1.20	0.78	-
1969-71	1.00	-	1.06	1.51
1972-74	0.76	1.01	1.94	-
1975-77	4.23	0.68	4.24	2.00
1978-80	3.05	1.63	3.58	2.23

by BKB, BADC, or a private dealer with BKB credit. Most sellers of used tillers accepted part cash payment. In two cases, full cash payment was made by borrowing from private lenders. The interest rate for BKB credit increased from 5% in the mid-1960s to 10% in the late-1970s.

Of 36 owners purchasing with credit, 64% had repaid fully, 25% partially, 6% not at all, and 5% had not yet reached the repayment stage. The number of defaulters was similar in both areas, but those in Mymensingh had been defaulting longer, some since 1966.

Characteristics of tiller operators

Respondents were asked who operated the tiller during the survey year. In Mymensingh, 12% used only family members, 32% annual hired labor and family members, 35% only annual hired labor, 12% hired tiller drivers, and 9% hired tiller drivers and family members. In Munshigonj, 14% used only family members, 45% hired tiller drivers, and 41% hired tiller drivers along with family members.

Over 90% of the family members operating tillers in Mymensingh had some secondary education and 15% were high school graduates. In Munshigonj, more than 40% of family tiller operators had no formal education and none had above secondary education. In both places, few tiller operators from the other categories had any education; none were educated beyond primary level.

Nine percent of the tiller owners in Mymensingh and 35% in Munshigonj reported receiving no training in tiller operation and maintenance. They learned mostly from other tiller drivers. Those receiving training obtained it predominantly from sellers: 29% of owners in Mymensingh and 48% in Munshigonj reported that a member of the family, who was trained by the supplier, taught other family members and hired laborers.

Major and minor breakdowns

The number of major breakdowns of the tillers since acquisition is in Table 5. Breakdowns increased with the tiller age at the time of purchase. The main reasons given for breakdowns were overturning during operation, loose-fitting parts, irregular gasoline delivery, and excessive or insufficient oil use. No owners could specify the reason for the third and fourth major breakdowns and 54% could not name the cause of the first and second major breakdowns.

During 1978-80, 64, 23, and 13% of the owners reported doing 1 to 4, 5 to 8, and more than 8 minor repairs, respectively. Repair frequency was significantly higher in Munshigonj. Average repair costs for the 2 years were \$24 in Mymensingh and \$41 in Munshigonj, and 20 and 14 potential work days, respectively, were lost.

Table 5. Major breakdowns of tillers by region.

Breakdowns (no.)	Mymensingh (%)	Munshigonj (%)
0	29	52
1	35	28
2	27	17
3 and 4	9	3

Repair facilities

Service guarantees, ranging from 1 to 3 years, were assured for 79% of the new tillers purchased in Mymensingh and 56% in Munshigonj. No guarantee was available for used tillers. Of those with service guarantees, 59% reported receiving proper service, 14% did not require service, and 27% (located in Mymensingh) did not get service apparently because of problems with suppliers.

In Munshigonj, repair facilities were available within 8 km. In Mymensingh, 30% of owners reported that the nearest repair shop was more than 64 km away, 30% reported between 32 and 64 km, and the remainder reported between 8 and 32 km. Tillers usually had to be hauled to repair shops on trains, trucks, boats or bullock carts, and then most of the repair shops did not stock sufficient parts. Sometimes transportation was not possible and mechanics, who charged very high fees, were called.

Tiller problems

The main problems in tiller use were unavailability of spare parts, lack of repair facilities, high priced spare parts and fuel, and unavailability of pure diesel (Table 6).

EXTENT OF TILLER USE AND RELATED FACTORS

Information on the extent of tiller use was collected from the owners for 1976-77 to 1979-80. For 1979-80, data were collected for each operation whereas for the 3 other years, the limited records kept by the users were supplemented by their recollections. Annual use varied from 640 to 696 hours in Mymensingh and from 1,144 to 1,432 hours in Munshigonj. Detailed analysis is based on 1979-80 only.

Various characteristics of tiller users in Mymensingh and Munshigonj are in Table 7. In Mymensingh, only 38% of the owners provided custom services, compared to 97% in Munshigonj. Custom services accounted for 9% and 59% of total operations, respectively. Possible reasons for the lower level in custom services in Mymensingh are fewer repair services and large landowner concern about loss of status in the area.

Forty-eight percent of the owners in Munshigonj traveled 16-40 km, usually by boat to provide custom services and another 11% traveled 8-10 km. Farmers with

Table 6. Problems in tiller use reported by owners.

