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FARM POWER IN BANGLADESH

Volume 1

G.J. GILL

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FARM POWER IN BANGLADESH

VOLUME I

A Comparative Analysis of Animal and Mechanical Farm Power in Bangladesh

by

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FOREWORD

Interest in this Department in the economics of farm power, or, more specifically, power deployed in field-production operations, has a long history. It began with the study carried out by C. E. Finney (1972), when the likely impact of alternative innovations in mechanisation technology were investigated for the major irrigated regions of West Pakistan. Private and social costs and benefits - and employment effects were already an important consideration - were investigated. Finney's findings caused so much controversy between engineers and economists that the Ministry of Overseas Development (now ODA), who were the original sponsors, commissioned further work by Dr. Tahir-ur-Rehman, to test the effect on Finney's results of changing some of his assumptions.

In October, 1973, the world economy was shaken by the first leap in world oil prices. The Department was, at this time, asked by ODA to extend its activities in the area of farm power. A series of studies followed, including

- Tractor Aid to India by Dr. G. E. Dalton, (1975),
- The Mechanisation of Rice Production in Northern Ghana by D. J. Ansell (1976),
- Oxenisation in The Gambia by H. Mettrick (1976).

Meanwhile a team had been set up to carry out a desk-study of the literature on Agricultural Mechanisation in Southern Asia and to make recommendations for further research.[1] As a result of its recommendations and the findings of a field reconnaissance carried out by one of the authors, research projects, again mainly financed by ODA, were set up in Bangladesh and subsequently Sri Lanka. The Sri Lanka study is still in progress though a series of interim papers have already been published at the Agrarian Research and Training Institute, Colombo.[2] What follows in this and a companion volume is a report of some of the results of the study in Bangladesh.

One reason for the choice of Bangladesh was that interest had been shown by the Bangladesh Ministry of Agriculture in obtaining assistance in conducting an evaluation of agricultural mechanisation (particularly tractorisation) following upon the receipt of two-axle tractor aid from the United Kingdom.

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[1] Mettrick, H., Roy, S. and Thornton, D.S. (1976).

[2] See References under Farrington et al.

Early in the field-work phase it became apparent that data on privately-owned single-axle power tillers were essential as a complement to those being gathered on the performance of tractors deployed by the Bangladesh Agricultural Development Corporation. A further grant was obtained from the Bangladesh Ministry of Agriculture to extend the study to include this technology.

The study in Bangladesh was further enlarged by the joining together of Reading University and War-on-Want. The latter had already been engaged in supplying tractor aid in Southern Bangladesh in the wake of the 1970 cyclone, and resolved to evaluate their experience. War-on-Want provided personnel who were vital to the success of the research project, in particular Peter James (Sociologist) and Arvian Llewellyn-Jones (War-on-Want Project Manager).

Volume I of this Report comprises the findings of the main field Survey for which Dr. G. J. Gill was responsible. Volume II (Development Study No. 20) comprises two studies closely related to the main survey: the first by H. Mettrick, who was responsible for the original plan and overall control of the Bangladesh programme and, in the analytical phase, concentrated his attention on various aspects of the economics of animal power; and the second by Peter James who has reported on his detailed socio-economic investigations in one pair of villages in Noakhali thana.

In all, the Bangladesh study occupied the period from March, 1977 to December, 1980. Fieldwork began in June, 1977, and continued until September, 1979. It revealed many unexpected things, as the following pages will show. Above all perhaps, it emphasises how varied are rural conditions in a country which, to the outsider, is largely composed of one vast alluvial delta and therefore might be presumed to have a fair degree of uniformity. Moreover, the variety extends in many dimensions - environmental, agronomic, demographic, social, institutional. It is therefore extremely difficult to generalise about Bangladesh, and, on some specific theme like Farm Power, to say things of universal applicability and usefulness for policy purposes. Moreover the social scientist must always be conscious of the ephemeral nature of his findings. In a situation where rapid changes are occurring in most of these dimensions, it is doubly difficult to capture the main strands. Nevertheless careful and intelligent observation, sensitive hypothesising and meticulous statistical analysis can do something to provide an account of highly complex processes. These volumes represent a strenuous attempt to render such an account.

It still remains to integrate the findings reported here with other related studies of rural Bangladesh, all of which contribute to an alarming picture of a large, rapidly increasing and generally poverty-stricken society, in a potentially rich environment, in continuous though fluctuating decline.

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and Management.

1981.

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A great many people co-operated in collecting and/or providing the information upon which this report is based. I would like to thank them all, but can mention only a few by name. I wish especially to thank: all of the staff of BKB and BADC, but especially our counterparts Alauddin Mujid and Atiqur Rahman respectively; my colleagues from War on Want, Arvian Llewellyn-Jones and Peter James, without whose hard work and dedication this project would not have been possible; the hardworking field supervisors, research assistants and office staff; my colleagues at Reading University for their advice and encouragement and Mrs. Marion Kitcher who typed the manuscript so ably; Hugh Brammer and John Harrop, two FAO soil scientists who provided invaluable background information; most of all the farmers for their time, patience and hospitality through many long interviews. Any errors of fact or interpretation contained in this report are my sole and personal responsibility. The views expressed herein are personal and do not necessarily reflect those of any of the organisations or individuals mentioned above.

G. J. G.

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Addendum to the last sentence of page iii

.... or of the funding agencies, of whom the Overseas Development Administration (United Kingdom) was the main contributor.

CONVERSION RATES

16 taka = US $1.00 (at time of writing)

1 maund = 82 lbs = 37 kg = 40 seers

27 maunds = 1 ton

1 maund/acre = 92 kg/hectare

1 quintal (100 kg)/hectare = 1.09 maunds/acre

(See also Appendices 1 and 8).

CHAPTER 1: INTRODUCTION

The debate on the appropriateness or otherwise of engine powered farm machinery in general and of tractors[1] in particular in developing countries is of very long standing.[2] It has been a confused, even bitter, debate whose quality has not benefited from the fact that the two contending schools of thought have tended to represent different sets of professional disciplines. In general and with some notable exceptions, those from the biological and physical sciences, and particularly from engineering, have stressed the paramount need to increase agricultural production in developing countries, while social scientists tend to emphasise the employment and income distribution aspects of the development process. There is of course, little overt disagreement concerning the desirability (as distinct from the practicability) of increasing both employment and output. The conflict arises as to the extent - even the direction - of any net employment and production effects in the event of a trade-off situation arising.

1.1. HYPOTHETICAL ADVANTAGES AND DISADVANTAGES OF TRACTORISATION

Binswanger (1978, Ch. II) draws a useful distinction between two apparently contradictory views of tractorisation. One, which he calls the 'substitution view', "looks at tractors and animals as two different power sources which are technically 'perfect substitutes'", so that the differences between engine and animal powered cultivation are seen as purely quantitative. If a sufficient number of animals is available with the appropriate implements they can achieve the same results as a tractor. The opposite, or 'net contributor' view, in Binswanger's parlance, sees the tractor as contributing a qualitative improvement to productivity; in other words, a discrete upward shift in the production function which cannot be achieved by other means.

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[1]Throughout the forthcoming discussion the generic term 'tractor' will be used to describe both two-axle tractors and single-axle power tillers. The distinction will be made specific wherever necessary.

[2]The entire 'appropriate technology' debate is plagued with semantic difficulties. Thus, for example, technologies which have a relatively high labour:capital ratio are usually described as being 'labour intensive' when they are in fact precisely the opposite, using capital, not labour, intensively. Even the expression 'manufacture' is a complete misnomer, since the word literally means 'hand-made'. Similar difficulties arise in the present case. Many power tillers are not true tractors, since they do not drag a detachable load (such as a plough, harrow or seed drill) behind them, but cultivate by means of a revolving scroll (or 'rotavator') which is an integral part of the machine. The expression 'tractor' is nonetheless used here in preference to the more precise but clumsy 'engine powered tillage equipment'. (One final linguistic note: 'rotavator' is the longest palindrome in the English language!)

The advantages attributed to tractorisation stem largely from the machine's superiority in power and speed compared to draught animals. Since in Bangladesh there is no 'land frontier' to be rolled back, any such benefits must be realised through intensification of farming, in which context the potential advantages can be briefly summarised as follows:

(a) Greater available power permits deeper and more thorough tillage and therefore, for example, improved soil aeration, destruction of weeds and incorporation of plant residues. This in turn tends to promote vigorous crop growth and hence better yields.

(b) Increased power also permits cultivation of soils which are otherwise difficult or impossible to work: for instance, land which is dry or compacted, as is often the case before the onset of seasonal rains. This should then permit earlier sowing of the crop than would otherwise be feasible, again with beneficial effects on yields.

(c) The tractor's greater speed and power permit it to cultivate faster than draught animals. In addition a tractor can be operated 'round the clock' with drivers working in shifts at peak periods, compared with a five or six hour working day for bullocks. Thus crops can be sown earlier and/or turnaround times between successive crops reduced. This can confer a number of advantages. First, crops can be seeded at the optimum time, thus increasing yields; second, it becomes possible to cultivate lands which would otherwise remain idle because of time pressures; third, the amount of time the land lies idle between crops can be reduced thus facilitating increased cropping intensities; fourth, enhanced timeliness, precision and power increase the degree of flexibility in farming operations, making it possible to introduce new crops, cropping patterns and rotations.

(d) Draught animals require fodder. If land is set aside for its production this reduces the cultivable area available for the support of the human population.

(e) The cost of cultivation (at market prices at least) may be lower with tractors than with draught animals.

The above arguments in favour of tractorisation are quite familiar. They are mainly couched in terms of the contribution that this form of mechanisation can make to increased output, reduced costs, or both. There is, however, another less widely recognised class of potential advantage which accrues only at the level of the individual farm but does nothing to increase productivity or reduce costs at the aggregate, national level.[1] This derives from the one of the diseconomies of scale: namely increased level of supervisory

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[1] The argument is put in rather more rigorous terms in Appendix 2.

cost per unit area with increased scale of operation. On smallholdings such costs are negligible: most labour is 'self-supervised' family labour and even when additional casual labour is hired a family member generally works alongside, so that there is no additional cost of supervision. As farm size increases, however, supervisory costs become increasingly important as the ratio of hired labour to family labour grows. Hence the economic attractiveness of techniques which reduce the cost of supervision is in direct proportion to operated acreage. Since it is much easier to supervise a small number of tractor operators than a large number of bullock teams, tractors are relatively attractive to large farmers and to those who can expand their operated acreages with relative ease; for example, those who currently rent out part of their holdings.[1] If this theoretical advantage holds true in practice the implication is that, even if Binswanger's 'substitution view' is correct and even if costs per unit area or per unit output are no higher on small bullock-operated holdings than on large tractor-operated ones, there is still an incentive to tractorise and this is in direct proportion to the net returns to this type of farming.[2] Two further advantages of mechanisation, which are more social than economic, should be added to the above list. These are a reduction in human toil and drudgery, and the prestige which ownership of modern equipment can confer - particularly in a largely traditional setting.

In theory a number of disadvantages can be ascribed to mechanisation in general and tractorisation in particular in developing countries. These are mainly of the employment/resource endowment type and may be summarised as follows:

(a) Tractorisation causes direct labour displacement in land preparation and possibly also in weeding. If it does not also contribute directly to increasing cropping intensities and yields, or a switch to more labour intensive crops, there will be a net loss of employment opportunity in areas where alternative sources of income are extremely meagre.

(b) If tractorisation leads to increases in yields only, the sole offsetting employment effect will be increased labour demand at harvest and for post-harvest operations. Under these circumstances, even if the net employment effect of tractors is not negative, there will be a reduction in the demand for labour at one or possibly two periods of peak demand at the expense of adding to demand at another such peak. Thus both the period and the amplitude of the employment cycle would be increased.

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[1]Presumably the reason large landowners rent out land is that supervisory costs (including the opportunity costs of the landowner's time) are sufficiently high to reduce the net returns to owner-operation below rental levels.

[2]The appropriate cost calculations would of course include that of renting the land in question. This would represent the opportunity cost if this land were owner-operated.

The potential implications of this are extremely important. In the short term the farm labourer will be forced to earn his year's income in the course of fewer working days, but at the same time the labour supply-demand situation will move in his favour during those working days. Both factors will tend to produce increased labour militancy during the harvest and post-harvest period and this together with the increased work load will tend to make the period in question increasingly expensive for the farmer and/or increasingly protracted with consequent crop losses due to spoilage, shattering, etc. The above situation would adversely affect production in the short term and in the longer term would tend to increase pressures for mechanised harvesting and post-harvest operations with consequent further loss of employment.

(c) In addition to any direct labour displacement, indirect labour displacement will occur to the extent that tractorised farms grow at the expense of marginal farmers and sharecroppers. This would add to the existing very serious problem of landlessness in Bangladesh.

(d) Tractorisation consumes scarce resources, especially the foreign exchange required for machines and spares[1], fuel and lubricants. Another less widely recognised scarce resource is the distributive system which would be required to deliver the above equipment and supplies to the rural areas. Thus additional capacity would ultimately be required in the ports and in the internal system of distribution such as lorries and tankers, trains, ferries, roads etc., together with the associated organisational skills.

(e) To the extent that mechanisation increases the incomes of larger, and therefore presumably wealthier, farmers while simultaneously reducing that of marginal farmers and the landless, it will cause income distribution to become increasingly skewed. Aside from the obviously undesirable social and political repercussions which might be expected to flow from this, it would also reduce the real incomes of those with a high marginal propensity to consume locally grown farm produce and local manufactures while increasing that of income groups which tend to spend a relatively high proportion of any additional income on imports. Thus the negative impact of tractorisation on foreign exchange resources, like that on employment, may be both direct and indirect. At the same time the lost opportunity to stimulate demand for local produce could result in either falling prices of farm produce and hence reduced incentive for further production increases, or expensive government support schemes to maintain domestic prices in the face of low effective demand. This last problem would however, be overcome if the crop(s) in question could be exported, always provided that the quantities involved did not increase world market supplies sufficiently to have an offsetting depressant effect on world prices.

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[1] Or materials, components and capital equipment if they are domestically manufactured.

1.2. AGRICULTURAL PRODUCTION AND EMPLOYMENT IN BANGLADESH

Both issues are of unusually vital concern to Bangladesh today. On the production side the country, far from being food self-sufficient, is both the world's largest rice importer and its largest recipient of food aid. Yet average foodgrain consumption is low - an estimated $15\frac{1}{2}$ oz. per capita per day.[1] Moreover both the quantity and the quality of per capita food consumption (measured approximately by average intake of calories and proteins respectively) have been declining in recent years. These conclusions can be drawn from Table 1.1 which attempts to put such statistics into regional perspective. Not all of the figures are very precise, of course, and no significance should be read into small differences. Nevertheless a useful overall view does emerge from these data.

A great deal is often made of the extreme population density of Bangladesh - with some justiciation as can be seen from the Table (Column 8).[2] This arises in part, however, from the relatively high proportion of the country's land base which is under cultivation (Column 6), implying that it is capable of supporting an unusually high overall population density. When these densities are converted to a per cultivated acreage basis (Column 9) the figure for Bangladesh, although still relatively unfavourable, is clearly comparable with that of China and better than those of Indonesia, South Korea and Japan.[3]

A major problem for Bangladesh in this respect, however, lies in the fact that such a high proportion of her population is engaged in agriculture (Table 1.1, Column 10). This has negative implications for employment prospects. First, labour intensity in agriculture is unusually high; at the present time there is an estimated average of less than one acre of cultivated land to each agricultural worker. Even assuming what the current five year plan calls 'a drastic reduction' in human fertility, this ratio will fall to about two-thirds of an acre by the end of the century. If, on the other hand, present population growth rates continue, it will fall to just under

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[1] Bangladesh Government (1979) page 470.

[2] One familiar calculation demonstrates that if the entire population of the world were shipped to a large country, such as China, the USA, the USSR, Australia or Brazil, that country's overall population density would still be less than that of present day Bangladesh.

[3] Yields of the starchy staple, rice, tend to be much higher in these countries than in Bangladesh, partly because in these countries japonica varieties are grown instead of the indica varieties which are favoured in South Asia. Taking Bangladesh as 100, average paddy yields over the period 1976-78 were: Indonesia 151, China 188, Japan 319, South Korea 344 (computed from FAO (1979)).

TABLE 1.1: LAND, POPULATION AND AGRICULTURE IN SELECTED ASIAN COUNTRIES, 1978

	PRODUCTION INDICES[a]		FOOD CONSUMPTION[b]			LAND		POPULATION		AGRICULTURE	
	Food per Capita	Agricultural per Capita	Calories per cap. per day	Protein grams/ cap/day	Protein % Animal	% Culti-vated[c]	% Irri-gated	Density per sq.mile	Cult. Acres[c] per cap.	% of Population	% of G D P[d]
BANGLADESH	93	93	1,945	42	13	68	14	1,545	0.28	85	51
BURMA	96	95	2,211	57	14	15	10	132	0.74	53	47
CHINA	110	110	2,439	63	21	11	46	245	0.30	61	n.a.
INDIA	100	99	1,949	48	11	57	21	576	0.63	65	36
INDONESIA	98	97	2,115	44	12	10	29	210	0.23	60	32
JAPAN	97	96	2,845	87	48	13	66	802	0.11	13	5
KOREA (SOUTH)	117	119	2,682	73	20	23	49	969	0.15	41	22
PAKISTAN	101	97	2,255	62	25	26	68	259	0.65	55	31
PHILIPPINES	115	116	2,155	52	39	27	14	403	0.67	48	28
SRI LANKA	112	99	2,043	41	16	33	25	595	0.35	54	34
THAILAND	116	112	2,193	46	26	34	15	235	0.94	76	29

Notes: [a] Average 1976-78 (1969-71 average = 100)
[b] 1975-77
[c] i.e. arable and permanently cropped land
[d] 1976

SOURCE: Computed from FAO (1979) and UN (1979).

half an acre.[1] In this situation the marginal product of labour is likely to be low, even zero, except in peak seasons; so that mechanisation of operations at such employment peaks could reduce the overall marginal product of labour to zero and thereby provide a rationale for permanent labour displacement.

The corollary of a high proportion of the labour force in agriculture is a relatively unimportant non-agricultural sector in terms of job opportunity, and hence little scope for expansion at a sufficient pace and on a sufficient scale to absorb much labour displaced from agriculture. For example, at the present time in Bangladesh the number of jobs in industry would have to be doubled in order to absorb just six per cent of the agricultural labour force.[2]

The major reason that a trade-off situation might now arise between the agricultural employment and output goals in Bangladesh lies in the draught availability position. Almost all of the draught power used in the country's agriculture derives from animals, and although statistics on livestock populations are weak (and they are notoriously so in most developing countries) it is evident that the supply of such animals is a qualitatively, if not quantitatively, inadequate base from which to launch a major drive towards significantly increased land productivity. Many of the animals currently in use for draught purposes are undersized, undernourished and sickly. In many cases they are also immature

It is against this background that the 'tractorisation' debate must be conducted in Bangladesh. The range of policy options open in such a situation is potentially fairly wide - wider perhaps than is generally appreciated - but the present discussion will focus for the most part on the option of introducing engine powered tillage equipment in view of its presently highly controversial nature. After presenting the findings of empirical testing of the various hypotheses set out in the previous Section, this report will go on to examine their implications given the type of national parameters just outlined, and will then conclude by exploring a number of policy alternatives.

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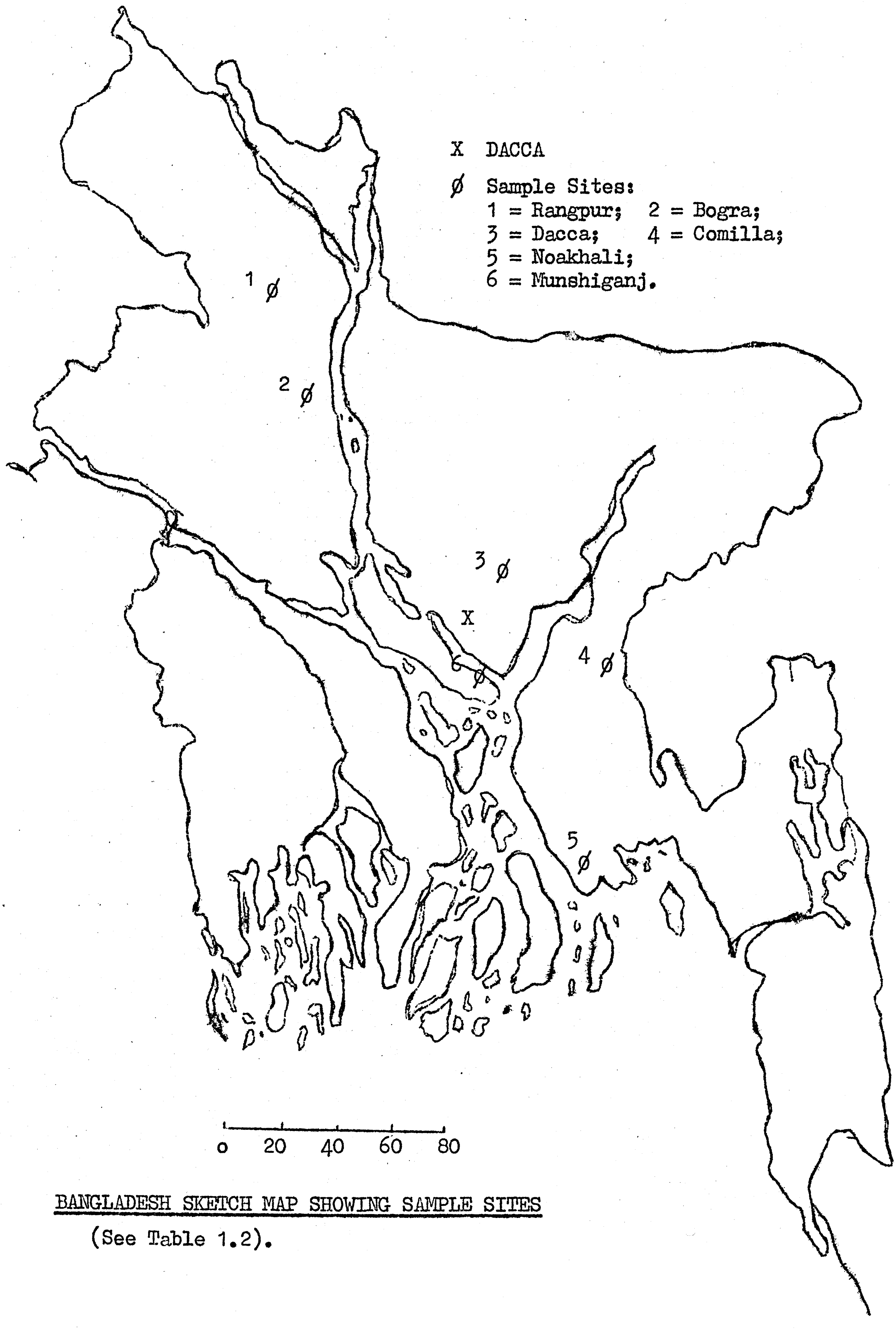
[1] Official statistics imply a present ratio of 0.82 net cropped acres per 'economically active' person employed in the agricultural sector. By the year 2000 this ratio will have declined to between 0.63 and 0.46, depending upon the actual level of fertility reduction achieved on a scale ranging from 'drastic' to zero (computed from Bangladesh Government, 1979 and 1980). A 'drastic reduction' in this context means a decline in the net reproduction rate from the present 2.7 per cent per annum to 1.0 per cent by 1990 (Bangladesh Government (1980) p. XVII-27).

[2] Of the 'economically active' population 20 millions (79 per cent) are estimated to be employed in agriculture compared with 1.2 million in entire industrial sector: large and medium scale, handloom and other small and cottage manufacturing combined (Bangladesh Government (1980) Table 6.2 page vi-4). See also Vol. I, Chapter 7.



<u>BANGLADESH SKETCH MAP SHOWING SAMPLE SITES</u>

(See Table 1.2).

1.3. METHODOLOGY

Of the various elements comprising the formal data collection programme, by far the most important was the multi-interview 'Weekly Survey'. A Panel of 360 farmers in a total of ten villages in different parts of the country was interviewed on a regular weekly basis for a period of up to 15 months. The present section describes the methodology followed in sample selection and related procedures. Those interested in the more detailed operational and logistic aspects of the Survey and of handling the very large[1] data set (and volume of paper) it generated should refer to Appendix 3.

Sample selection for the Survey fell into three stages/strata. The first comprised those few parts of the country in which a significant degree of mechanised cultivation exists, the second, particular villages within these zones, and the third, the farmers within these villages. The choice of strategy was, as always, chosen with logistic considerations in mind. Four areas of the country were initially selected for investigation in order to provide as wide a spread as possible of agroclimatic and other relevant conditions. A fifth area was later added. The initial sample sites were all based on government tractor hire services,[2] the fifth on a private power tiller service. These areas and their basic characteristics and described in Table 1.2 and their locations are shown on the map opposite. Appendix 3 contains further details.

Within these zones the basic approach was to select two villages, one 'experimental' (having access to mechanised cultivation services), the other 'control' (having the same basic agroclimatic and associated attributes as the local 'experimental' village, but without access to tractor services). In each case the two villages were selected with the help of local extension service personnel. The process was fairly time-consuming.

In the North West of the country a different approach was adopted. The 'tractorised' area of Rangpur District lies on the border of two quite different soil types: Barind Tract and Tista floodplain (See Table 1.2), and farms in the area usually comprise a variable number of plots of each type. It did not prove practicable to control for this factor in addition to all of the others so that instead of a 'control' village in Rangpur, the 'non-tractorised' farmers came from the same village as those using tractors. A non-tractorised village in the North West was however selected in neighbouring Bogra District in an area of traditionally high cropping

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[1]For the digitally-minded the raw data set generated by the family labour schedule alone occupies a total of 8.5 megabytes of storage.

[2]Provided under the auspices of the Bangladesh Agricultural Development Corporation (BADC).

TABLE 1.2: BASIC CHARACTERISTIC OF SAMPLE SITES

Sample Site	Thana	Main(Secondary) (Other) Land Use Association	Land Development Unit *	Period of Survey
1. Rangpur	Pirganj	Aus (part jute) - transplanted aman - fallow (Aus (part jute) - rabi crops (part fallow) on high ridges)	Tista Floodplain (higher part)	May, 1978 to August, 1979
2. Bogra	Gabtali	As above	Tista Floodplain (lower part)	As above
3. Dacca	Kaliakair	Aus - transplanted aman fallow (transplanted aman - fallow)	Madhupur Tract	April, 1978 to August, 1979
4. Comilla	Kotwali	Aus - transplanted aman fallow (transplanted aman - fallow)	High Meghna Estuarine Floodplain and Comilla Basin	May, 1978 to August, 1979
5. Noakhali	Ramgati	Transplanted aman - fallow	Young lower Meghna Estuarine Floodplain	April, 1978 to August, 1979
6. Munshiganj	Munshiganj	Mixed Aus and deepwater aman - rabi crops (Deepwater aman - fallow basin) (Aus (part jute), transplanted aman fallow; aus - rabi crops on highest ridges)	Active Bramaputra - Jamuna Floodplain	September, 1978 to September, 1979

*Derived from IBRD (1971) Map V.

intensities. In the North West therefore the two sample villages should not be regarded as being closing closely comparable and results will be reported separately. In the other four areas, however, the 'experimental' - 'control' village approach worked out quite well.

Two enumerators were assigned to each village and were required to live there. Their first task was to complete a census of all village households, classified by occupation. It was assumed that the information provided on sensitive subjects such as size of holding at this initial stage would not be particularly reliable (suspicions which subsequently proved to be well-founded), and no attempt was therefore made to stratify the sample on a size of holding basis. A simple random sample of thirty-six[1] farmers was instead drawn from our village census. This sample was drawn in the course of a public meeting by (a) writing the name of each farmer in the village on a separate slip of paper, (b) placing these in a container and mixing them and (c) having a bystander draw out the slips one by one and calling out the names. Thus the sample was not only random; it was also seen to be random.

Interviewers then had to establish a working relationship with each of the selected farmers and subsequently to begin the interviewing programme with an 'Initial Inventory' of farm assets (Appendix 4). The main data collection schedule then began and the sample farmers were subsequently interviewed each week until the end of the Survey. They were questioned as to their use of family labour, casual labour, animals (both own and hired), machinery, inputs and outputs. Sample crop cuts were taken at harvest time in the case of paddy and wheat (See Appendix 5 for schedules). At the end of this period a Final Inventory of assets plus some attitudinal information was collected (Appendix 6).

This extensive-cum-intensive programme of data collection by resident enumerators provided an unrivalled opportunity for cross-checking on the accuracy of the information provided, and for 'follow-up' interviews where necessary. It also provided almost unlimited scope for collecting supplementary information through 'participant observation' and non-structured interviews with selected respondents.

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[1] That is: two enumerators, three interviews each per day, six working days per week. Such an apparently light programme was fixed in order to provide ample time for sample farmers to be interviewed during the busiest season when interviews are both more difficult to schedule and take more time than usual.

CHAPTER 2: LAND RESOURCES AND DRAUGHT REQUIREMENTS

Any potential contribution which mechanised land preparation can make to increased land productivity is greatly constrained by the physical properties of the land itself, by the economic climate in which it is farmed and by the legal and institutional framework determining the method by which it is held and its produce disposed of. The physical properties of the land - in Bangladesh: altitude relative to flooding, for example - will have a fundamental effect on variables such as soil condition and feasible cropping patterns and these in turn will obviously help determine power requirements.

Economic factors specifically relating land resources to power requirements can be either direct or indirect. For any given plot of land physical characteristics will dictate a range of cropping patterns which may be adopted. Economic considerations, particularly the relationships among and between relative product prices and relative factor prices (or opportunity costs) will help determine which, if any, cropping pattern is adopted, and one of the factors of production which must be included in these considerations is draught power. A more direct economic linkage is between total operated acreage and the economics of using relatively large machines such as tractors and power tillers, since both scale economies and management economies enter into the picture. For a given farm size, however, the degree of fragmentation will seriously influence the economics of using different power sources. Land tenure, particularly the level of rents and the method by which they are determined will have a major influence on the intensity of land use and again therefore on power requirements.

Institutional and legal factors also tend to have an indirect effect on power requirements through their influence on intensity of cultivation. For example, insecurity of tenure caused by the threat of legal action over land ownership will tend to inhibit investment in land improvement. More immediately, the fear that standing crops may be illicitly harvested by someone else discourages farmers from cropping their land very intensively.

2.1. PHYSICAL CHARACTERISTICS

The range of cropping patterns which may be adopted on a given piece of land is not uniquely determined by its physical features, nor is it invariable comparing one year with another. Cropping patterns in Bangladesh as elsewhere are in part determined by weather and soil conditions at the time the farmer wishes to seed or transplant his crop and may be modified during their course by, for example, planting a catch crop after a failure. Economic considerations can also help determine changes in cropping patterns from year to year and alterations in crop rotations over a number of years. Nevertheless, there is a sufficient number of constants in the equation to permit meaningful association of 'normal' cropping patterns with the physical and climatic characteristics of a given plot of land.

The most important of the physical land features and the cropping patterns with which they are generally associated have been described by Brammer (1976a, b), whose broad categorisation for the country as a whole is here reproduced as Table 2.1. This classification illustrates how land type can determine both the varieties that can be grown on a given type of land and the degree of multiple cropping that is possible. It also demonstrates the influence that irrigation can have in ameliorating natural conditions, in allowing transplanted varieties of paddy to substitute for much lower yielding broadcast ones and in permitting high-yielding varieties to be grown in place of traditional strains.

The categorisation by land type of Table 2.1 is extremely useful as a control variable when cropping patterns in relation to draught availability are examined in a later chapter. Tables 2.2 to 2.8 classify the more than four thousand plots on the sample farms by the same categories, except for some slight modification. First it was not possible to separate the first two categories of Table 2.1, (High Land and Medium-High Land Very Shallowly Flooded) so that these two categories have been amalgamated. Second, no high rainfall areas were included in the sample. Third, extra categories have been added to both permeability and irrigation, the former because interviewees seemed to prefer the wider choice and the latter because of the concern of the present study with issues affecting employment.

Examination of Table 2.2 shows an overall association between land height and permeability, with a tendency for the higher land categories to be permeable and vice versa. This is not unexpected and when the picture is disaggregated by region, as in Tables 2.3-2.8, the tendency to cluster becomes more pronounced. It shows up most clearly in Dacca where an extremely high proportion of the soils were of the Madhupur tract so that plots cluster around the 'High, Permeable and Early Draining' categories. In Rangpur the division between higher and lower land types is largely associated with whether the land is of the Barind tract or the floodplain.

Irrigation facilities are the only man-made features of Tables 2.1 to 2.8. Manual methods are nearly all traditional ones such as the dhone and the chetti, although manually operated shallow tubewells are occasionally used for irrigation.[1] Engine-powered methods used

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[1] The dhone resembles a dugout canoe open at one end and balanced on a bund separating an irrigation ditch from a (lower) water source. The operator pushes the closed end down into the water against a counterweight which on release swings it up again so as to discharge the water through the open end into the ditch. The chetti (names vary with locality) is a shallow basket suspended from ropes which two operators swing back and forth scooping water upwards. Sometimes a series of chettis are used to move water up a slope via a series of small pools. In the Rangpur area water is sometimes lifted from open wells by means of a counterbalanced bucket. It is worth observing although not unexpected, that the average distance between the water source and the plot is very much greater (210 yds) in the case of engine powered irrigation than in the case of manual methods (85 yds). The difference is significant at the 0.01 per cent level.

TABLE 2.1: LAND USE IN RELATION TO FLOODING IN BANGLADESH[1]

Land type and normal maximum flooding depth	Permeable soils (except sands) Suitable crops or crop rotation		Impermeable soils Suitable crops or crop rotation	
	Without irrigation	With irrigation	Without irrigation	With irrigation
Highland - not flooded (or flooded only within field bunds on impermeable soils)	1. Broadcast aus or mesta, followed by early rabi crops. 2. Kharif vegetables and oil seeds, followed by early rabi crops. 3. Fruit trees, bananas.	1. HYV aus (line-sown) or jute, followed by tobacco, rabi vegetables, wheat, groundnuts, rapeseed. 2. Kharif vegetables followed by rabi vegetables, tobacco, etc. 3. Sugarcane, pine-apples, bananas, fruit trees.	1. (High rainfall areas): broadcast aus, followed by transplanted aman. 2. (Low rainfall areas): transplanted aman.	HYV boro (or transplanted HYV aus), follwoed by HYV aman
Medium Highland - very shallowly flooded (0-6")	As 1 above	As 1 above	As 1 or 2 above	As above
Medium Highland - shallowly flooded (6"-3') (see footnote 5)	1. (Early draining): As 1 above. 2. (Late draining): Mixed local aus and broadcast aman, followed by middle rabi crops	1. (Early draining): As 1 above. 2. (Late draining): HYV aus (line-sown) or jute, followed by local transplanted aman.	1. (High rainfall areas): broadcast, line-sown or transplanted HYV or local aus, followed by local transplanted aman. 2. (Low rainfall areas): local transplanted aman. 3. (Ganges floodplain): mixed local aus and broadcast aman, followed by middle rabi crops (only on early draining land).	1. HYV boro, followed by transplanted aman. 2. (Ganges floodplain): local broadcast aman, followed by wheat (only on early draining land).

..... continued

[1]See Notes at the end of Table.

TABLE 2.1 (continued)

Land type and normal maximum flooding depth	Permeable soils (except sands) Suitable crops or crop rotation		Impermeable soils Suitable crops or crop rotation	
	Without Irrigation	With Irrigation	Without Irrigation	With Irrigation
Medium lowland (3-6' flooding) - without serious risk if flood damage	1. (Early draining): mixed local aus and broadcast aman, followed by middle rabi crops. 2. (Late draining): mixed local aus and broadcast aman; possibly followed by pulses or kaun.	1. (Early draining): mixed local aus and broadcast aman, followed by wheat, groundnuts, some rabi vegetables, potatoes. 2. (Late draining): mixed local aus and broadcast aman, possibly followed by pulses or kaun. 3. (Permanently or nearly permanently wet): boro.	Mixed local aus and broadcast aman, or broadcast aman alone.	HYV boro
Lowland (6'+ flooding) - without serious risk of flood damage	1. (Early draining): broadcast aman, followed by wheat (part), pulses, oilseeds or kaun. 2. (Late draining): broadcast aman; possibly followed by pulses or kaun. 3. (Permanently wet): boro.	1. (Early draining): broadcast aman, followed by wheat (part), pulses or oilseeds. 2. (Late draining): broadcast aman, possibly followed by pulses or kaun. 3. (More or less permanently wet): boro.	1. Broadcast aman. 2. (Permanently wet): boro.	Boro.
Medium lowland and lowland with serious risk of flood damage - (3'+ flooding).	As 1-3 above, but broadcast aman subject to damage or loss in some years; boro may be unsuitable on sites liable to early flooding.	As 1-3 above, but broadcast aman subject to damage or loss in some years; boro may be unsuitable on sites liable to early flooding.	As 1-2 above, but broadcast aman subject to damage or loss in some years	Boro (except on sites liable to early flooding.

See Notes Overleaf.

Source: Brammer (1976a)

NOTES ON TABLE 2.1

1. Permeable soils allow rainwater and irrigation water to enter and drain through without causing waterlogging. They include sandy loams, most silt loams and some friable silty clay loams and clays which do not have a plough-pan. Many permeable soils also store water well for use by dryland rabi crops, unless they are underlain by sand within 2-3 feet.

2. In impermeable soils, rainwater and irrigation water enter and move through the soil only very slowly. When puddled, they hold water on the surface. They include some silt loams, silty clay loams and clays, especially where these have a ploughpan. Most impermeable or puddled soils do not store moisture satisfactorily for use by dryland rabi crops, and they are poorly suited for irrigation of such crops.

3. HYV aus (broadcast or line-sown) can be grown where there is adequate soil moisture (from natural storage, rainfall or irrigation) in April or May and where flooding is not deeper than 1-2 feet by time of harvest (June-August, according to variety). HYV aus can be transplanted on soils that can be puddled (after sufficient rainfall, or irrigation). If HYV aus is to be followed by HYV aman, a quick-maturing variety must be grown, sown early in April and harvested by mid-July.

4. HYV aman can be grown on soils that are not flooded deeper than about 6 inches at time of transplanting (July or August, according to variety) and which hold water on the surface until at least the time of flowering (early October).

5. Local aman varieties can be transplanted in water up to about 1 foot deep and in the month of September (although yields decrease progressively with time of transplantation after early September). Some of this land on the Brahmaputra and Meghna floodplains may have been flooded up to 3 or more feet deep at flood peak in July or August, but transplantation is done as the floodwater recedes.

