ANIMAL POWER SITUATION IN BANGLADESH

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ABSTRACT

This paper emphasizes that draught power has received inadequate attention in the process of formulating and implementing agricultural development programmes. The conventional method of measuring draught power adequacy in terms of the number of animals available in relation to requirement is questioned. Disaggregation according to age, sex and health of draught animals, their spatial and temporal distribution, and distribution across farm size groups show that there is substantial shortage of drought power in the country. Large scale use of cows for draught purposes has been shown as a problem of serious concern because of the long term negative effect on fertility and milk production. At the end, some suggestions have been made with a view to ease the power problem.

INTRODUCTION

The main objective of agricultural policy in Bangladesh during the last two decades has been to achieve self-sufficiency in foodgrain production. Since there was no unused land to be brought under cultivation, raising crop yield and increasing cropping intensity through the use of irrigation, fertilizer and HYV seeds were adopted as strategies to achieve the objective. Major research, extension and credit facilities have been directed toward cereals and substantial foreign assistance has been received in these fields.

So far, self-sufficiency in foodgrain production has remained an elusive target because growth rate in foodgrain production has remained far behind the growth rate in population. The overall performance of the crop sector has been poor. Inadequate investment in agriculture, substantial under utilization of irrigation capacities, sub-optimal used of fertilizers, unfavourable agrarian structure (farm size and land tenure system) are generally identified as major reasons for the poor performance of agriculture.

Though power is an important component of production technology, little attention has been given to expand the power base of agricultural operations except in the case of irrigation. The area now comprising Bangladesh is one of the earliest user of animal power for crop production. For many reasons, animals still provide nearly all the power for tillage, a substantial amount of power for threshing paddy, crushing oilseeds and sugarcane, and for transportation of goods. It has been generally reported in planning and other documents that since the early 1960s there was some shortage of animal power in the country. But the nature and dimension of shortage has not been properly identified and quantified nor has this shortage been considered a constraint on the success of the

crop production strategy, particularly the expansion of seed-fertilizer-water technology (see for example, Pakistan 1970; Lawrence 1970s; Bangladesh 1973; FAO 1977; Bangladesh 1978; Hossain 1973; Hossain 1980). Only in the Second Five Year Plan (1980-85), the problem has been given some appreciation:

"…This low level of availability [of animal power] is due to almost doubling of human population, reduced availability of feeds and fodder and traditional negligence of the sector during the past 30 years. If this situation is allowed to continue, the programme for doubling of food production is bound to suffer seriously for shortage of draught animal power and malnutrition will continue to pose a serious threat to the vast vulnerable group of the human population. Livestock development, therefore, deserves a high priority not only for production of livestock products but also for production of crops …"(Bangladesh 1980, pp.xii-69).

An adequate and expanding power base is obviously essential to expand agricultural production which is particularly essential for poor Bangladesh. Therefore, an objective analysis of the nature of the power problem can be adapted to give new insights into strategies for the development and eventual extension of appropriate technology congruent with the existing farming system. In Bangladesh, the forms of appropriate technology will be dominated by animal power for many more years.

The main objective of the paper is to analyze the nature and extent of animal power shortage in the country. In doing so, the problems of conventional method of measuring shortage are discussed and alternative indicator of shortage suggested. Possible ways of solving the power problem are also suggested.

PROBLEMS OF MEASURING ADEQUACY OF ANIMAL POWER

Shortage in animal power availability has been generally defined for the country as a whole by the difference between the number of animals available and the number of animals required for cultivation. Requirement has been generally estimated on the assumption of a pair of bullock to every 4 acres of cultivable land irrespective of the intensity of cropping. There are a number of pitfalls in this method of measuring adequacy. First, statistics on the availability of draught cattle is very poor. Second, adequacy may vary between regions and between different types and sizes of farms. Animals are indivisible, consequently the ratio of a pair of bullock to every 4 acres may not be relevant for all farms. Third, agricultural operations being highly seasonal, adequacy in the peak seasons is more important than year round adequacy. In fact, substantial excess capacity may exist in off-peak seasons. Fourth, quality of animals reflected in age, sex and health may be such that the number of animals may not be a proper proxy for the actual amount of power available. Moreover, quality of animals may vary across regions and sizes of farms. These issues are discussed further giving supporting empirical evidence.

Livestock Statistics

Livestock statistics in Bangladesh is very poor[1]. Estimate of the total cattle population in recent years range from 18.3 million to 31.0 million and there is similar variation in estimates of the number of draught animals (Table 1). Estimates for 1960 and 1977 are based on livestock component of the Agricultural Census conducted in those years. The exact basis of estimate for the other years has not been made known[2]. Estimates for 1970-71 and 1972 are unusually low because of an estimated loss of 0.47 to 2.8 million cattle during a cyclone in November 1970 and an estimated slaughter of about 2.3 million cattle for meat by the Pakistani Army during the War of Independence in 1971 (Samad 1971; Mettrick 1976; Odend'hal 1978).

In 1960 and 1977, there were 2.04 and 2.28 draught animals respectively for every 4 acres of cultivated land. Thus in the aggregate there was no shortage of draught power in terms of number of animals in those two years. However, given the rather dubious reliability of the data for all other years adequacy measurement is likely to be highly inaccurate, even when other considerations discussed below are not taken into account.

Inter-regional and Inter-farm Differences in Adequacy

Level of adequacy may differ between regions and between sizes of farms. Cattle and draught cattle densities in different districts of Bangladesh in 1977 are shown in Tabe 2. Inter-district comparison indicates substantial differences in human, cattle and draught cattle densities. There is strong positive correlation between densities of agricultural population and cattle ($r = 0.65$, $P<0.01$) and between densities of agricultural population and draught cattle ($r = 0.59$, $P< 0.01$)[3]. These associations may be partly explained by the fact that densely populated districts also have smaller size holdings which tend to maintain relatively more cattle or draught cattle per unit of land than larger holdings (Table 2). These relationships are observed more clearly when farms are classified according to size of holding (Table 3-4). Both population and cattle densities are negatively correlated with size of holding but population and cattle densities themselves are positively correlated. It indicates that labour rather than land is a more important factor for small holdings and landless in their ability to rear animals. Labour

[1] Quality of crop statistics is much better than that of livestock statistics yet there are numerous examples of unjustified policy decisions and unnecessary debates resulting from inaccurate official statistics on crop acreage, yields, irrigation and fertilizer application (Pray 1980, pp. 1-2).