Problem	Mymensingh (%)	Munshigonj (%)	All areas (%)
Unavailability of spare parts	94	76	86
Frequent breakdown	38	17	29
Lack of repair facilities	41	14	29
High price of spare parts	35	3	21
High price of fuel	35	7	22
Unavailability of pure diesel	15	31	22
High charge for mechanics	6	3	5
Lack of training facility for repair work	3	-	2
Lack of efficient tiller driver	3	-	2

Table 7. Extent of tiller use in 1979-80.

Characteristics	Mymensingh		Munshigonj	
	Farms (%)	Hours/farm	Farms (%)	Hours/farm
Type of work				
Tillage only	62	496	100	1192
Tillage and other tasks	38	1008	-	-
Area cultivated (ha)				
Under 6.0	23	116	52	872
6.1-8.0	23	536	21	1448
8.1-10.0	15	864	14	1800
10.1-12.0	8	1864	3	1960
12.1 and over	31	824	10	1224
Type of family				
Single	68	568	56	1088
Joint	32	916	44	1328
Past experience in machine use				
Yes	53	864	21	1304
No	41	424	73	1152
Main income source				
Farming	47	504	35	1352
Farming and business	44	752	62	1096
Farming and service	9	960	3	1400

inadequate, or no, draft animals bought tiller services. Twenty-four percent of the owners reported charging lower custom rates in distant places, but still making a profit because custom services were done after finishing their own work.

Tiller use increased with size of cultivated holdings up to 12 ha and then declined sharply. This size effect was indirectly reflected through type of family because most joint families had larger holdings.

Owners with experience in handling different types of machines used the tiller longer than those without such experience. Experienced owners could do minor repairs, getting more use from the tiller. In Mymensingh, owners who had income from business or services as well as farming had better external contacts which helped them locate mechanics, manage parts, and make quick repairs.

CONSEQUENCES OF TILLER USE

There are three approaches to measuring the effects of tiller use. First, tiller owners and nonowners may be compared at a given time with differences attributed to tiller use. The main problem with this approach is that owners and nonowners may differ in respects unrelated to tiller ownership. The second approach involves before-and-after comparison, with any differences attributed to the tiller. Here the main problems are that other changes might have taken place simultaneously and "before" data must be collected by recall, which is less reliable. The third possibility is to combine the cross section and time series approaches (Binswanger 1978). All three approaches were used in this study.

Effect on animal ownership

Tiller ownership was expected to have an immediate effects on work animal ownership. Changes in the number of owned work animals and the number per cultivated hectare are in Table 8. On the average, 2-2.5 animals were replaced by a power tiller. The degree of substitution was much higher in Munshigonj where 53% of tiller owners completely replaced their animals. Although only 3% of the farms in Mymensingh replaced all their animals, some of the larger ones replaced 5 or 6, yet still retained several because: 1) the tiller was not considered fully reliable, 2) the tiller was not suitable for puddling in low-lying areas or for preparing dry hard soils in summer, 3) land preparation with a tiller followed by laddering with animals gave better results, 4) during short sowing or planting seasons some larger farmers needed to supplement their tiller power with draft animals, 5) some farmers had increased their operational holdings beyond the capacity of one tiller, and 6) animals were fed mostly on crop by-products and could be retained for investment at little additional cost.

Effect on land ownership and tenure

Those who bought tillers in both areas normally had larger forms than those who did not (Table 9). By 1979-80, the farms in all categories were significantly larger, but the relative differences between owners and nonowners remained similar. Indeed, a substantial proportion of farmers had acquired additional land whether they had tillers or not. Tenure status of tiller owners and nonowners in both areas changed substantially. However, the impact of the tiller on and changes could not be ascertained.

Table 8. Changes in work animal ownership on farms of tiller owners and nonowners.

	Mymensingh		Munshigonj	
	Owner	Nonowner	Owner	Nonowner
Number of animals/farm				
Before tiller purchase	7.3	6.4	3.6	3.1
1979-80	5.3	6.8	1.1	2.4
% change	-27	+6	-70	-23
Number of animals per cultivated ha				
Before tiller purchase	0.22	0.20	0.17	0.19
1979-80	0.11	0.19	0.05	0.13
% change	-48	-8	-69	-33

Table 9. Changes in size of land ownership of tiller owners and nonowners.

	Land ownership			
	Mymensingh		Munshigonj	
	Owner	Nonowner	Owner	Nonowner
Year before tiller purchase (ha)	8.64	6.23	3.15	2.70
1979-80 (ha)	9.53	7.10	3.87	3.36
% change	10	14	23	25

Effect on cultivated area

There were negligible differences in the average size of cultivated holdings of tiller owners and nonowners in both areas at time of purchase (Table 10). By 1979-80, the average size of cultivated holdings of tiller owners and nonowners had increased in both areas. The difference between the two groups increased in Mymensingh but not in Munshigonj.