6. HYV boro can be grown on soils that are not flooded deeper than about 6 inches at time of transplanting (January-February) nor deeper than 1-2 feet at time of harvesting (April-June, according to variety), and which hold water on the surface naturally or from irrigation through the dry season.

7. Early draining soils are those which become free from floodwater or waterlogging in September, October or November.

8. Late draining soils are those which remain flooded or waterlogged until December or later.

9. On the Ganges floodplain, broadcast aman is grown on medium highland as well as more deeply flooded land. The peak of the Ganges floods is in late August or September, which prevents transplanted aman from being grown except on highland or very shallowly flooded medium highland (except in flood protected areas).

Dryland rabi crops, as listed below, can be sown in the months indicated if the land is free from flooding or waterlogging by this time. Some crops - such as cotton, tobacco, mustard, wheat, khesari, lentils and most winter vegetables are very susceptible to damage or destruction by waterlogging following late monsoon rains or heavy winter rains if they are grown on puddled or relatively impermeable soils. Crops sown later than the months indicated may give low yields or interfere with the timely sowing of a following aus, jute or broadcast aman crop. Late rabi crops must not be sown on land liable to be flooded before they are mature, nor so as to interfere with the sowing of following kharif crops.

Early rabi crops

Sept: tobacco, cotton, groundnuts, sweet potatoes, brinjal, chillies, radish.

Oct: tobacco, groundnuts, mustard, potatoes, sweet potatoes, winter vegetables, chillies, radish, millet, sorghum.

Middle rabi crops

Nov: mustard, rapeseed, groundnuts, potatoes, sweet potatoes, winter vegetables, chillies, grams, fodder legumes, wheat (HYV and local).

Dec: (first half): as November, but less suitable than November sowing for most crops.

Late rabi crops

Dec: (second half): sweet potatoes, chillies, some pulses.

Jan: As December (second half)

Feb: chillies, kaun, sorghum, sesamum.

TABLE 2.2: LAND USE IN RELATION TO FLOODING : ALL AREAS
(Number and Percentage of All Plots)

Land Type		Permeable None	Permeable Man.	Permeable Eng.	Moderately Permeable None	Moderately Permeable Man.	Moderately Permeable Eng.	Impermeable None	Impermeable Man.	Impermeable Eng.	TOTAL
Highland	No.	269	82	76	123	81	42	83	46	42	844
	%	6.6	2.0	1.9	3.0	2.0	1.0	2.1	1.1	1.0	20.8
Medium Highland (E.D.)	No.	63	72	116	120	178	660	18	12	24	1263
	%	1.6	1.8	2.9	3.0	4.4	16.3	0.4	0.3	0.6	31.1
Medium Highland (L.D.)	No.	-	-	-	5	2	-	4	2	1	14
	%	-	-	-	0.1	0.1	-	0.1	0.1	0.0	0.4
Medium Lowland (E.D.)	No.	85	66	12	488	158	195	47	14	48	1113
	%	2.1	1.6	0.3	12.0	3.9	4.8	1.2	0.4	1.2	27.4
Medium Lowland (L.D.)	No.	10	3	-	120	6	3	7	2	1	152
	%	0.3	0.1	-	2.9	0.2	0.1	0.2	0.1	0.0	3.8
Lowland (E.D.)	No.	36	6	1	43	26	12	24	5	29	182
	%	0.9	0.2	0.0	1.1	0.6	0.3	0.6	0.1	0.7	4.5
Lowland (L.D.)	No.	5	-	-	8	11	-	6	2	-	32
	%	0.1	-	-	0.2	0.3	-	0.2	0.1	-	0.8
Lowland (P.W.)	No.	-	-	-	1	1	-	3	-	-	5
	%	-	-	-	0.0	0.0	-	0.1	-	-	0.1
Medium Lowland (E.D.+F.)	No.	23	35	2	65	31	7	47	42	36	288
	%	0.6	0.9	0.1	1.6	0.8	0.2	1.2	1.0	0.9	7.1
Medium Lowland (L.D.+F.)	No.	10	7	-	57	26	-	13	27	5	145
	%	0.3	0.2	-	1.4	0.6	-	0.3	0.7	0.1	3.6
Medium Lowland (P.W.+F.)	No.	-	1	-	5	4	1	2	6	-	19
	%	-	0.0	-	0.1	0.1	0.0	0.1	0.2	-	0.5
TOTAL	No.	501	272	207	1035	524	920	254	158	186	4057
	%	12.4	6.7	5.1	25.5	12.9	22.7	6.3	3.9	4.6	100.0

Abbreviations

E.D. = Early draining)
L.D. = Late draining) As defined in Table 2.1.
P.W. = Permanently wet)
+ F = With serious risk of flood damage)
Man. = Manually-powered irrigation
Eng. = Engine-powered irrigation
% = Percentage
No. = Number
\- = None

TABLE 2.3: LAND USE IN RELATION TO FLOODING : RANGPUR
(Number and Percentage of All Plots)

Land Type		Permeability and Type of Irrigation									TOTAL
		Permeable			Moderately Permeable			Impermeable			
		None	Man.	Eng.	None	Man.	Eng.	None	Man.	Eng.	
Highland	No.	52	13	17	27	24	11	76	40	42	302
	%	9.5	2.4	3.1	4.9	4.4	2.0	13.8	7.3	7.6	54.9
Medium Highland (E.D.)	No.	11	3	10	39	15	39	15	4	6	142
	%	2.0	0.5	1.8	7.1	2.7	7.1	2.7	0.7	1.1	25.8
Medium Highland (L.D.)	No.	-	-	-	1	-	-	3	-	-	4
	%	-	-	-	0.2	-	-	0.5	-	-	0.7
Medium Lowland (E.D.)	No.	1	2	2	9	9	4	10	9	5	51
	%	0.2	0.4	0.4	1.6	1.6	0.7	1.8	1.6	1.0	9.3
Medium Lowland (L.D.)	No.	-	-	-	-	-	-	-	-	-	-
	%	-	-	-	-	-	-	-	-	-	-
Lowland (E.D.)	No.	-	-	-	-	-	-	-	-	-	-
	%	-	-	-	-	-	-	-	-	-	-
Lowland (L.D.)	No.	-	-	-	-	-	-	-	-	-	-
	%	-	-	-	-	-	-	-	-	-	-
Lowland (P.W.)	No.	-	-	-	-	-	-	-	-	-	-
	%	-	-	-	-	-	-	-	-	-	-
Medium Lowland (E.D.+F.)	No.	-	-	1	-	7	-	1	26	1	36
	%	-	-	0.2	-	1.3	-	0.2	4.7	0.2	6.5
Medium Lowland (L.D.+F.)	No.	-	-	-	-	-	-	2	4	-	6
	%	-	-	-	-	-	-	0.4	0.7	-	1.1
Medium Lowland (P.W.+F.)	No.	-	-	-	-	3	-	-	6	-	9
	%	-	-	-	-	0.5	-	-	1.1	-	1.6
TOTAL	No.	64	18	30	76	58	54	107	89	54	550
	%	11.6	3.3	5.5	13.8	10.5	9.8	19.5	16.2	9.8	100.0

(For Abbreviations see Table 2.2)

TABLE 2.4: LAND USE IN RELATION TO FLOODING : BOGRA
(Number and Percentage of All Plots)

Land Type		Permeability and Type of Irrigation									TOTAL
		Permeable			Moderately Permeable			Impermeable			
		None	Man.	Eng.	None	Man.	Eng.	None	Man.	Eng.	
Highland	No.	10	15	10	21	39	9	-	6	-	110
	%	1.7	2.6	1.7	3.7	6.8	1.6	-	1.0	-	19.2
Medium Highland (E.D.)	No.	1	34	14	13	120	29	3	8	11	233
	%	0.2	5.9	2.4	2.3	20.9	5.1	0.5	1.4	1.9	40.6
Medium Highland (L.D.)	No.	-	-	-	4	2	-	1	2	1	10
	%	-	-	-	0.7	0.3	-	0.2	0.3	0.2	1.7
Medium Lowland (E.D.)	No.	-	9	2	5	47	16	2	2	1	84
	%	-	1.6	0.3	0.9	8.2	2.8	0.3	0.3	0.2	14.6
Medium Lowland (L.D.)	No.	1	2	-	4	6	3	1	2	1	20
	%	0.2	0.3	-	0.7	1.0	0.5	0.2	0.3	0.2	3.5
Lowland (E.D.)	No.	1	-	-	1	7	-	3	-	-	12
	%	0.2	-	-	0.2	1.2	-	0.5	-	-	2.1
Lowland (L.D.)	No.	5	-	-	8	11	-	6	2	-	32
	%	0.9	-	-	1.4	1.9	-	1.0	0.3	-	5.6
Lowland (P.W.)	No.	-	-	-	1	1	-	1	-	-	3
	%	-	-	-	0.2	0.2	-	0.2	-	-	0.5
Medium Lowland (E.D.+F.)	No.	-	-	-	2	1	1	-	-	-	4
	%	-	-	-	0.3	0.2	0.2	-	-	-	0.7
Medium Lowland (L.D.+F.)	No.	4	2	-	5	18	-	2	23	5	59
	%	0.7	0.3	-	0.9	3.1	-	0.3	4.0	0.9	10.3
Medium Lowland (P.W.+F.)	No.	-	1	-	3	1	-	2	-	-	7
	%	-	0.2	-	0.3	0.2	-	0.3	-	-	1.2
TOTAL	No.	22	63	26	67	253	58	21	45	19	574
	%	3.8	11.0	4.5	11.7	44.1	10.1	3.7	7.8	3.3	100.0

(For Abbreviations see Table 2.2)

TABLE 2.5: LAND USE IN RELATION TO FLOODING : DACCA
(Number and Percentage of All Plots)

Land Type		Permeability and Type of Irrigation									TOTAL
		Permeable			Moderately Permeable			Impermeable			
		None	Man.	Eng.	None	Man.	Eng.	None	Man.	Eng.	
Highland	No.	71	2	39	8	-	18	-	-	-	138
	%	10.1	0.3	5.5	1.1	-	2.5	-	-	-	19.5
Medium Highland (E.D.)	No.	1	-	3	35	12	490	-	-	-	541
	%	0.1	-	0.4	5.0	1.7	69.4	-	-	-	76.6
Medium Highland (L.D.)	No.	-	-	-	-	-	-	-	-	-	-
	%	-	-	-	-	-	-	-	-	-	-
Medium Lowland (E.D.)	No.	-	-	-	-	-	-	-	-	23	23
	%	-	-	-	-	-	-	-	-	3.3	3.3
Medium Lowland (L.D.)	No.	-	-	-	-	-	-	-	-	-	-
	%	-	-	-	-	-	-	-	-	-	-
Lowland (E.D.)	No.	-	-	-	-	-	-	4	-	-	4
	%	-	-	-	-	-	-	0.6	-	-	0.6
Lowland (L.D.)	No.	-	-	-	-	-	-	-	-	-	-
	%	-	-	-	-	-	-	-	-	-	-
Lowland (P.W.)	No.	-	-	-	-	-	-	-	-	-	-
	%	-	-	-	-	-	-	-	-	-	-
Medium Lowland (E.D.+F.)	No.	-	-	-	-	-	-	-	-	-	-
	%	-	-	-	-	-	-	-	-	-	-
Medium Lowland (L.D.+F.)	No.	-	-	-	-	-	-	-	-	-	-
	%	-	-	-	-	-	-	-	-	-	-
Medium Lowland (P.W.+F.)	No.	-	-	-	-	-	-	-	-	-	-
	%	-	-	-	-	-	-	-	-	-	-
TOTAL	No.	72	2	42	43	12	508	4	-	23	706
	%	10.2	0.3	5.9	6.1	1.7	72.0	0.6	-	3.3	100.0

(For Abbreviations see Table 2.2)

TABLE 2.6: LAND USE IN RELATION TO FLOODING : COMILLA
(Number and Percentage of All Plots)

Land Type		Permeability and Type of Irrigation									TOTAL
		Permeable			Moderately Permeable			Impermeable			
		None	Man.	Eng.	None	Man.	Eng.	None	Man.	Eng.	
Highland	No.	50	51	10	6	18	4	-	-	-	139
	%	6.0	6.2	1.2	0.7	2.2	0.5	-	-	-	16.8
Medium Highland (E.D.)	No.	41	15	89	27	27	102	-	-	7	308
	%	5.0	1.8	10.7	3.3	3.3	12.3	-	-	0.8	37.2
Medium Highland (L.D.)	No.	-	-	-	-	-	-	-	-	-	-
	%	-	-	-	-	-	-	-	-	-	-
Medium Lowland (E.D.)	No.	1	3	7	22	16	170	3	3	19	244
	%	0.1	0.4	0.8	2.7	1.9	20.5	0.4	0.4	2.3	29.5
Medium Lowland (L.D.)	No.	-	-	-	-	-	-	-	-	-	-
	%	-	-	-	-	-	-	-	-	-	-
Lowland (E.D.)	No.	-	-	-	5	2	10	17	5	29	68
	%	-	-	-	0.6	0.2	1.2	2.1	0.6	3.5	8.2
Lowland (L.D.)	No.	-	-	-	-	-	-	-	-	-	-
	%	-	-	-	-	-	-	-	-	-	-
Lowland (P.W.)	No.	-	-	-	-	-	-	2	-	-	2
	%	-	-	-	-	-	-	0.2	-	-	0.2
Medium Lowland (E.D.+F.)	No.	-	-	-	1	-	4	17	12	32	66
	%	-	-	-	0.1	-	0.5	2.1	1.4	3.9	8.0
Medium Lowland (L.D.+F.)	No.	-	-	-	-	-	-	1	-	-	1
	%	-	-	-	-	-	-	0.1	-	-	0.1
Medium Lowland (P.W.+F.)	No.	-	-	-	-	-	-	-	-	-	-
	%	-	-	-	-	-	-	-	-	-	-
TOTAL	No.	92	69	106	61	63	290	40	20	87	828
	%	11.1	8.3	12.8	7.4	7.6	35.0	4.8	2.4	10.5	100.0

(For Abbreviations see Table 2.2)

TABLE 2.7: LAND USE IN RELATION TO FLOODING : NOAKHALI
(Number and Percentage of All Plots)

Land Type		Permeability and Type of Irrigation									TOTAL
		Permeable			Moderately Permeable			Impermeable			
		None	Man.	Eng.	None	Man.	Eng.	None	Man.	Eng.	
Highland	No.	86	-	-	61	-	-	7	-	-	154
	%	11.3	-	-	8.0	-	-	0.9	-	-	20.2
Medium Highland (E.D.)	No.	-	-	-	-	-	-	-	-	-	-
	%	-	-	-	-	-	-	-	-	-	-
Medium Highland (L.D.)	No.	-	-	-	-	-	-	-	-	-	-
	%	-	-	-	-	-	-	-	-	-	-
Medium Lowland (E.D.)	No.	10	-	-	352	-	-	32	-	-	394
	%	1.3	-	-	46.3	-	-	4.2	-	-	51.8
Medium Lowland (L.D.)	No.	9	-	-	115	-	-	6	-	-	130
	%	1.2	-	-	15.1	-	-	0.8	-	-	17.1
Lowland (E.D.)	No.	2	-	-	1	-	-	-	-	-	3
	%	0.3	-	-	0.1	-	-	-	-	-	0.4
Lowland (L.D.)	No.	-	-	-	-	-	-	-	-	-	-
	%	-	-	-	-	-	-	-	-	-	-
Lowland (P.W.)	No.	-	-	-	-	-	-	-	-	-	-
	%	-	-	-	-	-	-	-	-	-	-
Medium Lowland (E.D.+F.)	No.	8	-	-	34	-	-	1	-	-	43
	%	1.1	-	-	4.5	-	-	0.1	-	-	5.7
Medium Lowland (L.D.+F.)	No.	-	-	-	29	-	-	8	-	-	37
	%	-	-	-	3.8	-	-	1.1	-	-	4.9
Medium Lowland (P.W.+F.)	No.	-	-	-	-	-	-	-	-	-	-
	%	-	-	-	-	-	-	-	-	-	-
TOTAL	No.	115	-	-	592	-	-	54	-	-	761
	%	15.1	-	-	77.8	-	-	7.1	-	-	100.0

(For Abbreviations see Table 2.2)

TABLE 2.8: LAND USE IN RELATION TO FLOODING : MUNSHIGANJ
(Number and Percentage of All Plots)

Land Type		Permeability and Type of Irrigation									TOTAL
		Permeable			Moderately Permeable			Impermeable			
		None	Man.	Eng.	None	Man.	Eng.	None	Man.	Eng.	
Highland	No.	-	1	-	-	-	-	-	-	-	1
	%	-	0.2	-	-	-	-	-	-	-	0.2
Medium Highland (E.D.)	No.	9	20	-	6	4	-	-	-	-	39
	%	1.4	3.1	-	0.9	0.6	-	-	-	-	6.1
Medium Highland (L.D.)	No.	-	-	-	-	-	-	-	-	-	-
	%	-	-	-	-	-	-	-	-	-	-
Medium Lowland (E.D.)	No.	73	52	1	100	86	5	-	-	-	317
	%	11.4	8.2	0.2	15.7	13.5	0.8	-	-	-	49.7
Medium Lowland (L.D.)	No.	-	1	-	1	-	-	-	-	-	2
	%	-	0.2	-	0.2	-	-	-	-	-	0.3
Lowland (E.D.)	No.	33	6	1	36	17	2	-	-	-	95
	%	5.2	0.9	0.2	5.6	2.7	0.3	-	-	-	14.9
Lowland (L.D.)	No.	-	-	-	-	-	-	-	-	-	-
	%	-	-	-	-	-	-	-	-	-	-
Lowland (P.W.)	No.	-	-	-	-	-	-	-	-	-	-
	%	-	-	-	-	-	-	-	-	-	-
Medium Lowland (E.D.+F.)	No.	15	35	1	28	23	2	28	4	3	139
	%	2.4	5.5	0.2	4.4	3.6	0.3	4.4	0.6	0.5	21.8
Medium Lowland (L.D.+F)	No.	6	5	-	23	8	-	-	-	-	42
	%	0.9	0.8	-	3.6	1.3	-	-	-	-	6.6
Medium Lowland (P.W.+F.)	No.	-	-	-	2	-	1	-	-	-	3
	%	-	-	-	0.3	-	0.2	-	-	-	0.5
TOTAL	No.	136	120	3	196	138	10	28	4	3	638
	%	21.3	18.8	0.5	30.7	21.6	1.6	4.4	0.6	0.5	100.0

(For Abbreviations see Table 2.2)

TABLE 2.9: METHOD OF IRRIGATION
(Percentage of all plots)

Area	None	Manually-Powered	Engine-Powered
RANGPUR	39.8	31.8	28.4
BOGRA	22.7	58.7	18.6
DACCA	23.8	2.7	73.5
COMILLA	16.2	13.9	70.0
NOAKHALI	100.0	-	-
MUNSHIGANJ	51.8	44.0	4.2
ALL SITES	49.1	19.3	31.7
ALL SITES EXCLUDING NOAKHALI	31.2	28.9	39.8

are: shallow tubewells (Bogra) low-lift pumps (Bogra and Munshiganj), and deep tubewells (all other irrigated areas). In the sample areas almost all are diesel-powered although plans exist to electrify a number of the deep tubewells. There is no irrigation in the Noakhali sample because of the high salinity of both groundwater and rivers. Table 2.9 pulls together the information on method of irrigation by region contained in Tables 2.3 to 2.8. It must be remembered however, that 'type of irrigation available' in this sense need not imply that irrigation water is necessarily available at any given time. Break-downs and fuel shortages can cut off supplies when mechanical methods are used and groundwater irrigation can also fail during a drought owing to the fall in the water table. All of these problems were encountered in the Survey areas.

2.2. FARM SIZE AND FRAGMENTATION

Summary statistics on operated areas and farm fragmentation are presented in Table 2.10. These figures obviously provide ample support for the view that the typical Bangladeshi farm is small and highly fragmented.[1] There is, moreover, a clear regional pattern with larger than average holdings tending to be located in the less productive areas, that is the Barind and Madhupur tract areas

[1] See for example Zaman (1976)

TABLE 2.10: OPERATED AREA AND FRAGMENTATION

	Mean	S.D.	Min.	Max.	Skewness	Kurtosis
1. RANGPUR						
No. of plots	16	7.93	6	40	1.42	2.00
Plot size (acres)	0.34	0.34	0.01	5.00	5.83	64.40
Distance from farmstead	450y	610y	-	4m	6.01	52.82
Total Operated Acres/farm	5.42	2.96	1.30	13.90	1.29	1.56
2. BOGRA						
No. of plots	16	7.22	5	36	0.62	0.22
Plot size (acres)	00.22	0.22	0.02	3.00	4.85	46.60
Distance from farmstead	350y	442y	-	3m	5.56	53.49
Total Operated Acres/farm	3.55	1.89	0.72	8.95	0.80	0.65
3. DACCA						
No. of plots	10	10.09	1	83	5.60	39.59
Plot size (acres)	0.43	0.39	0.02	3.33	2.78	11.59
Distance from farmstead	225y	366y	3y	2m	4.84	31.92
Total Operated Acres/farm	4.22	3.39	0.33	21.8	2.30	9.13
4. COMILLA						
No. of plots	12	6.04	3	31	0.91	0.40
Plot size (acres)	0.23	0.44	-	10	15.82	319.25
Distance from farmstead	250y	284y	-	1.5m	2.16	8.31
Total Operated Acres/farm	2.68	2.76	0.65	17.96	3.50	14.71
5. NOAKHALI						
No. of plots	11	6.03	2	30	0.61	0.04
Plot size (acres)	0.49	0.78	0.02	11	6.16	57.62
Distance from farmstead	¾m	2m	-	20m	5.09	31.74
Total Operated Acres/farm	5.31	5.24	0.32	27.46	1.98	5.01
6. MUNSHIGANJ						
No. of plots	9	4.70	1	30	1.50	4.67
Plot size (acres)	0.36	0.37	0.02	3.61	3.73	20.44
Distance from farmstead	530y	544y	-	5m	6.36	85.16
Total Operated Acres/farm	3.21	2.63	0.32	13.42	1.90	3.78
7. ALL AREAS						
No. of plots	11	7.48	1	83	3.15	23.35
Plot size (acres)	0.35	0.48	0.01	11.00	8.46	126.71
Distance from farmstead	540y	1632y	-	20m	11.02	158.42
Total Operated Acres/farm	4.00	3.58	0.32	27.46	2.50	9.40

y = yards, m = miles.

Definitions and Notes

STANDARD DEVIATION (S.D.): a measure of the degree of dispersion of the variable about the mean (or 'average'), expressed in the same units. In this Table the standard deviations tend to be large mainly because of the presence of a few values much larger than the mean (see SKEWNESS and KURTOSIS).

SKEWNESS: A measure of the extent to which a distribution deviates from the symmetry of the 'bell' shape. Every distribution in the Table shows positive skew, i.e. the 'peak' of the curve is closer to the minimum value than to the maximum, indicating that the bulk of the observations are smaller than the mean value and that a few large values have had a disproportionate effect on the average.

KURTOSIS: This measures the extent to which a curve 'peaks' at its most common (modal) value. Again in this Table every value is positive, indicating a relatively high peak in the distribution and therefore a much smaller degree of dispersion of the bulk of values than is suggested at first sight by a relatively high standard deviation.

(Rangpur and Dacca respectively), and Southern Noakhali, whereas in the areas of multiple cropping, Bogra, Munshiganj and Comilla, holdings tend to be smaller. This is an important point as far as farm mechanisation is concerned since it implies that, where farm sizes are relatively large, intensity of cultivation, and therefore the prospects of full capacity utilisation of machinery, are relatively low - and vice versa.

In all of the areas studied the average farm size is too low to permit full utilisation of the capacity even of a power tiller. Therefore if such machines are used under these circumstances, either the size of owners' farms would have to be or become larger than the average, or excess capacity would have to be hired out - or both.[1] However, the relatively high degree of positive skewness in the Operated Area distribution for all districts indicates both that the modal or 'typical' farm is smaller than the arithmetic mean and that there exists a number of farms which are substantially larger than the mean. This is confirmed by the figures in Table 2.11, which shows how sample farms are distributed by size category and indicates that almost three quarters of the farms are of less than five acres while only 1.5 per cent comprise more than ten acres. These figures should be viewed in the context of studies from other parts of the subcontinent which show that full tractor capacity is not used in on-farm work until operated area is in the 25 to 50 acre range.[2] Moreover, in the Bangladesh sample the degree of fragmentation is largely uninfluenced by farm size, so that even when a farm is large enough in total operated area to support a tractor or power tiller, the relatively large number of plots over which this total area is spread will tend to militate against efficient use of such machines.[3]

The figures on plot size, number of plots and distance from the farmstead presented in Table 2.10 help quantify the degree of fragmentation which exists. Again there is a fairly high degree of positive skewness in both cases so that again the modal value is less than the mean. Tables 2.12 and 2.13 show the distribution of the sample plots by acreage and by distance from the farmstead respectively. The 'typical' plot is thus between a tenth and half an acre - and more likely to be on the lower than the higher end of this range. Only around one plot in twenty is of one acre or more, the figure which is generally considered to be the minimum size of plot for efficient use of a conventional four-wheel tractor such as that supplied by BADC.[4]

The modal distance from farmstead to plot, 100 yards to $\frac{1}{4}$ mile over the sample as a whole, is not excessively large, and where bullocks are used for cultivation the proportion of their time required for travelling between farmstead and plot is not excessive in terms of

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[1] With the present situation of largely hired tractors and power tillers, users tend to have significantly larger farms than non-users. Details are provided in Table 4.2.

[2] These studies are summarised by Binswanger (1978, pp. 47-50).

[3] There is a significant positive correlation between total farm size and the total number of plots comprising that farm (r^2=0.342, level of significance 0.01%).

[4] See Kline et al (1969).

TABLE 2.11: TOTAL OPERATED AREAS BY SIZE AND DISTRICT (Percentage frequencies and cumulative percentage frequencies)

	RANGPUR		BOGRA		DACCA		COMILLA		NOAKHALI		MUNSHIGANJ		ALL AREAS	
	%	Cum.%	%	Cum.%	%	Cum.%	%	Cum.%	%	Cum.%	%	Cum.%	%	Cum.%
Less than 1 acre	-	-	2.8	2.8	11.1	11.1	12.5	12.5	13.9	13.9	8.3	8.3	9.4	9.4
1 acre but less than 2.5	8.3	8.3	36.1	38.9	22.2	33.3	59.7	72.2	25.0	38.9	44.4	52.7	34.7	44.1
2.5 acres but less than 5.0	44.5	52.8	41.7	80.6	34.7	68.0	18.0	90.2	23.6	62.5	30.6	83.3	30.0	74.1
5.0 acres but less than 7.5	33.3	86.1	13.9	94.5	20.8	88.8	4.2	94.4	11.1	73.6	8.3	91.6	13.6	87.7
7.5 acres but less than 10.0	2.8	88.9	5.5	100.0	5.6	94.4	1.4	95.8	12.5	86.1	4.2	95.8	5.6	93.3
10.0 acres but less than 15.0	11.1	100.0	-	100.0	4.2	98.6	2.8	98.6	9.7	95.8	4.2	100.0	5.3	98.6
More than 15 acres	-	100.0	-	100.0	1.4	100.0	1.4	100.0	4.2	100.0	-	100.0	1.4	100.0

TABLE 2.12: PLOT AREAS BY SIZE AND DISTRICT (Percentage frequencies and cumulative percentage frequencies)

	RANGPUR		BOGRA		DACCA		COMILLA		NOAKHALI		MUNSHIGNAJ		ALL AREAS	
	%	Cum.%	%	Cum.%	%	Cum.%	%	Cum.%	%	Cum.%	%	Cum.%	%	Cum.%
Less than 0.1 acres	8.6	8.6	23.2	23.2	7.9	7.9	24.5	24.5	12.2	12.2	8.8	8.8	14.5	14.5
0.1 acres but less than 0.25	35.1	43.7	47.7	70.9	25.1	33.0	47.2	71.7	35.4	47.6	40.1	48.9	38.4	52.9
0.25 acres but less than 0.5	33.4	77.1	21.4	92.3	36.8	69.8	21.7	93.4	29.0	76.6	34.2	83.1	29.2	82.1
0.5 acres but less than 1.0	18.3	95.4	6.1	98.4	21.4	91.2	5.6	99.0	13.1	89.7	11.6	94.7	12.5	94.6
1.0 acres but less than 5.0	4.4	99.8	1.6	100.0	8.8	100.0	0.8	99.8	9.4	99.1	5.3	100.0	5.1	99.7
More than 5 acres	0.2	100.0	-	100.0	-	100.0	0.2	100.0	0.9	100.0	-	100.0	0.3	100.0

TABLE 2.13: DISTANCE FROM FARMSTEAD TO PLOT BY DISTRICT (Percentage frequencies and cumulative percentage frequencies)

	RANGPUR		BOGRA		DACCA		COMILLA		NOAKHALI		MUNSHIGANJ		ALL AREAS	
	%	Cum.%	%	Cum.%	%	Cum.%	%	Cum.%	%	Cum.%	%	Cum.%	%	Cum.%
Not more than 100 yards	21.3	21.3	29.1	29.1	48.0	48.0	41.2	41.2	26.4	26.4	14.7	14.7	31.0	31.0
Over 100 yards up to $\frac{1}{4}$ mile	40.4	61.7	52.1	81.2	41.5	89.5	43.4	84.6	32.8	59.2	49.1	63.8	42.7	73.7
Over $\frac{1}{4}$ mile up to $\frac{1}{2}$ mile	29.5	91.2	14.8	96.0	7.5	97.0	14.1	98.7	21.3	80.5	25.2	89.0	18.3	92.0
Over $\frac{1}{2}$ mile up to 1 mile	7.0	98.2	3.7	99.7	2.1	99.1	1.2	99.9	7.6	88.1	10.0	99.0	5.1	97.1
Over 1 mile up to 5 miles	1.8	100.0	0.3	100.0	0.9	100.0	0.1	100.0	8.0	96.1	0.8	99.8	2.1	99.2
More than 5 miles	-	100.0	-	100.0	-	100.0	-	100.0	3.9	100.0	0.2	100.0	0.8	100.0

their working day.[1] Where problems could arise is where much faster power sources such as tractors and power tillers are used, since they could cultivate a much larger number of different plots in a working day travelling between plots or between plot and farmstead. This is particularly true of a tractor hire service.

Table 2.13 shows that the distances between farmstead and plots tends to be unusually high in the Noakhali sample area. This arises from the peculiarly unstable nature of land in the delta, where river erosion is continually wasting away great tracts of land. At the same time new '<u>char</u>' lands are built up elsewhere by the reverse process. Farmers losing land in this way are entitled to compensation in the form of <u>char</u> lands. Although in practice there is seldom a straightforward process of restitution, the net effect is that farmers tend to acquire <u>char</u> land at fairly long distances from their farmsteads. Since they are of comparatively recent origin, however, these <u>char</u> plots have not been subjected to the same degree of exposure to fragmentation by inheritance or sale that affects older lands, so that they tend to be comparatively extensive. Thus the same type of trade-off situation arises as was mentioned earlier: a factor tending to favour the use of engine powered cultivation (large plots) is balanced by one tending to disfavour it, long distances.[2] This discouragement arises from two sources: long and therefore expensive travelling and problems with security which expose the crop to theft before the owner can harvest it. It is certainly the case in Noakhali that the <u>char</u> plots are much less intensively cultivated and yields lower than is the case with other plots in the area, and that theft of charland crops is extremely common. It should be noted however that when plots are a very long way from the farmstead such problems will arise regardless of the form of draught power which is used.

The conventional answer to land fragmentation is consolidation, i.e. the amalgamation of neighbouring plots into large blocks in which the tractor can operate with optimum, economic and technical efficiency. This would, theoretically also improve accessibility and reduce the amount of land devoted to access paths, bunds and plot boundaries. If this argument were to be applied to Bangladesh, however, it would have to be modified to take account of the reasons for land fragmentation. One fact which emerges very clearly from the present study is that this is not, as is sometimes supposed, for purely non-agricultural reasons, such as the Muslim laws of inheritance. Farmers in fact often deliberately split up their fields into smaller plots separated by bunds. This is done for the purpose of water control and water management, and in order to facilitate levelling. If these plots were to be amalgamated in order to tractor-cultivate them, the

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[1]For example, assume that the average walking speed of a pair of bullocks is 50 per cent more than their working speed (FAO, 1969), i.e. 2 mph. The modal plot would therefore be reached in $2\frac{1}{2}$-10 minutes or a total travelling time of 1.4 to 6 per cent of the working day for the return journey. If more than one plot were cultivated on a given day then this figure would increase, but farmers obviously try as far as possible to minimise travelling time in this case by cultivating neighbouring plots on the same day.

[2]The relationships between these variables are discussed in Chapter 4 below (Section 4.1).

TABLE 2.14: FARM AREA AND OWNERSHIP

	Mean	Standard Deviation	Min.	Max.	Skewness	Kurtosis	Percentage Of Farms	Percentage Of Acreage
1. RANGPUR								
Total Operated Acres/Farm	5.42	2.96	1.30	13.90	1.29	1.56	100.0	100.0
(of which owned)	4.61	3.35	-	13.90	0.99	0.73	97.2	85.1
(of which rented in)	0.72	1.04	-	5.23	2.59	9.12	58.3	13.3
(of which mortgaged in)	0.09	0.20	-	0.81	2.47	5.77	22.2	1.6
2. BOGRA								
Total Operated Acres/Farm	3.55	1.89	0.72	8.95	0.80	0.65	100.0	1 00.0
(of which owned)	2.39	1.79	0.05	7.58	0.84	0.40	100.0	67.5
(of which rented in)	1.15	1.22	-	4.80	1.40	1.47	77.8	32.5
(of which mortgaged in)	-	-	-	-	-	-	-	-
3. DACCA								
Total Operated Acres/Farm	4.22	3.99	0.33	21.8	2.30	9.13	100.0	100.0
(of which owned)	3.12	2.54	0.25	11.05	1.27	1.17	100.0	73.9
(of which rented in)	0.98	2.05	-	13.95	4.24	23.07	48.6	23.2
(of which mortgaged in)	0.12	0.38	-	2.05	3.82	14.92	16.7	2.9
4. COMILLA								
Total Operated Acres/Farm	2.68	2.76	0.65	17.96	3.50	14.71	100.0	100.0
(of which owned)	1.93	2.53	-	16.80	3.92	18.76	95.8	72.0
(of which rented in)	0.56	1.48	-	11.73	6.35	42.28	52.8	20.9
(of which mortgaged in)	0.19	0.29	-	1.42	1.96	4.12	50.0	7.1
5. NOAKHALI								
Total Operated Acres/Farm	5.31	5.24	0.32	27.46	1.98	5.01	100.0	100.0
(of which owned)	3.19	3.96	-	19.97	2.40	6.10	97.2	60.2
(of which rented in)	1.98	3.85	-	27.46	4.52	27.17	58.3	37.3
(of which mortgaged in)	0.13	0.78	-	6.40	7.64	61.40	9.7	2.5
6. MUNSHIGANJ								
Total Operated Acres/Farm	3.15	2.63	0.32	13.42	1.90	3.78	100.0	100.0
(of which owned)	2.01	2.26	-	10.22	1.99	3.68	94.4	64.3
(of wich rented in)	0.75	0.73	-	3.20	0.88	0.47	69.4	23.2
(of which mortgaged in)	0.39	1.00	-	6.88	4.69	26.26	37.5	12.1
7. ALL AREAS								
Total Operated Acres/Farm	4.00	3.58	0.32	27.46	2.50	9.40	100.0	100.0
(of which owned)	2.76	2.95	-	19.97	2.32	6.99	97.2	69.5
(of which rented in)	1.04	2.19	-	27.46	6.56	64.51	59.4	26.1
(of which mortgaged in)	0.18	0.62	-	6.88	7.52	70.25	25.0	4.4

NOTES

Percent of farms: the percentage of farms having some land in the given ownership category. Since many farms have land in more than one such category, double counting occurs and the sum of the percentages is greater than 100. Theoretically any or all of these percentages could be 100.

Percent of Acreage: the percentage of the entire acreage in the sample which is farmed under a given ownership category. Thus, for example, in Rangpur 97.2 per cent of sample farmers own at least some of the land they farm, but only 85.1 per cent of the total land area is farmed by its owners.

bunds would have to be rebuilt and the land relevelled afterwards, thus negating any time and labour-saving effects of the tractor. Where plots are not contiguous, they are often of different land types (as defined in Table 2.1), a factor which serves to reduce risk and, perhaps even more important, flatten out peaks in demand for labour and draught, by incorporating a range of different crops and cropping patterns on the same farm at the same time.

2.3. LAND TENURE

The relationship between land tenure and draught requirements (via cropping intensities) was mentioned earlier in the present chapter. There is also an employment aspect of this relationship. If the degree of labour intensity on large farms differs from that on small farms then factors which permit average farm size to increase will have an indirect employment effect. In a situation where there are few non-agricultural employment opportunities, as in present day Bangladesh, few farmers will willingly give up their cultivation rights, but insecure tenancy may force them to do so. This insecurity may be legally based, as in the case of tenant farmers with only short term leases, or economically based, as in the case of marginal smallholders being forced as a last resort to sell or mortgage all or part of their holdings in times of need. The remainder of this chapter will examine Bangladesh land tenure arrangements as to their potential impact on employment and productivity.

Table 2.14 shows the breakdown of farms and overall acreages between three basic ownership categories. The degree of owner-operation is fairly high, with almost all farmers owning some of the land they operate and a total of around 70 per cent of the total acreage farmed in this way. However, as was shown earlier (Table 2.11), almost half of all farmers cultivate less than 2½ acres, and, three quarters less than 5 acres. The figures on mortgaged-in ('bondhok') land indicate one way in which at any given time land is in process of changing hands in present day Bangladesh. This system operates as follows. Land is pledged as security for a loan, generally because of distress, and the mortgagee (i.e. the lender) acquires usufructuary rights to the land in question and retains these until the loan is repaid. Thus the system removes from the control of the mortgagor at least some of the productive base from which he might otherwise have been able in time to generate sufficient income to repay the loan. For the purposes of economic analysis therefore, mortgaged-in land may be treated in the same way as owner-operated land. The figures on mortgaged-in land presented in Table 2.14 must be regarded as minimum, rather than representative estimates. This is true for at least two reasons. First when a mortgage is not repaid the mortgagor - and even more so his heir in the event of inheritance - comes increasingly to regard the plot in question as family property, and these plots are often reported as such. Second, mortgaged-in land is not always cultivated by the mortgagor, but is sometimes sharecropped out - not infrequently to the legal owner! - and will not therefore appear in the figures for operated holdings. This topic will be explored further in Chapter 8 below.