2 The Thana Livestock Officers under the Directorate of Livestock Services are supposed to collect livestock statistics. If this is the source of yearly data reported in Statistical Yearbook, the cause of frequent revision of published data needs to be explained (see for example, Bangladesh 1977, pp. 165-6, Bangladesh 1982, pp. 282-4). [2]

[3] Mukherjee wrote many years ago, "… it is one of the striking economic paradoxes in India that the provinces which have the smallest crop area per capita maintain the largest number of cattle. In fact the density of bovine population per crop area varies directly with human population density and inversely with the crop area per person" (Mukherjee 1938, p. 130). Unaware of this statement, Vaidyanathan et al (1979) postulated and tested a number of hypotheses including Mukherjee's above statement.

permits supervision of animals scavenging on boundaries of crop fields, road sides or other grazing areas, and collection of grass, crop residues from distant places.

Higher draught cattle density on smaller farms is partly due to the indivisibility of work animals. Because of indivisibility number of draught animals maintained on the farm is more stepped than land ownership (Tables 4-5). First, compared to Moymonshingha, a higher proportion of farms in Bogura are without draught animals. Since population and cattle densities in Bogura were earlier shown to be higher than in Moymonshingha, the difference support the hypothesis postulated by Vaidyanathan et al. (1979, pp. 3-4) that "areas with relatively higher pressure of population relative to land will tend to have a relatively high proportion of households without draught animals". Second, in measuring adequacy of draught power (in terms of number of animals) for the individual farmer, the ratio of a pair of animal to 4 acres has little relevance. Since animals are indivisible, the number of draught animals kept by a farmer may be able to provide more or less draught services than is required by the farmer. This imbalance then provides the basis for hiring or exchanging draught services. Very small land holders find hiring of draught services more economic than maintaining draught animals, those maintaining one animal usually pair with another single animal owner or with one owning 3 animals to make 2 pairs. Draught services in Bangladesh are exchanged in a variety of ways (for details see, Mettrick 1981, pp. 21-2). Renting of land is one of the important mechanisms for adjusting imbalance in land, labour and draught animal ownership (Table 6). Farms with surplus labour and animal power in relation to land holding rent in land from those having surplus land in relation to available labour and animal power.

Seasonality in Draught Power Adequacy

The annual supply of draught animal power may be relatively constant though seasonal fluctuations in the supply of fodder and incidence of diseases may cause some fluctuation in draught capacity. The demand for power is, however, marked by extreme fluctuations over the year. Thus, it is not the year-round availability of draught power which may be limiting but the availability at peak periods. In Bangladesh the critical periods are the turn-around between the *aus* paddy (summer) and the *aman* paddy (winter) crops, between the sowing time of *aus* and jute, and between *aman* and other *rabi* (winter) crops. In the absence of irrigation, the sowing of *aus* paddy and jute are entirely determined by the arrival of the pre-monsoon rains. Once the rain comes, sowing has to be completed in the shortest possible time if optimal germination and yields are to be obtained. Again, a very short period is available to harvest, thresh, dry and store *aus* paddy, harvest and process jute, prepare land for *aman* paddy and transplant *aman*. Where improved varieties of paddy are grown in the *aus* season, the growing season is extended by 2-3 weeks, making the turn-around period even tighter. Harvesting and threshing *aman* and preparing land for *rabi* crops create another peak in non-irrigated condition. Since soil moisture tend to decrease rather quickly, a short period is available for sowing/planning *rabi* crops under optimum condition. In sugarcane, tobacco and

potato growing areas, this peak is even sharper. These are the periods when a shortage of draught power may manifest itself in Bangladesh agriculture.

Draught Capacity of the Animal

Draught capacity depends on breed, size, sex, age and health of the animals. Other things remaining the same, draught capacity increases in proportion to body weight up to a weight of 500 kg. First, Bangladeshi breeds of cattle are small in size. An average size male draught cattle weigh 200-250kg and draught cow 150-170 kg compared to over 500 kg for a North Indian or Pakistani draught cattle (BARC, 1975; Mettrick, 1976; Gill, 1981). So draught capacity of local cattle is very low. Second, according to the 1960 Agricultural Census, 28.8 percent of the draught cattle were female. In 1977, 30.3 percent were female. Between these years, number of female draught cattle increased 17.3 percent compared to 14 percent for male. Some of these cows are put to work even at advanced stage of pregnancy. Cows are generally less powerful than bullocks and these are usually used by smaller holdings. Farm level data from Moymonsingha and Bogura show that smaller holdings had a significantly larger number of draught animals per acre but a significantly higher proportion of their draught animals were female (Table 4). Further, it was found that farms without any draught cattle or with only female draught cattle had significantly smaller land holdings compared to farms with only male or both male and female draught cattle (Table 7). Geographically, districts with higher population and cattle densities also have higher proportion of female in the cattle herd and a higher proportion of their draught cattle are female (Table 2).

Third, nearly a quarter of the draught animals are under and over-aged (below 4 and above 11 years) (Table 8). These poor capacity animals are also found on smaller holdings.

Fourth, general health of the cattle is poor because they live mostly on inadequate amount of crop by-products (e.g. rice straw, weeds, rice bran, pulse bran, oil cakes etc.) and suffer from various diseases. An analysis of feed intake of work animals on a sample of 40 farms in Moymonsingha in 1967 revealed that the animals received only 31.4 percent of the required total digestible nutrients (Masud and Underwood 1969). The general health of cattle has deteriorated over time because of further reduction in the quality and quantity of available animal feeds but no appreciable improvement in disease control.