Regardless of tiller ownership, most farmers increased their areas under cultivation, and the predominant mechanism was acquiring new land (Table 11). Tiller owners in Mymensingh also increased their cultivated holdings by using land previously rented out or left fallow. Previously rented out land was used by 81% of tiller owners in Mymensingh, compared to only 33% in Munshigonj.

Effect on cropping pattern and intensity

Because farmers could not be expected to recall crop areas accurately over several years, cropping pattern and cropping intensity differences of the two groups were compared using average cropping patterns for 1978-79 and 1979-80. The proportions of irrigated crop area and of area devoted to high-yielding varieties (HYV) were similar for owners and nonowners in both areas. However, contrary to the findings of Gill (1979, 1980), cropping intensity differed markedly between the two groups in Munshigonj. It is likely that the increase in cultivated area in Mymensingh and in cropping intensity in Munshigonj was the result of different initial sizes of holdings.

The increased cropping intensity in Mushigonj was accompanied by greater diversification. A decrease in the paddy area on farms with tillers was accompanied by increases in the areas for potato, jute, mustard, and wheat.

Table 10. Changes in sizes of cultivated holdings of tiller owners and nonowners.

	Cultivated holdings			
	Mymensingh		Munshigonj	
	Owner	Nonowner	Owner	Nonowner
Year before tiller purchase (ha)	4.75	4.80	2.92	2.63
1979-80 (ha)	7.59	5.95	3.61	3.11
% change	60	24	24	18

Table 11. Sources of additional cultivated land.

Source of land	Additional cultivated land (ha)			
	Mymensingh		Munshigonj	
	Owner	Nonowner	Owner	Nonowner
New land acquired	0.89	0.87	0.72	0.66
Cultivation of previously rented out land	1.42	0.35	-0.08	-0.19
Cultivation of previously fallow land	0.60	-0.06	-	-
Mortgaged land	-0.03	-0.01	0.05	
Total additional land cultivated	2.84	1.15	0.69	0.48

Table 12. Changes in regular hired labor employment by tiller owners.

Location, time period	Hired labor/farm						Total no./cul- tivated ha
	Annual plowman	Seasonal plowman	Other annual labor		Tiller driver	Tenant farmer	
			Male	Female			
Mymensingh							
Before tiller purchase (no.)	2.15	0.79	3.90*	0.90*	-	7.00	14.74
1979-80 (no.)	1.68	0.38	3.60*	1.00*	0.20	3.00	9.86
% change	-22	-41	-8	+11	+*	-57	-33
Munshigonj							
Before tiller purchase (no.)	0.66	0.31	0.90	0.30	-	2.00	4.17
1979-80 (no.)	0.28	0.14	0.60	0.30	0.86	2.00	4.18
% change	-59	-55	-33	-	+*	-	-
							-21

*About 20% below 14 years old.

Effect on employment

Although the introduction of tillers may have various effects on employment, the only one measured was the effect on regular hired labor. This was done using a before-and-after comparison (Table 12). In Mymensingh, there was a negative, aggregate impact on regular employment per farm; in Munshigonj, employment per farm remained constant. In both areas, however, use of regular labor per hectare declined.

Most of the evicted plowmen were working as casual laborers on the same farms or elsewhere, and some got plowing jobs elsewhere. About 60% of the evicted tenants in Mymensingh were cultivating their own small holdings, or renting. Others became day laborers.

Tiller use has changed the pattern of family labor participation in farming. For example, the number of families having members working as plow drivers declined from 12% to 3% in Mymensingh and from 45% to 2.1% in Munshigonj following tiller introduction. On the other hand, 54% of the families had members working as tiller drivers in 1979-80. Other changes included increases in the number of family members participating in farm activities, hours worked per person, and increase in supervisory work.

Effect on machine orientation

After purchasing tillers, owners wanted to buy more equipment. However, lack of money and available machinery limited additional purchases. Although most desired machines are labor displacing, some have potential for indirect employment expansion.

CONCLUSIONS

Machine use is being encouraged by distorting market prices in a situation where animals are in short supply, but labor remains quite cheap. Such policies may be justified if tiller use increases output, but there is little supporting evidence. The large scale introduction of tillers appears likely to benefit the rich farmers, at the expense of small and marginal ones, through employment, tenancy, land accumulation, and machine orientation. Detailed studies, incorporating mechanization of other farm operations, are required if there are to be sound farm mechanization policies.

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