TABLE 2.15: RENTED PLOTS BY METHOD OF PAYMENT (Percentages)

	RANGPUR	BOGRA	DACCA	COMILLA	HOAKHALI	MUNSHIGANJ	ALL SITES
Cash	3.7	13.7	20.0	25.0	-	97.4	22.4
Share (50%)	96.3	86.3	80.0	70.0	100.0	2.6	76.9
Share (Other)[a]	-	-	-	5.0	-	-	0.7

Note: [a]Forty per cent in two instances, 33 per cent in four, 15 per cent in one.

TABLE 2.16: CASH RENTALS (Taka per acre per annum)[a]

	RANGPUR	BOGRA	DACCA	COMILLA	MUNSHIGANJ
Number	4	23	35	35	112
Minimum	2188	444	30	500	625
Maximum	2857	2142	671	5625	3409
Median[b]	2384	742	500	2400	1633
Mean	2453	827	488	2348	1726
Standard Deviation	284.9	405.9	133.9	1267.0	550.9

Notes

[a]These figures are not strictly comparable between areas, since the Khai Khalashi system is used in Bogra and Baghi is in use in all other sites (see paragraph
In the former case the annual rentals were calculated by treating the problem as essentially one of compound interest with a one-year compounding period (for comparability with annual cash leases). The formula is:

$$A = \frac{(P(1+i)^y)}{y}$$

where A is the annual rent, P the original sum advanced, y the number of years, and i the rate of interest, expressed as a decimal fraction. The rate of interest is the opportunity cost of capital. Roughly ten per cent could be earned by investing in a savings account. Non-institutional loans in the area usually earn ten per cent per month, but the demand is seasonal and the risk high, so roughly the same (discounted) rate is assumed.

[b]The median is the value which comes midway along the distribution when it is arranged in order of magnitude (the mean of the two midway values in the case of an even number of observations). In all cases here the median and mean are fairly close to each other, indicating fairly symmetrical distribution.

Table 2.14 shows that just over a quarter of the total operated area is rented in, and Table 2.15 shows the breakdown of these figures between fixed and share leases. In the sample all of the fixed rent leases are cash leases, although in some parts of the country, for example Pabna, a system of fixed crop leasing operates. Cash rents are generally payable in advance, share and fixed crop rents after the harvest.

Summary statistics on cash rents are presented in Table 2.16. There are two basic systems in use (names may vary with locality). Baghi (poltan) is a fixed rent payable in advance, usually for one (occasionally two) years. This is the type of lease that is in operation in all sample areas except Bogra. Here the Khai Khalashi system is used whereby a fixed cash payment is made and the land is then cultivated by the payer for an agreed period - usually seven or more years - and then returned to the owner. The essential difference between this system and mortgaging (bondhok) is therefore the fixed period and the fact that no repayment is required in the case of Khai Khalashi, so that it is essentially a long-term cash lease with payment made in full in advance. When calculating an annual rent for land leased in this way it is necessary to make allowance for the opportunity cost of having capital tied up for a number of years (see the Notes on Table 2.16).

Share tenancy has two important advantages over fixed payments from the tenant's viewpoint: it is payable in arrears and it forces the landlord to share in the risk of a bad harvest, and, unlike cash tenancies, low crop prices. Sharecropping can however have a disincentive effect as far as increasing land productivity is concerned, since for the sharecropper, unlike the owner cultivator and fixed rent tenant, rent is a variable cost of production. If the landlord's proportional contribution to variable costs is less than the proportion of output he receives as rent, the sharecropper's optimum level of output will be less than that of the owner-cultivator or fixed rent tenant, other things being equal.[1] Whether this disincentive effect will be translated into lower land productivity in practice depends very largely on the relationship between, and relative bargaining power, of landlord and sharecropper, since it is clearly in the interest of the former that land productivity be maximised.

It would be easy to assume that in a situation of severe competition for leases, as can be presumed to exist in present-day Bangladesh, the landlord will always be in the stronger position. This is generally, but not invariably the case and the situation is in fact quite complex.[2] Table 2.17 reflects some of the diversity of sharecrop

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[1] See Heady (1950) chs. 20-21, or, for a more detailed exposition in an Asian context, Cheung (1969).

[2] Stereotype images, such as that of a free peasantry vis-a-vis a downtrodden class of sharecroppers must be firmly put aside. Farmers whose own holdings are too small do of course rent in supplementary land, but so too do some of the larger farmers. In fact there is no statistically significant relationship between the area owner-operated and that rented in, whereas the simple stereotype would suggest a strong negative correlation.

TABLE 2.17: LEASES: INPUTS PROVIDED BY LANDLORD

LANDLORD'S CONTRIBUTION						PERCENTAGE OF ALL CONTRACTS						
PERCENTAGE OF INPUT PROVIDED					CASH (mean: taka per acre)	RANGPUR	BOGRA	DACCA	COMILLA	NOAKHALI	MUNSHIGANJ	ALL SITES
Fertiliser	Seed	Irrigation	Pesticide	Cultivation								
-	-	-	-	-	-	21.9	2.8	1.4	35.2[a]	57.7	33.3	27.3
50	-	-	-	-	-	1.0	-	27.4	2.9	-	-	5.9
100	-	-	-	-	-	-	-	1.4	-	12.8	-	4.3
-	50	-	-	-	-	12.4	14.5	-	-	-	-	4.7
-	100	-	-	-	-	37.1	-	-	-	8.8	66.7	8.4
-	-	-	-	100	-	-	-	-	9.5	-	-	1.4
15	50	-	-	-	-	-	0.7	-	-	-	-	0.1
20	50	-	-	-	-	-	0.7	-	-	-	-	0.1
25	50	-	-	-	-	-	0.7	-	-	-	-	0.1
32	50	-	-	-	-	-	0.7	-	-	-	-	0.1
40	50	-	-	-	-	-	4.8	-	-	-	-	1.0
50	50	-	-	-	-	24.8	75.2	10.6	1.0	-	-	20.8
50	100	-	-	-	-	1.9	-	15.6	-	-	-	3.3
100	100	-	-	-	-	-	-	1.4	-	-	-	0.3
50	50	50	-	-	-	1.0	-	27.7	-	-	-	5.5
50	50	-	50	-	-	-	-	-	-	20.7	-	6.5
50	100	50	-	-	-	-	-	13.5	-	-	-	2.6
100	50	50	-	-	-	-	-	0.7	-	-	-	0.1
50	50	50	50	-	-	-	-	-	43.8	-	-	6.3
-	-	-	-	-	630(50% rent)	-	-	-	5.7	-	-	0.8
-	-	-	-	-	125(33% rent)	-	-	-	1.9	-	-	0.3

Notes: [a]Includes two contracts with 40% rents, two with 33% and one with 15%.

leasing arrangements which exist in Bangladesh to-day. Virtually all of the sharecrop leases encountered stipulate a 50 per cent share rent, sometimes subject to certain conditions. For example, if the landlord supplies all of the seed or seedlings, extra payment is usually required. In some cases he receives all of the straw, while in others an equivalent amount of seed is set aside for him after the harvest, the remainder being divided 50-50. Table 2.17 shows that the landlord's contribution to variable costs can be quite substantial - in some cases approximating to the 'perfect share lease' (see Cheung, op. cit.). Some of the 'softer' leases are influenced by custom and culture or reflect kinship, friendship and patronage ties more than market forces.[1] There are however, two clear peaks in the distribution: at No Inputs Supplied and at Fifty Percent Fertiliser and Seed. The key to this dichotomy lies in the fact that land is generally sharecropped for a season, not a year, at a time (although leases are frequently renewable from season to season). In certain seasons, for example, boro, or if transplanted HYV paddy is grown in aus and for some rabi crops, variable costs are high and the demand for share leases correspondingly low. It is in these seasons that share lease agreements approximate to the 'perfect share lease'. During aman on the other hand, the No Inputs Supplied lease generally obtains. Thus the potential of the sharecropping system for depressing land productivity is minimised: by sharing variable costs in seasons of otherwise low demand for such leases and in other seasons by requiring high standards of husbandry as a condition of the lease. Any sharecropper who failed to meet these standards would find it extremely difficult to obtain a lease in subsequent seasons.

The picture presented in Tables 2.14 to 2.17 is of necessity a static one, since as far as long term developments are concerned the Survey on which it was based was essentially cross-sectional. However, it is possible in the course of such a study to build up a picture of longer term developments. This was largely done in the course of non-structured interviews with selected informants. It is also possible to understand some of these developments by comparing survey areas at different levels of modernisation.

The picture which emerges from this process is largely what economic theory would predict. As population pressures have increased in a situation of minimal non-agricultural employment opportunity, pressure of demand for land has increased and the relative bargaining power of landlords correspondingly strengthened. This has manifested itself in a tendency for rents to increase and for new institutional arrangements relatively favourable to landlords to be adopted. An example of the latter is the shift from sharecropping to cash renting. The advantage of this from the landlord's viewpoint is that it relieves him both of the risks of the farming enterprise and of the necessity to ensure that he receives the agreed share of output. It is also

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[1] A sociological study was conducted by Peter James of War on Want in close collaboration with Reading University project; see James, Volume II of this Study.

accompanied by a change from arrears to advance rent payment. As can be seen from Table 2.15, there is virtually no sharecropping in Munshiganj, an area of relatively commercialised agriculture. Yet in this area, sharecropping was reportedly the only rental system in use at the time of Partition, and the system was still not unusual by the mid-1970's. This can be compared with the situation in Noakhali, the most subsistence oriented of the sample areas. It is also widely and reliably reported that levels of share rents are increasing from older levels, vestiges of which can be seen in the figures for Comilla (Table 2.15), and that landlords are now tending to appropriate such by-products as straw which used to be regarded as the sharecropper's perquisite.

CHAPTER 3 : ON-FARM POWER SOURCES

Most of the power used in Bangladesh agriculture is human and animal muscle power.[1] It is worth bearing in mind that the major use of engines is for irrigation pumps: Table 2.9 showed that one-third of all plots in the sample were linked to engine-powered irrigation, the regional figure varying from three-quarters in Dacca to zero in Southern Noakhali. Engine-powered irrigation systems are not, as a rule, owned by the farmers themselves, however.

The sources of power owned on-farm for field operations in this study were (a) permanent labour, (b) draught animals and power tillers, on 100%, 62.8% and 1.4% of the sample farms respectively.

3.1. PERMANENT LABOUR

It must be emphasised from the outset that the labour force in question is that available for field operations, and that in Bangladesh this generally means men and children only. Women certainly do invaluable agricultural work, such as crop processing and caring for the garden plot, but they do not as a rule work in the fields. A number of instances was recorded of women being employed for field work on a casual basis (such employment implying very low social status), but no female member of a sample farm family or of its permanent labour force was ever reported as doing such work.[2]

In order to permit comparison of different age groups, all permanent labour has been converted to man-equivalents (for methodology see Appendix 7) and summary statistics are presented in Table 3.1. Clearly the hiring of labour on a permanent or long term basis is not a very widespread practice: fewer than one farmer in five has any such labour and overall it constitutes less than ten per cent of the permanent labour force. When it does exist it is obviously on the larger farms where farm family labour availability is less than the norm.[3] Most of the permanent employees are in fact adolescent boys - apprentices really - who leave on attaining maturity. They receive board and lodging and occasional grants of clothing, but very little in cash. When family labour supplies are insufficient for a particular peak operation, the practice is to hire in extra labour on a casual basis, as will be shown in Chapter 7.

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[1] Bhatia (1977, Table 2) gives the following breakdown for rural India, which is not very different from rural Bangladesh; of energy consumption converted to coal replacement terms: draught power 24%, irrigation 4%, fertilisers 10%, household 62%.

[2] There may of course be under reporting here by poorer farmers, but if so it is not much.

[3] There is a significant negative correlation between farm family, in man equivalents per acre and the number of m.e.'s permanently hired. (r^2=0.057, level of significance 0.1%). There is also a significant positive correlation between the latter figure and farm size (r^2=0.202, level of significance 0.1%).

TABLE 3.1: TOTAL AND HIRED PERMANENT LABOUR

		Mean	Standard Deviation	Min.	Max.	Skewness	Kurtosis	Percentage of all farms	Percentage of all permanent labour
1. RANGPUR	Total Permanent Labour (m.e.)	1.67	0.87	0.44	4.83	1.53	3.47		
	" " " (m.e./acre)	0.34	0.15	0.12	0.77	0.96	1.05		
	Hired " " (m.e.)	0.34	0.55	-	1.72	0.92	-0.63	41.7	20.4
2. BOGRA	Total Permanent Labour (m.e.)	1.24	0.53	0.10	2.10	0.01	-0.73		
	" " " (m.e./acre)	0.42	0.27	0.08	1.49	2.12	6.24		
	Hired " " (m.e.)	0.08	0.23	-	1.00	3.17	9.52	13.9	6.5
3. DACCA	Total Permanent Labour (m.e.)	1.62	0.84	0.61	5.00	1.58	3.04		
	" " " (m.e./acre)	0.67	0.96	0.11	7.73	5.93	41.70		
	Hired " " (m.e.)	0.26	0.54	-	3.00	2.89	9.93	29.2	16.0
4. COMILLA	Total Permanent Labour (m.e.)	1.36	0.58	0.10	2.94	0.77	0.39		
	" " " (m.e./acre)	0.77	0.53	0.04	3.07	1.88	5.52		
	Hired " " (m.e.)	0.05	0.20	-	1.00	4.00	15.96	8.3	3.7
5. NOAKHALI	Total Permanent Labour (m.e.)	1.63	0.96	0.10	5.00	1.48	2.87		
	" " " (m.e./acre)	0.61	0.60	0.04	3.12	2.04	4.53		
	Hired " " (m.e.)	0.09	0.26	-	1.00	2.76	6.40	12.5	5.5
6. MUNSHIGANJ	Total Permanent Labour (m.e.)	1.64	0.94	0.10	6.10	2.05	6.81		
	" " " (m.e./acre)	0.78	0.64	0.03	3.44	2.15	5.91		
	Hired " " (m.e.)	0.05	0.18	-	1.10	4.79	24.01	16.7	3.1
7. ALL AREAS	Total Permanent Labour (m.e.)	1.54	0.83	0.10	6.10	1.74	4.89		
	" " " (m.e./acre)	0.64	0.65	0.03	7.73	4.86	41.63		
	Hired " " (m.e.)	0.14	0.37	-	3.00	3.40	14.80	18.9	9.1

Notes: m.e. = man equivalents (for methodology see Appendix 7).
Percentage of all farm - i.e. percentage hiring any labour on a permanent basis.

TABLE 3.2: AVERAGE CULTIVATED AREA BY TYPE OF DRAUGHT ANIMAL USED

	Bullocks Only	Bullocks & Cows	Cows Only	None	Total
Number of Farms	134	31	61	134	360
Percentage	37.2	8.6	16.9	37.2	100.0
Mean Cultivated Area (Acres)*	5.52	4.43	3.25	2.37	3.87

*Differences are statistically significant at the 0.1% level (ANOVA)

TABLE 3.3: INSTALLED HORSEPOWER

	Mean	Standard Deviation	Min.	Max.	Skewness	Kurtosis
1. RANGPUR						
Total Installed Horsepower	0.94	0.52	-	2.30	0.50	1.11
Installed Horsepower per Acre	0.21	0.13	-	0.57	0.74	0.62
2. BOGRA						
Total Installed Horsepower	0.42	0.27	-	1.00	-0.42	-0.55
Installed Horsepower per Acre	0.14	0.12	-	0.43	0.78	0.03
3. DACCA						
Total Installed Horsepower	0.74	0.53	-	2.05	0.59	0.05
Installed Horsepower per Acre	0.21	0.24	-	1.82	4.53	28.57
4. COMILLA						
Total Installed Horsepower	0.41	0.40	-	2.00	1.02	1.84
Installed Horsepower per Acre	0.18	0.19	-	0.59	0.65	-0.92
5. NOAKHALI						
Total Installed Horsepower	0.45	0.49	-	2.00	0.86	0.27
Installed Horsepower per Acre	0.08	0.11	-	0.57	2.11	5.50
6. MUNSHIGANJ						
Total Installed Horsepower	0.82	1.83	-	8.00	3.07	8.58
	(0.34)	(0.52)	(-)	(1.90)	(1.27)	(0.41)
Installed Horsepower per Acre	0.22	0.44	-	2.60	3.41	13.88
	(0.14)	(0.25)	(-)	(1.47)	(2.97)	(12.32)
7. ALL AREAS						
Total Installed Horsepower	0.62	0.93	-	8.00	5.04	33.34
	(0.53)	(0.51)	(-)	(2.30)	(0.85)	(0.46)
Installed Horsepower per Acre	0.18	0.26	-	2.60	4.61	33.00
	(0.16)	(0.20)	(-)	(1.82)	(3.16)	(19.76)

Notes: The non-bracketed figures for Munshiganj and All Areas include the five power tiller owners in the sample. These farmers are excluded from the bracketed figures.

The labour force figures of Table 3.1 are clearly broadly consistent across all areas. The typical farm family labour force for field operations comprises a father and one or two adolescent sons - as the figures on man equivalents suggest. There is, however, a significant positive relationship between size of this labour force and both the total area the family owns[1] and the total area it cultivates.[2]

The figures on permanent labour force per unit area are obviously very high, reflecting the equally high national population density. It must be kept in mind also that these figures represent only part - perhaps not much more than half - of the national (male) agricultural labour force, since apart from permanent employees, the data in Table 3.1 do not incorporate all of the landless.

3.2. DRAUGHT ANIMALS[3]

In Bangladesh draught animals have traditionally been used for land preparation (ploughing, harrowing, levelling, making drainage ditches), for weeding, for haulage, for threshing and, more recently, for powering machinery such as sugarcane crushers. Animal-powered irrigation is, surprisingly, almost unknown. By-products of animal draught are manure and (ultimately) meat and hides. If cows are used instead of bullocks they can also be used for breeding and for milking. It is said that the use of cows for cultivation was almost unknown in Bangladesh until fairly recently. Partition in 1947 cut off much of the grazing which has previously been available for cattle in East Bengal and feed supplies for the national herd suffered correspondingly. One result is that nowadays female cattle are used quite extensively for cultivation, sometimes even into advanced stages of pregnancy. As is to be expected it is the poorer farmers who tend to use cows for this purpose, as can be seen from Table 3.2, which also shows that it is farmers in the smallest holding category who have no draught animals of their own. The use of cows into advanced pregnancy is obviously highly undesirable - and is only done as a measure of desperation. Arguments can be presented both for and against the use of cows in draught. Against the practice it does cause a reduction in milk yields while the animal is working, but this may be a reasonable price to pay for a multi-purpose beast. The practice is also said to cause a reduction in fertility, although to what extent it is not clear. On the positive side there is less work to be done on a smaller farm and a pair of cows could pay for their upkeep (in milk and calves) where bullocks could not. The smaller the workload the fewer also would be the problems of lactation and fertility.[4]

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[1] $r^2=0.035$, n=360, significance=0.02 per cent.
[2] $r^2=0.129$, n=360, significance=0.01 per cent.

[3] Draught animals should at present best be regarded as complementary to, more than substitutes for, human labour in Bangladesh. There is, however, some direct substitution (eg primary cultivation by hoe) and some indirect (eg when increased animal draught for land preparation reduces weed infestation and hence the need for hand weeding).

[4] This argument is cogently put by Smith (1979). The general theme is the subject of further economic analysis by Mettrick in Volume II of this Study.

As in the case of permanent labour, the capacities of different draught animals is best understood if reduced to a common unit. Figures on installed horsepower are presented in Table 3.3 (see Appendix 7 for methodology). The overall figure of just under 0.2 h.p. per acre corresponds reasonably closely to the rule of thumb that one pair of draught animals is sufficient to cultivate five acres. The figures can also be seen in an international perspective if compared with Makhijani's estimates presented in Table 3.4. These sample figures show, perhaps surprisingly, that installed draught power per acre is on average quite close to the figure for Taiwan, so that at least the overall agricultural draught power picture in Bangladesh is perhaps not as bleak as is sometimes suggested.

The overall average of course disguises important sources of variability within the distribution. At the area level, Bogra has a lower than average installed power capacity, but the soils of that sample area are generally light and easily worked, so that requirements are also relatively low. The equivalent figures for two heavy soil areas, Rangpur and Dacca, are correspondingly high. The Comilla sample site is also an area of heavy (clay) soils and its relatively low level of installed draught power per acre (Table 3.3) is reflected in relatively high rates of hiring draught animals (Table 4.6). The area of really low draught power is Southern Noakhali with only forty per cent of the installed horsepower per acre of the other areas taken as a whole. This point is especially relevant in view of the evidence presented in the previous chapter, that the mean distance between plots and farmstead is higher in Noakhali than elsewhere - and that the wastage of draught energy in travelling between plots and farmstead is consequently higher.

The relative draught shortage in Southern Noakhali is largely the result of two factors. First, the area is one which has been continually afflicted by cyclones, the most recent of which devastated that part of the country in 1970. This cyclone and its accompanying bore inflicted enormous loss of life and property and virtually wiped out the cattle population of many areas, and this has clearly not yet recovered to pre-1970 levels. Second, a short term contributory factor was an epidemic of foot-and-mouth disease in 1978.[1]

The distributions of horsepower and horsepower per acre shown in Table 3.3 are obviously subject to considerable variation about the mean, as is suggested by the large standard deviations. (Some of this variability is removed when the power tiller owners are excluded from the picture). Variations in the ownership of draught animals is of course no more unexpected than variations in the size of land holdings and in fact these two variables are themselves positively correlated.

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[1]The Southern Noakhali sample site was the especial responsibility of the War on Want research team. For the rationale behind the original setting up of the War on Want Agricultural Mechanisation and evaluation programme see MacDonald, I.O. 'Programme Proposal ...', which is reproduced as Appendix A of Llewellyn-Jones (1979). For a full socio-economic analysis of farm power in the area see James in Volume II of this Study.

TABLE 3.4: INSTALLED HORSEPOWER : IN SELECTED COUNTRIES

	Installed Horsepower (per acre)[a]	Of which Tractors & Power Tillers %
India	0.28	20
China	0.28	20
Taiwan	0.20	50
Japan	0.65	90
USA	0.61	100

[a]Farm machines and and draught animals only.

Source: Derived from Makhijani (1975), Table 2-1.

TABLE 3.5: PERCENTAGE DISTRIBUTION OF FARMERS BY NUMBER OF DRAUGHT ANIMALS OWNED

Number Owned	Rangpur	Bogra	Dacca	Comilla	Noakhali	Munshiganj	All Areas
None	8.3	22.2	19.4	41.7	43.1	66.7	37.2
One	2.8	13.9	13.9	20.8	6.9	1.4	10.3
Two or more	88.9	63.9	66.7	37.5	50.0	31.9	52.5

TABLE 3.6: CORRELATION BETWEEN INSTALLED HORSEPOWER AND OPERATED ACREAGE

Area	Total Installed Horsepower			Installed Horsepower per Acre		
	Coefficients		Level of Significance	Coefficients		Level of Significance
	r	(r^2)	%	r	(r^2)	%
RANGPUR	0.279	(0.078)	5.0	-0.454	(0.206)	0.3
BOGRA	0.443	(0.196)	0.3	-0.317	(0.101)	3.0
DACCA	0.730	(0.532)	0.1	-0.203	(0.041)	5.0
COMILLA	0.164	(0.027)	n.s.	-0.156	(0.024)	n.s.
NOAKHALI	0.742	(0.551)	0.1	0.022	(0.001)	n.s.
MUNSHIGANJ[a]	0.446	(0.199)	0.1	0.088	(0.008)	n.s.
" [b]	0.269	(0.073)	2.0	-0.107	(0.012)	n.s.
ALL AREAS[a]	0.359	(0.129)	0.1	-0.083	(0.006)	n.s.
" " [b]	0.512	(0.262)	0.1	-0.137	(0.019)	0.5

Notes: n.s. = not significant at 5%; [a] = All farmers; [b] = Excluding Power Tiller Owners

TABLE 3.7: DETAILS OF FIVE POWER TILLERS

	When Purchased	Where Purchased	Approx. Distance (Miles)	New/ S.H.	Purchase Price (Taka)	Model	Horse-Power
1.	1976	Bogra	155	S.H.	13,000	Yanman YC7	7 - 8
2.	1977	Kustia	120	S.H.	10,000	" "	7 - 8
3.	1973	Rangpur	220	New	11,300	" "	7 - 8
4.	1974	Dacca	20	New	17,000	" "	7 - 8
5.	1977	Munshiganj	6	New	28,200	" ZY8N	8 - 9

Notes: US$ 1.00 = Tk 15/-; S.H. = Second Hand.

Whether or not the installed draught power on farms is adequate as an average, Table 3.5 shows that almost half of the farmers in the sample have fewer than the two draught animals required to pull a plough. Farmers with only one animal are normally able to arrange to share animals with another farmer in the same position. More than a third of the farmers, however, have no draught animals at all, so that they are totally dependent on outside sources of draught power. The regional figures reflect the averages in Table 3.3 with the exception of Munshiganj, where power tillers are so extensively used. (None of the power tiller owners kept draught animals for cultivation, although some do purchase them to operate sugarcane crushers and sell them again when the season is over). The relationship between installed horsepower and tractor use is taken up in the next chapter.

As far as the relationship between installed horsepower and operated acreage is concerned - shown in Table 3.6 - the results are at first sight rather surprising. It is to be expected of course that there should be a strong positive correlation between total installed horsepower and total area operated. However, the fact that when installed horsepower is converted to a unit area basis it correlates negatively (if at all) with operated acreage is important. At first sight this might suggest that small farms are relatively energy-intensive, but in fact what the correlation does reflect is the relative quality of draught animals comparing smaller with larger farms. It is quite obvious on seeing both sets of animals that those on the latter are larger, stronger and apparently healthier than small farmers' beasts, qualitative differences which could not adequately be included in the rather rough and ready coefficients used here to convert draught animals to horsepower equivalents. Thus, the relative energy-intensity of smaller farms suggested by some of the figures in Table 3.6, is more apparent than real. Small farms in these circumstances are in fact relatively inefficient users of feed energy, since an unhealthy and undernourished draught animal must devote a relatively high proportion of its feed intake to support its basal metabolism, simply to stay alive, and therefore a relatively low proportion of energy intake becomes available for useful work.

3.3. POWER TILLERS

Most of the discussion on power tillers will be reserved for the next and subsequent chapters, but some brief observations are appropriate at this point. Five of the sample farmers in one of the villages were owners of these machines and Table 3.7 provides basic details. Although this is obviously a rather small sample, some very interesting facts nonetheless emerge from the figures. The first is the age of the machines. The fact that it is possible to keep such machines operational for at least five years in a remote area is both a great tribute to the care and perseverance of the owners and an indication of the profitability of the machines! This impression is further reinforced by the fact that would-be owners have been able to ascertain that a machine is available for sale more than 200 miles away and to travel there, purchase it and transport it back home over sometimes very difficult terrain. This last point is of especial relevance to the present study, since it indicates that any scheme aimed at limiting power tillers to specific parts of the country, where perhaps a crucial shortage of draught power had been identified, would be most unlikely to succeed - particularly if the machines in question were in private ownership.

CHAPTER 4 : COMPARISON OF TRACTOR AND ANIMAL DRAUGHT[1]

4.1. TRACTOR USERS' CHARACTERISTICS

It was noted in Chapter 1 that the extent to which land preparation is presently tractorised in Bangladesh is quite small, and that the present study was therefore designed to include a disproportionate number of areas with access to tractor cultivation. Table 4.1 shows the percentage breakdown of the sample farmers who used tractors during the course of the Survey. Obviously, the figure is highest in the power tiller area, Munshiganj, but the corresponding percentage of users based on the BADC Agricultural Development Estate at Kashimpur (i.e. the Dacca sub-sample) is also relatively high.

In the context of the present discussion, there are two basic questions to examine: first, on what basis are tractors allocated among farmers? and second, how do tractor users allocate the machines among their various plots of land?

The most obvious hypothesis to test in relation to the first question is that it is the larger more influential farmers who are best able to bid for tractor services where these are in scarce supply. The most convenient surrogate measure of the relative wealth, social position, etc. of a given farmer is his total operated acreage. Table 4.2 compares the two groups, tractor users and non-users, in those villages with access to tractor services, using analysis of variance to test the significance of differences in mean operated acreages. A number of points emerge from these data. First, although in all areas the tractorised farms are the larger as an average, the differences are not always statistically significant (at the five per cent level), so that our 'obvious' hypothesis is not as strongly supported by the evidence as might have been supposed. Indeed the largest farm of all, 27½ acres, did not employ a tractor even though it is situated in an area which does have a tractor service.

The most clear-cut relationship obtains in Munshiganj, where the private power tiller hire service operates and the allocation of these tractors, especially outside of the owners' village, is on purely commercial grounds (according to both owners and hirers). Within the village non-economic criteria do apply to a certain extent. Within the areas receiving the BADC tractor service, sociological analysis by James suggests very strongly that, at least in the Noakhali

[1] Some of the material in this chapter was contained in the author's Preliminary Report on Mechanised Land Preparation which appeared in September, 1979.

TABLE 4.1: PERCENTAGE OF SAMPLE FARMERS USING TRACTORS

In tractorised villages only:	RANGPUR	55.6
	DACCA	86.1
	COMILLA	36.1
	NOAKHALI	47.2
	MUNSHIGANJ[a]	22.2
	MUNSHIGANJ[b]	91.7
	TOTAL	56.5
In overall sample		34.2

Notes: [a]less tractorised area; [b]more tractorised area.

TABLE 4.2: OPERATED ACREAGE : TRACTOR USES VS. NON-USERS (ANOVA)

	No.	Mean	Std. Devn.	Std. Error	Min.	Max.	95% Confidence Interval for Mean	F-Ratio	F-Probability[a]
RANGPUR									
Users	20	6.53	3.37	0.75	1.30	13.90	4.96 to 8.11	7.664	0.009
Non-Users	16	4.02	1.51	0.38	1.54	6.59	3.21 to 4.82		
DACCA									
Users	31	5.02	4.14	0.74	0.82	21.80	3.50 to 6.54	2.667	0.112
Non-users	5	1.92	1.80	0.80	0.33	4.94	- to 4.16		
COMILLA									
Users	13	2.64	2.72	0.75	0.67	11.16	1.00 to 4.28	0.021	0.884
Non-users	23	2.53	1.89	0.39	0.65	8.06	1.71 to 3.34		
NOAKHALI									
Users	17	6.70	5.66	1.37	1.10	23.17	3.79 to 9.62	0.770	0.387
Non-users	19	4.86	6.82	1.57	0.32	27.46	1.57 to 8.15		
MUNSHIGANJ									
Users	41	4.01	3.13	0.49	0.32	13.42	3.03 to 5.00	10.076	0.002
Non-users	31	2.14	1.10	0.20	0.34	4.51	1.74 to 2.55		
ALL AREAS									
Users	122	4.91	3.99	0.36	0.32	23.17	4.20 to 5.63	12.332	0.001
Non-users	94	3.09	3.46	0.36	0.32	27.46	2.38 to 3.80		

[a]i.e. the probability of the observed difference arising by chance.
Statistical significance at the five per cent level requires a probability of 0.05 or less.

Survey area, kinship and political ties are the key determinants in the allocation of tractor services.[1] It is hardly surprising that non-economic criteria should determine distribution in a situation where demand for a service greatly exceeds supply. Demand for tractor services is high because the charge, at least officially, is much lower than the cost of hiring draught animals, but artificially so since substantial subsidisation is required to maintain a level of charges which is less than even the marginal cost of the service (see Section 4.9 below). Supply, on the other hand, is low. This is partly because increased supply would require an increase in the total level of subsidy; it is also partly because of the unreliability of the machines themselves, which results largely from lack of spare parts, a shortage which derives in turn from the fact that the service does not cover costs!

The scarcity of tractors is such that even the tractor users cannot cultivate all of their land with these machines. Table 4.3 shows that overall only one third of all plots of such farms have been tractor-cultivated during the course of the Survey. Again Munshiganj appears as the area with the highest degree of tractor penetration, although this may be due in part to the fact that power tillers can be used on smaller plots than can accommodate a two-axle tractor.

Even if non-economic considerations predominate when tractors are allocated among competing farmers, one would nevertheless expect economic criteria to play a dominant role when users allocate scarce tractor resources among plots, i.e. that tractors would be allocated to plots on which their marginal productivity was maximised. The major likely associations, those between tractor use on the one hand and cropping intensities and cropping patterns on the other will be examined in the next chapter, but two other possible explanatory variables will be examined here: plot area and plot-to-farmstead distance.[2] Because of their very different technical specifications, particularly as regards size and weight, 2-axle tractors and power tillers have been treated separately. Economic considerations would suggest that all types of tractors should be used on plots relatively close to the farmstead, first because plots tend to be more concentrated there, thus minimising travelling time and, second, because it makes it easier for the farmer to supervise the operator's work. Two-axle tractors work more efficiently the larger the plot, so that they should be allocated to larger plots other things being equal. This scale factor is, however, of no great relevance in the case of the much smaller power tiller.

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[1] See James, Volume II of this Study.

[2] The Chi-square test was used to examine the relationship between tractor allocation by plot on users' farms and two nominal level variables, viz ownership (own, mortgaged in, rented) and type of irrigation (none, manual, engine-powered). In neither case was the relationship statistically significant at the 5 per cent level.

TABLE 4.3: PERCENTAGE OF PLOTS CULTIVATED BY TRACTOR

On tractor-using farms only:	RANGPUR	18.4
	DACCA	30.0
	COMILLA	22.0
	NOAKHALI	25.6
	MUNSHIGANJ[a]	31.8
	MUNSHIGANJ[b]	65.1
	TOTAL	33.1
On overall sample:		12.1

Notes: [a]less tractorised area; [b]more tractorised area.

The figures in Table 4.4 confirm the above expectations: tractor-cultivated plots on tractor-using farms do tend to be significantly closer to the farmstead than other plots, while in the case of 2-axle tractor areas, the tractorised plots are significantly larger than those cultivated by animals. There is, however, some measure of trade-off here in that, as was shown in Chapter 2, the larger plots tend to be those furthest from the farmstead. In fact, as can be seen from Table 4.5, the relationship between distance and plot size on tractor users' farms is the strongest of the three relationships in the 2-axle tractor areas. Indeed the strength of this relationship is such as to produce problems of multicollinearity if a multiple regression model were attempted.[1] Multiple correlation analysis shows that the addition of a second explanatory variable significantly increases the coefficient of determination (r^2) only in the case of 2-axle tractors (Table 4.6).

4.2. FARMERS' ASSESSMENTS

Sample farmers familiar with mechanised land preparation were interviewed as to their opinions of the relative merits, costs and effectiveness of engine- and animal-powered cultivation. These interviews were both structured and non-structured, although in the latter case they were not limited to sample farmers. In the former case one of the questionnaires of the Final Survey sought farmers' views on the relative merits of the two techniques, and these reports form a convenient starting point for the discussion. It must be kept in mind, however, that in dealing with such matters the intent of the questions is more apparently obvious than is the case with the Weekly Survey and the farmers cannot be regarded as entirely disinterested

[1]See Johnston (1972), ch. 5. In a case such as this one where the dependent variable, y, is dichotomous with 1=tractor used and 0=not used, the estimated value of y may be interpreted as an estimate of the conditional probability of an occurence of y, given Xi, i=1, k. (Johnston (1972) ch. 6; also Orcutt <u>et al</u> (1961)).

TABLE 4.4: PLOT SIZE AND DISTANCE FROM FARM : TRACTOR- VERSUS ANIMAL-CULTIVATED PLOTS (ANOVA)

			No.	Mean	Std. Devn.	Std. Error	Min.	Max.	95% Confidence Interval for Mean[b]	F-Ratio	F-Probability
Two-Axle Tractor Areas	Plot Area (Acres)	Animal	859	0.35	0.49	0.02	0.01	5.40	0.32 to 0.38	20.24	0.001
		Tractor	276	0.50	0.44	0.03	0.01	5.00	0.45 to 0.55		
	Distance From Farmstead (y=yards; m=miles)	Animal	859	565y	1999y	67.82	-	11m	435 to 700y	4.75	0.030
		Tractor	276	305y	435y	26.29	3	2m	250 to 355y		
Power Tiller Areas	Plot Area (Acres)	Animal	162	0.39	0.38	0.03	0.02	2.60	0.33 to 0.45	0.10	0.748
		Tractor	164	0.41	0.42	0.03	0.04	3.61	0.34 to 0.47		
	Distance From Farmstead (y=yards; m=miles)	Animal	162	610y	790y	62.1	-	5m	490 t) 735y	8.82	0.003
		Tractor	163	410y	375y	29.4	-	1.5m	350 to 465y		

[a]Tractor using farms only;

[b]i.e. assuming a normal distribution there is a probability of 0.95 that the true (population) mean falls within these limits.

TABLE 4.5: BIVARIATE CORRELATION COEFFICIENTS BETWEEN TRACTOR USE, PLOT SIZE AND FARM-TO-PLOT DISTANCE (Tractor-using farms only)[a]

	Tractor Use	Plot Size	Plot Distance
Tractor Use[b]		0.133[.1]	-0.065[5.]
Plot Size	0.005[n.s.]		0.595[.1]
Plot Distance	-0.163[1.]	0.115[5.]	

Notes: [a]Upper triangle - 2-axle areas, lower triangle - power tiller areas. Superscripts show the percentage level of significance: ns = not significant at 5% level

[b]Entered as a dichotomy: 1=tractor used, 0=not used.

TABLE 4.6: COEFFICIENTS OF MULTIPLE CORRELATION AND DETERMINATION BETWEEN TRACTOR USE, PLOT SIZE AND FARM-TO-PLOT DISTANCE[a]

Dependent Variable	Independent Variable	Bivariate Correlation Coefficient	Coefficient of Multiple Determination (R^2)	Change in R^2	F-Ratio	F-Probability
Use of 2-axle Tractor	1. Plot Area	0.133	0.018	0.018	53.80	0.001
	2. Plot Distance	-0.065	0.049	0.032	29.38	0.001
Use of Power Tiller	1. Plot Distance	-0.163	0.027	0.027	8.97	0.001
	2. Plot Area	0.005	0.027	0.001	0.19	n.s.

n.s. = not significant at the 5% (0.05) level; [a]Tractor-using farms only.