If the above differences in the composition of draught cattle across districts and sizes of farms are taken into account, then the number of draught animals available in a district or a farm does not appear to be an appropriate indicator of the actual horse power available. Estimation of actual horsepower available is also difficult because horse power capacity of different age, sex and quality of draught animals are not well known. In 1970, the Farm Mechanization Committee assumed 0.30, 0.25 and 0.50 HP per

bullock, cow and buffalo respectively (Pakistan, 1970). In 1978, the Bangladesh Planning Commission assumed 0.25 HP for an average draught animal (Bangladesh 1978). Gill (1981) and Mettrick (1981) standardized draught cattle units for selected samples assuming 0.56 and 0.30 HP per bullock and cow respectively. In an earlier report Mettrick (1976) assumed 0.33 HP for a pair of oxen, nothing has been mentioned about cows. In a field level study Hussain and Sarker (1978) found draught capacity of 0.29-0.46 HP per pair for 3-4 hours of continuous work but they did not mention the body weight and other characteristics of the cattle used in the experiment. Subsequently, Hussain (1981) estimated draught power availability in the country assuming 0.17 HP per head for both bullock and cow, and 1.0 HP per buffalo. Sarker (1981), on the other hand, estimated draught power availability assuming 0.35 HP per pair irrespective of type and sex of the animal.

Given the rather dubious nature of the above mentioned data on horse power capacities of draught animals, their application for estimating actual horse power for a farm or a district or the country is unlikely to reveal the true situation. There are additional problems in using a single set of power rates for various types of animals across regions and farms. For example, a bullock on a smaller farm may be significantly less powerful than a cow on a larger farm. One can make alternative estimates under alternative set of assumptions but such theoretical exercise is also unlikely to give accurate estimates.

FEMALE DRAUGHT USE AS AN INDICATOR OF POWER SHORTAGE

Earlier it has been mentioned that about 50 percent of the adult female cattle are currently used for draught purposes and about 30 percent of the total draught cattle are female. Before the partition of India in 1947 only a small number of barren cows were used for draught by Muslim farmers[4]. Observing the recent phenomenal increase in the draught use of female, a low quality power source than bullock, Jabbar (1980) suggested this as an indication, though imprecise, of draught power shortage in the country.

He also argued that cows would not be used for draught if, as in the past, adequate power was available from bullocks. Moreover, he considered female draught use undesirable because: (i) once productive cows were put to draught use, the process started reinforcing itself through reduced fertility and growth rate in cattle number, (ii) draught use also reduced production of milk (a highly preferred food in the country) thus reducing milk consumption in rural areas and increasing dependence on imports to meet urban demand. On the other hand, Dolberg (1981) argued that cows in Bangladesh were more efficient than bullocks as they reproduce, give milk, dung and power. Gill (1981) considered female draught use as an inadequate indicator of power shortage and argued that cows were used for draught mainly by small holders who has small amount of work in hand, so that any adverse effect on fertility and lactation, if at all, would be minimal.

[4] Hindus generally do not use cows for draught because of religious sanctions, though they may use buffalo cows.

As such multipurpose cows might be advantageous for small farms. However, none of the above authors provided empirical evidence in support of their arguments.

The causes and consequences of female draught use are discussed below giving empirical evidence, wherever possible.

Causes of Draught Use of Cows

Inadequate Growth of Livestock Population

Growth of livestock population depends on birth, death due to diseases and slaughter for meat. Before partition in 1947, incidence of diseases and mortality were high (though precise statistics is not available) because of inadequate veterinary services. Moreover, Bengal being Muslim dominated, large number of cattle used to be slaughtered for meat, a substantial proportion of this would be slaughtered on the occasion of Eid-ul-Azha. Consequently growth of livestock population was inadequate to meet requirements but replacement cattle came from the neighbouring Hindu dominated states sof Tripura, Asam, Bihar and Orissa where fewer cattle were slaughtered. After partition, supply from these sources has largely diminished because no legal trading of cattle has been established with India. Some animals are smuggled into the country but no estimate of the number is available. The absence of a natural flow of supply forced Bangladesh farmers to find an alternative in cows.

Population pressure and reduction in size of land holdings accelerated the process of bringing cows to draught use. It has been shown earlier that districts with higher population density and farms of smaller size had higher proportion of females in the cattle herd and used a higher proportion of females for draught purposes. Smaller farms may use cows for draught because their smaller power requirement may be met from cows which are less powerful than bullocks. Draught cows are also cheaper than bullocks, so farms with capital constraint may be able to keep draught cattle if they choose to keep cows rather than bullocks. Through sub-division of holding, a small farmer may end up with one bullock and one cow or just one cow. Capital constraint to buy a bullock may force this farmer to use the cow for draught though previously it might not have been put to such use[5].

Once productive cows were put to draught use, the process started reinforcing itself. On the one hand, mortality due to disease is still high[6] and with increase in population, per capita income and urbanization, slaughter of cattle for meat has also increased. Records of slaughter houses in Dhaka and Chattagram cities revealed that

[5] Observing a high proportion of milking-cum-draught animals in some sample villages, Mettrick (1981, p. 29) suggested that farmers keep such cows from "Choice rather than dire necessity" because they get both milk and power. In reality, the choice is made because there is a dire necessity for power but in the long-run both fertility and milk production may be lost or reduced (see below).

[6] In a sample of 500 farms in three villages in Moymonshingha in 1981, 47.6 percent Disease Incidence Rate was found among cattle and 22.6 percent of the diseased cattle died during the year (Jabbar and Green 1983, p. 77).

23.6 percent of the cattle slaughtered in these two cities during 1980-81 were female. In the same year, a survey conducted on Eid-ul-Azha day in 114 villages throughout Bangladesh revealed that of all the cattle scarified in those villages, 39.9 percent were female. Most of these females were of productive age (Jabbar and Green 1983, p. 65). On the other hand, increased use of cows for draught resulted in decreased fertility (see below). Consequently less male draught cattle has become available, thus dependence on cows for draught has increased.

Draught Power and Mechanization Policy of the Government

Until the 1950s, animals were the only source of draught power in the country. For reasons described earlier, shortage in draught power have emerged since the late 1950s. Even though the existence of shortage has sometimes been recognized, its nature and dimension has not been identified; few positive measures have been taken to increase the number and improve the quality of draught animals. Instead the government started considering tractors and power tillers as suitable substitutes for bullocks. Tractors were first imported in the late 1950s for use on government farms. Japanese power tillers were first imported in 1965 for experimental purposes. By 1970, over 2,000 tractors and nearly 4,000 power tillers were imported with grant or tied aid. Most of these machines were used on government farms, or kept in farm machinery stations for hire services at subsidized prices to individual farmers. Some of the machines were also sold to individual farmers.

In 1970, the government organization responsible for the testing of tillers and tractors claimed in an evaluation report tillers were suitable for Bangladesh because tillers (a) were suitable for wet and dry land cultivation; (b) could be used for irrigation, threshing and haulage, thus reduce unit cost of operation; (c) were cheaper (at subsidized prices) than bullocks; (d) could be easily operated and maintained by small farmers (East Pakistan 1970). A high level Farm Mechanization Committee also reported "satisfactory" performance and farmer acceptance of tillers and tractors and recommended to build up a fleet of 30,000 tractors and 40,000 power tillers by 1985 (Pakistan 1970). The Committee did not give any consideration to the possibility of improving the quality of bullocks even though complete adoption of engine power was not envisaged by 1985[7]. The same year, a USAID consultant showed that at market prices bullock power was 2.3 and 3.4 times dearer than tractor and power tiller respectively but at real prices, both tillers and tractors were 2.5 times dearer than bullock power. No evidence of positive contribution of tractors and tillers on crop yields and crop intensities were found. Because of resource constraints (particularly foreign exchange), maintenance problems and potential adverse effects on income distribution and employment, tillers and tractors were considered undesirable at that time (Lawrence 1970).

[7] The Committee was composed of six civil servants, one agricultural economist, one crop scientist and one agricultural engineer. They consulted a good number of specialists, none of them animal scientists, and five farmers, all of them big landlords.

A large number of draught animals died in the coastal districts during a cyclone in November 1970. Relief and aid agencies donated 162 tractors and 652 power tillers to meet immediate power shortage but half of these machines were damaged beyond repair after only 200-300 hours of operation. More animals were lost during the war of independence in 1971 and to compensate that loss, 500 tractors (200 from UK and 300 from USSR) were received as grant aid in 1972. Another 450 (a different source say 648) tillers were cash purchased by the government (Bangladesh 1973; Mettrick 1976).

The Planning Commission of the new Bangladesh government chose to conduct more experiments with tractors and tillers rather than launching a large mechanization programme recommended by the Mechanization Committee of 1970. Up to 1977/78, 504 tractors and 1098 tillers were collected for experimentation but no more than 125 tractors and 200 tillers were used in any one of the four experimental years. Lack of spare parts and trained manpower, use of adulterated fuel, rough handling made most machines unusable after few months. The experiment was completely abandoned in 1977/78 and the remaining operable machines have been sold to the private sector[8].

A number of farm level studies conducted recently show that power tillers are more suitable than tractors under Bangladesh conditions because (a) small size and fragmented holdings impede efficient use of tractors, (b) tillers require one-tenth of the foreign exchange required for tractors, and tillers are cheaper to operate, (c) tractors are only twice as productive per manday as power tillers (Martius 1975; Gill 1981). However, comparison of bullocks and power tillers show that tillers (a) do not have significant positive effect on land productivity, (b) cause net labour displacement, (c) benefit the better off who can afford to buy and enjoy subsidy on the machines and fuel. These effects are undesirable from a welfare point of view. Moreover, the effects of ever increasing fuel prices on the relative economics of tiller and bullock power must be considered (Gill 1981b; Jabbar *et al*. 1981).

While all these experimentations and debates about the suitability and desirability of engine power were going on, shortage of draught bullocks continued to increase and farmers resorted to using cows for draught. Animals still provide over 98 percent of drought power in the country but at the cost of reduced fertility and milk yield of a large number of cows. Without cows being used for draught, limited success in crop production, particularly food grain production could not have been achieved. If simultaneous consideration could be given to the use of draught bullocks along with machines and crops, an integrated strategy for food production, nutrition and draught power could be developed which, had this already been adopted, would have had these interrelated problems in hand.

Consequences of Female Draught Use

Mettrick (1981) found considerable differences in the calving percentages between herds using their cows for draught and those which did not, and used this as an evidence to explain low herd productivity in the country. Jabbar and Green (1983) in a

[8] These experiences are replications of the many recounted by Kline *et al*. (1969) in Equatorial Africa.

detailed field study in Moymonshingha found significant differences in fertility and milk production between draught and non-draught Data with respect to three alternative measures of fertility and reproductive performance are shown in Table 10 and 11. Lifetime milk production of draught cows was found to diminish significantly through complete loss or reduced fertility, and reduced lactation yield. Data on highest daily milk yield differences between draught and non-draught cows are shown in Table 12. Reduced milk production affect the nutrition of small holders most because farm households previously consuming self-produced milk are now going without it because few can purchase milk. In order to produce grain, a source of carbohydrate, they are loosing an important source of protein, fat and vitamin. Demand for milk in urban areas is increasingly being met by imports, thus an expanding milk market is lost to foreigners due to draught use of cows.