4.7: TECHNIQUE PREFERRED FOR FIRST CULTIVATION BY FARMERS IN 'MECHANISED' AND NON-MECHANISED VILLAGES: NUMBER (PERCENTAGE) REPORTING

Technique preferred for first cultivation (Assuming Equal Cost)	TRACTOR VILLAGES			POWER TILLER VILLAGES		
	Tractor Hirers	Non-Users	Total	Power Tiller Users*	Non-Users	Total
Tractor	78(45.1)	27(15.6)	105(60.7)			
Power Tiller				41(56.9)	9(12.5)	50(69.4)
Draught Animals	10(5.8)	58(33.5)	68(39.3)	0(0.0)	22(30.6)	22(30.6)
TOTAL	88(50.9)	85(49.1)	173(100)	41(56.9)	31(43.1)	72(100)

*Including Owners.

parties. In particular, it is to be expected that some farmers would tend to over-emphasise the reported advantages of tractors and power tillers in the hope of attracting further injections of subsidised machinery (of which more later).

Farmers were first asked which method they preferred for the first cultivation assuming equal cost. Their replies are summarised in Table 4.7. These questions were asked only in the villages where mechanised cultivation services were available. During the course of our field work the rate of expansion of private hiring of power tillers was in fact sufficient to have reached our 'control' village in Munshiganj. This village has therefore been included in subsequent tables, although as yet no one in that particular village owns a power tiller and only a few farmers (14 per cent of the sample) use them. In the 'experimental' village in that area there are five power tiller owners and virtually all of the farmers hire them, as was shown in Table 4.1.

Table 4.7 shows that the majority of farmers state that they prefer the technique they currently use, although a substantial minority of the animal users report a preference for engine power. Probably the most striking statistic in this Table, however, is the number of farmers who report having used tractors but who (now) prefer animals for cultivation. The farmers giving reasons for this preference were unanimous in blaming the unreliability of tractors, by which they presumably refer to the BADC tractor hire service. The corresponding figure, zero, for the power tiller villages is instructive.

Table 4.8 and 4.9 summarise in highly condensed form the farmers' preferences and their reports on the relative advantages of animal-draught vis-a-vis tractors and power tillers. Unfortunately it has not been possible here to compare tractors and power tillers directly since, as was noted in Chapter 1, no government power tiller hire service now exists and privately operated tractors used for cultivation on small to medium-sized holdings are very few indeed. Some indirect comparisons can, however, be made.

In these interviews farmers were simply asked to state their views as to the advantages (if any) of the two techniques in question: the row titles of both tables result from later classification aimed at reducing them to manageable size. Greater detail will be provided in the remaining sections of this chapter, since the original answers often show considerable insight into particular questions. The row titles themselves, although not comprehensive, are useful headings for further discussion. Information on factors not generally mentioned by farmers in the structured interviews - for example on changes in cropping patterns and land holdings subsequent to mechanisation of land preparation - was sought in less formal discussions with them.

TABLE 4.8: RELATIVE PREFERENCES FOR MECHANISED AND NON-MECHANISED LAND PREPARATION AS REPORTED BY FARMERS (PERCENTAGES).

	TRACTOR VILLAGES			
	Tractor Hirers		Non-Users	
	Tractor Preference	Cattle Preference	Tractor Preference	Cattle Preference
Availability and Reliability	1.1	17.0	2.4	55.3
Institutional Factors	-	1.1	-	3.5
Quality of Tillage	59.1	21.6	15.3	17.6
Fine Tilth	1.1	1.1	-	2.4
Depth of Ploughing	12.5	-	10.6	-
Wetland cultivation	-	-	-	8.2
Final cultivation, etc.	3.4	13.6	5.9	28.2
Small/inaccessible plots	-	31.8	-	37.6
Yield/Output	14.8	-	10.6	1.2
Time Saving	72.7	17.0	27.1	-
Early Tillage	1.1	-	-	-
Fast Tillage	52.3	-	7.1	-
Cost	45.5	13.6	14.1	8.2
Versatility	-	5.7	-	56.5
Labour Saving	47.7	-	15.3	-

	POWER TILLER VILLAGES					
	Power Tiller Owners		Power Tiller Hirers		Non-Users	
	Power Tiller Preference	Cattle Preference	Power Tiller Preference	Cattle Preference	Power Tiller Preference	Cattle Preference
Availability and Reliability	-	100.0	-	77.1	3.2	29.0
Institutional Factors	-	-	-	-	-	-
Quality of Tillage	33.3	-	51.4	2.9	25.8	35.5
Fine Tilth	83.3	-	74.3	-	6.5	3.2
Depth of Ploughing	-	100.0	-	77.1	6.5	41.9
Wetland cultivation	-	-	-	-	-	-
Final cultivation, etc.	-	-	-	-	-	32.3
Small/inaccessible plots	-	-	-	-	-	-
Yield/Output	16.7	-	11.4	-	-	9.7
Time Saving	83.3	-	85.7	-	25.5	-
Early Tillage	16.7	-	20.0	-	-	-
Fast Tillage	33.3	-	25.7	-	-	-
Cost	-	83.3	14.3	65.7	9.7	19.4
Versatility	-	-	-	2.9	-	54.8
Labour Saving	83.3	-	71.4	-	22.6	-

4.3. AVAILABILITY AND RELIABILITY

A very large array of answers is subsumed under this heading, and it is the very mixture of the bag which largely explains the differences between the draught power sources in the first rows of Tables 4.8 and 4.9. Draught animals are widely thought to be the more reliable, provided they are owned by the farm family rather than hired in, since risk and uncertainty are thereby reduced. Some farmers mentioned the diseases to which cattle are subject and the difficulty of feeding them, but these were relatively few in comparison with corresponding complaints regarding the unreliability of farm machinery and the difficulty of obtaining spare parts and fuel. This fact is in itself somewhat surprising in view of frequent statements to the effect that draught animals in Bangladesh are weak, sickly and undernourished.

Perhaps the most surprising feature of Table 4.9, however, is the fact that power tiller owners were unanimous in their statement that draught animals are more reliable than their machines. These men, are, in fact, almost obsessed with the problems of maintenance. They take extreme care of their tillers, but scarcity of trained mechanics, spares and clean fuel and lubricants combined with the relative antiquity of some of the models and their very intensive use combine to produce mechanical failures. Given the problems it is remarkable that breakdowns are so few, but all of the power tillers in the Munshiganj sample had a breakdown during the past season. These ranged from periods of two days in the case of a one-year old machine (main bearing failure) to ten months for a six-year old machine which broke its crankshaft and was still not repaired by the end of the Survey, as the part was not available. One other machine had so many breakdowns that the owner restored it to (temporary) working order and sold it at the end of the rabi season! Minor spares for power tillers can be and are made in Bangladesh and are inexpensive and readily available. For example, a locally-manufactured plunger costs Tk 118-200/-, compared with Tk 900/- for the Japanese product. The former are, however, one-off copies made in small ill-equipped workshops, so that the product is of poor quality and, say the farmers, of very short working life. They prefer to pay the higher price for the imported part if it is available.

Government tractor hire services are provided under two separate divisions of BADC: the Mechanised Cultivation (MC) Division and the Agricultural Development Estate (ADE) Division. Three of the tractorised villages (Rangpur, Comilla and Southern Noakhali) had their tractors from the local MC sub-unit and one from an ADE (Kashimpur, Dacca District). In both cases the machines are fairly old and poorly maintained so that breakdowns are frequent and the greater part of the fleet out of action at any given moment. Spare parts are frequently unobtainable. It is small wonder therefore that the farmers find the service unreliable. In 1978/79 only around twenty per cent of the serviceable tractor fleet (MC) was operational.

TABLE 4.9: PROBLEMS OF MECHANISED LAND PREPARATION AS REPORTED BY USERS (PERCENTAGE OF THOSE REPORTING IN EACH GROUP)

Problems Relating To	Tractor Hirers	Power Tiller owners	Power Tiller Hirers
Availability and reliability	51.1	100.0	85.7
Institutional Factors	46.6	-	-
'Quality of tillage'	-	-	-
Tilth	-	-	40.0
Depth of ploughing	-	-	-
Wetland cultivation	26.1	-	-
Final cultivation, etc.	42.0	-	-
Small/inaccessible plots	26.1	-	-
Yield/output	-	-	-
'Time saving'	-	-	-
Early tillage	43.2	33.3	22.9
Fast tillage	-	-	-
Cost	1.1	33.3	54.3
Versatitility	-	-	-
Labour saving	-	-	

TABLE 4.10: COEFFICIENTS OF CORRELATION AND DETERMINATION BETWEEN INSTALLED HORSEPOWER PER ACRE, TRACTOR HIRING AND OPERATED ACREAGE

Type of Service	Independent Variable[a]	Bivariate Correlation Coefficient	Coefficient of Multiple Determination (R^2)	Change in R^2	F-Ratio	F-Probability
2-Axle Tractor (Govt)	1. Acreage	-0.189	0.036	0.036	5.255	0.025
	2. Tractor[b]	-0.122	0.043	0.007	1.055	n.s.
Power Tiller[c] (Private)	1. Tractor[b]	-0.272	0.074	0.074	5.206	0.025
	2. Acreage	-0.107	0.075	0.001	0.038	n.s.

Notes: [b]Tractor hiring is entered as a dichotomy: 1=tractor hirer; 0=non-hirer.

[c]Excluding power tiller owners

n.s. = non-significant at the 5% (0.05) level.

The degree of reliability of a tractor hire service may be assessed from the extent to which users also maintain draught animals. Presumably, if the service were completely reliable they would not maintain animals for cultivation at all, while at the other extreme potential users would regard the service, when it materialised, as a windfall (subsidised) gain but would also maintain the full complement of draught animals. For purposes of comparison the two types of tractor hire service, private (power tiller) and BADC (2-axle) will again be treated separately with the power tiller owners being excluded from the former group for obvious reasons. (In fact, none of the power tiller owners maintains any draught animals on a permanent basis, thus demonstrating the reliability of these machines as far as their owners are concerned).

Since it was shown in the previous chapter (Section 3.2) that there is a (negative) correlation between total operated acreage and installed horsepower per acre, the total operated acreage must be taken into account when assessing the relationship between installed horsepower per acre and tractor hiring. The results of the multiple correlation analysis are presented in Table 4.10, which confirms a tendency for power tiller hirers to install a lower level of horsepower per acre than non-hirers in the same area. The same relationship does not however hold true in the case of the 2-axle tractor hirers, since these farmers do not have a significantly lower level of installed horsepower per acre than non-hirers in the same area.[1] Thus, if the adoption of the private power tiller hire service is associated with a reduction in installed draught capacity, that of the BADC tractor hire service, at least in its present unreliable state, is not.

4.4. INSTITUTIONAL FACTORS

This item appears only under the villages using two-axle tractors in Tables 4.8 and 4.9 and represents disadvantages of mechanisation as seen by a substantial minority of the farmers in these villages. Two main points are subsumed under this heading: bureaucracy and malpractices. Farmers also report that it is an advantage of animal cultivation that the team works under their own supervision.

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[1] It was noted at the end of Section 3.2 that the method of estimating horsepower may tend to overstate that on smaller farms relative to larger ones. If this is the case, and given the fact that, in some areas at least, the hirers of BADC tractors tend to be the larger farmers (Table 4.2) this could explain the apparent (but non-significant) negative relationship between use of the BADC service and installed h.p. per acre. Thus, this factor would tend to confirm rather than contradict the view that hirers of BADC tractors maintain the full complement of draught animals.

In the case of bureaucracy, it seems that farmers cannot understand the need for procedures which were essentially destined to ensure that the service would be properly regulated, but which result in the farmers or scheme managers having to spend a good deal of time at the BADC office completing various formalities. The formalities in question do seem rather cumbersome and delays undoubtedly arise. The question of excessive bureaucracy is not unrelated to that of malpractices, since the latter is frequently an escape route from the former. Some farmers also complain that the staff with whom they deal are guilty of bribe-taking, delays and poor workmanship. While on the above evidence it would be invidious to attempt to accuse any one individual or group, complaints of this nature are so widespread that it is difficult to believe that they are entirely without substance. No complaints of this nature were heard with regard to the private power tiller hire service.

4.5. QUALITY OF TILLAGE

One of the major advantages claimed for mechanised land preparation is that it makes a higher standard of tillage possible, destroying weeds and promoting vigorous crop growth. The views of the farmers are, however, in some ways rather confusing on this issue as the majority of them stated simply that the standard of land preparation was better with one technique or another, without going into further detail (Table 4.8). The picture is made even more confusing by the fact that it is not clear from this Table which technique is generally preferred from this viewpoint. On disaggregation, however, one salient feature does emerge. Quality of tillage is in fact mentioned as an advantage of two-axle tractors by only a single user on the floodplain soils (and of course little reliance should be placed on an isolated response). Where the standard of tractor tillage is generally praised, however, is in the two villages where the soils, or a large proportion of them, are of the Barind and Madhupur tracts respectively. Three quarters of the tractor users in these villages praised the quality of tractor tillage, which is not surprising in view of the fact that these soils are extremely hard and difficult to work when dry. Table 4.9 shows that a substantial minority of power tiller hirers saw quality of tillage as a problem with this machine, and when more specific replies to the relevant question are examined the picture becomes a great deal clearer.

A really fine tilth is greatly prized by the Bangladeshi farmer and he is prepared to spend a great deal of time and money in achieving it. Traditionally the land is ploughed and harrowed ('laddered') normally three or four, but often as many as six or eight times, and, in the case of dryland cultivation, any remaining clods are smashed with a long-handled mallet. The great majority of power tiller users regard the fine tilth it produces as one of its major advantages. In contrast to this, virtually all of the farmers who had used a power tiller said that it cultivated to a shallower depth than the traditional plough. Indeed, only two farmers, neither of whom had used the machine, claimed otherwise. A few farmers report that the two-axle tractor cultivates to a greater depth than the traditional plough. This would certainly be the case if a plough were fitted to the machine, but in fact the BADC tractor services supply only offset disc harrows and Howard Rotavators and many farmers complain - with justification - about the poor standard of tillage achieved when the former is used for primary cultivation. The ability to plough very deeply is not necessarily an advantage in Bangladesh, as will be shown later.

4.6. SIZE OF PLOTS, ACCESSIBILITY, ETC.

The physical dimensions of a conventional two-axle tractor make it unsuitable for the small, fragmented and frequently water-logged plots which typify so much of Bangladeshi agriculture. (See Section 2.2 of this report). Its width makes it unsuitable for travelling along paths and field bunds, so that it must travel across the open fields. This fact, together with the intensive and overlapping nature of the cropping systems of Bangladesh, mean that very often the machine must pass over growing crops in order to reach the field to be cultivated. It therefore tends to leave a trail of damaged crops and sometimes also broken bunds in its wake. In addition, the size of the tractor and its relatively large turning circle results in an untouched strip being left around the boundaries of the plot and in the vicinity of trees, ditches and other obstructions. Obviously, the smaller the plot the greater will be the proportion of land left uncultivated.

It is significant that the question of final cultivation was rasied by so many farmers in the tractor village of the Survey. Basically three topics have been included under this head, all of which help illustrate points made earlier:

(a) Techniques were commended specifically because they were said to leave a level or flat surface; animal cultivation was generally preferred for this attribute.
(b) Many farmers reported that cattle were required after tractor tillage in order to make furrows for drainage.
(c) Cattle ploughing is generally reported to produce a finer tilth than tractors and the final cultivation is done with animals even after tractor tillage.

Cultivation in wet conditions presents special problems for tractors in Bangladesh. On many soils a layer of highly compacted and impermeable earth, the 'plough pan', has been formed a few inches beneath the surface by the compressing and shearing action of the traditional plough. This pan has been built up over sometimes very long periods of time, and if it is broken up by deep ploughing or by shear weight of the tractor serious problems ensue, since the bearing capacity of the land is much reduced so that the tractor itself can become bogged down in deep mud, as can draught animals when they are used subsequently.

4.7. YIELDS AND OUTPUT

In view of the frequent claims that mechanisation of land preparation results in increased yields and/or increased intensity of land use, both of which would tend to increase production, it is surprising how few farmers reported either as a specific advantage of machines compared with draught animals (Table 4.8). Improved methods of land preparation could contribute to increased yields either by providing a better seedbed or by improving the timeliness of sowing or both. It could contribute to higher output even without higher yields if it permitted more land to be brought under the plough. The question of yields is the subject matter of Chapter 6, while that of cropping intensities is dealt with in Chapter 5.

4.8. TIMELINESS

As in the case of quality cultivation, farmers' comments on timeliness fall mostly into the most general category - in this case the statement that machinery is 'time-saving' (Tables 4.8 and 4.9). This could mean either that it enables the work to be done at an earlier date, thus permitting earlier sowing, or that once cultivation commences it is completed more quickly. However, the more specific replies in Table 4.8, together with the fact that many users report problems over timeliness in Table 4.9, suggest that the latter interpretation is the more realistic.

When the farmers refer to one technique of cultivation as being 'faster' than another, this could be the result of any one or more of four separate factors: the average speed at which the piece of equipment in question moves across the field (which should include time required for turning at the end of the furrow); the width of the cultivated strip and hence the number of passes required to cover the plot; the number of times the plot must be tilled in order to achieve a given standard, and the number of working hours in a day. A fifth factor, the period the land is left between cultivations, is not considered here, since the team or machine would be free for other work during such periods. This fifth factor will, however, influence timeliness of sowing, which is considered in Chapter 5.

Table 4.11 provides basic details of time requirements for cultivation using different power sources and implements. These figures are averages based on observations, timing and measurement in the farmers' fields. Some amplification of the figures would probably be helpful. It should be noted that they relate to dryland cultivation only, since no instance of cultivation in the wet by tractors and power tillers was encountered during the course of the study.

The figures on cultivating speeds may at first cause some surprise. In the case of the two-axle tractor, the low average speed results from the small plot size and the fact that plots are bunded, which makes turning both frequent and difficult, and hence time-consuming. This drastically reduces the average operating speed of

TABLE 4.11: TIME REQUIREMENTS FOR CULTIVATION AND THEIR DETERMINANTS (DRY CONDITIONS)

Power Source / Implement	Bullock Team Plough	Bullock Team Ladder[a]	Power Tiller[b]	2-Axle Harrow[d]	Tractor[c] Rotavators[e]
Average Cultivating Speed (MPH)	1.75	1.1	1.5	2.75	2
'Furrow' Width (inches)[f]	9	54	30	55	60
Mean Field Size (acres)[g]	0.36	0.39	0.41	0.50	0.50
Working Day (hours)[h]	5.5	5.5	18	5.5	5.5
Acres per Day (consolidated)[i]	0.7	2.3	6.5	6.6	5.3
Acres per Day (fragmented)[i]	0.67	2.00	5.5	5.75	4.67

[a] This is a traditional bamboo harrow resembling a ladder
[b] Incorporating revolving tined cultivator ('rotavator')
[c] Massey-Ferguson MF 135
[d] Off-set disc harrow as supplied by BADC
[e] Howard 'Rotavator' as supplied by BADC
[f] Or width of cultivated strip in the case of implements other than the plough.
[g] See Table 4.4 and text.
[h] Excluding rest periods but including travelling time
[i] i.e. whether or not the machine/implement is assumed to be working in a single consolidated block.

the machine.[1] the power tiller's low operating speed is caused by the heavy power requirements of the built-in rotavator. This last figure was confirmed as being representative by the Agricultural Engineering Division of the Bangladesh Rice Research Institute.

One area in which machine methods do confer significant time advantage over the traditional plough (but not the traditional harrow or 'ladder') is in the width of the cultivated strip. This is shown in the second line of Table 4.11. The machines are also capable of working for much longer periods at a stretch than draught animals, although in the case of the 2-wheel tractors this advantage is lost through institutional factors, so that the actual working day, in this case, is no greater than that of bullocks. A third advantage of engine power, at least where a rotavator is used, is quality of tilth: typically only half as many cultivations are required with a power tiller or tractor rotavator as with a country plough or off-set disc harrow in order to achieve a comparable standard. (See for example Table 6.1 to 6.5).

Plot size and shapes are additional important determinants of time requirements. Generally speaking, the larger the machine, the longer and more regular should be the plot in order to reduce turning and manoeuvring time to a minimum. For a given area, the longer and narrower the plot the more suitable is it for machine cultivation.

[1] During the course of the study for example a 40 hp tractor was timed as it cultivated a rectangular plot 100 x 20 yards (0.413 acre). The machine took an average of 45 seconds to cultivate the length of the strip (4.5 mph), but a full minute to manoeuvre at each end.

It was shown earlier in the present chapter that tractor-cultivated plots tend to be significantly larger than those cultivated by bullocks (Section 4.2). However, an acre is generally regarded as the minimum plot size that can be operated economically by a two-axle tractor of 40 hp or so, such as those represented in Table 4.11. As can be seen from Table 4.4, however, such tractors in the present study were found to operate on plots averaging only half this size, and on very few of one acre or more.

The cultivating pattern commonly adopted by both bullock plough and tractor/power tiller operators in Bangladesh is shown in Figure 4.1.[1] This pattern eliminates the need for a tight turn at the end of the furrow. But is wasteful in that it requires repeated cultivation of the crosswise strip at either end of the field. The distance covered when this pattern is employed is approximated by the expression:

$$d = \underbrace{\frac{lw}{f}}_{\text{(useful effort)}} + \underbrace{\frac{w^2}{2f} - w + \frac{f}{2}}_{\text{('wasted' effort)}}$$

where d = distance covered;
l = length of the block being cultivated;
w = width of the block being cultivated;
f = width of the furrow or cultivated strip.

The first term on the right hand side of this model representes the useful work of cultivating the block and the remaining terms that 'wasted' in repeatedly re-cultivating the top and bottom strips. With a given block area and implement, this useful component remains constant, but the 'wasted effort' increases as w increases relatively to f, as can be verified from the equation.[2] Of course, when w = f (when a single long furrow is ploughed) this component disappears.

One last factor causing inefficiency in this situation is plot fragmentation, because it results in both smaller plots and greater travelling time than would otherwise be the case. Again the larger

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[1]It should be noted that all of the implements encountered in the course of the study were of the 'symmetrical' type. An asymmetrical implement, such as the mouldboard plough, would necessitate a more complex cultivation pattern.

[2]If, for example, a tractor with rotavator cultivates a rectangular acre of 242 x 20 yards the proportion of total cultivating distance 'wasted' is 3.4 per cent. If it cultivates a square field of one acre instead, this proportion increases to 32.3 per cent. In addition to the distance 'wasted', the faster the power source the more must it slow down to turn, so that time is wasted in this way too. Note that Table 4.11 allows for this factor by taking average speed, which includes turning time. The ideal acre from this particular viewpoint would be 2,904 yards long and the same width as the rotavator (60 inches)!

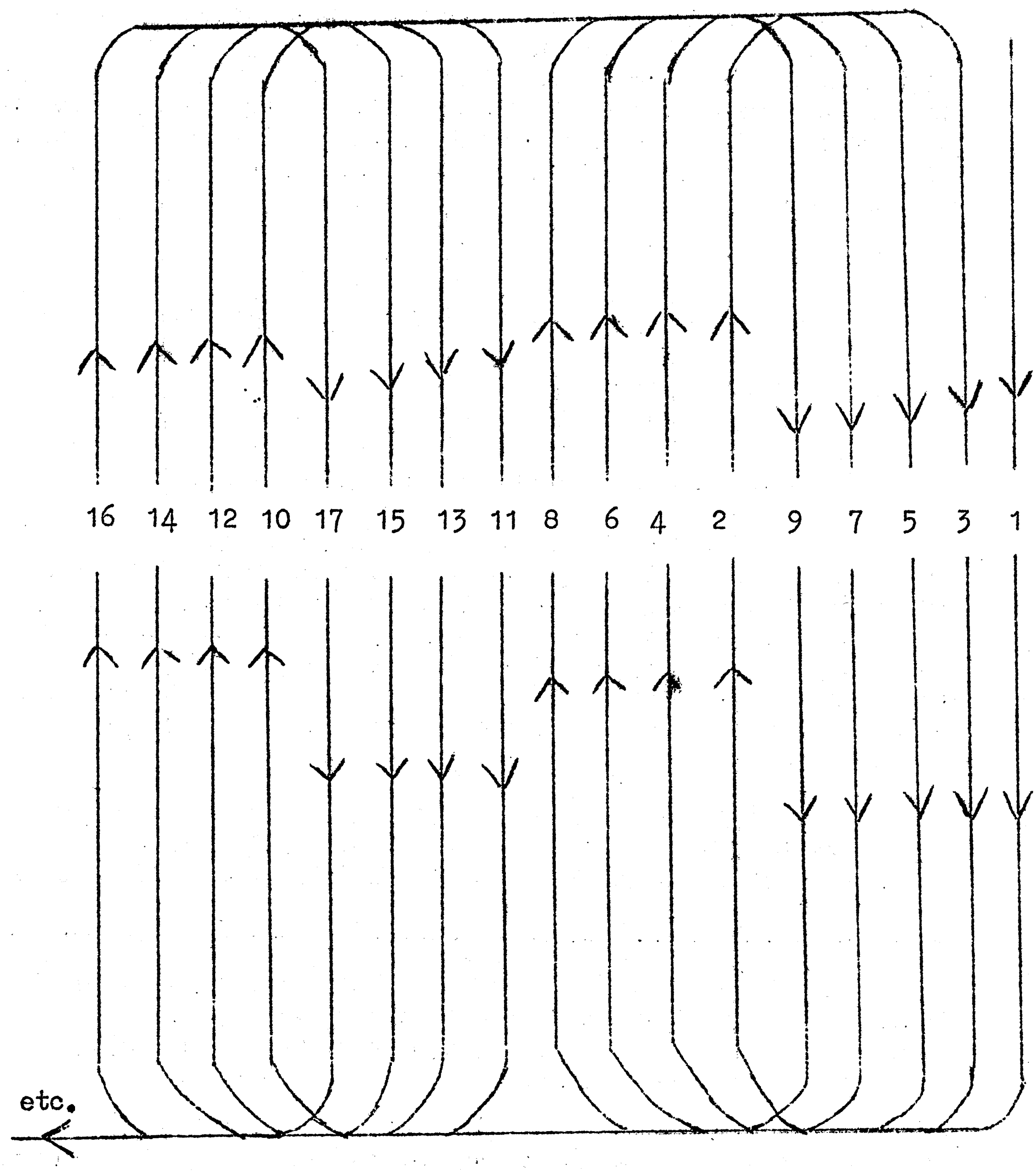

FIGURE 4.1: TYPICAL PLOUGHING PATTERN OF BANGLADESH

The plot is cultivated in adjacent long narrow strips.
Successive ploughings are usually at right angles to each other.

and faster the power source the greater will be the negative impact of fragmentation, since the number of journeys required in a given period of time is proportionate to the number of different plots cultivated. Moreover if a hire service is operated - as is likely to be the case with larger machines as a strategy for increasing capacity utilisation - travelling time is likely to increase still further as the machine travels between scattered farms each with fragmented plots. Table 4.11 shows the cultivation time requirements for both consolidated and fragmented blocks of land, in the latter case using the plot-to-plot and plot-to-farm distances which the present study indicates to be representative.

Before moving away from this topic, it is worth briefly returning to the question of reliability. As was shown earlier, (Section 4.3), the relative unreliability of engine-powered equipment in Bangladesh limits its capacity for timely cultivation - a factor which is reflected in the figures under 'early tillage' in Tables 4.8 and 4.9. The main advantage of early or timely cultivation is to enable the crop to be sown at an earlier date which in turn can result in faster growth, earlier harvest and higher yields. In addition, if a cash crop can be sold ahead of the main crop it usually has a scarcity value and therefore fetches a higher price. For example, in Munshiganj this year the early potato crop sold for Tk. 90-100 per maund, compared with Tk.26-30 for the main crop. (Yields in the former case were lower, however, as farmers harvested an immature crop in order to capture the high price). Apart from economic considerations there are also technical reasons why there is an advantage in early harvesting <u>only</u> if other farmers do not catch up. Insect pests can be a serious problem, for example cutworm in the case of potato, and, much more seriously, aphis in the case of mustard. The farmers well realise that the crop which has the best chance of escaping pest attack is the one which is harvested earliest, but if sufficient farmers sowed earlier and the main crop therefore ripened earlier, the pests would no doubt adjust their behaviour to suit the change in their food supply. (Time requirements are again referred to in the next section).

4.9. <u>COMPARATIVE COSTS</u>

Low cost is reported to be an advantage of tractors by many users while power tillers are said to be relatively expensive. This could be a source of misunderstanding. Tractors' users are referring to hire charges, power tiller users generally to the capital cost.

The MC and ADE Divisions of BADC operate different pricing systems. During our fieldwork the former charged Tk. 50/- per acre for disc harrowing and Tk. 60/- for rotavating. The ADE charged Tk. 30/- per hour for harrowing and Tk. 40/- for rotavating, plus Tk. 1/- per mile for travelling. These latter charges at average rates of operation in the dry season (Table 4.11) are equivalent to Tk. 25/- and Tk. 41.50 per acre for harrowing and rotavating respectively. Both of the above rates contain a considerable element of subsidy. During the 1977-78 financial year, for example, at ADE Kashimpur expenditure on <u>running costs</u> of tractors exceeded revenue (including a book-keeping entry for work done on the BADC estate) by nearly forty per cent. In the entire MC Division in the same financial[1] year running costs also exceeded revenue by around forty per cent.

Unlike BADC, the owners of power tillers vary their charges on a seasonal basis: Tk. 150/- per acre per cultivation during the peak season and Tk. 100/- off-peak. Owners of power tillers have moreover discovered a means of extending the period of peak demand for hire services. When the peak cultivation period is over in their own locality, the machines are sent to an area 20 miles distant which is relatively low-lying and from which therefore the monsoon flood waters recede relatively late. The arrival of the machines in this distant locality coincides with the peak cultivation period there.

Placing a representative cash value on draught animal services is a fairly complex matter when compared with tractor draught. First, there is a great range in quality of animals (age, sex, condition, etc.); second, the prices of the animals and of their feed and the scale of hire charges are the outcome of highly volatile market forces, and, third, many of the commodities concerned, most especially feedstuffs such as straw, are largely non-traded goods. A further source of variation derives from the Muslim festival of <u>Eid el Azha</u> when religious observance results in the sacrifice of very large numbers of high grade cattle. This is obviously reflected in the demand for both cattle and cattle feed, and, therefore, in their prices, increasingly so as the Festival approaches. <u>Eid el Azha</u> is based on the lunar month so that the calendar date shifts slightly from year to year. During the Survey period it occurred in early November.

A quite substantial proportion (47 per cent) of the draught animals used by sample farmers had been purchased. The remainder were either born on the farm or acquired through inheritance, gift, dowry, etc. Table 4.12 presents some summary statistics on reported prices of purchased draught animals for the two calendar years during which the Survey was operational (see Appendix 8). Prices are those of a <u>pair</u> of 'normal' bullocks (see Appendix 7). A number of features of this table deserve some comment. First, the figures for skewness and kurtosis are generally low, indicating distributions not too far removed from the normal curve, so that confidence limits for the mean can reasonably be calculated. Second, since the Survey covered only the first three to four months of the second year not too much can be read into any comparison of prices across these two years - or indeed into any of the figures for the second year. Third, there is clearly a good deal of variability in the figures both within districts (as would be expected given the sources of variability mentioned above) and

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[1]For a recent evaluation of BADC/MC see Llewellyn-Jones (1979).

TABLE 4.12: PRICES OF DRAUGHT ANIMALS 1978/79 to 1979/80 (taka per horsepower)

Area	Year[b]	Mean	No.	Std. Dev.	95% Confidence Limits for Mean	Skewness	Kurtosis
RANGPUR	1978/79	3,660	10	1,627	2,433 to 4,887	0.592	-1.779
	1979/80	2,000	2	-	- -	-	-
BOGRA	1978/79	5,600	1	-	- -	-	-
	1979/80	-	-	-	- -	-	-
DACCA	1978/79	3,351	15	1,387	2,556 to 4,146	1.446	1.673
	1979/80	4,241	8	1,982	2,470 to 6,012	1.819	4.201
COMILLA	1978/79	3,296	9	851	2,603 to 3,959	0.667	-1.155
	1979/80	3,660	5	2,007	2,656 to 4,664	0.417	-1.468
NOAKHALI	1978/79	4,000	14	1,986	2,811 to 5,189	0.802	-0.676
	1979/80	5,156	3	2,231	- -	1.349	-
MUNSHIGANJ	1978/79	5,893	27	1,726	5,197 to 6,589	-0.025	-0.910
	1979/80	5,600	6	1,133	4,297 to 6,903	-0.530	0.173
ALL AREAS	1978/79	4,437	76	1,939	3,996 to 4,878	0.543	-0.831
	1979/80	4,387	24	1,920	3,537 to 5,237	0.481	-0.373

[a]NB: One 'Normal' bullock is taken to equal 0.5 hp (see Appendix 7).
[b]Bangla Calendar - see Appendix 8. The figures for 1979/80 cover only the first three or four (depending on district) months of the Bangla year 1386.

TABLE 4.13: PRICES OF DRAUGHT ANIMALS BY YEAR OF PURCHASE (taka per horsepower)

Area	Period[a]	Annual Growth Rate(%)[b]	Change in Mean Price Over Period[c] BEGINNING	END	Overall Mean Price	r^2[d]
Rangpur	1969/70-78/79	6.3	1,875 (28)	3,383 (12)	2,420 (70)	0.152•1
Bogra	1970/71-77/78	8.5	1,759 (20)	3,740 (9)	2,270 (42)	0.203•1
Dacca	1969/70-78/79	43.8	2,015 (24)	3,661 (23)	2,686 (97)	0.247•1
Comilla	1969/70-78/79	11.4	2,278 (25)	3,426 (14)	3,030 (59)	0.162•1
Noakhali	1969/70-78/79	61.9	2,011 (19)	4,203 (17)	3,034 (72)	0.221•1
Munshiganj	1969/70-78/79	10.9	3,045 (5)	5,839 (33)	5,206 (62)	0.127•2
All Areas	1969/70-78/79	12.3	2,037(121)	4,357(108)	3,097(402)	0.226•1

Notes: [a]Based on Bangla Calendar - see Appendix 8.
[b]i.e. 100g where g is derived from the regression equation

$\log_e Y = a + gX$ where X is the year and Y is price,

g = percentage rate of price change

[c]Mean over first five years and last two years respectively (Number of observations in brackets)

[d]Superscripts are percentage levels of significance.

comparing different districts. Some of this variability has been eliminated by reducing the figures for animals of different ages, sex, condition, etc. to a common horsepower basis by a method which, to some extent at least, takes these sources of variation into account.

One major source of variability in livestock prices is time of purchase, both the year itself and the time of year. Table 4.13 gives some indication of the growth in prices of draught power over a ten year period, but considerable caution must of course be exercised when interpreting recall data based on such a long period of time. Draught animals are nonetheless a very major item of investment for most farmers, so that prices can probably be recalled with some degree of reliability. The estimates of annual growth rates in the Table are obviously influenced by a few extreme cases, especially in Noakhali and Dacca, so that the average figures for the beginning and end periods are probably a more realistic guide to price changes over the period.

Both prices and purchases of draught animals show a seasonal pattern, as can be seen from the figures in Table 4.14. The figures for all areas (converted to index form in the case of purchases) are illustrated in Figure 4.2. Inspection of this diagram suggests that there may be a negative relationship between these two series. In particular the seasonal peak in purchases coincides with the lowest level of prices while the peak in prices occurs at a very low point in the purchasing cycle. However the observed negative relationship is statistically significant only at the ten per cent level, and this is not normally regarded as sufficiently close for rejection of the null hypothesis.

Although farmers will obviously try to purchase draught animals when prices are at their lowest, it is clear that there are other factors which they must take into account, the most important of these being the requirements of the cultivation schedule. This is obviously a dominating influence as is shown by the fact that the three peaks in the incidence of purchasing of draught animals coincide with the start of the three crop seasons, boro, aus, and aman.[1] The fact that the major peak occurs in the aus season is probably the outcome of at least two factors. First, cattle prices tend to be

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[1] If, as was noted earlier, the data on prices are not likely to be recalled with any marked degree of accuracy, those on season of purchase may nevertheless be more accurately recalled, since purchasing shows such a markedly seasonal pattern; indeed several farmers (20 per cent) reported not a month but a season of purchase - e.g. "before aus", "before aman". These have been translated into months for purposes of comparison. Inspection and comparison of the data in a year-to-year basis also confirms that the overall (10 year) pattern is repeated without major variation. On the prices side, the influence of Eid el Ahza on seasonal patterns should be kept in mind, although, given that its date is not fixed, it is difficult to assess accurately.