Cows were extensively used for draught in Germany during the 1930s and 40s but it did not significantly affect fertility or milk production because draught cows were given extra feed allowance for the loss of energy due to draught (Personal communication: Klaus J. Lampe, 1982). In Bangladesh, draught use adversely affect fertility and milk production primarily because of feed constraint. Level of nutrition is generally very poor, so draught cows hardly receive any extra allowance for their work. In reality, farmers show some bias toward milk cows in allocating feeds.

CONCLUSIONS

The above analysis indicates the existence of substantial draught power shortage in the country for the present level of farm operations. If cropping intensity is to be significantly raised from the present level of about 150 percent, power problem will further intensify unless appropriate steps are taken and resources found to reduce demand or increase supply or both. In the process of economic development of the developed countries agriculture has become more specialized and mechanized substituting engine power for human and animal power because of the steady decline of rural population. In Bangladesh, an increasing number of people will continue to depend on land for their work and livelihood for a long time, so animal will remain the predominant source of power for agriculture.

There is hardly any known opportunity to reduce demand for draught power. However, two potential areas have been suggested for investigation by Gill (1981b): zero/minimum tillage and pre-tillage irrigation. Some promising research is being done in other countries on zero and minimum tillage. Research is also required on pre-tillage irrigation to explore the trade off between irrigation costs and cultivation costs and the extent of substitutability between these operations. A third area of investigation is to explore the possibility of modulating the power requirement in seasonal peaks through choice of appropriate cropping patterns and rotations. The on-going farming systems research programme at various research institutions may add this as a component to that programme.

On the supply side, along with increasing the availability of power, immediate attention is necessary to find ways of releasing cows from draught use and restoring their status as the principal milk producer. Supply of draught power from animal depends on the number of available animals, their quality (size and health) and the efficiency of the mechanism for transforming their power into useful work.

Given the fact that cattle live almost exclusively on crop by-products, cattle density is already too high in Bangladesh. Therefore, the increased power supply should come not from an increased number of degraded animals but from the better quality of existing, or preferably a smaller number of animals. Since population pressure will lead to sub-division of farm holdings for some more time, reducing absolute number of animals may not be a feasible proposition for the time being. Thus the main focus should be on improving quality through feeding, breeding, and prevention and control of diseases. In general, public investment in these areas should be considerably increased because in the past the livestock sector has been neglected. Encouraging results of some research on methods of improving quality and quantity of animal feeds are available (see, Jackson *et a.l* 1981). More applied and investigatory studies should be conducted in this field by giving due emphasis on the strong interaction between crop and livestock enterprises in the traditional farming systems (Jabbar 1982).

Single animal ploughing which is currently practiced in some parts of Sylet district has been occasionally suggested as a possible means to ease the power problem (Ahmed 1975; FAO 1977; GOB 1978; Jabbar 1980). Use of animals as singles will lead to a reduction in the required number of power animals, thus draught cows may be released for milk production. Per capita feed availability may improve and the health of the reduced number of animals may improve as well. O'dendhal (1978) considered extension of single animal ploughing impractical in Bangladesh because of the small size and poor health of the animals. In a recent empirical study in Sylet district Jabbar (1984) found that only buffaloes were used as singles and single buffalo plough was technically and economically more efficient than plough drawn by a pair of cattle. However, expansion of the technique outside Sylet seems to be restricted because draught buffaloes account for only about 2 percent of the total draught animals and these small number of buffaloes are also scattered throughout the country.

In the past, attempts to introduce heavy improved ploughs failed because small and weak animals were incapable of pulling such implements, particularly for puddling in muddy conditions and in dry season when the soil is very hard. Design of local ploughs and harnesses evolved through long time practice. Designs vary across the country and some designs are likely to be more efficient than others in using energy. The identification of more efficient designs, their improvement and/or development of new designs may help to ease the draught power situation. Hussain *et al*. (1980) have recently developed an improved neck harness for cattle but its economics and farmer acceptance has not been tested yet.

Use of animals for transportation is substantial in certain districts and in the urban areas in general. However, the extent of competition between transportation and tillage

for animal is not adequately understood. Identification of the activities which create such competition, the time and location of the activities may be useful for planning farm power policy.

REFERENCES

Ahmed, Mosleuddin (1975): "Appropriate Technology – Aid to Small Farmers", In: Proceedings of the Workshop on Appropriate Agricultural Technology. Dhaka: BARC.

Bangladesh, Government of the People's Republic of (1973): The First Five Year Plan (1973-78). Dhaka: The Planning Commission, Ministry of Finance and Planning.

_____ (1977): Statistical Pocket Book of Bangladesh, 1978. Dhaka: The Bangladesh Bureau of Statistics, Ministry of Planning.

_____ (1978): The Two Year Plan (1978-80). Dhaka: The Planning Commission.

_____ (1980a): The Second Five Year Plan. (1980-85). Dhaka: The Planning Commission, Ministry of Planning.

_____ (1980b). Yearbook of Statistics. Dhaka: The Bangladesh Bureau of Statistics, Ministry of Planning.

_____ (1981): Report on the Agricultural Census of Bangladesh 1977. (National Volume) Dhaka: Bangladesh Bureau of Statistics, Ministry of Planning.

_____ (1982): Statistical Pocket Book of Bangladesh 1982. Dhaka: Bangladesh Bureau of Statistics, Ministry of Planning.

De Boer, A.J. (1972): "Technical and Economic Constraints on Bovine Production in Three Villages in Thailand". Unpublished Ph.D. Thesis, University of Minnesota, Minneapolis, St. Paul.

Dolerg, Frands (1981): "Availability of Feeds in Bangladesh in Relation to Cattle Numbers: Emphasis on Roughage Diet and a Development Strategy". ADAB NEWS. 8, 1 (January- February).

East Pakistan, Government of (1970): Report of the Test of Power Tillers. Dhaka: East Pakistan Agricultural Development Corporation (Mimeo).