FIGURE 4.2: INDICES OF SEASONAL VARIATION IN PRICES AND PURCHASES OF DRAUGHT ANIMALS (1970-79)

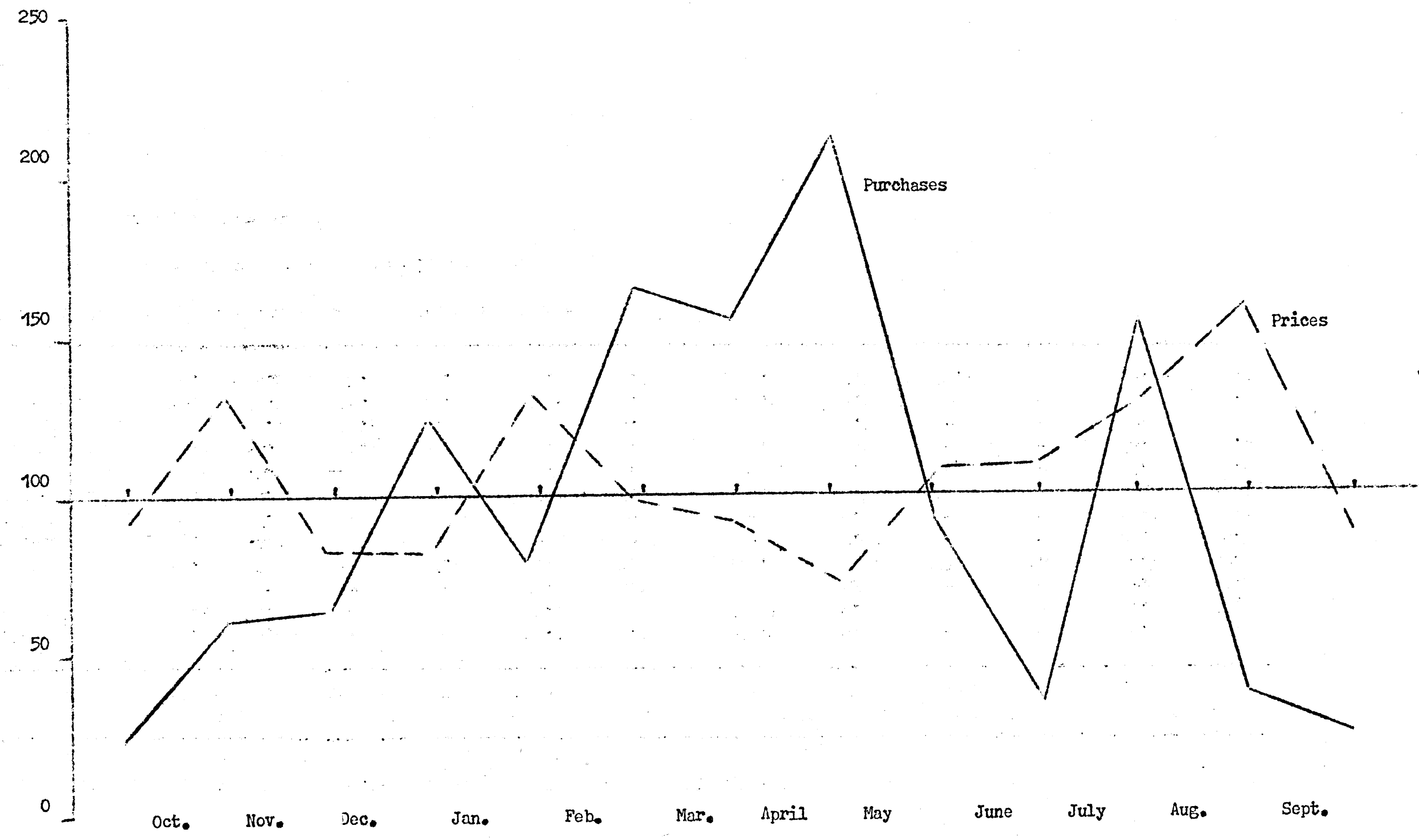

TABLE 4.14: SEASONAL VARIATION IN PRICES AND PURCHASES OF DRAUGHT ANIMALS (1970-79)

	RANGPUR		BOGRA		DACCA		COMILLA		NOAKHALI		MUNSHIGANJ	
	Prices	P	Prices	P	Prices	P	Prices	P	Prices	P	Prices	P
April-May	97.7	13.0	-	-	79.0	52.7	100.1	16.7	-	-	80.0	6.4
May-June	78.2	3.9	-	-	97.1	6.8	102.1	19.0	-	-	97.4	10.6
June-July	-	-	-	-	117.6	8.1	-	4.8	-	-	77.0	4.3
July-August	69.5	5.2	86.6	21.4	78.4	2.7	200.2	7.1	122.6	31.8	128.4	19.1
August-September	52.1	1.3	-	-	-	-	-	2.4	-	-	124.6	8.5
September-October	107.2	5.2	-	-	-	-	-	4.8	-	-	96.1	1.1
October-November	142.0	3.9	-	-	72.4	2.7	120.1	2.4	-	-	102.4	12.8
November-December	102.2	6.5	-	-	105.7	8.1	61.3	9.5	-	-	58.0	5.3
December-January	138.1	9.1	86.3	45.2	95.3	2.7	80.1	9.5	-	-	108.1	5.3
January-February	89.1	6.5	148.9	4.8	-	1.4	96.0	7.1	-	-	113.5	12.8
February-March	131.6	26.0	86.3	26.2	112.9	6.8	70.1	7.1	-	-	130.4	9.6
March-April	92.3	19.5	92.0	2.4	141.7	8.1	70.1	9.5	77.4	68.2	84.0	4.3

Prices: Indices of prices based on de-trended data (annual average = 100)

P: Percentage of all purchases occurring in that month

-: No purchases/prices recorded

low then as dealers try to sell off stocks before the monsoon when feed supplies become difficult to obtain with much of the land under water. (Farmers on the other hand may store sufficient crop residues in anticipation of purchasing animals at this time). Second, farmers who have grown cash crops during the <u>rabi</u> season will have the necessary cash in hand at this time of year. This factor certainly applies in the case of the Dacca sample, where the main cash crop is potato and where the tendency to purchase after <u>rabi</u> is very marked. In other parts of the country farmers often use the proceeds of their sales of jute to finance cattle purchases, a factor which explains part of the <u>aman</u> peak.

Problems of placing a cash value on the feed intake of draught animals are much more complex than those of costing the animals themselves. As was noted earlier, the great bulk of these animals' feed consists of non-traded commodities, especially rice straw and other crop residues, rough grazing, weeds and crop thinnings, rice water, etc. This is further complicated by the fact that the farmers cannot state with any certainty how much of this type of feed is consumed by which animals. The standard economic technique in this type of situation is to calculate the opportunity cost of the feed in question - i.e. the revenue it could have produced in its next most profitable employment. In this case the alternative would be to use the feed for the production of dairy produce, beef, and other cattle products. In this particular instance, however, a more direct method of employing the concept of opportunity cost is available. The practice of hiring draught animals is extremely common in Bangladesh, so that the opportunity cost for a farmer's using his animals on his own land is the revenue which he could have earned by hiring them out to others. Draught animals can therefore be costed at the going hire rate even when they are used on the owner's land. (Precisely the same type of argument can, of course, be applied to owners of tractors). Before going on to explore this topic, however, it will be instructive to look briefly at the cost of feed for draught animals in the few instances where this is purchased rather than home-produced.

Table 4.15 provides a weekly breakdown of cash expenditure on feedstuffs for draught animals over the period of the Survey and a number of points emerge from these figures. The most obvious is the extremely low level of cash expenditure which is devoted to maintaining these animals. It should be noted moreover that the figures in the Table relate only to animals which receive <u>some</u> feedstuffs, so that the average level of expenditure on draught animals in general is lower than that indicated in the Table. Purchased feedstuffs tend to be the more nutritious part of the diet, especially when oil-cake is provided. Other purchased feedstuffs include salt and molasses. The seasonal pattern in feeding draught animals, insofar as one exists, obviously does not emerge from these figures as clearly as it would from figures for total feed supply. In addition in many cases it was quite difficult for the farmers to separate out from total feedstuff purchases that fraction which was fed exclusively to draught animals, so that these figures are not too exact.

TABLE 4.15: CASH EXPENDITURE ON FEED FOR DRAUGHT ANIMALS 1978-79 (Takas)

Date (Week Ending)	RANGPUR Mean(Total)	BOGRA Mean(Total)	DACCA Mean(Total)	COMILLA Mean(Total)	NOAKHALI Mean(Total)	MUNSHIGANJ Mean(Total)	ALL AREAS Mean(Total)
4th June			2.40(2.)				2.40(2.)
11th "			17.54(212.)				17.54(212.)
18th "	2.00(2.)		11.54(80.)		11.00(57.)		10.60(140.)
25th "		7.90(50.)	11.46(124.)		8.29(70.)		9.53(244.)
2nd July	3.68(14.)	3.55(67.)	11.52(53.)		8.83(56.)		5.65(191.)
9th "	4.89(46.)	4.95(98.)	21.12(85.)		8.59(55.)		7.16(283.)
16th "	5.81(40.)	5.32(118.)	11.62(75.)	14.57(131.)	13.33(72.)		8.74(436.)
23rd "	4.67(28.)	4.42(155.)	11.04(74.)	20.45(1468.)	19.37(62.)		14.55(1787.)
30th "	4.61(41.)	3.51(73.)	19.19(95.)	21.41(2073.)	7.42(45.)		16.81(2327.)
6th Aug.	5.57(39.)	4.56(90.)	4.28(40.)	14.56(836.)	22.22(40.)		10.96(1045.)
13th "	4.63(47.)	4.09(71.)	6.75(46.)	14.65(604.)	19.74(75.)		10.62(842.)
20th "	4.90(74.)	4.64(57.)	4.90(48.)	12.50(534.)	12.88(67.)		9.16(780.)
27th "	4.93(83.)	4.72(61.)	4.76(65.)	13.81(713.)			9.70(922.)
3rd Sept.	5.23(110.)	5.73(59.)	6.45(68.)	11.60(612.)			8.97(850.)
10th "	4.78(77.)	6.91(50.)	6.22(70.)	12.49(602.)			9.66(798.)
17th "	4.25(85.)	4.08(50.)	7.76(90.)	12.75(621.)	8.00(8.)		9.12(854.)
24th "	4.49(89.)	4.66(63.)	3.87(24.)	12.33(627.)	8.12(24.)		8.87(827.)
1st Oct.	5.21(112.)	4.77(61.)	7.41(49.)	11.97(659.)	8.57(31.)		9.16(912.)
8th "	4.69(93.)	5.97(77.)	10.52(59.)	11.51(476.)	3.93(8.)		8.73(713.)
15th "	6.52(78.)	3.29(32.)	3.09(21.)	10.60(438.)	41.45(128.)		9.58(697.)
22nd "	4.26(38.)	6.08(93.)	3.13(57.)	11.04(500.)	5.58(15.)		7.77(703.)
29th "	3.73(30.)	6.84(49.)	4.64(41.)	10.58(459.)	4.75(10.)	9.57(44.)	8.55(633.)
5th Nov.	4.32(39.)	6.11(63.)	5.13(25.)	10.23(423.)	3.60(22.)	15.08(1027.)	11.44(1600.)
12th "	4.39(40.)	7.19(52.)	3.87(15.)	11.25(455.)	3.45(17.)	15.85(778.)	11.82(1357.)
19th "	5.17(31.)	6.68(78.)	4.09(15.)	9.66(357.)	6.54(51.)	21.00(1235.)	14.15(1767.)
26th "	3.42(20.)	5.67(82.)	5.38(14.)	9.09(309.)	3.60(22.)	16.20(860.)	11.26(1307.)
3rd Dec.	4.90(25.)	5.68(78.)	4.76(15.)	10.26(354.)	3.97(22.)	16.35(731.)	11.48(1225.)
10th "	4.83(29.)	5.96(84.)	7.86(35.)	11.23(352.)	4.86(31.)	11.66(718.)	11.86(1250.)
17th "	4.25(25.)	5.97(89.)	6.25(37.)	10.75(389.)	3.97(22.)	19.68(946.)	12.93(1509.)
24th "	4.79(33.)	6.27(88.)	6.93(29.)	10.72(366.)	3.60(22.)	14.96(582.)	10.74(1121.)
31st "	4.06(32.)	6.18(85.)	12.04(70.)	9.72(376.)	7.26(52.)	15.09(602.)	10.74(1218.)
7th Jan.	2.36(16.)	6.70(100.)	6.12(35.)	10.10(340.)	6.01(59.)	16.02(572.)	10.50(1124.)
14th "	2.11(19.)	6.28(107.)	4.17(21.)	10.06(373.)	6.46(50.)	14.42(669.)	10.14(1239.)
21st "	1.80(19.)	6.68(100.)	3.94(22.)	9.79(353.)	13.78(101.)	15.00(628.)	10.49(1224.)
28th "	2.48(25.)	7.26(100.)	6.93(46.)	9.82(347.)	6.53(69.)	14.53(550.)	9.95(1138.)
4th Feb.	2.55(37.)	6.67(110.)	8.32(45.)	10.22(399.)	10.40(114.)	14.77(542.)	10.13(1247.)
11th "	2.50(37.)	10.17(173.)	8.86(37.)	11.34(378.)	6.21(75.)	15.52(582.)	10.78(1281.)
18th "	2.14(29.)	11.58(181.)	8.76(37.)	11.24(400.)	6.32(70.)	14.05(510.)	10.56(1226.)
25th "	2.31(33.)	11.57(187.)	10.04(52.)	11.40(443.)	6.21(75.)	13.15(656.)	10.59(1447.)
4th Mar.	2.74(40.)	10.90(173.)	9.85(51.)	11.06(424.)	7.00(77.)	14.52(817.)	11.21(1582.)
11th "	2.21(29.)	10.57(192.)	8.79(42.)	9.74(396.)	6.69(80.)	13.60(758.)	10.37(1498.)
18th "	3.12(44.)	9.77(183.)	6.42(96.)	8.49(338.)	10.21(185.)	17.45(930.)	11.17(1775.)
25th "	2.88(44.)	8.49(194.)	6.90(110.)	8.42(349.)	9.41(165.)	16.75(805.)	10.34(1668.)
1st Apr.	2.59(40.)	10.39(197.)	6.94(110.)	10.21(398.)	9.19(122.)	13.37(734.)	10.17(1602.)
8th "	2.32(33.)	10.06(219.)	9.25(138.)	7.81(293.)	8.35(100.)	11.83(607.)	9.15(1390.)
15th "	2.45(45.)	8.60(139.)	8.09(364.)	8.70(370.)	6.72(58.)	12.98(626.)	8.95(1602.)
22nd "	2.55(44.)	9.36(168.)	8.94(254.)	7.70(269.)	3.61(25.)	13.06(684.)	9.15(1444.)
29th "	2.58(52.)	9.74(157.)	8.83(325.)	8.06(375.)	3.37(20.)	13.48(627.)	9.04(1557.)

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TABLE 4.15 (Continued)

Date (Week Ending)	RANGPUR Mean(Total)	BOGRA Mean(Total	DACCA Mean(Total)	COMILLA Mean(Total)	NOAKHALI Mean(Total)	MUNSHIGANJ Mean(Total)	ALL AREAS Mean(Total)
6th May	2.54(44.)	9.58(143.)	8.79(255.)	7.71(350.)	4.66(37.)	11.88(558.)	8.58(1387.)
13th "	2.51(46.)	9.64(164.)	9.82(317.)	7.48(332.)	33.7(20.)	11.61(577.)	8.69(1456.)
20th "	2.70(62.)	9.13(155.)	8.80(426.)	8.21(379.)	5.75(40.)	12.51(521.)	8.64(1584.)
27th "	2.76(50.)	8.91(152.)	8.64(260.)	7.99(340.)	7.89(55.)	11.42(462.)	8.50(1319.)
3rd June	2.54(43.)	7.31(159.)	6.88(268.)	7.25(294.)		12.57(440.)	7.85(1204.)
10th "	2.59(39.)	7.50(170.)	7.41(247.)	7.15(283.)		11.04(370.)	7.69(1109.)
17th "	2.40(43.)	7.28(171.)	5.81(153.)	9.35(374.)		12.11(333.)	7.93(1075.)
24th "	2.69(43.)	7.21(174.)	6.60(244.)	9.55(385.)	6.00(18.)	13.39(328.)	8.22(1192.)
1st July	2.38(43.)	7.21(174.)	7.26(325.)	8.80(356.)	2.00(4.)	12.54(385.)	8.04(1287.)
8th "	2.67(48.)	7.27(169.)	8.38(244.)	10.17(453.)	11.00(44.)	11.79(437.)	8.94(1395.)
15th "	2.27(40.)	7.28(167.)	6.89(164.)	10.30(451.)	2.33(7.)	16.13(722.)	9.96(1551.)
29th "	2.41(36.)	7.25(166.)	6.88(125.)	10.03(364.)		19.43(831.)	11.27(1522.)
5th Aug.	0.50(1.)		6.75(38.)	11.00(305.)	25.00(25.)	17.49(700.)	14.17(1068.)
12th "			6.25(6.)			13.73(384.)	13.47(391.)
19th "				5.83(2.)		14.36(416.)	14.27(418.)
26th "						15.01(525.)	15.01(525.)
MEAN[a]	3.46(44.)	6.92(115.)	7.75(108.)	10.43(450.)	8.50(52.)	14.40(618.)	9.96(1080.)

[a]Excluding zero values.

MEAN = mean expenditue per horsepower excluding zero values

TOTAL = Total expenditure on feed for draught animals in the area in question
(N.B. Sample size in Rangpur and Bogra is half that for other areas)

NOTE: The Study was launched in Munshiganj much later than elsewhere (see Chapter 1).

Nevertheless, some semblance of seasonal pattern does emerge, particularly the relatively high input for the main (aman)season in most areas, but most particularly in Comilla. A final point of interest from these figures is that in all areas the periods when total expenditure on feed for draught animals is relatively high, mean expenditure per animal also tends to be high, as can be seen from the correlations in Table 4.16.

It was stated earlier that the hiring, borrowing and mutual exchange of draught animals is very common in Bangladesh. Table 4.17 shows that the great majority of sample farmers hired-in draught animals at some time during the Survey Period, while around half allowed their own animals to be used on others' land. (The 'overlap' in the Table is largely accounted for by owners of single animals exchanging them on a mutual basis, so that entries for the farmers appear on both sides of the Table.) In the great majority of cases (90 per cent) animals are hired for land preparation, otherwise for threshing ($8\frac{1}{2}$ per cent), or weeding (1 per cent). In a small number of cases (3 per cent) animals were hired-in because the owners' animals were sick, and that mostly in Noakhali during an outbreak of foot and mouth disease. Otherwise animals were hired either because the farmer did not have any animals of his own, needed a second animal to form a team or did not have sufficient animals to complete the work on time.

TABLE 4.16: CORRELATION BETWEEN TOTAL AND MEAN CASH EXPENDITURE ON FEED FOR DRAUGHT ANIMALS (1978-79)

	RANGPUR	BOGRA	DACCA	COMILLA	NOAKHALI	MUNSHIGANJ	ALL AREAS
r^2	0.247	0.624	0.064	0.708	0.180	0.604	0.154
Observations	59	60	63	58	53	44	67
Significance (%)	0.1	0.1	4.5	0.1	0.2	0.1	0.1

TABLE 4.17: HIRING (INCL. EXCHANGING) OF DRAUGHT ANIMALS

Area	Percentage of All Farmers	
	Hiring-in	Hiring-out
Rangpur	83.3	77.8
Bogra	80.6	61.1
Dacca	75.0	48.6
Comilla	80.6	69.4
Noakhali	75.0	37.5
Munshiganj	99.2	45.8
ALL AREAS	81.9	54.2

As in the case of power tillers, the scale of charges for hiring draught animals varies according to seasonal demand, but in the latter case the picture is very complex indeed. Some animals are hired on a daily basis, some on a piece rate: generally speaking the former system tends to apply on smaller plots. In all areas ploughing charges can shoot up very dramatically if conditions become suddenly just right for cultivation (jho), for example, just after a shower of rain when pressure of demand becomes very heavy. Because of limitations on the distance animals can travel, rates can vary quite markedly comparing locations which are quite close together.

Table 4.18 shows the variation in mean hiring charges and in the incidence of hiring animals week-by-week over the Survey Period in the Sample villages. It must be noted that these figures do not include draught animals given out free of charge between friends, relatives or mutually exchanged between those with single animals, since their inclusion would produce an unrealistically low estimate of the going market rate.

A number of important features of the economics of animal draught emerge from the figures in Table 4.18. The most important of these are the actual level of charges and incidence of hiring and the degree of inter-seasonal and inter-district variation therein. First, in contrast to the figures in Table 4.15, it can be seen that the peaks and troughs in the demand for draught power are reflected very clearly in the figures presented here. Again, unlike Table 4.15, however, there is no statistically significant correlation between the level of charges and the amount of time that is hired. As in the case of animal purchases the relationship between hire charges and the level of demand is a complex one. Ploughing rates can increase very dramatically when conditions are ideal, but this may dissuade many farmers who must balance the marginal cost of another ploughing (or of cultivating the land at all) against the expected marginal revenue discounted for time.

Because of the variability in both hire charges and cultivation requirements, a comparison of cultivation costs between tractors and draught animals is not at all straightforward. Some generalisations can, however, be made. First, it should be kept in mind that the figures in Table 4.18 relate to horsepower equivalents and can be regarded as being the equivalent of one pair of bullocks. Draught animals are generally hired out complete with yoke, plough and ploughman, so that in each case, 2-axle tractor, power tiller and animals, the charges in question are for the complete ploughing team.

The amount of work which can be done in a day is a variable which depends on soil type, soil condition (especially moisture content), etc. There are seasonal variations here too. In the aus season when the soil is relatively hard and dry the number of ploughings is 25-50 per cent higher than in aman, when underfoot conditions are wet. In the latter case, however, animals move much more slowly, about two-thirds as fast, as they plod through the mud. The length of the animals' working day also varies. Typically this is five to six hours, but in Noakhali, where animals tend to be smaller and weaker than in many places, three to four hours is common.

TABLE 4.18: HIRE CHARGES FOR DRAUGHT ANIMALS AND TOTAL TIME HIRED

Date (Week Ending)	RANGPUR Mean(Total)	BOGRA Mean(Total)	DACCA Mean(Total)	COMILLA[b] Mean(Total)	NOAKHALI Mean(Total)	MUNSHIGANJ Mean(Total)	ALL AREAS Mean(Total)
4th June			12.(2.00)				12.(2.00)
11th "			15.(1.00)		33.(0.60)		22.(1.60)
18th "			11.(3.00)		27.(3.00)		19.(6.00)
25th "	8.(5.00)	17.(0.60)	20.(3.80)		11.(5.50)		12.(14.90)
2nd July	8.(19.00)	19.(1.80)	16.(8.20)		15.(13.35)		12.(42.35)
9th "	7.(14.75)	25.(1.60)	13.(3.80)		18.(10.40)		12.(30.55)
16th "	7.(13.25)		18.(8.20)		19.(18.30)		15.(39.75)
23rd "	8.(18.00)		21.(2.10)		20.(30.90)		16.(51.00)
30th "	8.(15.50)	15.(1.20)	12.(6.50)	18.(3.00)	26.(27.00)		18.(53.20)
6th Aug.	9.(8.50)	25.(1.80)	14.(12.20)	20.(2.00)	24.(35.70)		20.(60.20)
13th "	10.(7.00)	28.(5.62)	11.(6.00)	60.(1.00)	26.(38.20)		23.(57.82)
20th "	9.(16.50)	25.(8.20)	13.(8.80)	12.(2.00)	25.(68.95)		21.(104.45)
27th "	9.(8.00)	25.(0.60)	16.(6.70)	24.(7.00)	20.(89.90)		19.(112.20)
3rd Sept.	8.(9.00)		12.(6.60)	18.(2.00)	22.(32.05)		18.(49.65)
10th "			12.(8.10)	14.(3.00)	15.(18.60)		14.(29.70)
17th "	8.(7.00)	40.(3.00)	15.(9.37)	23.(3.00)			18.(22.37)
24th "		18.(7.95)	16.(8.22)				17.(16.17)
1st Oct.		17.(3.30)	15.(2.00)				16.(5.30)
8th "	8.(1.00)	17.(0.60)	10.(2.00)				10.(3.60)
15th "	8.(1.00)						8.(1.00)
22nd "		22.(1.80)					22.(1.80)
29th "		10.(1.00)	8.(0.50)			39.(9.00)	35.(10.50)
5th Nov.						33.(37.75)	33.(37.75)
12th "			13.(6.50)			54.(16.00)	42.(22.50)
19th "		10.(2.00)	14.(5.55)		15.(7.00)	39.(15.50)	27.(30.05)
26th "		25.(1.80)	10.(10.00)		17.(8.00)	54.(7.75)	25.(27.55)
3rd Dec.		25.(1.80)	7.(27.00)	10.(2.00)	14.(4.00)	42.(10.00)	16.(44.80)
10th "		19.(2.40)	17.(4.00)	10.(1.00)	14.(9.00)	36.(7.50)	22.(23.90)
17th "			14.(8.75)		21.(8.00)	34.(5.00)	21.(21.75)
24th "	8.(2.00)		17.(5.15)		25.(6.00)	17.(3.00)	19.(16.15)
31st "	8.(2.00)	25.(2.40)	13.(7.30)		27.(8.00)		20.(19.70)
7th Jan.	8.(3.00)	25.(0.60)			27.(12.50)	17.(3.00)	22.(19.10)
14th "	7.(2.00)	25.(1.80)			25.(15.25)	16.(5.00)	22.(24.05)
21st "	7.(2.00)	25.(1.20)	10.(3.00)	25.(6.00)	26.(16.75)		23.(28.95)
28th "	7.(2.00)	25.(0.60)	9.(1.00)	27.(8.00)	27.(12.50)	20.(1.00)	25.(25.10)
4th Feb.	7.(2.00)	25.(0.60)	8.(1.00)	29.(24.00)	26.(7.25)	28.(2.75)	26.(37.40)
11th "				29.(18.00)	26.(10.25)	19.(30.75)	23.(59.00)
18th "	7.(5.00)		10.(4.00)	22.(6.00)	24.(30.75)	29.(41.87)	25.(87.60)
25th "	7.(1.00)	25.(1.20)		33.(6.00)	24.(19.50)	29.(19.00)	28.(46.70)
4th March	8.(3.00)	25.(1.80)		24.(3.00)	25.(15.00)	29.(16.00)	25.(38.80)
11th "	9.(1.00)	18.(2.20)			23.(14.00)	28.(12.75)	24.(29.95)
18th "	8.(4.00)	17.(0.60)			19.(15.00)	28.(14.50)	22.(34.10)
25th "		15.(3.30)			22.(14.00)	29.(17.00)	25.(34.30)
1st April	8.(2.00)	22.(0.90)			20.(5.00)	36.(19.50)	31.(27.40)
8th "	9.(2.00)		10.(9.30)		20.(1.00)	21.(7.00)	14.(19.30)
15th "	10.(2.00)	20.(4.40)	11.(9.80)			27.(5.50)	17.(21.70)
22nd "	10.(1.00)	21.(9.00)	12.(10.00)		42.(1.80)		18.(21.80)
29th "	10.(1.00)		15.(12.00)			16.(2.50)	14.(15.50)

..... continued

TABLE 4.18 (continued)

Date (week Ending)	RANGPUR Mean(Total)	BOGRA Mean(Total)	DACCA Mean(Total)	COMILLA[b] Mean(Total)	NOAKHALI Mean(Total)	MUNSHIGANJ Mean(Total)	ALL AREAS Mean(Total)
6th May		15.(1.00)	12.(11.60)				13.(12.60)
13th "	13.(2.00)	25.(3.60)	9.(10.00)	25.(1.00)			14.(16.60)
20th "	13.(2.00)	25.(1.80)	23.(2.20)				20.(6.00)
27th "	12.(2.00)		12.(0.80)				12.(2.80)
3rd June			14.(4.40)			14.(4.00)	14.(8.40)
10th "			18.(4.60)				17.(4.60)
17th "		25.(1.20)	12.(8.90)		25.(2.00)		16.(12.10)
24th "		17.(1.80)	10.(4.90)				11.(6.70)
1st July		25.(0.60)	17.(5.20)		25.(1.00)		19.(6.80)
8th "			12.(3.80)		24.(6.00)		20.(9.80)
15th "			15.(2.30)		19.(1.00)		17.(3.30)
22nd "			15.(1.20)		21.(3.00)		19.(4.20)
29th "					19.(2.00)		19.(2.00)
5th Aug.			15.(1.50)				15.(1.50)
12th "			12.(1.00)				12.(1.00)
OVERALL MEAN[a]	8.(5.18)	22.(2.40)	13.(3.76)	26.(2.72)	22.(8.78)	31.(4.36)	21.(4.90)

NOTES: MEAN = Mean charge in taka per horsepower-day

Total = Total number of horsepower-days hired

[a]Excluding zero values; the figure in parentheses is the average number of horsepower-days hired per annum per farm.

[b]One village only; in the other village contract work is typical and farmers cannot state time requirements.

The number of cultivations required also depends on the crop, both that from which the land was harvested and that to which it will be sown. If a crop is uprooted, as is the case with mustard, onion and potato, little or no tillage is required before the next crop, whereas with paddy the land must be tilled repeatedly in order to clear away the stubble. In addition to ploughing and laddering charges, some additional manual land preparation is sometimes performed. For example, when high value cash crops like potato are grown, gangs of men are employed to smash the clods left by the bullock plough so as to obtain a fine tilth. In Munshiganj, for example, this costs around Tk.75-100 per acre. Such men are not required when a power tiller is used for cultivation.

Given the above sources of variability, it would be unrealistic to attempt to give a single set of figures for the cost of cultivating a given land area. Table 4.19 gives instead a set of ranges in which costs depend upon season, hire rates, quality of land preparation and district. As usual some explanation is desirable. First, as can be seen from Table 4.18, even within a pattern of seasonal variation, hire rates are still very variable and some of the extremes very marked. The ranges presented in Table 4.19 are therefore the mean charge across the period as a whole ± one standard deviation. This effectively excludes one-sixth at each extreme of the reported range while embracing the bulk of the actual charges. As was shown above, cultivation in the wet (for tansplanted paddy) is much slower than in the dry, so that other things being equal the former is the more expensive. Other things are not however equal, since fewer cultivations are the norm in the wet season. An example is Noakhali farmers who reduce from five ploughings plus six ladderings in the dry <u>rabi</u> season to three plus five for t.<u>aman</u>. The respective price ranges are Tk.315-430 and Tk.365-500.

Inter-district differences are important. The most expensive area is Noakhali. As has already been shown, the long term explanation lies mainly on the supply side, successive cyclones and tidal bores having wiped out much of the cattle population and prevented its regeneration. Moreover, those cattle which remain are small and weak even by Bangladesh standards, so that the typical animal's working day is only about two-thirds as long in Noakhali as in other parts of the country. In the short term a major problem has been a recent outbreak of foot-and-mouth disease which reduced the supply of animals available for hire while simultaneously increasing the demand from farmers with sick beasts.

At the other extreme from Noakhali, Rangpur has the lowest daily hire rates. Here farm size tends to be relatively large and pressure on land resources less severe than elsewhere. The typical number of cultivations in both Rangpur and Dacca is fairly high, because a high proportion of the soils in these areas is of the Barind and Madhupur Tracts respectively, both of them soils which are difficult to work. Four ploughings plus four ladderings would tend to be the minimum cultivation standard in these areas. The same is true of the clayey soils of Comilla, whereas two plus two would often be sufficient in the areas of lighter soils such as Bogra and Munshiganj. This whole question of costs will be taken up again in Chapter 9.

Table 4.20 provides details of the anticipated costs and returns resulting from investment in a power tiller as supplied by the Bangladesh Krishi (Agricultural Development) Bank (BKB) in its most recent distribution of these machines (1977-8). The sources of data and assumptions from which these estimates derive are detailed in the Notes to the Table. No allowance has been made for cost inflation in the figures, since it is reasonable to assume that, given the machines' popularity, owners will be able as well as willing to raise hire charges in line with increasing costs. It cannot be stressed too strongly that many of the cost figures in Table 4.20 contain a very considerable element of subsidy and other concessions. The cost calculations will be reviewed in Section 9.16.

During the course of the preliminary investigation for the present study, a power tiller owner, outraged by the fact that he could not easily obtain spare parts for his machine, reported that he had once forfeited Tk.12,000/- in lost net hire revenues when his machine was out of action for 25 days during the peak cultivation season. This report met with considerable scepticism among the interviewers at the time, but the data in Table 4.20 prove his figures to have been perfectly accurate. The power tiller at existing prices in fact represents an extremely profitable investment. The payback period, for example, is, in the event of outright cash purchase, less than one year! Discounting at the rate charged by BKB (11.5 per cent) the investment produces a gross benefit cost ratio (v/c) of 2.12 and a net present value (NPV) of 127 thousand taka. If the rate on bank loans ($15\frac{1}{2}$ per cent) is taken as a better measure of the (opportunity) cost of capital, v/c falls only to 2.09 and the NPV to Tk.113,000/-. Even taking an exceptionally high discount rate of 50 per cent, v/c is 1.86 and NPV still a very handsome Tk.50,000. The internal rate of return is no less than 264 per cent, which is actually higher than the interest rates typically charged by village moneylenders in the Survey Areas - and on a very much less risky investment! (Rates paid by sample farmers to moneylenders were of the order of ten per cent per month at simple interest.)

It is widely accepted by users of power tillers that these machines produce the same standard of cultivation in one pass that a pair of draught animals achieve in two ploughings plus two 'ladderings'. (The comparison was made by farmers in a number of parts of the country, while Tables 6.1 to 6.5 of Chapter 6 below, suggest that it is a rule of thumb which is also familiar on government experiment stations.) As was shown in Table 4.19, the cost per acre of achieving this level of cultivation by hired animals in the power tiller area (Munshiganj) is Tk. 90/- to Tk.160/-, depending upon the season. This is virtually the same seasonal variation as obtains in power tiller hire charges, viz. Tk.100/- to Tk.150/- per cultivation. Thus the power tiller owners do not pass on any of their profits to those who hire the machines from them, but behave as 'economic men' and charge the going rate.

4.10. VERSATILITY

This question is obviously closely related to that of cost, since increased utilisation rates will spread the overhead costs over a longer period and thus reduce the hourly rate. Returning to Tables 4.7 and 4.8, it is quite clear that all farmers prefer draught animals from this viewpoint.

The types of work performed by animal power was discussed in the previous chapter.

Tractors can also be put to a variety of uses, but in Bangladesh 2-axle tractors are used only for land preparation and haulage (especially the latter).

Power tillers are mainly used for cultivation, although the owners realise that they can also be used for pumping and haulage (they do not know of any other functions) if the attachments were available. At the moment power tiller owners have themselves devised two ways to adapt the machine. First, it is used for seed-covering by tying the traditional bamboo 'ladder' behind the machine and towing it along, and second, it is used for threshing wheat. The heads of grain are first cut off and placed in a wide flat heap. The wheel of the tiller is then adjusted for maximum elevation and the machine run over the crop so that it is flailed by the revolving tines of the scroll. The owners report that this method saves around three quarters of the time required for animal trampling, but the main advantage they see is that the crop does not become polluted by urine and manure as it does when animals are used.[1]

4.11. LABOUR SAVING

The questions raised under this heading depend upon whether the phrase means (a) that the technique in question saves the farm family a certain amount of drudgery, or (b) the technique reduces the need to hire in labour. While few would object to the former process, the latter is the most controversial of the issues surrounding the question of farm mechanisation. Discussion of this is taken up later in Chapters 7 and 8 of this report.

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[1] Bangladesh farmers in general show a great deal of ingenuity in adapting modern equipment to local needs and conditions. The following further example was encountered in Bogra. The coolant reservoir of a tubewell engine had been stolen, but the engine had been restored to working order by rigging a bamboo framework which allowed some of the water from the tubewell itself through the engine by means of the severed inlet and outlet pipes.

TABLE 4.19: DRAUGHT ANIMAL HIRE COSTS (Taka per acre)

		Rangpur	Bogra	Dacca	Comilla	Noakhali[b]	Munshiganj[c]
Range of Charges (Taka per day) [a]		(7-9)	(17-28)	(10-16)	(19-32)	(19-26)	(22-40)
2 Ploughings plus 2 Ladderings	D	30-35	70-110	40-65	75-130	120-165	90-160
	W	50-65	120-195	70-110	135-225	210-285	-
3 Ploughings plus 4 Ladderings	D	45-60	110-180	65-104	125-210	195-265	145-260
	W	80-105	200-330	115-190	225-375	340-465	-
4 Ploughings plus 4 Ladderings	D	55-70	135-225	80-130	150-255	240-330	175-320
	W	100-125	240-390	140-225	265-450	420-575	-
4 Ploughings plus 6 Ladderings	D	65-80	155-250	90-145	170-290	270-365	200-360
	W	110-140	270-440	160-250	300-500	470-640	-

NOTES: D = Dryland Cultivation;

W = Wetland cultivation.

[a] = Mean rate $\pm$ 1 standard deviation

[b] = Working day in Noakhali averages $3\frac{1}{2}$ hours; other areas $5\frac{1}{2}$ hours.

[c] = Virtually no transplanted paddy is grown in this area.

TABLE 4. 20: COSTS AND REVENUES FOR A SIX YEAR POWER TILLER INVESTMENT

	YEAR							
	0	1	2	3	4	5	6	TOTAL
COSTS								
Deposit[a]	14,100	-	-	-	-	-	-	14,100
Repayment[b]	-	4,700	4,700	4,700	4,700	4,700	4,700	28,200
Interest[c]	-	3,243	2,703	2,162	1,622	1,081	541	11,352
Fuel[d]	-	8,000	7,900	7,600	7,100	5,800	4,100	40,500
Lubricants[d]	-	590	580	530	500	420	280	2,900
Repairs and Maintenance[e]	-	500	1,000	1,500	2,000	2,500	3,500	11,000
Labour[f]	-	7,000	7,000	7,000	7,000	7,000	7,000	42,000
Supervision[g]	-	1,100	1,100	1,100	1,100	1,100	1,100	6,600
Storage[h]	-	200	200	200	200	200	200	1,200
TOTAL COST (Rounded)	14,100	25,300	25,200	24,800	24,200	22,800	21,400	157,800
REVENUE								
Peak period[i]	-	47,900	47,000	45,400	41,300	32,200	24,800	238,600
Slack period[j]	-	14,600	14,400	14,200	13,700	12,400	7,300	76,600
Deposit Return[a]	-	-	-	-	-	-	14,100	14,100
Salvage Value[k]	-	-	-	-	-	-	13,000	13,000
TOTAL REVENUE	-	62,500	61,400	59,600	55,000	44,600	59,200	342,300
NET REVENUE	-14,000	37,200	36,200	34,800	30,800	21,800	37,800	184,500

NOTES Information on terms and conditions of power tiller loans were supplied by BKB. Other data derives from the Survey and from owners' reports of the machines' past performance. The loan is for six years and it is assumed that this is the 'project life'. Cultivation on the owner's farm is valued at the full rate, this being the opportunity cost.

[a]BKB requires the deposit of securities (property title deeds, etc.) equal to half the price of the machine. This is returned on payment of the last instalment of the loan. The figure used is the opportunity cost, since the collateral involved could have been used to secure loans for alternative purposes.

[b]Six equal annual repayment instalments beginning one year after the loan is granted.

[c]Charged annually at 11.5% on the declining balance.

[d]Fuel and lubricant consumption under village operating conditions are assumed to increase at 10% per annum. Fuel consumption: 0.35 gallons per hour, @ Tk.15/- per gallon (including transport costs; oil consumption: 1 gallon per 100 hours @ Tk.38/- per gallon.

[e]Machines tend to break down fairly frequently and increasingly as they age. They are also increasingly difficult to repair as they age, especially in the peak season when they are under maximum stress. The following 'down times' have been assumed (days).

Year	1	2	3	4	5	6
Peak period	2	2	5	10	21	30
Slack period	-	1	2	4	9	30

The loss of revenue is slightly instigated by correspondingly reduced fuel and lubrication costs, but aggravated by increasingly expensive spares and mechanics' charges.

..... Notes continued

TABLE 4.20 Notes (Continued)

[f] 1 operator 500/- per month for two months
1 operator 400/- per month for two months
1 operator 400/- per month for four months
Food and board: 240 man-day @ Tk.15/-.

[g] Half owners' time : opportunity cost is that he could replace one operator.

[h] Actual cost divided by six.