FAO (1977): Livestock and Draught Power Development. Working Paper V. Dhaka: Government of Bangladesh and FAO/UNDP Mission (Mimeo).

Gill, Gerard J. (1981): Farm Power in Bangladesh, volume 1, Development Study No. 19. Reading: Department of Agricultural Economics and Management, University of Reading.

Hossain, Mahabub (1974); "Farm Size and Productivity in Bangladesh Agriculture: A case Study of Phulpur Farms", The Bangladesh Economic Review, II, 1 (January), 469-500.

_____ (1980): "Foodgrain Production in Bangladesh: Performance, Potential and Constraints". The Bangladesh Development Studies, 8, 1-2, 39-70.

Hussain, A.A. Mainul (1981): "Draught Power Requirement in Bangladesh", In: Jackson et al. (eds): Maximum Livestock Production from Minimum Land. Proceedings of a seminar held at Bangladesh Agricultural University, Mymensing. 2-5 February.

Hussain, A.A. Mainul et al. (1980): "Design and Development of Neck Harness for cattle in Bangladesh". Agricultural Mechanization in Asia, SI, 1 (Winter), 85-89.

IBRD (1972): Land and Water Resources Sector Study, Bangladesh. Volume IV. Washington D.C.: World Bank.

Jabbar, M.A. (1977): "Relative Productive Efficiency of Different Tenure Classes in Selected Areas of Bangladesh". The Bangladesh Development Studies. V, 1 (January), 24-49.

_____ (1980): "Draft Power Shortage and Mechanization of Tillage in Bangladesh". The Bangladesh Journal of Agricultural Economics. III, 1 (June) 1-26.

_____ (1982): "Technological Change, Agricultural Development and the Relevance of Crop-livestock Interaction". Paper presented at the seminar on Mechanization of small-scale Farming in Asia, held in Hangshou, People's Republic of China, 21-26 June.

_____ (1984): "Potential of Single Animal Ploughing in Bangladesh", Report Prepared for the Agricultural Development Council, Inc. New York.

_____ , M.S.R. Bhuiyan and A.K.M. Bari (1982): "Causes and Consequences of Power Tiller Utilization in Two Areas of Bangladesh", In: Selected Papers on the Consequences of Small Rice Farm Mechanization in Asia. Los Banos: International Rice Research Institute.

_____ and D.A.G. Green (1983): The Status and Potential of livestock within the Context of Agricultural Development Policy in Bangladesh. Aberystwyth: university College of Wales.

Jackson, M.G., et al (eds) (1981): Maximum Livestock Production from Minimum Land. Proceedings of a seminar held at Bangladesh Agricultural University, Moymonshingha, 2-5 February.

Lawrence, Roger (1970): Some Economic Aspects of Farm Mechanization in Pakistan. Islamabad: United States Agency for International Development (Mimeo).

Martius, Hartwig (1975): Agricultural Mechanization and Rural Development in Bangladesh: An Empirical Study at Farm Level. Gottingen: University of Gottingen (Mimeo).

Masud, S.M. and F.L. Underwood (1969): Power in East Pakistan Farming: A Study of Power Animal Costs. Farm Management Research Report No. 2 Mymensingh: Bureau of Socio-economic Research and Training, Bangladesh Agricultural University.

Mettrick, H. (1976): Socioeconomic Aspects of Agricultural Mechanization in Bangladesh. Reading: University of Reading, Department of Agricultural Economics and Management (Mimeo).

Mettrick, H. (1981): " Some Aspects of the Economics of Animal Power", In: Farm Power in Bangladesh, Volume 2, by H.M. Mettrick and D.P. James. Development Study No. 20. Reading: University of Reading, Department of Agricultural Economics & Management.

Mukherjee, Radhakamal (1938): Food Planning for Four Hundred Millions. London: Macmillan and Co.

Odend'hal, Stewart (1978): Past, Present and Future Research on Livestock in Bangladesh, with Particular Emphasis on Draught Power and Mechanization, Dhaka: The Ford Foundation.

Pakistan, Government of (1961): Pakistan Census of Agriculture. Karachi: Census Wing, ministry of Agriculture.

_____ (1970): Farm Mechanization in East Pakistan. Report of the Farm Mechanization Committee. Rawalpindi: Ministry of Agriculture and Works.

Pray, C.E. (1980): "An Assessment of the Accuracy of the Official Agricultural Statistics of Bangladesh". The Bangladesh Development Studies, 8, 1-2 (Winter-Summer), 1-38.

Samad, M.A. (1971): Cyclone of 1970 and Agricultural Rehabilitation. Dhaka: Agriculture Information Service, Ministry of Agriculture.

Sarker, R.I. (1981): "Improved Utilization of Animal Draught Power in Bangladesh", In: Jackson *et al* (eds): Maximum Livestock from Minimum Land. Proceedings of a seminar held at Bangladesh Agricultural University, Mymensingh, 2-5 February.

Vaidyanathan, A., N.K., Narayanan, and M. Harriss (1979): Bovine Sex and Species Ratios in India. Working Paper No. 108. Ullor, Trivandrum: Centre for Development Studies.

Table 1. Total cattle and draught cattle population in Bangladesh, 1960-80

Source of Data	Year	Total cattle [a/] 000 head	Draught Cattle '000 head	Draught as % of total cattle
A	1960	19,416	9,890	51
B	1965	23,627	-	-
	1970	26,721	-	-
C	1970/71	18,800	10,000	53
D	1972	18,300	11,400	62
E	1972/73	24,875	-	-
	1973/74	25,404	-	-
	1974/75	25,945	-	-
	1975/76	26,502	-	-
F	1976/77	23,151	12,480	50
G	1977	20,978	10,925	52
H	1977/78	-	8,200	-
I	1977/78	21,245	-	-
	1978/79	21,516	-	-
	1979/80	21,792	-	-
J	1979/80	31,000	10,300	33

[a] Include buffalo accounting for about 3-4 percent of total numbers.
- Not available.

Source: A (Pakistan 1961, quoted in Bangladesh 1981, pp. 203-4).
B, E (Bangladesh 1977, pp. 165-6).
C (Bangladesh 1973, p. 281).
D (IBRD 1972).
F (FAO 1977, pp. 17-24).
G (Bangladesh 1981, pp. 48-9).
H (Bangladesh 1982, pp 282-4).
I (Bangladesh 1982, pp 282-4).
J (Bangladesh 1980, pp. xii-69).

Table 2. Human, cattle and draught cattle densities by district, 1977

District[a]	Av. Size of agricultural holding, acres	Number per cultivable acre			Proportion of	
		Agricultural population	Cattle	Draught cattle	Total cattle female	Draught Cattle female
Dinajpur	3.94	1.63	1.02	0.54	47.2	22.4
Rangpur	2.92	2.26	1.19	0.64	50.6	34.4
Bogura	2.58	2.43	1.12	0.62	50.3	33.7
Rajshahi	3.37	1.91	0.90	0.51	41.6	18.8
Pabna	3.46	2.18	1.03	0.59	54.5	43.7
Kushtia	3.43	2.21	0.88	0.47	38.9	9.3
Jashohore	3.34	2.17	0.95	0.50	42.4	16.7
Khulna	3.54	1.92	1.16	0.57	47.4	21.5
Barishal	2.98	2.22	0.98	0.49	49.3	21.2
Patuakhali	4.80	1.43	0.92	0.53	48.9	22.4
Jamalpur	3.13	2.12	0.85	0.50	58.6	56.6
Tangali	2.66	2.64	1.18	0.68	56.1	50.2
Moymonshingha	2.85	2.27	1.02	0.58	56.5	48.5
Dhaka	2.14	3.16	1.26	0.62	55.5	39.1
Faridpur	2.72	238	0.91	0.46	44.6	17.3
Seelet	3.39	2.00	1.09	0.59	45.9	23.8
Kumilla	1.66	3.87	1.23	0.69	51.6	33.0
Noakhali	2.32	2.85	0.96	0.49	48.3	17.7
Chattagtam	2.05	3.35	1.50	0.79	47.3	26.0
Parbattya Chattagram	3.76	1.70	0.95	0.48	46.4	20.5
All districts	2.88	2.33	1.06	0.57	49.4	30.3

[a] Spelling of district names correspond to their Bengali pronunciation. The author alone is responsible for the spelling used.

Source: Bangladesh

Table 3 Human and cattle densities by size of holding in Bangladesh, 1977

Size of holding, acres	Proportion of holding %	Number per holding		Number per acre	
		Persons	Cattle	Persons	Cattle
o[a]	8.7	5.6	2.28	b	b
0.01-0.49	5.0	5.0	0.80	20.8	3.33
0.50-0.99	9.5	5.3	1.25	8.8	2.10
1.00-1.49	11.7	5.7	1.83	5.5	1.76
1.50-2.49	19.3	6.1	2.42	3.6	1.41
2.50-7.49	37.3	7.4	3.73	2.0	0.98
7.50+	8.7	10.3	7.35	0.9	0.67
All	100.0	6.7	3.10	2.3	1.06

[a/] Only livestock holding, i.e. owning no land but certain units of livestock.
[b/] Not defined.

Source: Bangladesh 1981.

Table 4. Number of draught animals per farm and per acre, and proportion of female draught animals by size of cultivated holding in Bogura (1977) and Moymonshingha (1981)

Size of holding, acres	Bogura			Moymonshingha		
	No. per farm X^2	No. per acre X^3	% female X^4	No. per farm X^2	No. per acre X^3	% female X^4
0.01-0.49	0.32	1.12	45	0.58	1.87	86
0.50-0.99	0.83	1.12	47	0.93	1.31	88
1.00-2.49	1.41	0.86	48	1.45	0.90	70
2.50-4.99	2.13	0.63	35	2.07	0.60	50
5.00-7.49	2.88	0.48	28	3.29	0.55	46
7.50-9.99	3.55	0.42	24	3.46	0.38	62
10.00-14.99	4.31	0.36	22	3.80	0.33	47
15.00-24.99	5.15	0.29	22	5.40	0.27	52
25.00-above	7.58	0.23	18	5.00	0.14	47
All farms	1.71	0.79	37	1.81	0.59	58

Correlations

	Bogura				Moymonshingha			
	X_1	X_2	X_3	X_4	X_1	X_2	X_3	X_4
X_1	1.00	0.59	-0.31	-0.43	1.00	0.54	-0.43	-0.38

(All significant at less than 1 percent level)

Source: Agricultural Census in Bogura, 1977; Field Survey in Moymonshingha, 1981.

Table 5. Average size of holding according to number of draught cattle owned in Bogura (1977) and Moymonshingha (1981)

Number of Draught cattle owned	Bogura		Moymonshingha	
	% farms	Acres per farm	% farms	Acres per farm
0	28.8	1.35	13.1	0.91
1	16.3	1.78	26.8	1.48
2	35.2	2.84	42.0	2.85
3	6.2	3.95	9.1	5.03
4+	13..2	6.63	9.0	9.47
All	100.0	2.78	100.0	3.00

Source: Agricultural Census in Bogura, 1977; Farm Survey in Moymonshingha, 1981.