[i] Peak period: two months (early November to end December) of full operation less 'down days' @ Tk. 150/- per acre $5\frac{1}{2}$ acres per day.

[j] Slack period: 60 days (less 'down days') spread over $3\frac{1}{2}$-4 months (early January to mid or late April) @ Tk.100/- per acre 2.4 acres per day.

[k] The salvage value is as high as the spares problem is acute since scrap machines can be 'cannibalised'. It is not uncommon either for owners of machines of this vintage to patch them up temporarily and sell them outside of their native region as being in working order!

CHAPTER 5 : MECHANISATION AND CROPPING SYSTEMS

If mechanisation (broadly defined) has a positive impact on land productivity it will be achieved either through improved standards of husbandry (for example better tillage) or through easing constraints which affect or determine the timing of operations, or both. The relevant linkages were explored in Section 1.1. Any such changes in land productivity can usefully be subsumed under two headings: alterations in cropping systems (including changes in crop patterns and in the extent of multiple cropping) and changes in crop yields. These are the topics of Chapters Five and Six respectively.

5.1. CROPPING INTENSITY, TIMING AND TRACTORISATION

The exact definition of cropping intensity is not universally agreed upon. It is a relationship between net cropped area and either gross cropped area or total operated area, the difference between the alternative denominators being fallow land. The Bangladesh Government tends to use the latter definition (MoA, 1975 pp. 32-52), although the former, used here, is more common. In practice when there is little fallow land, as in Bangladesh, the distinction is of little practical importance.

What is of practical importance in attempting to quantify cropping intensities in Bangladesh is the fact that in most areas cropping systems are very complex resultants of inter-cropping, multi-cropping and relay cropping which defy simple categorisation. A familiar example in the _aus_-_aman_ pattern: aman can be transplanted after the aus harvest, but on lower land the two crops are often broadcast mixed with the _aus_ being harvested several months before the _aman_.[1] The former is a straightforward double cropping system, the second is not. Second, some cropping cycles are of more than one year's duration: a five crop two year pattern, for example, is not uncommon.[2] Cropping patterns in the _rabi_ season are especially complex: a plot of land which had been harvested from paddy in the _aman_ or _aus_ season can in the _rabi_ season be under as many as ten different crops, all of different periods and in different patterns: some may be intercropped in rows or in a 'chequerboard' pattern, some planted around

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[1] Hereafter it may be necessary to distinguish between t(ransplanted) and b(roadcast) aman rice.

[2] Since the Survey covered a period of much less than two years, it has not been possible to chart the exact progression of these long cycles. One such cycle which can be inferred, however, on irrigated medium high or high land is: boro - t.aman - middle rabi crops - HYV aus (or jute) - early rabi crops - boro.

the boundaries of stands of other crops, while other parts of the field may have crops grown in pure stand. It is thus possible to have parts of the same field double cropped and other parts triple cropped.

The method used to quantify cropping intensities in the present analysis has been to approach any doubtful case from the viewpoint of land preparation requirements. Where aus and aman are broadcast mixed, for example, cultivation requirements are the same as would be the case were b.aman grown in pure stand, other things being equal. Land under mixed aus and aman has therefore been regarded as single-cropped land for present purposes.[1] Where a plot is subject to a cropping sequence of more than one year's duration, an annual average has been taken. For example, a five crop rotation spread over two years indicates a cropping intensity of 250 per cent for the plot in question. In the case of complexes of rabi crops such as that mentioned earlier, only detailed examination of the plot's cropping history can determine the appropriate intensity.

Table 5.1 provides summary statistics on cropping intensities over the sample as a whole. These figures were derived from cropping histories of all plots which were in turn constructed from the information provided weekly by sample farmers. The fact that the sample areas are on average more intensively cropped than the thanas to which they belong is attributable to a number of factors. First, the sample contains a fairly high proportion of irrigated land. The largest difference is to be seen in the figures for Dacca, and this is largely due to the fact that the sample area in Dacca is one of an unusually high level of tubewell irrigation associated with the BADC estate at Kashimpur. Although comparison of only two sets of annual statistics must be treated with caution, the fact that the sample figures (for 1978/79) are invariably higher than the 1972/73 estimates almost certainly also reflects an underlying upward trend in cropping intensity in response to increasing population pressures. (Total population increased by about 18 per cent over the same period). Another likely explanation of the difference lies in the treatment of rented plots. Where these are rented for less than a full year it is impossible to derive the cropping histories and hence intensity coefficients. Such plots were therefore excluded from this particular analysis. To the extent that such plots' cropping intensities are below average the computed overall figures will overstate the true

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[1] A further argument in favour of treating plots of mixed aus/aman in this way runs as follows. If two halves of a given plot were put under two different crops at the same time, the plot would be regarded as being single cropped in that particular season even if one of the crops were of longer period than the other. This would similarly be true if the crops in question were planted in alternate rows or in a 'chequerboard' pattern rather than in two separate stands. The aus/aman mixture can be regarded in the same way, since at first each seedling occupies a different (minute) fraction of the same plot simultaneously. After the aus harvest the plot is clearly single-cropped.

TABLE 5.1: CROPPING INTENSITIES AT FARM LEVEL[a]

Area	Mean[b]	Standard Deviation	Min.	Max.	Skewness	Kurtosis	National Estimates[c]
Rangpur	174	19.3	133	216	0.96	1.05	162
Bogra	223	33.3	153	289	0.18	-0.33	179
Dacca	230	28.8	176	300	0.41	-0.34	137
Comilla	193	23.4	132	259	-0.31	1.41	153
Noakhali	186	23.9	112	225	-1.72	2.38	118
Munshiganj	224	28.2	150	300	0.48	0.52	168
All Areas	207	33.3	112	300	0.24	0.48	-

Notes: [a]Cropping intensity at plot level weighted by plot size; excludes plots rented in for less than one year.

[b]All intensities are expressed in percentage terms (e.g. 200 represents double cropping).

[c]Official estimates for the same thanas from which the sample data were drawn (1972/73). Source: MoA (1975) pp. 33-52.

TABLE 5.2: TURNROUND PERIOD BETWEEN AUS AND T.AMAN (All Areas)

Turn-round Period (Days)	No.	Percent Ind.	Percent Cum.	Turn-round Period (Days)	No.	Percent Ind.	Percent Cum.	Turn-round Period (Days)	No.	Percent Ind.	Percent Cum.
0	10	3	3	21	13	4	64	42	4	1	88
1	6	2	4	22	9	3	66	43	2	1	89
2	3	1	5	23	8	2	69	44	4	1	90
3	9	3	8	24	8	2	71	45	6	2	92
4	9	3	10	25	3	1	72	46	1	0	92
5	7	2	12	26	7	2	74	47	4	1	93
6	11	3	15	27	2	1	74	48	2	1	94
7	9	3	18	28	7	2	76	49	1	0	94
8	11	3	21	29	4	1	77	50	1	0	94
9	10	3	24	30	1	0	78	51	1	0	94
10	13	4	27	31	2	1	78	52	3	1	95
11	10	3	30	32	5	1	80	53	4	1	96
12	14	4	34	33	2	1	80	54	2	1	97
13	12	3	38	34	3	1	81	55	1	0	97
14	13	4	41	35	5	1	82	57	4	1	98
15	15	4	45	36	4	1	83	58	2	1	99
16	15	4	50	37	6	2	85	60	1	0	99
17	8	2	52	38	1	0	85	61	1	0	99
18	14	4	56	39	1	0	86	65	1	0	100
19	13	4	59	40	2	1	86	67	1	0	100
20	3	1	60	41	3	1	87				

(ind. = Individual; Cum. = Cumulative).

Mean	20.566	Std. Error	0.787	Median	16.687
Mode	15	Std. Deviation	14.866	Variance	220.987
Kurtosis	0.203	Skewness	0.944	Range	67
Minimum	0	Maximum	67	No. of Cases	357

mean.[1]

Mechanisation of land preparation is linked to cropping intensity through its impact on the timing of operations. If it reduces the turnround period between successive crops or if it allows earlier cultivation than would otherwise be possible, tractorisation for example may permit a given farmer to switch from single to double cropping or from double to triple. This relationship can be investigated by analysing the extent to which tractorisation of land preparation (or some other energy-related variable) does in fact correlate positively with cropping intensity. As a starting point to the discussion, however, it will be instructive to examine the existing turnround periods between crops.

Over the country as a whole the most crucial turnround is between aus and transplanted aman. A secondary such period is between jute and t.aman. The relevant distributions are presented in Tables 5.2. to 5.11, both for the sample as a whole and for the individual areas, except Munshiganj, which is not a t.aman area. Turnround period is here defined as the number of days which elapse between completion of harvesting of the earlier crop and the transplanting of the aman paddy, so that it embraces the entire period of land preparation for the latter crop. As is often the case in such distributions, the mean turnround period here is unduly influenced by the presence of a few extreme values. This can be seen from the summary statistics which show that positive skewness is present in every case and that the mean value is always larger - in some cases substantially so - than the median (the value of which lies half way along the distribution) which in turn is larger - again sometimes substantially so - than the mode (the most common value).

The general shape of the distributions can probably be seen most clearly from those tables with the greatest number of observations, but it is fairly well apparent in all cases that there is a quite rapid build-up towards a peak at around the modal value and then a gradual falling off towards the longer turnround periods. The proportion of plots transplanted to aman within a week of the aus or jute harvest is quite impressively high - around twenty per cent overall. Rangpur clearly performs much better than average in this regard with half of the plots in question being transplanted within a week of the previous harvest.

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[1] This would tend to bias the findings on the intensity of cultivation of tractorised plots only if the proportion of rented plots which were tractor-cultivated were significantly different from that of owner cultivated plots. However it was earlier shown that this is not the case. The irrigation factor clearly does not account for the differences in the case of Noakhali sample, since there is no irrigation there. In this area the 'typical' cropping pattern nowadays is aus-t.aman, whereas the official statistics seem to be based on t.aman alone. This may reflect a changing pattern over the period in question. See James Volume II.

TABLE 5.3: TURNROUND PERIOD BETWEEN AUS AND T.AMAN (Rangpur)

Turn-round Period (Days)	No.	Percent		Turn-round Period (Days)	No.	Percent		Turn-round Period (Days)	No.	Percent	
		Ind.	Cum.			Ind.	Cum.			Ind.	Cum.
0	6	13	13	7	1	2	51	14	2	4	83
1	3	6	19	8	3	6	57	18	2	4	87
2	3	6	26	9	2	4	62	21	1	2	89
3	4	9	34	10	4	9	70	25	2	4	94
4	3	6	40	11	1	2	72	28	1	2	96
5	1	2	43	12	2	4	77	29	1	2	98
6	3	6	49	13	1	2	79	52	1	2	100

Mean	9.298	Std. Error	1.460	Median	7
Mode	0	Std. Deviation	10.011	Variance	100.214
Kurtosis	6.236	Skewness	2.120	Range	52.000
Minimum	0	Maximum	52	No. of Cases	47

TABLE 5.4: TURNROUND PERIOD BETWEEN AUS AND T.AMAN (Bogra)

Turn-round Period (Days)	No.	Percent		Turn-round Period (Days)	No.	Percent		Turn-round Period (Days)	No.	Percent	
		Ind.	Cum.			Ind.	Cum.			Ind.	Cum.
0	1	3	3	22	1	3	45	42	1	3	82
5	1	3	6	23	2	6	52	45	1	3	85
11	1	3	9	24	2	6	58	46	1	3	88
13	1	3	12	26	1	3	61	48	1	3	91
14	2	6	18	30	1	3	64	51	1	3	94
15	3	9	27	31	1	3	67	53	1	3	97
16	1	3	30	34	1	3	70	57	1	3	100
19	3	9	39	35	1	3	73				
21	1	3	42	37	2	6	79				

Mean	26.788	Std. Error	2.519	Median	23.250
Mode	15	Std. Deviation	14.469	Variance	209.359
Kurtosis	- 0.587	Skewness	0.448	Range	57
Minimum	0	Maximum	57	No. of Cases	33

TABLE 5.5: TURNROUND PERIOD BETWEEN AUS AND T.AMAN (Dacca)

Turn-round Period (Days)	No.	Percent Ind.	Percent Cum.	Turn-round Period (Days)	No.	Percent Ind.	Percent Cum.	Turn-round Period (Days)	No.	Percent Ind.	Percent Cum.
0	2	3	3	15	1	1	46	39	1	1	81
1	1	1	4	16	4	6	51	40	1	1	82
3	3	4	9	18	3	4	56	45	1	1	84
4	4	6	15	19	2	3	59	49	1	1	85
5	1	1	16	21	1	1	60	50	1	1	87
6	4	6	22	24	1	1	62	53	2	3	90
7	1	1	24	26	1	1	63	54	1	1	91
8	3	4	28	28	2	3	66	57	2	3	94
9	3	4	32	29	2	3	69	58	1	1	96
10	4	6	38	32	1	1	71	60	1	1	97
11	1	1	40	33	1	1	72	65	1	1	99
12	1	1	41	35	1	1	74	67	1	1	100
13	1	1	43	36	3	4	78				
14	1	1	44	37	1	1	79				

Mean	22.809	Std. Error	2.278	Medium	16.250
Mode	4	Std. Deviation	18.783	Variance	352.783
Kurtosis	- 0.516	Skewness	0.810	Range	67
Minimum	0	Maximum	67	No. of Cases	68

TABLE 5.6: TURNROUND PERIOD BETWEEN AUS AND T.AMAN (Comilla)

Turn-round Period (Days)	No.	Percent Ind.	Percent Cum.	Turn-round Period (Days)	No.	Percent Ind.	Percent Cum.	Turn-round Period (Days)	No.	Percent Ind.	Percent Cum.
3	1	2	2	12	2	4	38	24	2	4	81
4	1	2	4	13	4	8	45	25	1	2	83
5	4	8	11	14	2	4	49	26	1	2	85
6	2	4	15	15	3	6	55	27	2	4	89
7	5	9	25	16	2	4	58	32	1	2	91
8	1	2	26	17	2	4	62	35	2	4	94
9	1	2	28	18	3	6	68	40	1	2	96
10	1	2	30	21	3	6	74	41	1	2	98
11	2	4	34	23	2	4	77	42	1	2	100

Mean	16.585	Std. Error	1.381	Median	14.667
Mode	7	Std. Deviation	10.053	Variance	101.055
Kurtosis	0.241	Skewness	0.898	Range	39
Minimum	3	Maximum	42	No. of Cases	53

TABLE 5.7: TURNROUND PERIOD BETWEEN AUS AND T.AMAN (Noakhali)

Turn-Round Period (Days)	No.	Percent		Turn-round Period (Days)	No.	Percent		Turn-round Period (Days)	No.	Percent	
		Ind.	Cum.			Ind.	Cum.			Ind.	Cum.
0	1	1	1	18	6	4	47	37	3	2	82
1	2	1	2	19	8	5	53	38	1	1	83
3	1	1	3	20	3	2	54	41	2	1	84
4	1	1	3	21	7	4	59	42	2	1	85
6	2	1	4	22	8	5	64	43	2	1	87
7	2	1	6	23	4	3	67	44	4	3	89
8	4	3	8	24	3	2	69	45	4	3	92
9	4	3	11	26	4	3	71	47	4	3	94
10	4	3	13	28	4	3	74	48	2	1	95
11	5	3	17	29	1	1	74	52	2	1	96
12	9	6	22	31	1	1	75	53	1	1	97
13	5	3	26	32	3	2	77	54	1	1	97
14	6	4	29	33	1	1	78	55	1	1	98
15	8	5	35	34	2	1	79	57	1	1	99
16	8	5	40	35	1	1	79	58	1	1	99
17	6	4	44	36	1	1	80	61	1	1	100

Mean	23.019	Std. Error	1.097	Median	19
Mode	12	Std. Deviation	13.703	Variance	187.773
Kurtosis	- 0.055	Skewness	0.887	Range	61
Minimum	0	Maximum	61	No. of Cases	156

TABLE 5.8: TURNROUND PERIOD BETWEEN JUTE AND T.AMAN (All Areas)

Turn-round Period (Days)	No.	Percent		Turn-round Period (Days)	No.	Percent		Turn-round Period (Days)	No.	Percent	
		Ind.	Cum.			Ind.	Cum.			Ind.	Cum.
0	3	9	9	12	1	3	53	28	1	3	82
1	1	3	12	13	2	6	59	30	1	3	85
2	2	6	18	14	2	6	65	37	1	3	88
3	2	6	24	17	1	3	68	40	1	3	91
4	4	12	35	18	1	3	71	50	1	3	94
5	1	3	38	19	1	3	74	51	1	3	97
7	1	3	41	25	1	3	76	57	1	3	100
9	3	9	50	27	1	3	79				

Mean	15.618	Std. Error	2.723	Median	9.500
Mode	4	Std. Deviation	15.878	Variance	252.122
Kurtosis	0.705	Skewness	1.244	Range	57
Minimum	0	Maximum	57	No. of Cases	34

TABLE 5.9: TURNROUND PERIOD BETWEEN JUTE AND T.AMAN (Rangpur)

Turn-round Period (Days)	No.	Percent Ind.	Percent Cum.	Turn-round Period (Days)	No.	Percent Ind.	Percent Cum.	Turn-round Period (Days)	No.	Percent Ind.	Percent Cum.
0	1	14	14	2	2	29	57	5	1	14	86
1	1	14	29	4	1	14	71	14	1	14	100

Mean	4	Std. Error	1.786	Median	2.250
Mode	2	Std. Deviation	4.726	Variance	22.333
Kurtosis	4.302	Skewness	1.976	Range	14
Minimum	0	Maximum	14	No. of Cases	7

TABLE 5.10: TURNROUND PERIOD BETWEEN JUTE AND T.AMAN (Bogra)

Turn-round Period (Days)	No.	Percent Ind.	Percent Cum.	Turn-round Period (Days)	No.	Percent Ind.	Percent Cum.	Turn-round Period (Days)	No.	Percent Ind.	Percent Cum.
0	1	7	7	12	1	7	53	25	1	7	87
3	2	13	20	13	2	13	67	27	1	7	93
4	1	7	27	17	1	7	73	30	1	7	100
9	3	20	47	19	1	7	80				

Mean	12.867	Std. Error	2.370	Median	12
Mode	9	Std. Deviation	9.180	Variance	84.267
Kurtosis	- 0.633	Skewness	0.535	Range	30
Minimum	0	Maximum	30	No. of Cases	15

TABLE 5.11: TURNROUND PERIOD BETWEEN JUTE AND T.AMAN (Dacca)

Turn-round Period (Days)	No.	Percent Ind.	Percent Cum.	Turn-round Period (Days)	No.	Percent Ind.	Percent Cum.	Turn-round Period (Days)	No.	Percent Ind.	Percent Cum.
0	1	11	11	14	1	11	56	37	1	11	89
4	2	22	33	18	1	11	67	51	1	11	100
7	1	11	44	28	1	11	78				

Mean	18.111	Std. Error	5.777	Median	14
Mode	4	Std. Deviation	17.331	Variance	300.361
Kurtosis	- 0.090	Skewness	0.935	Range	51
Minimum	0	Maximum	51	No. of Cases	9

However, with such a small difference and such a considerable overlap, it is unlikely that the differences are agriculturally significant! These results are much more meaningful than those presented in the previous Table, because of the much greater number of observations in the case of tractor draught, but it must be kept in mind that institutional as well as technical factors help determine the timing of cultivation. This does not invalidate the above results, but does make them inapplicable outside of the special case of tractors supplied under a government hire service.

The existence of the owner-operated cum private sector hire service in Munshiganj makes it possible to extend the analysis to a totally different institutional environment. The Munshiganj area is one which is quite deeply flooded during the monsoon season. When both aus and aman are grown, therefore they are broadcast mixed so that there is no aus-aman turnround. The peak period for land preparation occurs after the b.aman harvest when the land must be cleared of stubble and quickly prepared for the rabi crop. The major rabi crops are potato and mustard and most land goes under these two crops immediately after the monsoon. The sowing dates for the bulk of these two crops (and for a locally much less important rabi crop, wheat) are shown in Tables 5.14 to 5.16 and cover a period of five to eight weeks from the end of October. The distribution of cultivation date by four categories of power tiller user are illustrated in Figures 5.1 and 5.2 for potato and mustard respectively.[1] The reasons for specifying four, rather than say two, categories of power tiller user here should be fairly evident. Owners obviously have first claim on the machine, while hirers in the more mechanised village (the one where power tillers are actually based) are likely to have better opportunities to secure a machine than those in the more distant villages.

Before proceeding to analyse the variance in these distributions it is necessary to control for the drainage condition of the land since this is obviously an important determinant of the sowing date of the first crop after the recession of the monsoon floods (see Table 2.1 above). The two-way analysis of variance did not support the hypothesis of significantly different sowing dates in the case of mustard, but did support it in the case of potato (which is the major cash crop of the region).

The results of this latter analysis which are presented in detail in Table 5.17 are most interesting. First, although both are significantly related to the dependent variable (5% level) it is clear from the analysis of variance results that land drainage is by far the more important of the two independent variables (factors) in terms of 'explanatory' power. Second, since the interaction effects between these factors are negligible it is posssible to proceed with a multiple classification analysis (MCA) in order to estimate the net effect of each independent variable when the other

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[1]No sowing dates were recorded for the few tractor-cultivated wheat plots.

The bulk of the plots where turnaround this fast is not achieved are transplanted within two or three weeks of the previous harvest. These figures, however, probably over-state the true picture to some extent, since some plots are harvested and transplanted in successive sections, a fact that is sometimes lost within the overall figures for the plot in question. In addition, before it can be assumed that there is room for substantial improvement by increasing the supply of draught power it must be appreciated that the period in question is one of the busiest, if not the busiest, in the year for most farmers. If overall draught power supply were to be increased to a level which could achieve really fast turnround in this period, there would be substantial over-supply at other times of the year unless alternative employment could be found for it. This would in turn impose considerable cost whether the draught power in question were supplied from the farm's own resources or from outside - for example through a tractor hire service.

The extent of tractor cultivation in the t.aman areas of the country is not sufficiently large to permit satisfactory testing of the effects of this factor on turnround times.[1] In fact not one example of tractor cultivation between jute and t.aman was encountered in the course of the Survey, and only in one sample area - Noakhali - was there more than one observation of tractor cultivation between harvesting a plot from aus and transplanting it to aman. The results of the one-way analysis of variance, in this case (for what they are worth) are presented in Table 5.12. Obviously one could not, on the basis of this evidence at least, conclude that the present tractor hire service improves turnround times.

Where the BADC tractor hire service has had considerable impact (in terms of number of farmers utilising it for a particular crop) is in cultivation for potato in the Dacca sample. In this case it is not particularly illuminating to look at turnround periods, since a very wide variety of crops and crop types precede potato.[2] It is however instructive to examine sowing dates for the crop in question, since this permits a test of our second hypothesis: namely, that mechanisation of land preparation permits earlier sowing than would otherwise be possible. The results of the one-way analysis of variance are shown in Table 5.13, and again the differences are not statistically significant. However, three extreme (and possibly erroneous) values distort the distribution, and when these are eliminated the difference does become statistically significant.

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[1]The effect of variations in animal draught on such factors as turnround periods is treated by Mettrick in Volume II of this Study.

[2]Mostly the preceding crop is paddy, but this can be traditional boro, aus or t.aman or non-traditional varieties. Other crops preceding potato in this area are jute and a variety of early rabi crops. Turnround period showed no marked tendency to cluster, but half of the observations fall into the 10-40 day range with about ten per cent of observations being of less than one week. Observations were divided around 50-50 between tractor and animal draught, and as in the case of Noakhali there was no significant difference between the two means (F-statistic = 0.234, 24 observations).

TABLE 5.12: AUS-T.AMAN TURNROUND WITH TRACTOR AND ANIMAL DRAUGHT (Noakhali)

	Animal Draught	Tractor Draught
No. of Observations	149	7
Mean turnround period (days)	23	24
F. Statistic	0.019	
Significance	n.s.	

TABLE 5.13: DATE OF SOWING POTATO WITH TRACTOR AND ANIMAL CULTIVATION (Dacca): ONE-WAY ANALYSIS OF VARIANCE

	Tractor	Animal	Tractor	Animal
No. of Observations	56	51	54	50
Deviation from 'Mean' (Days)	-1	+1	-2	+2
Grand 'Mean'	Dec. 22nd		Dec. 23rd	
F-Statistic	1.67		9.63	
Significance (%)	n.s.		1.0	

Note: The criterion variable was a day identification number (days being numbered from the beginning of the Survey). The second set of figures eliminates three extreme values

TABLE 5.14: SOWING DATES FOR POTATO (Munshiganj)

Sowing Date	No.	Percent Ind.	Percent Cum.	Sowing Date	No.	Percent Ind.	Percent Cum.	Sowing Date	No.	Percent Ind.	Percent Cum.
Oct. 30	1	0	0	Nov. 18	3	1	36	Dec. 4	1	0	87
31	1	0	1	(cont)19	8	4	40	(cont) 5	1	0	87
Nov. 2	1	0	1	20	13	6	46	6	2	1	88
3	1	0	2	21	3	1	47	7	2	1	89
5	2	1	3	22	4	2	49	10	5	2	91
6	6	3	5	23	8	4	52	11	1	0	92
7	5	2	8	24	13	6	58	12	2	1	92
8	8	4	11	25	12	5	63	13	4	2	94
9	9	4	15	26	10	4	68	14	4	2	96
10	8	4	19	27	6	3	70	15	3	1	97
11	10	4	23	28	16	7	77	17	3	1	99
13	3	1	24	29	4	2	79	19	1	0	99
14	5	2	27	30	3	1	81	22	1	0	100
15	6	3	29	Dec. 1	8	4	84	23	1	0	100
16	3	1	31	2	2	1	85				
17	10	4	35	3	3	1	86				

Ind. = Individual; Cum. = Cumulative.

Mean	206.367	Std. Error	0.744	Median	206.875
Mode	212	Std. Deviation	11.188	Variance	125.175
Kurtosis	- 0.212	Skewness	0.415	Range	54
				No. of Cases	226

TABLE 5.15: SOWING DATES FOR MUSTARD (Munshiganj)

Sowing Date	No.	Percent Ind.	Percent Cum.	Sowing Date	No.	Percent Ind.	Percent Cum.	Sowing Date	No.	Percent Ind.	Percent Cum.
Oct. 26	1	0	0	Nov. 9	25	11	34	Nov. 20	6	3	88
30	1	0	1	(cont)10	14	6	40	(cont)21	9	4	92
31	3	1	2	11	12	5	46	22	3	1	94
Nov. 1	2	1	3	12	3	1	47	23	5	2	96
2	1	0	4	13	20	9	56	24	2	1	97
3	1	0	4	14	12	5	62	25	1	0	97
4	6	3	7	15	17	8	69	26	3	1	99
5	1	0	7	16	9	4	74	Dec. 1	1	0	99
6	8	4	11	17	10	5	78	3	1	0	100
7	18	8	19	18	9	4	82	5	1	0	100
8	7	3	22	19	7	3	85				

Mean	196.945	Std. Error	0.432	Median	196.825
Mode	193	Std. Deviation	6.400	Variance	40.960
Kurtosis	2.553	Skewness	0.727	Range	50
				No. of Cases	219

TABLE 5.16: SOWING DATES FOR WHEAT (Munshiganj)

Sowing Date	No.	Percent Ind.	Percent Cum.	Sowing Date	No.	Percent Ind.	Percent Cum.	Sowing Date	No.	Percent Ind.	Percent Cum.
Nov. 7	3	6	6	Nov. 26	6	13	38	Dec. 3	2	4	79
9	1	2	9	(cont)27	1	2	40	(cont) 4	3	6	85
20	1	2	11	28	2	4	45	5	2	4	89
22	2	4	15	29	5	11	55	8	2	4	94
23	2	4	19	30	6	13	68	10	1	2	96
24	2	4	23	Dec. 1	2	4	72	11	1	2	98
25	1	2	26	2	1	2	74	14	1	2	100

Mean	211.872	Std. Error	1.183	Median	213
Mode	210	Std. Deviation	8.107	Variance	65.722
Kurtosis	1.700	Skewness	-0.985	Range	37
				No. of Cases	41

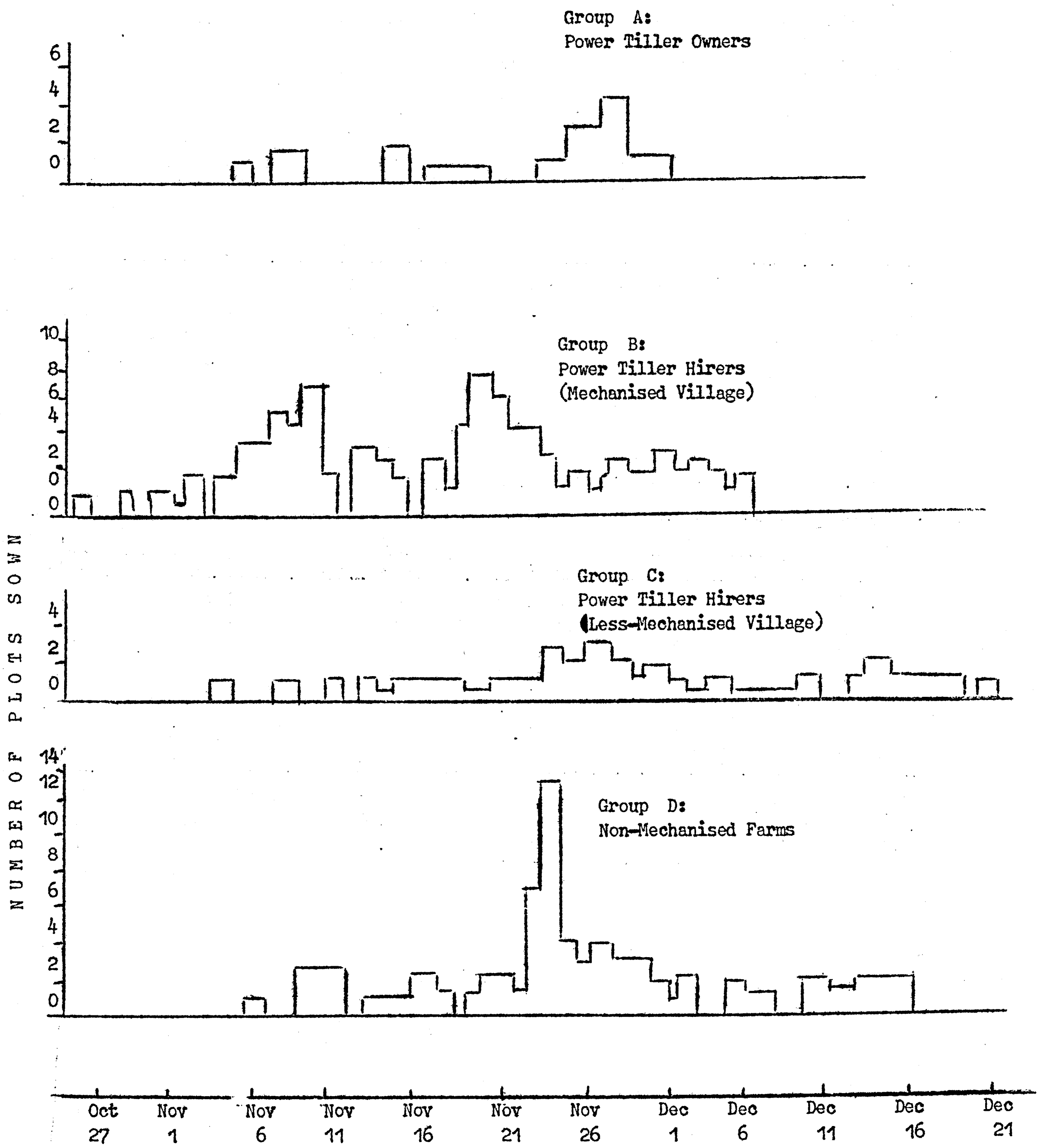

FIGURE 5.1: SOWING DATES FOR POTATO (1978) FOR TWO MUNSHIGANJ VILLAGES

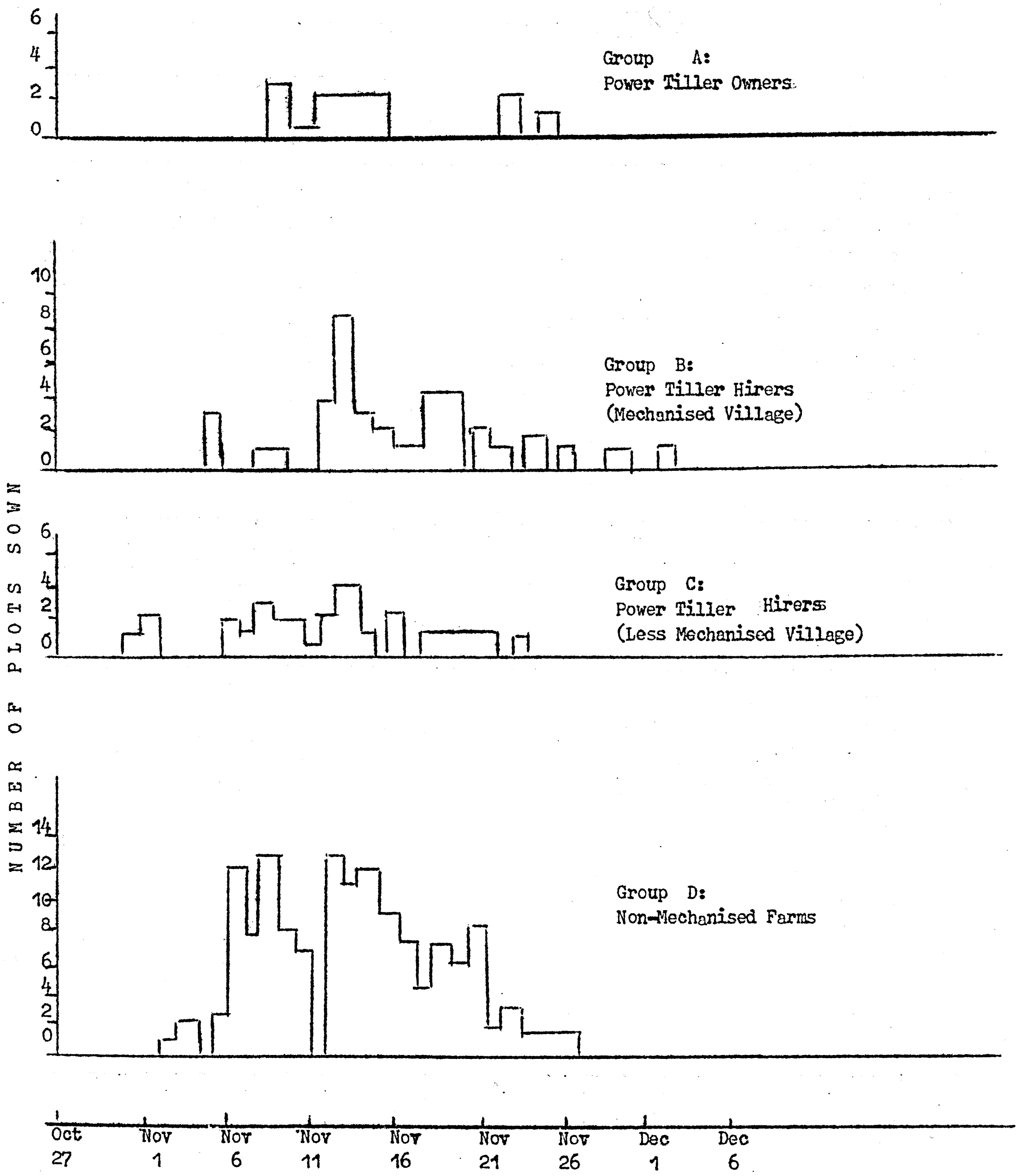

FIGURE 5.2: SOWING DATES FOR MUSTARD (1978) FOR TWO MUNSHIGANJ VILLAGES

TABLE 5.17: DATE OF SOWING POTATO WITH POWER TILLERS AND ANIMAL DRAUGHT (Munshiganj)

CRITERION VARIABLE: Date of Sowing[a]

FACTORS: (1) Power Tiller User Category; (2) Land Drainage Category.

I: ANALYSIS OF VARIANCE

Source of Variation	Sum of Squares	DF	Mean Square	F	Signif. of F
Main Effects	2340.900	4	585.225	4.999	0.001
Power Tiller User Category	1023.578	3	341.193	2.915	0.035
Land Drainage Category	1224.497	1	1224.497	10.461	0.001
2-Way Interactions	187.777	2	93.888	0.802	0.450
P. T. User Drainage	187.777	2	93.888	0.802	0.450
Explained	2528.680	6	421.447	3.600	0.002
Residual	25635.477	219	117.057		
TOTAL	28164.156	225	125.174		

II: MULTIPLE CLASSIFICATION ANALYSIS

Grand 'Mean' = Nov. 22nd

Variable & Category	N	Unadjusted		Adjusted for Independents	
		Dev'n	Eta	Dev'n	Beta
Power Tiller User					
1 PT Owner	19	3.90		1.78	
2 PT Hirer (Mech. Vill.)	68	-3.09		-3.14	
3 PT Hirer (Less Mech.)	22	2.31		2.81	
4 Animal Cultivation	117	0.73		1.01	
			0.20		0.19
Land Draining					
1 Early Drainage	217	-0.49		-0.49	
2 Late Draining	9	11.85		11.89	
			0.22		0.22

Multiple R Squared 0.083

Multiple R 0.288

[a]The deviation figures, both adjusted and unadjusted, show the number of days ahead of (negative numbers) or later than the 'grand mean' date by which the 'Mean' sowing date for a particular variable and category falls.

is controlled for. In fact controlling for power tillage makes virtually no difference to the influence of drainage regime on sowing dates (admittedly though on a small number of observations in one category). Late draining land is 'on average' seeded nearly two weeks later than early draining land. The period separating the extremes of the power tiller group falls from seven to five days when controlling for the effect of land drainage regime.

While the period of time separating sowing dates of different categories of power tillers is not large enough to have any very noticeable effect upon yields, it is surprising that the power tiller hirers manage to sow their potato crop a few days ahead of the owners from the same village. The most likely explanation for this is that the owners are so busy supervising the operation of the machine on others' plots that they do not have sufficient time for their own farming operations. Indeed the individuals in question could be regarded as much power tiller contractors as farmers. As will be shown in Chapter 9, they derive considerable revenue from hiring out their machines. As in the case of the BADC tractor cultivation schemes, there is clearly nothing in these figures that would justify the conclusion that the use of power tillers contributes to relatively timely cultivation under the actual operating conditions found in the countryside.