Table 6. Pattern of land, fixed labour and draft animal ownership by tenure status in selected samples, 1974

Location and tenure class	Average acres owned	Average acres cultivated	Average man-units	Average No. of work animals	Acres per man-unit	
					Owned	Cultivated
Moymonshingha						
Part-operator	6.02	4.38	1.54	2.40	3.91	2.84
Owner-operator	2.57	3.57	2.12	2.47	1.68	1.68
Part-tenant	1.60	2.64	1.50	2.09	1.07	1.76
All classes	3.24	3.40	1.87	2.38	1.73	1.82
Rangpur						
Part-operator	7.32	3.75	2.50	2.00	2.93	1.50
Owner-operator	3.60	3.60	2.28	2.29	1.58	1.58
Part-tenant	1.21	1.21	1.94	1.65	0.62	1.27
All classes	3.13	3.13	2.17	1.97	1.44	1.44
Dinajpur						
Part-operator	16.69	7.18	2.21	3.07	7.55	3.25
Owner-operator	6.31	6.31	1.79	2.39	3.52	3.52
Part-tenant	3.14	4.77	1.60	2.37	1.96	2.96
Tenant	-	5.00	1.33	2.00	0	3.76
All classes	9.76	6.17	1.91	2.67	5.11	3.23

Source: Jabbar 1977.

Table 7. Relationship between number and sex of draught animals and size of holding in Bogura (1977) and Moymonshingha (1981)

No. and sex of animals	Bogura		Moymonshingha	
	% farms	Acres cultivated per farms	% farms	Acres cultivated per farm
None	28.7	1.34	13.1	1.05
1 Male	6.7	1.96	5.1	2.08
1 Female	9.6	1.66	21.5	1.35
2 Male	18.9	3.26	12.9	3.47
2 Female	10.6	2.29	18.4	2.52
2 Both sexes	5.8	2.47	10.6	2.67
3+ Male	8.1	6.25	1.6	4.43
3+ Female	0.6	3.60	3.1	4.22
3+ Both sexes	11.0	5.29	14.3	8.10
All	100.0	2.78	100.0	3.00

Source: Jabbar and Green 1983.

Table 8: Frequency distribution of draught cattle by sex and age in Moymonshingha, 1981

Sex	Age class (years)							
	Under 3	3-4.9	5-6.9	7-8.9	9-10.9	11-12.9	13+	Total
Male	2.3	3.0	23.0	32.1	18.2	8.8	2.7	100
Female	3.1	2.2	22.2	27.7	9.9	9.7	5.1	100

Source: Jabbar and Green 1983, p. 18.

Table 9. Production, per caput availability and consumption of beef, and number of edible offals and hides of cattle produced in Bangladesh, 1972/73 – 1979-80.

Year	Beef				Edible offals of cattle	Hides of cattle	Edible offals as % of of hides
	Production	Availability	Consumption				
			Rural	Urban			
	000 tons		gm/caput/day		000 pieces		
1972/73	136.2	5.2	-	-	2465	3091	80[a]
1973/74	139.2	5.2	2.03	2.08	2518	3158	80
1974/75	142.1	5.1	-	-	2518	3225	80
1975/76	145.2	5.1	-	-	2628	3296	80
1976/77	115.0	3.9	1.80	2.80	2074	2603	80
1977/78	116.0	3.9	-	-	2101	2637	80
1978/79	117.0	3.8	-	-	2127	2670	80
1979/80	119.2	3.8	-	-	2154	2703	80

- Not available

a. Implies that remaining hides have been collected from dead animals

Source: Colums 1, 2, 5,6,7 - Bangladesh 1977, pp. 167-68. Bangladesh 1982, pp. 282. Columns

Columns 3,4 – Household Expenditure Survey 1973-74 and 1975-76; quoted in Bangladesh 1980, p. 579.

Table 10. Number, average age and average number of calves in life time of draught and non-draught cows in selected areas in Moymonshingha

Type of cow[a]	No. of cows	Percent	Average, Age, years	No. of calves/cow in life time	Correlation (r) between age of cow and no. of calves in life time
Non-draught – 1	54	9	7.3	2.04	0.89**
Non-draught – 2	64	11	4.0	0.00	B
All non-draught	118	20	5.5	0.92	C
Draught – 1	156	28	8.7	2.13	0.78**
Draught – 2	103	18	8.1	1.62	0.60**
Draught – 3	193	34	6.2	0.00	B
All draught	452	80	7.5	1.10	C
All cows	570	100	6.9	1.06	c

a. Notes and definitions

Non-draught – 1 : non-draught cows already gave calf or were pregnant at the time of the survey

Non-druaght – 2: non-draught cows never gave any calf or were not pregnant at the time of the survey

Draught – 1 : Cows used for draught after the first calf was born

Draught – 2: Cows used for draught at least one year before the first calf was born or in case of first pregnancy, before the cow became pregnant.

Draught – 3: Draught cows never gave any calf or were not pregnant at the time of the survey.

For each pregnant cow, 0.5 calf was added.

b. Not calculable
c. Not calculated because of b.

* Significant at less than one percent level.

Source: Jabbar and Green 1983, p. 42.

Table 11. Average age at first ploughing and first calving and number of services per conception of draught cows in Moymonshingha

Type of cow[a]	No. of cows	Average age at first ploughing yrs	Average age at first calving yrs	No. of cows serviced	Services per conception	Percent conceived with one service
Non-draught – 1	41	a	3.82	18	1.44	67
Draught – 1	109	3.77	3.85	46	1.57	57
Draught – 2	103	2.91	5.45	37	2.03	35
Draught – 3	76	2.82	a	a	a	a
All types	329	a	a	101	1.70	50

a. For definition see Table 10.

Source: Jabbar and Green 1983, pp. 46-7.

Table 12. Highest daily milk yield of draught and non-draught cows in latest lactation in Moymonshi, 1981.

Type of cow[a]	Including cows in milk at the time of survey		Excluding cows in milk at the time of survey	
	Cows	Milk Kg/cow/day	Cows	Milk Kg/cow/day
Non-draught – 1	45	1.42	14	1.57
Draught – 1	184	1.21	99	1.16
Draught – 2	101	1.21	63	1.20
All draught	285	1.24	162	1.18
All cows	330	1.24	179	1.21

a. For definition see table 10.

Source; Jabbar and Green 1983, p.50.