5.2. CROPPING INTENSITIES AND TRACTORISATION

If the use of engine powered equipment has not improved the timeliness of operations under field conditions, it is difficult to see how it could have the effect of increasing cropping intensities, although the relationship must nevertheless be investigated. As was demonstrated above, a most important determinant of timing and therefore, potentially at least, of cropping intensities, is land type in relation to flooding and related variables. This requires investigation at the plot level, but before doing this it is worthwhile examining the relationship at the overall farm level between cropping intensity and tractor use. Two other energy and related variables which were discussed earlier (Chapter 3) will also be included in the regression analysis: installed horsepower per acre and permanent labour per acre. Since both of these tend in turn to correlate with farm size this variable too will be entered into the model. Tractor user status will be entered as a 'dummy variable' ('user' or 'non-user').

The one-to-one relationships between most of the above variables were discussed earlier (Chapter 4). For the sake of coherence, however, the bivariate correlation coefficients of all pairs from the entire set are presented in Table 5.18. A 'stepwise' regression model was used to test the relationships between cropping intensity

TABLE 5.18: CORRELATION MATRIX FOR CROPPING INTENSITIES

	Tractor Use	Farm Size	Inst. HP/acre	Perm. Lab/acre	Crop Int.
RANGPUR[a] & BOGRA[b]					
Tractor Use	...	0.4200	-0.3571	0.0031	-0.5044
Farm Size	-	...	-0.4493	-0.4314	-0.1371
Installed HP/acre	-	0.3171	...	0.2927	0.2359
Permanent Labour/acre	-	-0.5281	0.5712	...	0.0166
Cropping Intensity	-	-0.2294	0.1452	0.2597	...
DACCA[a] & COMILLA[b]					
Tractor	...	0.1720	-0.616	-0.1858	0.1382
Farm Size	-0.0037	...	-0.2563	-0.3358	0.0091
Installed HP/acre	-0.0950	-0.1562	...	0.7750	0.2888
Permanent Labour/acre	-0.0044	-0.4791	-0.0776	...	0.2177
Cropping Intensity	-0.0462	0.0236	0.1565	0.1491	...
NOAKHALI[a] & MUNSHIGANJ[b]					
Tractor Use	...	0.1372	-0.1806	-0.2513	-0.1323
Farm Size	0.3547	...	0.0163	-0.5197	-0.2441
Installed HP/acre	0.0267	0.0883	...	-0.1994	0.0529
Permanent Labour/acre	-0.1268	-0.5299	0.0041	...	0.2068
Cropping Intensity	-0.1380	-0.0397	-0.2032	-0.0574	...
ALL AREAS					
Tractor Use	...	0.1823	0.0030	-0.1039	-0.0083
Farm Size		...	-0.0919	-0.4223	-0.1371
Installed HP/acre			...	0.2203	0.0802
Permanent Labour/acre				...	0.1409
Cropping Intensities					...

Notes: [a] = upper right hand triangle; [b] = lower left hand
Underlined coefficients are significant at the 5% level or better.

TABLE 5.19: RESULTS OF REGRESSION ANALYSIS FOR CROPPING INTENSITIES

Area	Dependent Variable	Constant	Slope	St. Error of B
Rangpur	Tractor Use	1.84	-0.192	0.057
Bogra	Permanent Labour/acre	2.09	0.317	0.202
Dacca	Installed HP/acre	2.23	0.346	0.140
Noakhali	Operated area	1.92	-0.011	0.005
All Areas	Permanent Labour/acre	2.02	0.074	0.028

and this independent variable set, but in no case did the addition of a second independent variable significantly improve the 'explanatory' power of the model. The cases where a statistically significant correlation was found for a bivariate relationship are shown in Table 5.19. The results presented in these two tables are extremely interesting for a number of reasons. First, the single most consistent feature of Table 5.18 is the high level of negative correlation between farm size and labour intensity (as measured by permanent labour per acre), reflecting the relative labour intensity of small farms. Perhaps the most surprising feature of the tables is the strong negative correlation between tractor use and cropping intensities in the Rangpur sample area. This in fact arises from two major factors. First, there is an unusually high degree of positive correlation in the Rangpur area between tractor use and farm size (which in turn correlates negatively with cropping intensities), so that there is some degree of multicollinearity present. Second, in this area tractor use does tend to be associated to some extent with long-season crops such as sugar (see 5.3 below).

Where cropping intensity does correlate significantly with energy-related variables, it is in the areas of installed horsepower and installed manpower per unit area, particularly the latter. In most areas too cropping intensity shows a tendency to correlate negatively with farm size. Thus it would appear that far from relatively high cropping intensities being associated with tractor use, they do in fact tend to be associated with high availability of labour and draught animals. This may not be particularly conclusive as regards tractors except in the power tiller area, where the problems of non-availability associated with the BADC tractor hire service do not arise.

In order to take account of the influence of the physical features of the land it is necessary to move from the level of the farm to that of the individual plot. The appropriate independent variables are land height and permeability-irrigation status. These, when additionally classified according to whether or not a tractor was used in the plot, produce a total of almost 200 possible categories - obviously too many for meaningful analysis and interpretations. The number has therefore been reduced by (a) amalgamating the two irrigation categories and (b) including only those altitude categories embracing at least ten per cent of all plots. This reduces the number of altitude categories to the three most important for the area in question (two in Dacca). The two energy-related variables noted above should also be controlled for. Since these are continuous variables they are introduced as covariates rather than as factors. The results of the analysis of covariance are presented in detail in Tables 5.20 to 5.23.[1]

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[1]Figures for Noakhali were found to be non-significant and are not presented here. It is probable that this non-significance is attributable to the existence of char land plots where cropping intensity is low due to non-farming conditions (see Section 2.2. above). See also James, Volume II of this Study.

TABLE 5.20: CROPPING INTENSITY WITH TRACTOR AND ANIMAL DRAUGHT (Dacca)

Criterion Variable: Cropping Intensity

Factors: (1) Tractor Use; (2) Land Height; (3) Permeability - Irrigation

Covariates: (1) Installed H P/acre; (2) Permanent Labour/acre

I: ANALYSIS OF VARIANCE

Source of Variation	Sum of Squares	DF	Mean Square	F	Signif. of F
Covariates	1.789	2	0.895	3.004	0.051
I. Horsepower (IHP)	0.822	1	0.822	2.760	0.097
P. Labour (P.Lab.)	0.931	1	0.931	3.125	0.078
Main Effects	19.046	5	3.809	12.789	0.000
Tractor Use (Trac.)	0.060	1	0.060	0.200	0.655
Land Height (Land)	2.119	1	2.119	7.116	0.008
Perm.-Irrig. (Perm.)	17.836	3	5.945	19.960	0.000
2-way Interactions	1.246	3	0.415	1.394	0.244
Trac. Perm.	0.897	1	0.897	3.012	0.083
Land Perm.	0.275	2	0.137	0.462	0.631
Explained	22.082	10	2.208	7.414	0.000
Residual	117.652	395	0.298		
Total	139.734	405	0.345		

Covariate Raw Regression Coefficient

I HP 0.310

P.Lab. 0.076

II: MULTIPLE CLASSIFICATION ANALYSIS[a]

Grand Mean = 2.30

Variable & Category	N	Unadjusted Dev'n.	Unadjusted Eta	Adjusted for Independents & Covariates Dev'n.	Adjusted for Independents & Covariates Beta
Tractor Use					
1 Used	99	0.06		0.02	
2 Not Used	307	-0.02		-0.01	
			0.06		0.02
Land Height (see Tables 2.1 & 2.5)					
1 Highland	109	-0.06		0.22	
2 Medium Highland (ED)	297	0.02		-0.08	
			0.07		0.23
Perm.-Irrign.					
1 Permeable - Non-irrig.	52	-0.44		-0.67	
2 Permeable - irrig.	37	0.24		0.05	
3 Mod. Perm. - non-irrig.	32	-0.24		-0.25	
4 Mod. Perm. - irrig.	285	0.08		0.14	
			0.33		0.47

Multiple R Squared 0.149

Multiple R 0.386

[a] The 'grand mean' is the cropping intensity for all plots expressed as a fraction. The adjusted and unadjusted deviations are expressed in the same units, so that for example the mean cropping intensity (adjusted) for highland plots is 2.52 (252%) and for medium highland plots 2.22 (222%).

TABLE 5.21: CROPPING INTENSITY WITH TRACTOR AND ANIMAL DRAUGHT (Rangpur)

Criterion Variable: Cropping Intensity

Factors: (1) Tractor Use; (2) Land Height; (3) Permeability - Irrigation

Covariates: (1) Installed HP/acre; (2) Permanent Labour/acre.

I: ANALYSIS OF VARIANCE

Source of Variation	Sum of Squares	DF	Mean Square	F	Signif. of F
Covariates	4.001	2	2.001	7.249	0.001
I. Horsepower (I HP)	2.927	1	2.927	10.606	0.001
P. Labour (P. Lab.)	2.014	1	2.014	7.299	0.007
Main Effects	14.329	8	1.791	6.490	0.000
Tractor Use (Trac.)	0.004	1	0.004	0.014	0.905
Land Height (Land)	7.851	2	3.926	14.225	0.000
Perm.-Irrig. (Perm.)	3.221	5	0.644	2.335	0.042
2-way Interactions	3.820	15	0.255	0.923	0.539
Trac. Land	0.549	2	0.274	0.994	0.371
Trac. Perm.	0.952	5	0.190	0.690	0.631
Land Perm.	1.806	8	0.226	0.818	0.587
3-way Interactions	0.197	4	0.049	0.179	0.949
Explained	22.438	29	0.771	2.792	0.000
Residual	108.458	393	0.276		
Total	130.806	422	0.310		

Covariate	Raw Regression Coefficient
I HP	0.685
P. Lab.	0.097

II: MULTIPLE CLASSIFICATION ANALYSIS

Grand Mean = 1.69

Variable & Category	N	Unadjusted Dev'n.	Unadjusted Eta	Adjusted for Independents & Covariates Dev'n	Adjusted for Independents & Covariates Beta
Tractor Use					
1 Used	57	-0.06		0.01	
2 Not Used	366	0.01		-0.00	
			0.04		0.01
Land Height (see Tables 2.1 & 2.3)					
1 Highland	266	0.05		0.08	
2 Medium Lowland (ED)	122	0.03		-0.05	
9 Med. Lowland (ED+F)	35	-0.46		-0.46	
			0.25		0.27
Perm.-Irrign.					
1 Permeable - Non-Irrig.	52	0.06		0.00	
2 Permeable - Irrig.	40	-0.04		-0.03	
3 Mod. Perm. - Non-Irrig.	54	0.15		0.15	
4 Mod. Perm. - Irrig.	83	0.05		0.08	
5 Imperm. - Non-Irrig.	81	0.11		0.04	
6 Imperm. - Irrig.	113	-0.20		-0.14	
			0.23		0.18

Multiple R Squared 0.140

Multiple R 0.374

TABLE 5.22: CROPPING INTENSITY WITH TRACTOR AND ANIMAL DRAUGHT (Comilla)

Criterion Variable: Cropping Intensity

Factors: (1) Tractor Use; (2) Land Height; (3) Permeability - Irrigation

Covariates: (1) Installed HP/acre; (2) Permanent Labour/acre

I: ANALYSIS OF VARIANCE

Source of Variation	Sum of Squares	DF	Mean Square	F	Signif. of F
Covariates	1.055	2	0.527	3.638	0.027
I Horsepower (I HP)	0.958	1	0.958	6.610	0.010
P. Labour (P. Lab.)	0.084	1	0.084	0.580	0.447
Main Effects	19.265	8	2.408	16.608	0.000
Tractor Use (Trac.)	0.000	1	0.000	0.000	0.991
Land Height (Land)	1.253	2	0.626	4.320	0.014
Perm.-Irrig. (Perm.)	18.622	5	3.724	25.686	0.000
2-way Interactions	2.235	13	0.172	1.186	0.287
Trac. Land	0.217	2	0.108	0.747	0.474
Trac. Perm.	0.554	4	0.138	0.955	0.432
Land Perm.	1.405	7	0.201	1.384	0.210
Explained	22.555	23	0.981	6.763	0.000
Residual	58.580	404	0.145		
Total	81.135	427	0.190		

Covariate	Raw Regression Coefficient
I HP	0.261
P. Lab.	0.022

II: MULTIPLE CLASSIFICATION ANALYSIS

Grand Mean = 1.91

Variable & Category	N	Unadjusted Dev'n	Unadjusted Eta	Adjusted for Independents & Covariates Dev'n	Adjusted for Independents & Covariates Beta
Tractor Use					
1 Used	27	0.01		0.00	
2 Not Used	401	-0.00		-0.00	0.00
			0.01		
Land Height (see Table 2.1 & 2.6)					
2 Med. Highland (ED)	214	0.03		0.06	
4 Med. Lowland (ED)	167	-0.01		-0.07	
6 Lowland (ED)	47	-0.11		-0.00	
			0.09		0.14
Perm.-Irrign.					
1 Permeable - Non-Irrig.	26	-0.57		-0.61	
2 Permeable - Irrig.	82	0.12		0.09	
3 Mod. Perm. - Non-Irrig.	43	-0.29		-0.33	
4 Mod. Perm. - Irrig.	221	0.10		0.12	
5 Imperm. - Non-Irrig.	16	-0.35		-0.35	
6 Imperm. - Irrig.	40	0.04		0.07	
			0.46		0.50

Multiple R Squared 0.25
Multiple R 0.50

TABLE 5.23: CROPPING INTENSITY WITH POWER TILLER AND ANIMAL DRAUGHT (Munshiganj)

Criterion Variable: Cropping Intensity

Factors: (1) P.Tiller Use; (2) Land Height; (3) Permeability - Irrigation.

Covariates: (1) Installed HP/acre; (2) Permanent Labour/acre.

I: ANALYSIS OF VARIANCE

Source of Variation	Sum of Squares	DF	Mean Square	F	Signif. of F
Covariates	2.180	2	1.090	6.253	0.002
I Horsepower (I.HP)	2.180	1	2.180	12.503	0.000
P. Labour (P. Lab.)	0.011	1	0.011	0.061	0.805
Main Effects	8.176	8	1.022	5.862	0.000
Tractor Use (Trac.)	0.641	1	0.641	3.678	0.056
Land Height (Land)	1.494	2	0.747	4.285	0.014
Perm.-Irrig. (Perm.)	5.822	5	1.164	6.680	0.000
2-way Interactions	3.038	13	0.234	1.341	0.185
Trac. Land	0.514	2	0.257	1.474	0.230
Trac. Perm.	2.261	5	0.452	2.594	0.025
Land Perm.	0.631	6	0.105	0.603	0.728
3-way Interactions	1.027	6	0.171	0.982	0.437
Explained	14.421	29	0.497	2.852	0.000
Residual	85.599	491	0.174		
Total	100,020	520	0.192		

Covariate	Raw Regression Coefficient
I HP	-0.149
P. Lab.	-0.006

II: MULTIPLE CLASSIFICATION ANALYSIS

Grand Mean = 2.22

Variable & Category	N	Unadjusted Dev'n.	Unadjusted Eta	Adjusted for Independents & Covariates Dev'n.	Adjusted for Independents & Covariates Beta
Tractor Use					
1 Used	165	-0.05		-0.06	
2 Not Used	356	0.02		0.03	
			0.08		0.09
Land Height (see Tables 2.1 & 2.8)					
4 Medium Lowland (ED)	298	0.04		0.05	
6 Lowland (ED)	91	-0.10		-0.09	
9 Medium Lowland (ED+F)	132	-0.03	0.13	-0.05	0.13
Perm.-Irrign.					
1 Permeable - Non-Irrig.	115	-0.10		-0.12	
2 Permeable - Irrig.	93	0.14		0.13	
3 Mod. Perm. - Non-Irrig.	148	-0.08		-0.07	
4 Mod. Perm. - Irrig.	133	0.12		0.10	
5 Imperm. - Non-Irrig.	26	-0.20		-0.10	
6 Imperm. - Irrig.	6	0.12		0.27	
			0.26		0.25

Multiple R Squared 0.104

Multiple R 0.322

Again, as in the two-way analysis of variance presented in Table 5.17, the effect of tractor cultivation on cropping intensity is in no case significantly (5 per cent level) related to cropping intensity, and again it is the physical properties of the land (height, flooding, irrigation) which do tend to show such a significant relationship. In no case is the three-way interaction among the factors significant and in only one case (Munshiganj) is there a significant two-way interaction effect, so that the MCA results are for the most part useable. These show that in each of the areas the lower land is less intensively cropped than the higher categories, which accords with the information contained in Table 2.1. This is true both for the unadjusted deviations and for when they are adjusted for the influence of factors and covariates. With one notable exception (again Rangpur) the effect of irrigation is to increase cropping intensity quite substantially. This is hardly surprising, but the exception is of great interest. The Rangpur area was hit by a very severe shortage of diesel fuel during the drought which affected the country during the first half of 1979. This factor undoubtedly contributed to very poor productivity on the plots which are irrigated by diesel tubewells.

5.3. CROPPING PATTERNS AND TRACTORISATION

The above analysis, which clearly provides no support for the view that tractorised land preparation has in practice been associated with increased cropping intensities in Bangladesh, is very much in accordance with the views expressed in non-structured interviews by farmers who have experience of tractor use. These farmers did however associate particular crops with engine-powered cultivation. Cotton was mentioned by one or two farmers in the North West in this regard. By far the most important such association however was between tractor use and potato, with a fairly substantial number claiming that it is not possible to grow potato without such cultivation.

Table 5.24 shows the distribution of crop types according to whether the land was cultivated by animal or by tractor ('mechanised' villages only). First, it is clear that although the claim that potato cannot be grown without tractor cultivation is an exaggeration, there is indeed a very strong tendency to use tractors for potato in the two areas where it is the major cash crop. This tendency can be seen most clearly in the Dacca sample, where the BADC tractors are used almost exclusively for this crop - a fact which is reflected in the very high chi-square coefficient for this area. Apart from this, there is only one case of a clearcut association between BADC tractor cultivation and a particular crop and this is in Noakhali where all of the observations of tractor cultivation are for <u>aman</u>. There seems to be another such association (as was stated by the farmers) between tractor cultivation and non-jute industrial crops in the Rangpur area, although the number of observations is small.

The most instructive area in this respect is once again Munshiganj, in view of its relatively high availability of engine-powered cultivation equipment. A fairly clear pattern emerges here. In both villages the most heavily mechanised crops are the two main <u>rabi</u>

crops mentioned earlier, potato closely followed by mustard. A greater association of potato with power tillage can however be seen when the two areas are compared. Land for potato in Munshiganj is much more thoroughly cultivated than that for mustard, and it is not surprising therefore to find that potato tends to be associated with the more mechanised of the two villages. Around two thirds of the plots under these two crops is under potato in this village while the proportions are reversed in the other.

Cultivation requirements fall off sharply after these two crops, since they are both uprooted, leaving the soil almost ready for reseeding or replanting without much further tillage. Although the number of observations is much smaller, it would appear that this concentration of power tillage also applies to two less important first crops after the monsoon, wheat and boro. Other rabi crops, such as onion and sesame, are grown late in the season after the first rabi harvest, so that cultivation requirements for these crops too are low. In any case in the late rabi season many of the power tillers are based away from the village, contracted out to farms in low lying areas about twenty miles distant, where they cultivate for the first rabi crop. (This point again illustrates the dynamism and resourcefulness which the power tiller owners show in their search for income).

While in all of the areas except Comilla there is a significant measure of association between cultivation technique and crop type (as is demonstrated by the chi-square and V values), the lambda coefficients show that only in the Dacca and Munshiganj samples does acquiring information about one factor improve the prospect of predicting the other. Given the scarce supply situation as regards tractors, there is a problem of causation here. Does a farmer try to get a tractor because he wants to grow a particular crop, or does he grow that crop because he has had the good fortune to obtain a tractor? The point is moot and all three lambda coefficients are therefore given in Table 5.24. As these figures show, the ability to predict crop type given cultivation technique (or vice versa) can be improved by as much as 35 per cent in some cases.

The adoption by particular farmers of particular crops and cropping patterns is of course the resultant of a great many factors of which the method of cultivation is but one. Therefore, to demonstrate that an association exists between tractor cultivation and the adoption of a particular crop need not imply that the observed relationship is causative.[1] In the particular case of potato, however, such a relationship does in fact exist because cultivation costs for this crop by traditional means are unusually high

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[1]Because the dependent variable crop type is measured at the nominal level and contains a large number of categories, only tests of association can be applied. Increasing the number of independent variables under these circumstances can involve an exponential increase in the number of cells and hence rapidly falling cell frequencies, leading to serious problems of interpretation.

TABLE 5.24: CROP TYPE BY METHOD OF CULTIVATION

CROP TYPE	RANGPUR				DACCA				COMILLA				NOAKHALI				MUNSHIGANJ(L)				MUNSHIGANJ(M)			
	Animal		Tractor		Animal		Tractor		Animal		Tractor		Animal		Tractor		Animal		Tractor		Animal		Tractor	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Paddy Aman	216	94.3	13	5.7	24	100	-	-	170	97.1	5	2.9	217	88.9	27	11.1)	120	99.2	1	0.8	58	68.2	27	31.8
Aus	102	100	-	-	16	100	-	-	20	83.3	4	16.7	76	100	-	-)								
HYV	156	95.7	7	4.3	226	99.1	2	0.9	221	94.0	14	6.0	119	100	-	-)	3	100	-	-)	6	46.2	7	53.8
Boro	1	100	-	-	10	100	-	-	-	-	-	-	-	-	-	-)				)				
Wheat	1	50	1	50	15	83.3	3	16.7	-	-	-	-	-	-	-	-	45	93.7	3	6.2	8	57.1	6	42.9
Millet	-	-	-	-	1	50	1	50	-	-	-	-	-	-	-	-	29	100	-	-	-	-	-	-
Other Cereals	-	-	-	-	2	100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pulses	47	95.9	2	4.1	12	92.3	1	7.7	6	100	-	-	12	100	-	-	1	100	-	-	-	-	-	-
Mustard	43	89.6	5	10.4	-	-	-	-	1	100	-	-	-	-	-	-	191	93.6	13	6.4	16	25.4	47	74.6
Other Oilseeds[a]	1	100	-	-	4	100	-	-	-	-	-	-	9	100	-	-	27	100	-	-	13	72.2	5	27.8
Potato	9	100	-	-	62	40.8	90	59.2	-	-	-	-	5	100	-	-	79	85.9	13	14.1	22	25.0	66	75.0
Other Rootcrops[b]	6	100	-	-	-	-	-	-	-	-	-	-	5	100	-	-	22	100	-	-	12	63.2	7	36.8
Other Vegetables[c]	4	100	-	-	1	100	-	-	3	100	-	-	-	-	-	-	-	-	-	-	2	66.7	1	33.3
Spices[d]	7	87.5	1	12.5	-	-	-	-	-	-	-	-	44	100	-	-	23	100	-	-	35	70	15	30
Jute	48	100	-	-	9	100	-	-	-	-	-	-	1	100	-	-	358	99.7	1	0.3	96	71.1	39	28.9
Other Industrial Crops[e]	32	78.0	9	22.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	100	-	-
Others	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	100	-	-	1	100	-	-
TOTAL	670	94.6	38	5.4	382	79.7	97	20.3	421	94.8	23	5.2	488	94.8	27	5.2	901	96.7	31	3.3	272	55.3	220	44.7
Chi-Square[f]	43.36(0.247)				215.12(0.670)				9.20(0.143)				31.65(0.248)				58.16(0.250)				86.67(0.420)			
Significance (%)[g]	0.1				0.1				n.s. 1				0.1				0.1				0.1			
Lambda (%)[h]	0.0;0.0;0.0				28.9;35.1;33.3				- - -				0.0;0.0;0.0				0.0;2.1;2.0				34.5;7.6;17.9			

NOTES on TABLE 5.24:

(L) and (M) for Munshignaj denote the less and more mechanised villages respectively.

Aus and aman are shown bracketed here because they are normally broadcast mixed in the Munshiganj area. HYV paddy is grown only in the boro season.

[a] Mainly groundnuts and sesame

[b] Sweet potato, radish, garlic

[c] Including melons

[d] Mainly chillie, some tumeric

[e] Sugar, cotton, tobacco

[f] The figure in parentheses is Cramer's V, which corrects chi-square for the size of the sample

[g] n.s. = not significant at the 5% level; otherwise significant at the stated level or better

[h] The three values of lambda are as follows:-

(first) asymmetric lambda with method of cultivation dependent;
(second) asymmetric lambda with crop type dependent;
(third) symmetric lambda (i.e. no assumption is made regarding dependency)

TABLE 5.25: METHOD OF CULTIVATION AND IRRIGATION: NUMBER (AND PERCENTAGE) OF PLOTS[a]

	METHOD OF IRRIGATION				Measures of Association
	None	Manual	Engine	Total	
RANGPUR					C=13.93
Tractor	10 (1.6)	5 (0.8)	17 (2.6)	32 (5.0)	(S=0.1)
Animal	272(42.4)	912(29.9)	146(22.7)	610 (95.0)	V=0.146
Total	282(43.9)	197(30.7)	163(25.4)	642(100.0)	L=0.0
DACCA					C=0.33
Tractor	1 (0.2)	0 (0.0)	96(20.3)	97 (20.5)	(n.s.)
Animal	10 (2.1)	0 (0.0)	365(77.3)	375 (79.4)	V=0.044
Total	11 (2.3)	0 (0.0)	461(97.7)	472(100.0)	
COMILLA					C=1.34
Tractor	2 (0.5)	1 (0.2)	20 (4.7)	23 (5.4)	(n.s.)
Animal	46(10.8)	45(10.6)	311(73.2)	402 (94.6)	V=0.056
Total	48(11.3)	46(10.8)	331(77.9)	425(100.0)	
MUNSHIGANJ(L)					C=6.84
Tractor	10 (1.1)	21 (2.3)	0 (0.0)	31 (3.4)	(S=5.0)
Animal	463(50.6)	394(43.1)	27 (3.0)	884 (96.0)	V+0.086
Total	473(51.7)	415(45.4)	27 (3.0)	915(100.0)	L=0.0
MUNSHIGANJ(M)					C=13.26
Tractor	92(18.9)	115(23.6)	12 (2.5)	219 (44.9)	(S=1.0)
Animal	142(29.1)	125(25.6)	2 (0.4)	269 (55.1)	V=0.165
Total	234(48.0)	240(49.2)	14 (2.9)	488(100.0)	L=5.8

[a] It will be recalled that there is no irrigation in the Noakhali sample area

[b] The measures are: C = Chi-Square; (S = Significance (%));
V = Cramer's V;
L = Lambda (Asymmetric with tractor use dependent (%)).

and tractor cultivation, by eliminating the need for manual clod breaking, confers a comparative advantage (see Chapters 7 and 9). It is also, however, important in this context that potato is a high input, high value cash crop which, on a commercial scale at least, is only grown by relatively well-to-do farmers - who also have relatively easy access to tractor services.

One determinant which can clearly have a fundamental effect on the adoption of different crop types is irrigation. The relationship between irrigation and cultivation technique is shown in Table 5.25. The degree of irrigation of plots in the Dacca sample is obviously very high, so that no association exists between these two variables in this area and it is clear that the association between tractor use and potato cultivation in that area cannot be explained away as a result of irrigation.

The areas in which a significant degree of association does exist are worth closer investigation and the relevant figures appear in Tables 5.26 to 5.28. A major problem of interpretation does arise here however. Since the number of tractor cultivated plots, not too large to begin with, now has to be classified by district, irrigation type and crop type (more than 100 categories in total) the cell frequencies in some cases become extremely small. Table 5.25 does however show that engine-powered irrigation and cultivation show a measure of positive association. For example, in the case of 'other industrial crops' mentioned earlier, half the tractor plots but only one-eighth of the animal-cultivated plots, are tubewell irrigated, so that the observed association between these crops and tractor cultivation may be due in part to this factor. In the Munshiganj area engine-powered irrigation (from low-lift pumps) is not very widespread. The crop which tends to be associated most closely with irrigation is <u>boro</u> paddy. In the case of the major <u>rabi</u> crops, mustard and potato too, there is a tendency for the power tilled plots to be the more closely associated with irrigation. Irrigation is not however of overwhelming importance here, since the first crop of the <u>rabi</u> season depends largely on residual soil moisture from the monsoonal flooding.[1]

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[1] It must be appreciated that 'irrigated' plots are those which have access to irrigation facilities. These need not be utilised in any particular season.

TABLE 5.26: CROP TYPE BY METHOD OF CULTIVATION AND IRRIGATION (Rangpur)

CROP TYPE		TRACTOR CULTIVATION Non-Irrig.	Man. Irrig.	Eng. Irrig.	ANIMAL CULTIVATION Non-Irrig.	Man. Irrig.	Eng. Irrig.	TOTAL No. & %
	No.	1	1	7	72	50	66	197
Paddy:	(	0.5	0.5	3.6	36.5	25.4	33.5	30.7
Aman	%(	10.0	20.0	41.2	26.5	26.0	45.2	
	(	0.2	0.2	1.1	11.2	7.8	10.3	
	No.	0	0	0	54	21	25	110
Paddy:	(	0.0	0.0	0.0	54.0	21.0	25.0	15.6
Aus	%(	0.0	0.0	0.0	19.9	10.9	17.1	
	(	0.0	0.0	0.0	8.4	3.3	3.9	
	No.	0	2	5	46	69	39	161
Paddy:	(	0.0	1.2	3.1	28.6	42.9	24.2	25.1
HYV	%(	0.0	40.0	29.4	16.9	35.9	26.7	
	(	0.0	0.3	0.8	7.2	10.7	6.1	
	No.	0	0	0	0	1	0	1
Paddy:	(	0.0	0.0	0.0	0.0	100.0	0.0	0.2
Boro	%(	0.0	0.0	0.0	0.0	0.5	0.0	
	(	0.0	0.0	0.0	0.0	0.2	0.0	
	No.	0	1	0	1	0	0	2
	(	0.0	50.0	0.0	50.0	0.0	0.0	0.3
Wheat	%(	0.0	20.0	0.0	0.4	0.0	0.0	
	(	0.0	0.2	0.0	0.2	0.0	0.0	
	No.	1	0	0	20	5	3	37
	(	2.7	0.0	0.0	57.7	13.5	8.1	5.8
Pulses	%(	10.0	0.0	0.0	10.3	2.6	2.1	
	(	0.2	0.0	0.0	4.4	0.8		
	No.	4	1	0	29	11	3	48
	(	8.3	2.1	0.0	60.4	22.9	6.2	7.5
Mustard	%(	40.0	20.0	0.0	10.7	5.7	2.1	
	(	0.6	0.2	0.0	4.5	1.7	0.5	
	No.	0	0	0	1	0	0	1
Other	(	0.0	0.0	0.0	100.0	0.0	0.0	0.2
Oilseeds	%(	0.0	0.0	0.0	0.4	0.0	0.0	
	(	0.0	0.0	0.0	0.2	0.0	0.0	
	No.	0	0	0	3	5	1	9
	(	0.0	0.0	0.0	33.3	55.6	11.1	1.4
Potato	%(	0.0	0.0	0.0	1.1	2.6	0.7	
	(	0.0	0.0	0.0	0.5	0.8	0.2	
	No.	0	0	0	0	4	0	4
Other	(	0.0	0.0	0.0	0.0	100.0	0.0	0.6
Rootcrops	%(	0.0	0.0	0.0	0.0	2.1	0.0	
	(	0.0	0.0	0.0	0.0	0.6	0.0	
	No.	0	0	0	1	1	0	2
Other	(	0.0	0.0	0.0	50.0	50.0	0.0	0.3
Vegetables	%(	0.0	0.0	0.0	0.4	0.5	0.0	
	(	0.0	0.0	0.0	0.2	0.2	0.0	
	No.	0	0	1	4	2	0	7
	(	0.0	0.0	14.3	57.1	28.6	0.0	1.1
Spices	%(	0.0	0.0	5.9	1.5	1.0	0.0	
	(	0.0	0.0	0.2	0.6	0.3	0.0	
	No.	0	0	0	19	15	6	40
	(	0.0	0.0	0.0	47.5	37.5	15.0	6.2
Jute	%(	0.0	0.0	0.0	7.0	7.8	4.1	
	(	0.0	0.0	0.0	3.0	2.3	0.9	
	No.	4	0	4	14	8	3	33
Other	(	12.1	0.0	12.1	42.4	24.2	9.1	5.1
Industrial	%(	40.0	0.0	23.5	5.1	4.2	2.1	
Crops	(	0.6	0.0	0.6	0.2	1.2	0.5	
	No.	10	5	17	272	192	146	642
TOTAL	%	1.6	0.8	2.6	42.4	29.9	22.7	100.0

TABLE 5.27: CROP TYPE BY METHOD OF CULTIVATION AND IRRIGATION (Munshiganj - Less 'Mechanised' Area)

CROP TYPE[a]			POWER TILLAGE Non-Irrig.	Man. Irrig.	ANIMAL CULTIVATION Non-Irrig.	Man. Irrig.	Eng. Irrig.	TOTAL No. & %
		No.	0	1	79	38	1	119
Paddy:		(	0.0	0.8	66.4	31.9	0.8	13.0
Aus-	%	(	0.0	4.8	17.1	9.6	3.7	
Aman		(	0.0	0.1	8.6	4.2	0.1	
		No.	0	0	1	0	2	3
Paddy:		(	0.0	0.0	33.3	0.0	66.7	0.3
Boro + HYV	%	(	0.0	0.0	0.2	0.0	7.4	
		(	0.0	0.0	0.1	0.0	0.2	
		No.	0	3	29	12	1	45
		(	0.0	6.7	64.4	26.7	2.2	4.9
Wheat	%	(	0.0	14.3	6.3	3.0	3.7	
		(	0.0	0.3	3.2	1.3	0.1	
		No.	0	0	8	21	0	29
		(	0.0	0.0	27.6	72.4	0.0	3.2
Millet	%	(	0.0	0.0	1.7	5.3	0.0	
		(	0.0	0.0	0.9	2.3	0.0	
		No.	0	0	0	1	0	1
		(	0.0	0.0	0.0	100.0	0.0	0.1
Pulses	%	(	0.0	0.0	0.0	0.3	0.0	
		(	0.0	0.0	0.0	0.1	0.0	
		No.	10	3	142	39	3	197
		(	5.1	1.5	72.1	19.8	1.5	21.5
Mustard	%	(	100.0	14.3	30.7	9.9	11.1	
		(	1.1	0.3	15.5	4.3	0.3	
		No.	0	0	10	17	0	27
		(	0.0	0.0	37.0	63.0	0.0	3.0
Other Oilseeds	%	(	0.0	0.0	2.2	4.3	0.0	
		(	0.0	0.0	1.1	1.9	0.0	
		No.	0	13	3	68	6	90
		(	0.0	14.4	3.3	75.6	6.7	9.8
Potato	%	(	0.0	61.9	0.6	17.3	22.2	
		(	0.0	1.4	0.3	7.4	0.7	
		No.	0	0	2	19	1	22
		(	0.0	0.0	9.1	86.4	4.5	2.4
Other Rootcrops	%	(	0.0	0.0	0.4	4.8	3.7	
		(	0.0	0.0	0.2	2.1	0.1	
		No.	0	0	8	15	0	23
		(	0.0	0.0	34.8	65.2	0.0	2.5
Spices	%	(	0.0	0.0	1.7	3.8	0.0	
		(	0.0	0.0	0.9	1.6	0.0	
		No.	0	1	181	164	13	359
		(	0.0	0.3	50.4	45.7	3.6	39.2
Jute	%	(	0.0	4.8	39.1	41.6	48.1	
		(	0.0	0.1	19.8	17.9	1.4	
TOTAL		No.	10	21	463	394	27	915
		%	1.1	2.3	50.6	43.1	3.0	

TABLE 5.28: CROP TYPE BY METHOD OF CULTIVATION AND IRRIGATION (Munshiganj - More 'Mechanised' Area).

CROP TYPE[a]		POWER TILLAGE Non-Irrig.	POWER TILLAGE Man. Irrig.	POWER TILLAGE Eng. Irrig.	ANIMAL CULTIVATION Non-Irrig.	ANIMAL CULTIVATION Man. Irrig.	ANIMAL CULTIVATION Eng. Irrig.	TOTAL No. & %
	No.	20	6	1	43	15	0	85
Paddy:	(	23.5	7.1	1.2	50.6	17.6	0.0	17.4
Aus-Aman	% (	21.7	5.2	8.3	30.3	12.0	0.0	
	(	4.1	1.2	0.2	8.8	3.1	0.0	
	No.	2	0	5	1	3	2	13
Paddy:	(	15.4	0.0	38.5	7.7	23.1	15.4	2.7
Boro + HYV	% (	2.2	0.0	41.7	0.7	2.4	100.0	
	(	0.4	0.0	1.0	0.2	0.6	0.4	
	No.	3	3	0	5	3	0	14
	(	21.4	21.4	0.0	35.7	21.4	0.0	2.9
Wheat	% (	3.3	2.6	0.0	3.5	2.4	0.0	
	(	0.6	0.6	0.0	1.0	0.6	0.0	
	No.	30	13	4	12	4	0	63
	(	47.6	20.6	6.3	19.0	6.3	0.0	12.9
Mustard	% (	32.6	11.3	33.3	8.5	3.2	0.0	
	(	6.1	2.7	0.8	2.5	0.8	0.0	
	No.	2	3	0	9	4	0	18
	(	11.1	16.7	0.0	50.0	22.2	0.0	3.7
Other Oilseeds	% (	2.2	2.6	0.0	6.3	3.2	0.0	
	(	0.4	0.6	0.0	1.8	0.8	0.0	
	No.	20	45	1	10	12	0	88
	(	22.7	51.1	1.1	11.4	13.6	0.0	18.0
Potato	% (	21.7	39.1	8.3	7.0	9.6	0.0	
	(	4.1	9.2	0.2	2.0	2.5	0.0	
	No.	0	7	0	6	6	0	19
	(	0.0	36.8	0.0	31.6	31.6	0.0	3.9
Other Root-	% (	0.0	6.1	0.0	4.2	4.8	0.0	
crops	(	0.0	1.4	0.0	1.2	1.2	0.0	
	No.	3	12	0	17	18	0	50
	(	6.0	24.0	0.0	34.0	36.0	0.0	10.2
Spices	% (	3.3	10.4	0.0	12.0	14.4	0.0	
	(	0.6	2.5	0.0	3.5	3.7	0.0	
	No.	12	26	1	38	58	0	135
	(	8.9	19.3	0.7	28.1	43.0	0.0	27.7
Jute	% (	13.0	22.6	8.3	26.8	46.4	0.0	
	(	2.5	5.3	0.2	7.8	11.9	0.0	
	No.	0	0	0	1	2	0	3
	(	0.0	0.0	0.0	33.3	66.7	0.0	0.6
Other Indus.	% (	0.0	0.0	0.0	0.7	1.6	0.0	
Crops	(	0.0	0.0	0.0	0.2	0.4	0.0	
TOTAL	No.	92	115	12	142	125	2	488
	%	18.9	23.6	2.5	29.1	25.6	0.4	100.0

Notes on TABLES 5.26-5.28

(See also Notes on Table 5.24)

The three sets of percentages are as follows:

(first) row percentage

(second) column percentage

(third) overall percentage.

The results of the tests of association are:-

TEST	TABLE NO. 5.26	5.27	5.28
Chi-Square	218.81	342.43	326.21
Significance (%)	0.1	0.1	0.1
Cramer's V	0.261	0.306	0.366
Lambda's (%) (1)	8.1	24.8	23.4
(2)	5.2	4.0	13.0
(3)	6.5	13.3	18.2

Lambda (1) asymmetric with cultivation technique dependent
(2) asymmetric with crop type dependent
(3) symmetric.

CHAPTER 6: CROP YIELDS

6.1. EXPERIMENT STATION CULTIVATION TRIALS

The volume of controlled experimental work on yield response to cultivation technique in Bangladesh has not been very large. Nevertheless during and in the years immediately preceding the present study some such empirical work was conducted in the vicinity of our Dacca and Bogra sample sites. Most of this experimentation was done by the Agronomy Division of the Bangladesh Rice Research Institute (BRRI) at Joydebpur, which is around ten miles from our Dacca sample site. The Bogra work was also done about that distance from our sample area, by an FAO scientist at the local experiment station of the Bangladesh Agricultural Research Institute (BARI). The findings of these studies are presented (in chronological order) in Tables 6.1 to 6.5.

These results are extremely important from the viewpoint of the present study, even though the work in question was not designed as a consistent set of experiments replicated over time. The findings are broadly speaking very consistent, which is all the more remarkable in view of the difference in experiment site, variety of paddy, season and year. The first point of importance to emerge from the tables is the degree of uniformity of grain yield comparing the different treatments of a particular experiment. In all cases, except Table 6.2, the power tiller treatment gives highest average yield across the replicates, but in only one case, the Bogra trial, is the difference statistically significant. In the Bogra experiment the power tiller treatment gave just six per cent higher grain yield than the best animal-powered treatment. Table 6.3 is especially interesting in this regard, since it reports five animal-powered and four different power tiller treatments. Note that the most intensive power tiller treatment gives a significantly higher yield than all of the others - except the most intensive animal-powered treatment!

In view of the hypothesis that tractor cultivation gives better weed control than animal power, Tables 6.1, 6.2, 6.4 and 6.5 provide some illuminating results. In two of these tables (6.1 and 6.4) the results are quantified and in neither case does the power tiller give the best weed control of all treatments. The experiments in the other two tables (6.2 and 6.5) similarly indicate that there are no significant differences between animal and engine draught from this point of view.[1]

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[1] The results are of course incomplete: even for paddy, they do not include data for broadcast aus or b.aman. They do, however, cover the most important (transplanted) part of the most important crop (paddy) in Bangladesh.

TABLE 6.1: CULTIVATION-WEEDING TRIAL AT JOYDEBPUR (BORO PADDY (BR3), 1973-74)

Treatments[a]	Grain Yield (md/acre)[b]	Panicles per sq. Ft.	Spikelets per Panicle	1000 grain wt. (gms)	Plant Height (ins)	Total Dry wt. of weeds (gms)
Zero Tillage	50.8	32	71	27.7	26.8	1,636
1 Pl + 0 Hg	60.9	37	64	27.3	28.4	1,208
1 Pl + 1 Hg	62.4	37	73	28.0	28.7	738
2 Pl + 1 Hg	66.5	29	61	27.8	26.4	566
0 Pl + 2 Hg	65.0	32	66	28.2	27.6	514
Power Tiller	73.9	36	68	27.3	29.1	561

SOURCE: BRRI (1979) Tables 11 and 12 page 6.

Notes: Pl = ploughing with bullock plough
Hg = harrowing with bullock harrow ('ladder')
Power tiller treatment = one cultivation only
[a]No. of replicates not reported (probably three)
[b]The differences are not statistically significant.

TABLE 6.2: CULTIVATION-WEEDING TRIAL AT JOYDEBPUR (AUS PADDY (IR8) 1976)

Weeding Method[a]	Grain Yield[b]			
	Bullock Plough		Power Tiller	
	mds/acre	t/ha	mds/acre	t/ha
No Weeding	23.9	2.2	27.2	2.5
Two Hand Weedings	32.6	3.0	31.5	2.9
Two Hoe Weedings	26.1	2.4	29.3	2.7
Machete	32.6	3.0	30.4	2.8

SOURCE: BRRI (1979) Table 9, page 8

Notes: [a]No. of replicates not stated (three?); [b]Differences not statistically significant.

TABLE 6.3: CULTIVATION TRIAL AT JOYDEBPUR (AUS PADDY (BR3), 1977)

Power Source/Implement	No. of Ploughings	No. of Ladderings	Grain Yield[c] (t/ha)	(mds/acre)
Bullock Plough	3	3	3.2	37.8b
Bullock Plough	4	4	3.2	37.8b
Bullock Plough	5	5	2.6	28.3b
Bullock Plough	6	6	3.0	32.6b
Bullock Plough	7	7	3.4	37.0ab
"Sob-cum-plough"[b]	2	2	3.0	32.6b
"Sob-cum-plough"	3	2	3.2	37.8b
Power tiller	2	2	3.2	37.8b
(rotavator)	3	2	4.2	45.7a

SOURCE: SATTAR (1978) Table 3.

Notes: [a]Three replicates per treatment; [b]This is a steel rake pulled by a power tiller;
[c]Data having the same letter(s) do not differ significantly (Duncan Multiple Range Test).

TABLE 6.4: CULTIVATION TRIAL AT JOYDEBPUR (T. AMAN PADDY (BR4), 1977)

Treatment[c]	Weed Infestation Rating[b]	Seedling Mortality (per cent)	Panicles per Hill	Grain Yield[c] (mds/acre)	Total Labour Requirements
2 Pl + 2 Hg	2.0	6.7	9.1	42.6	11.1
3 Pl + 3 Hg	3.3	3.9	9.2	51.7	18.3
3 Pl + 4 Hg	1.7	4.7	8.8	43.9	19.0
4 Pl + 4 Hg	3.7	4.4	8.9	42.3	24.2
4 Pl + 5 Hg	3.0	2.8	8.9	40.8	24.6
2 PT + 3 Hg	3.3	4.2	7.9	53.4	4.3

SOURCE: BRRI (1981) Table 1, page 3 and Sattar (1978), Table 1.

Notes: [a]Three replicates per treatment;
Pl = ploughing with bullock plough
Hg = harrowing with bullock 'ladder'
PT = cultivation by power tiller

[b]1 = 100% of area infested
2 = 90% of area infested
3 = 75% of area infested
4 = 25% of area infested

[c]1 maund per acre = 92 kg/ha; tests of statistical significance not recorded.

TABLE 6.5: CULTIVATION TRIAL AT BOGRA (T.AMAN PADDY (Pajam), 1978)
Grain Yields in Maunds/acre[a]

Treatment[b]	Replicate I	Replicate II	Replicate III	Mean[c]
2 Pl + 2 Hg	30.3	30.4	30.9	30.5
3 Pl + 3 Hg	31.7	29.0	29.8	30.1
6 Pl + 6 Hg	32.2	31.2	30.5	31.3
2 PT + 2 Hg	33.5	33.1	32.9	33.2

SOURCE: J. HARROP, FAO-UNDP; personal communication quoted by permission

Notes: Pl = ploughing with bullock plough
Hg = harrowing with bullock 'ladder'
PT = cultivation with Power Tiller (rotavator)

[a]1 maund per acre = 92 kg per hectare

[b]Transplanted 24th July harvested 16th November (115 days). Weeding was equal on all plots (all plots showed similar weed growth)

[c]The differences are statistically significant at the 1 per cent level (analysis of variance).

Tables 6.1 and 6.4 provide some useful supplementary information on yield components (seedling mortality, spikelets per panicle, thousand grain weight, etc.). In most cases the relevant parameter for the power tiller treatment lies within the range embraced by the animal-powered treatments, so that no real difference can be inferred. In two cases plant height (Table 6.1) and panicles per hill (Table 6.4) the power tiller treatment gives respectively the best and the poorest result but unfortunately it has not been reported whether these differences are statistically significant. Where the differences are undoubtedly of practical significance is in the case of labour requirements for cultivation (Table 6.4) which shows the power tiller treatment as requiring from 60 to 80 per cent less labour input than the traditional alternatives.

Experiments of the type just described are ideally suited to testing the 'net contributor' view of tractorisation, at least in its more extreme form which postulates that tractor cultivation gives higher yields than any level of intensity of bullock cultivation (Binswanger, 1978, Ch. II and Section 1.1 above). The findings of this experimental work clearly do not support the hypothesis in the context of present day Bangladesh. This valuable information apart, however, such data are by themselves insufficient when farm-level 'choice of technique' decisions have to be made. Economic factors - such as the relationship between the marginal cost of a given improvement in cultivation standards and the discounted value of any resultant increase in output (the marginal value product) are not included in the above type of analysis, although such considerations would obviously be of prime importance to the farmer. Even on a purely physical level, experimental station findings cannot usually be replicated in the farmer's field, since the latter faces a quite different set of constraints and possesses a different set of resources from the research scientist. The most important of the constraint differences springs from the way in which the researcher, unlike most farmers, is able to control for factors other than that which is under investigation. Thus for example when comparing cultivation techniques the scientist ensures that all plots are cultivated at the same time, whereas the farmer may have access to draught animals immediately but would have to wait some time for a tractor, or vice versa. Economic considerations are examined in Chapters 4 and 9. Physical crop response to method of cultivation in the farmer's field is the subject of the remainder of the present chapter.

6.2. SURVEY FINDINGS

Single interview surveys of yield and production frequently produce unreliable results because of problems of recall, lack of trust or the respondent's desire to please the enumerator by giving what he perceives as the desired answer.[1] A long-term survey such as this one is much to be preferred from this viewpoint, since interviews are more timely and a working relationship has been established between interviewer and respondent. Many problems nevertheless remain and it would be foolish to ignore them.

In order to obtain a reliability check on farmers' yield reports in the present study, sample crop cuts of the two main cereals, paddy and wheat, were taken throughout the course of the Survey. A total of more than 500 such samples were taken and the methodology employed is described in Appendix 9. Yield estimates deriving from these samples were subsequently compared with those calculated from farmers' production reports wherever both were available for the same plot and although an exact correspondence is clearly not to be expected the degree of correlation is quite high.[2] In order, however, to avoid the problem of extreme - and obviously wrong - figures unduly biasing the findings, frequency distributions of yields were calculated for all crops and such extreme values excluded from further analysis.[3]

The yields of major crop types as calculated from the Survey data are presented in Table 6.6 which also provides national estimates for purposes of comparison. Each of these crop types of course includes a number of different varieties which have been aggregated to reduce them to manageable proportions. Because the level of aggregation is so high, it would obviously be unwise to read too much into relatively small differences; the overall picture which emerges shows that the yield figures arising from the Survey are broadly consistent with national estimates. In subsequent calculations, however, individual crop varieties will be treated separately.

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[1]This last phenomenon has been aptly described as "a conspiracy of courtesy". Other sources of misinformation include: farmers wishing to impress the interviewer by overstating yields; others might wish to plead poverty in the hope of obtaining relief goods. Farmers do not always weigh their crops; even when they are weighed there may be confusion between wet and dry, husked and unhusked crops. Where a given crop is grown in several plots they may be harvested at the same time and processed together, so that plot-by-plot information is unavailable. Similar problems apply to inputs.

[2]Coefficient of determination (r^2) = 0.26; No. of pairs observations = 526; Significance = 0.001%.

[3]Such extreme values will obvious have an unwarranted effect on calculated means, but in statistics such as correlation coefficients and variances where the square of the values is utilised, the bias will be very much greater. In practice, quite tolerant limits were set and only two per cent of all observations were excluded overall.

TABLE 6.6: YIELDS OF MAJOR TYPES OF CROPS BY DISTRICT (Maunds per acre)

CROP TYPE		RANGPUR Mean	RANGPUR S.D.	RANGPUR N	BOGRA Mean	BOGRA S.D.	BOGRA N	DACCA Mean	DACCA S.D.	DACCA N	COMILLA Mean	COMILLA S.D.	COMILLA N	NOAKHALI Mean	NOAKHALI S.D.	NOAKHALI N	MUNSHIGANJ Mean	MUNSHIGANJ S.D.	MUNSHIGANJ N	TOTAL Mean	TOTAL S.D.	TOTAL N	National Estimates** (Mean)
Paddy:	Aman*	20.7	7.4	197	21.1	9.2	118	22.5	11.3	141	32.7	13.2	357	18.7	8.2	379	26.7	11.3	101	24.1	11.8	1213	20.6(b)
	Aus	11.7	5.8	101	16.6	7.1	18	17.9	10.6	133	19.1	7.7	24	20.9+	10.0	93	12.6	9.1	100	16.1	9.7	469	14.0(b)
	Boro	11.5	-	1	23.7	16.2	13	38.7	6.8	10	-	-	-	-	-	-	13.1	8.0	2	28.2	15.1	26	23.1(b)
	HYV	25.3	10.1	161	23.5	16.3	54	30.5	14.8	287	33.4	14.8	501	35.3+	10.5	125	19.0	17.3	14	31.2	14.4	1142	41.9(b)
Wheat		17.5	-	1	16.1	9.4	88	15.3	10.7	61	-	-	-	-	-	-	29.4	9.1	59	19.6	11.5	209	17.6(b)
Millet		-	-	-	5.4	1.9	4	-	-	-	-	-	-	-	-	-	14.1	7.2	28	13.0	7.3	32	8.5(f)
Pulses		4.3	2.2	37	5.6	3.3	9	7.0	6.9	24	2.5	1.2	6	4.1	-	1	9.4	-	1	7.7	8.6	88	7.6(b)
Mustard Seed		3.8	1.4	47	0.8	0.3	2	4.0	1.4	4	2.3	0.7	3	-	-	-	13.7	5.2	254	11.9	6.1	310	8.4(b)
Potato		40.4	30.4	8	55.6	56.2	10	144.0	66.4	153	35.4	2.9	2	40.5	14.5	5	181.3	74.3	165	155.1	77.3	344	103.9(f)
Jute		11.3	6.2	40	15.2	7.8	41	9.1	3.8	31	-	-	-	-	-	-	13.3	10.3	461	13.1	9.7	574	14.5(b)

Notes: *B. Aman in Munshiganj; T. Aman elsewhere.
**Figures are based on estimates for 1976/77 by:
(b) Bangladesh Bureau of Statistics
(f) FAO

+Figures collected early in survey: probably over-reporting

S.D. = Standard Deviation in maunds/acre
N = No. of observations

1 maund per acre = 92 kg/hectare

27 maunds = 1 ton.

If the data presented in Tables 6.1 to 6.5 discredit the extreme form of the 'net contributor' view of tractorisation, it still remains to be seen whether in the operating conditions represented by the Bangladeshi farmers' fields tractors have a 'net contribution' to make to yield improvement. This less extreme form of the hypothesis in question was tested with the Survey data by examining all cases of a given crop variety in a given area where there were at least five observations each of animal- and tractor-tillage. Yields with these two techniques were then compared using analysis of variance (ANOVA).[1] The findings for the resulting twelve crop-area combinations are presented in Tables 6.7 to 6.12. These figures clearly lend little support to the above hypothesis: indeed in only half the cases is the mean yield of the tractorised plots the higher of the two, and in only one of the twelve cases is the difference in means statistically significant at the five per cent level.

The exception is <u>manta</u> potato in the less mechanised of the two Munshiganj villages, and this case is worth exploring further in order to try to determine whether any factor other than the use of power tillers 'explains' the observed differences in the mean yields: the eta^2 value (0.096) shows that the use of the machine 'explains' just under ten per cent of this difference. The following additional independent variables were considered: fertiliser application rate, seeding rate, sowing date and date of harvest.[2] This last factor is particularly important here since farmers in this area grow potato mainly for the market and often harvest the crop before full maturity in order to take advantage of high early-season prices. What is most unfortunate for this particular piece of analysis however is the fact that the Survey was launched at the time of the changeover from <u>kharif</u> (b. <u>aman</u>) to <u>rabi</u> crops, so that the number of missing values on inputs for <u>rabi</u> crops is particularly high in this instance.[3] This is clearly illustrated in the case of seeding rates, where forty two per cent of all values are missing. Much the same is probably true in the case of fertiliser although in this instance it is not possible to distinguish between zero application rates and missing values.

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[1] Clearly some continuous measure of the level of power input - such as the amount of time spent cultivating the plot - would have been preferable to the simple dichotomy presented here, but in practice very few farmers are able to report short periods of time, such as those required for tractor cultivation, with any degree of accuracy.

[2] The crop was not irrigated.

[3] Data on whether or not plots had been cultivated by power tiller were confirmed at a later date, after it was learned that, contrary to earlier information, such machines had begun to be used in this site.

TABLE 6.7: CROP YIELDS (maunds/acre) With and Without Tractors: Rangpur

	PADDY (IR8)	PADDY (Aman Pajjam)
Mean Yield Using Tractors (No.)	33.0 (5)	29.9 (5)
Mean Yield Without Tractors (No.)	25.2 (137)	30.7 (102)
Mean Yield Overall (No.)	25.5 (142)	30.7 (107)
Mean F. Statistic (ANOVA)	3.018	0.013
Significance of F	0.085	0.909
eta^2	0.021	0.000

(N.B. 1 maund per acre = 92 kg/hectare)

TABLE 6.8: CROP YIELDS (maunds/acre) With and Without Tractors: Dacca

	Seed Potato
Mean Yield Using Tractors (No.)	148.15 (90)
Mean Yield Without Tractors (No.)	140.61 (62)
Mean Yield Overall (No.)	144.97 (152)
F. Statistic (ANOVA)	0.504
Significance of F	0.479
eta^2	0.003

TABLE 6.9: CROP YIELDS (maunds/acre) With and Without Tractors: Comilla

	Paddy (IR8)
Mean Yield Using Tractors (No.)	42.85 (7)
Mean Yield Without Tractors (No.)	37.13 (71)
Mean Yield Overall (No.)	37.64 (78)
F. Statistic (ANOVA)	0.813
Significance of F	0.370
eta^2	0.011

TABLE 6.10: CROP YIELDS (maunds/acre) With and Without Tractors: Noakhali

	Paddy (Aman Kajulshail)
Mean Yield Using Tractors (No.)	18.2 (20)
Mean Yield Without Tractors (No.)	19.9 (143)
Mean Yield Overall (No.)	19.7 (163)
F. Statistic (ANOVA)	0.935
Significance of F	0.335
eta^2	0.006

TABLE 6.11: CROP YIELDS (maunds/acre) With and Without Power Tillers: Munshiganj (more mechanised site)

	Mustard Seed	Chillie	Potato	Jute
Mean Yield: Using Power Tillers (No.)	9.7 (44)	13.4 (14)	172.7 (58)	16.3 (38)
Without Power Tillers (No.)	11.2 (15)	7.8 (34)	163.2 (14)	19.0 (87)
Overall (No.)	10.1 (59)	9.5 (48)	170.9 (72)	18.2 (125)
F. Statistic (ANOVA)	0.982	2.018	0.168	3.091
Significance of F	0.326	0.162	0.683	0.081
eta^2	0.017	0.042	0.002	0.025

(N.B. 1 maund/acre = 92 kg/hectare)

TABLE 6.12: CROP YIELDS (maunds/acre) with and Without Power Tillers: Munshiganj (less mechanised site)

	Potato (Manta)	Mustard Seed (Sati)	Mustard Seed (Maghi)
Mean Yield: Using Power Tillers (No.)	242.4 (12)	10.3 (4)	14.8 (9)
Without Power Tillers (No.)	190.6 (63)	13.9 (36)	15.2 (146)
Overall (No.)	198.9 (75)	13.5 (40)	15.1 (155)
F. Statistic (ANOVA)	7.731	3.933	0.064
Significance of F	0.007	0.055	0.801
eta^2	0.096	0.094	0.000

TABLE 6.13: CORRELATION MATRIX FOR MANTA POTATO (MUNSHIGANJ)

	Yield	Sowing Date	Harvest Date	Fertiliser Rate	Seeding Rate	Tractor Use
Yield	1.000	0.123	<u>0.333</u>	0.005	0.072	-0.003
Sowing Date		1.000	<u>0.753</u>	0.177	0.057	0.037
Harvesting Date			1.000	0.024	0.184	0.024
Fertiliser Rate				1.000	<u>0.412</u>	0.235
Seeding Rate					1.000	<u>0.623</u>
Tractor Use						1.000

Underlined coefficients are significant at 5% or better.
Tractor Use is entered as a dichotomy: 1= used; 0 = not used.

Since the use of zero seeding rates would obviously be absurd, such cases were excluded from subsequent analysis. Table 6.13 shows the matrix of correlation coefficients for the above set of variables using the reduced data set. The most salient point to emerge is that the previously observed significant positive correlation between tractor use and yield has disappeared. The relationship between yield and harvest date is however confirmed to be significant at the five per cent level.[1] The other significant relationships shown in Table 6.13 are not particularly surprising.

The results of the multiple regression analysis are summarised in Table 6.14. A stepwise approach was used in this model, with independent variables being entered into the equation in order of their 'explanatory' power (that is, no predetermined hierarchy of independent variables was postulated). Variables were excluded if their addition to the 'explanatory' power of the estimating equation was not significant at the five per cent level. This resulted in the inclusion of only two independent variables, harvesting date and sowing date in that order, with the latter variable 'explaining' part of the yield variation not already 'explained' by the former.

Although the sample crop cuts mentioned earlier were conducted primarily as reliability checks on farmers' production reports, they too could be used to compare the yield effects of alternative cultivation techniques. However in the villages dependent upon the BADC tractor hire service, the overall level of tractor use was found to be quite low - as can be seen from Tables 6.7 to 6.10, whereas in the two villages mechanised with privately-owned power tillers these tend to be used on non-cereal crops. Overall it was possible to compare mean yields by cultivation techniques for fifteen village-variety combinations, but in only one case were there more than one or two observations of tractor cultivation, so that tests of statistical significance could not be employed. Nevertheless, the results were similar to those reported in Tables 6.7 to 6.12 in that in only nine cases was the mean yield on the tractor plots the higher of the two. In five cases they were actually lower and in one there was no difference.

Again there was one exceptional case, that of <u>Kajulshail</u> (<u>aman</u> paddy) in Char Alexander, Noakhali. In this case there was a sufficient number of observations to permit meaningful comparison and the results are presented in Table 6.15. This shows that not only is the difference in means negligible (1.7 per cent) but that the range of yields for the animal cultivated plots extends in both directions beyond that of the tractor plots. The F-statistic is also very small and of no statistical significance.

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[1]When the correlation coefficient between yield and harvesting date was calculated on the full data set the observed relationship was closer still: $r = 0.434$; level of significance = 0.1 per cent.

TABLE 6.14: RESULTS OF MULTIPLE REGRESSION ANALYSIS FOR MANTA POTATO (MUNSHIGANJ)

Dependent Variable. Yield

Variable entered on Step Number 1 Harvest Date

Multiple R	0.33289
R. Square	0.11082
Adjusted R Square	0.08859
Standard Error	48.13890

------------Variables in the Equation------------

Variable	B	BETA	STD Error B	F
Harvest Date	1.198805	0.33289	0.53692	4.985
(Constant)	-142.5831			

....

Variable Entered on Step Number 2 Sowing Date

Multiple R	0.38563
R Square	0.14871
Adjusted R Square	0.10506
Standard Error	47.70205

------------Variables in the Equation------------

Variable	B	BETA	STD Error B	F
Harvest Date	2.001411	0.55577	0.80879	6.123
Sowing Date	-2.061259	-0.29592	1.56444	1.736
(Constant)	53.07151			

TABLE 6.15: YIELDS OF KAJULSHAIL (Aman Paddy) IN CHAR ALEXANDER BY METHOD OF CULTIVATION (Estimates based on Crop Cuts)

	Tractor Cultivated Plots	Animal Cultivated Plots
No. of Observations	9	32
Mean Yield (maunds/acre)	23.3	22.9
Maximum Yield (maunds/acre)	23.9	32.6
Minimum Yield (maunds/acre)	21.7	15.2
Coefficient of Variation (%)	3.4	12.7

F Statistic = 0.140; (not statistically significant)

(N.B. 1 maund/acre = 92 kg/hectare)

In summary, therefore, in twelve cases out of thirteen where it has been possible to make a meaningful comparison, the Survey evidence offers no support for the view that the substitution of tractors or power tillers for animal draught in Bangladesh has in itself a significant positive impact upon yields. In the one case where a significant increase was observed, the evidence suggests that factors other than tractor uses may be responsible, although here because of missing data on inputs the evidence is best regarded as inconclusive.

CHAPTER 7: DIRECT EMPLOYMENT EFFECTS OF MECHANISATION

In Chapter 1 it was indicated that Bangladesh as well as having a very high population density also employs what is by regional standards a very high proportion of her 'economically active' population in the agricultural sector. The inferences drawn from this were that (a) the agricultural sector is presently extremely labour intensive, and (b) it would require a massive proportionate increase in non-agricultural employment opportunity in order to accommodate even a small percentage reduction in agricultural employment.

Table 7.1 below shows what is officially estimated[1] to have occurred in the field of sectoral distribution of employment over the greater part of the twenty years since the 1961 Census of Pakistan: the proportion of the population employed in agriculture has declined only very slowly, while non-agricultural employment has in absolute terms grown more slowly than population. Thus not only have the other sectors failed to absorb labour displaced from agriculture, but the degree of labour intensity in agriculture has actually grown with the growth in the absolute number employed.

In circumstances such as these even the simplest forms of mechanisation can cause labour displacement. An example, which was encountered during the course of the study among farmers in Bogra District, will help illustrate this point. These farmers reported that an investment of Tk.500/- in very simple hand-powered equipment - a single row seed drill and an inter-row cultivator - had enabled them to line-sow their jute crop instead of broadcasting it, an innovation which reportedly reduced combined labour requirements for sowing and weeding by 35 man-days per acre.

The focus of the present chapter will be the direct effects on labour requirements of farm mechanisation, whether actual, as in the case of land preparation, or potential, as in the case of harvesting or transplanting paddy - operations which have not as yet been the object of any degree of mechanisation in Bangladesh. Indirect employment effects are the subject of the next chapter.

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[1] Figures from the 1974 Census indicate that 77.1 per cent of the 'economically active' population were then employed in agriculture (Bangladesh Government, 1979, page 84). If this, and the figures in Table 7.1 are all correct, then the proportion in agriculture actually rose by an average of 0.6 per cent per annum between 1974 and 1978/79 after falling by an annual average of 1.1 per cent over the preceding ten years. FAO estimates suggest a very gradual proportionate decline from 85.9 to 84.4 per cent between 1970 and 1978, which implies an average annual fall of just 0.2 per cent. In all cases the FAO estimates are highest, but whichever set of figures is accepted, the basic inference remains the same.

TABLE 7.1: SECTORAL DISTRIBUTION OF EMPLOYMENT IN BANGLADESH 1961-1978/79

SECTOR	1961		1978/79		Annual growth rate (%)	
	Millions	%	Millions	%	Absolute	Relative
Agriculture	15.00	86.2	20.00	79.1	1.6	-0.5
All others	2.40	13.8	5.30	20.9	4.5	2.4
Total 'Economically Active'	17.40	100.0	25.30	100.0	2.1	-
Manufacturing	0.75	4.3	1.19	4.7	2.6	0.5
Trading	0.57	3.3	0.99	3.9	3.2	1.0
Transport & Storage	0.19	1.1	0.40	1.6	4.3	2.1
Services	0.78	4.5	2.67	10.6	7.0	4.9
Others	0.12	0.7	0.05	0.2	-5.0	-7.2
TOTAL POPULATION	54.53	-	90.25	-	2.9	-

SOURCES: Adapted from (i) Bangladesh Government (1979), Tables 2.6 and 2.45;
(ii) Bangladesh Government (1980) Table 6.2.

Notes: These percentage annual growth rates derive from the continuous growth formula:

$$100(\log_e(P_{78-9}/P_{61}))t^{-1}$$ where t = no. of years and

P = population or percentage in the subscript year.

Absolute growth refers to growth in numbers.
Relative growth refers to growth in percentage share.

The overwhelming importance of the labour displacement question derives of course from its potential effect on the incomes of farm labourers. If the employment effect of mechanisation were limited to the farm family any income effect would reflect the family's leisure preference - in effect by mechanising they would be purchasing (perhaps among other things) leisure. Under these circumstances the topic, although still of importance in terms at least of resource allocation, would lose a good deal of its urgency. The present chapter will therefore concentrate on the existing and potential effects of mechanisation on wage labour, particularly casual labour, since as was shown earlier, only a very small proportion of the farm labour force is in 'permanent' paid employment.[1] It must be emphasised from the outset that the term 'labour displacement' need not of itself imply that there is a net reduction in either labour-

[1] 'Permanent' as here defined implies a contract of at least one year's duration.

land or labour-output ratios since it is possible that consequent increases in labour requirements for some operations may offset a loss of employment opportunity following from mechanisation of others. The most suitable starting point for the discussion is an assessment of the relative importance of the various farm operations as regards their employment of wage labour.

7.1. CASUAL EMPLOYMENT BY TYPE OF WORK

Because casual labour is, almost by definition, hired for a specific task it is possible to derive from the Survey's farm records, an accurate picture of the relative importance of the various farm operations as regards employment creation. The relevant data are provided on a week-by-week basis in Tables 7.2 to 7.8. This is obviously a rather large data set, but the overall picture is not too difficult to discern. Before going on to this however a word of caution is required. One of the most difficult tasks faced by field staff in the course of a survey such as this arises during the busiest periods in the farming year. At such periods farmers find it unusually difficult to spare time for interviews, and yet because of the relatively heavy workload on the farm there is more information to impart and more time than usual is correspondingly required for interview sessions. It therefore demands considerable skill and perseverance on the part of the interviewer to elicit all of the necessary information, and there is a clear danger that under-recording may occur at such periods. The figures in Tables 7.2 to 7.8 are therefore probably best regarded as minimum rather than typical. This is especially true of periods of peak employment and of totals.

The figures in these tables nevertheless show that the hiring of casual labour is extensive. Converted to an annual unit area basis the overall means are as follows:-

Rangpur	33.5	man-day	equivalents	per	acre	per	annum	
Bogra	36.1	"	"	"	"	"	"	
Dacca	31.7	"	"	"	"	"	"	
Comilla	31.0	"	"	"	"	"	"	
Noakhali	26.4	"	"	"	"	"	"	
Munshiganj	104.0	"	"	"	"	"	"	
	(110-115	"	"	"	"	"	"	)
All Areas	47.25	"	"	"	"	"	"	

With one very obvious exception these overall figures are roughly of the same order of magnitude. A number of points should be made regarding the exception, Munshiganj. As noted in Chapter 1, the Survey in that area began later than in the others and is the only one which covers less than a complete calendar year. However, the period of the year which was not surveyed is for the most part of little agricultural interest, since it is a time of deep monsoonal flooding when no work takes place in the fields. The only missing period of any agricultural interest is the early part of the 1978 b. aman harvest, as can be seen from Table 7.8 where the figures for harvesting cut in at a high level. The figures in parentheses above are the estimated likely range for a full year in Munshiganj.

TABLE 7.2: WEEKLY EMPLOYMENT OF CASUAL LABOUR BY TYPE OF WORK, 1978-79 (Mean No. of Man-days Hired per Farm - All Areas)

Date (Week-Ending)	TYPE OF WORK: Land Improvement	Land Prepn.	Planting & Sowing	Trans-planting	Fert. & Manure Appl'n.	Weeding	Irrig. & Drainage	Harvesting	Crop Processing	Trans-portation	Marketing	Care of Live-stock	Other	Total
June 11th		0.01		0.10		0.03		0.01						0.15
18th	0.06	0.07		0.17		0.20		0.02	0.02				0.06	0.59
25th	0.17	0.06		0.04		0.48	0.02	0.06	0.03				0.25	1.11
July 2nd	0.09	0.10	0.02	0.11	0.02	0.61	0.02	0.13	0.01		0.01	0.01	0.09	1.21
9th	0.13	0.22		0.44	0.05	0.59	0.02	0.10	0.01	0.01			0.03	1.59
16th	0.10	0.18	0.01	0.37	0.06	0.35	0.01	0.18	0.07	0.07			0.02	1.40
23rd	0.06	1.22	0.03	0.55	0.01	0.33	0.01	0.56	0.07	0.02		0.02	0.08	2.97
30th	0.02	1.44		0.74	0.02	0.45		1.09	0.12	0.05		0.02	0.01	3.96
Aug. 6th	0.01	0.59		1.23		0.18	0.02	0.95	0.09	0.08		0.02	0.03	3.21
13th	0.05	0.43		1.83		0.24		1.50	0.16	0.03		0.01	0.01	4.26
20th	0.05	0.47	0.01	2.08	0.01	0.35	0.02	1.38	0.27	0.02			0.09	4.75
27th	0.05	0.66	0.01	2.63		0.60	0.01	1.60	0.33	0.07			0.29	6.27
Sept. 3rd	0.08	0.63		1.49	0.01	0.55		1.04	0.22	0.04		0.01	0.02	4.10
10th	0.08	0.26		2.79		0.50		0.22	0.17	0.01				4.03
17th	0.02	0.16		1.55	0.03	0.77	0.03	0.28	0.18	0.02			0.02	3.07
26th	0.02	0.15		0.76	0.03	0.56	0.05	0.19	0.11	0.03				1.93
Oct. 1st	0.06	0.15		0.21	0.03	0.67		0.07	0.08	0.03			0.01	1.33
8th	0.01	0.07		0.14		0.28		0.05	0.06				0.02	0.65
15th	0.05	0.03		0.03	0.01	0.60		0.13	0.03	0.03		0.01		0.93
22nd	0.02	0.07	0.05	0.02	0.04	0.68		0.34	0.09	0.03		0.01	0.01	1.35
29th	0.05	0.11	0.03	0.01	0.04	0.59	0.04	0.26	0.02	0.08	0.01	0.01		1.25
Nov. 5th	0.08	0.13	0.12	0.02	0.02	0.26	0.09	1.81	1.61	0.01		0.05	0.01	4.22
12th	0.08	0.45	0.16	0.02		0.22	0.06	2.61	1.87	0.13	0.01	0.06	0.01	5.69
19th	0.19	0.99	0.65	0.03	0.03	0.25	0.05	1.11	0.22	0.14	0.01	0.02	0.01	3.69
26th	0.49	1.17	0.81	0.03	0.10	0.20	0.05	1.73	0.18	0.07		0.01	0.01	4.85
Dec. 3rd	0.49	0.90	1.33	0.08	0.06	0.60	0.07	2.02	0.46	0.18	0.01	0.01	0.01	6.21
10th	0.53	0.47	0.71	0.02	0.06	0.65	0.29	1.47	0.34	0.17		0.02		4.73
17th	0.81	0.20	0.41	0.13	0.02	0.64	0.34	2.05	0.35	0.09		0.01		5.03
24th	0.97	0.28	0.47	0.40		0.38	0.37	2.42	2.27	0.08		0.02		5.65
31st	0.93	0.16	0.50	0.43	0.03	0.32	0.28	1.06	0.20	0.07		0.02	0.01	4.00
Jan. 7th	0.58	0.19	0.31	0.54	0.04	0.26	0.16	0.23	0.09	0.03		0.02	0.07	2.53

...... continued

TABLE 7.2 (continued)

Date (Week-ending)	Land Improve-ment	Land Prepn.	Planting & Sowing	Trans-planting	Fert. & Manure Appl'n	Weeding	Irrig. & Drainage	Harvesting	Crop Processing	Trans-porta-tion	Marketing	Care of Live-stock	Other	Total
	TYPE OF WORK													
Jan. 14th	0.61	0.20	0.04	0.48	0.02	0.26	0.11	0.22	0.12	0.01		0.06	0.01	2.14
21st	0.31	0.18	0.03	0.47	0.06	0.29	0.17	0.42	0.03	0.04		0.01	0.02	2.03
28th	0.34	0.26	0.04	0.49	0.18	0.14	0.14	0.55		0.01	0.01	0.01	0.04	2.23
Feb. 4th	0.19	0.32	0.03	0.55	0.13	0.09	0.07	0.75	0.02	0.01	0.01	0.01	0.01	2.21
11th	0.04	0.31	0.01	0.66	0.05	0.17	0.07	1.23	0.01	0.03	0.01	0.01	0.01	2.60
18th	0.27	0.31		0.90	0.05	0.32	0.04	1.47		0.03	0.01	0.02	0.01	3.44
25th	0.53	0.54	0.02	0.56	0.02	0.72	0.03	0.88		0.05		0.01	0.02	3.38
Mar. 4th	0.67	0.51	0.19	0.47	0.03	0.49	0.03	0.68		0.07		0.01		3.15
11th	0.59	0.41	0.37	0.37	0.01	0.50	0.01	0.52	0.02	0.02	0.01	0.01	0.11	2.95
18th	0.75	0.40	0.16	0.17	0.03	0.50	0.02	0.55	0.03	0.01		0.01	0.06	2.70
25th	0.58	0.37	0.16	0.20	0.01	0.78	0.01	0.68	0.04	0.01	0.02	0.01	0.06	2.91
Apr. 1st	0.38	0.44	0.05	0.17		0.42		1.29	0.07	0.01		0.01	0.04	2.87
8th	0.31	0.34	0.08	0.13	0.01	1.32	0.01	0.96	0.03	0.03		0.01	0.15	3.39
15th	0.28	0.17	0.03	0.05	0.01	2.71		0.42	0.01	0.02	0.02	0.01	0.10	3.82
22nd	0.24	0.26		0.08	0.04	3.46		0.04		0.01		0.01		4.13
29th	0.19	0.26	0.02	0.07	0.02	2.55		0.03				0.01		3.17
May 6th	0.10	0.20	0.09	0.06	0.01	2.43		0.13				0.01		3.04
13th	0.08	0.25	0.08	0.35	0.01	2.67		0.27	0.01	0.01				3.75
20th	0.07	0.23	0.12	0.46	0.02	2.20	0.01	0.38	0.05	0.03		0.01	0.01	3.59
27th	0.02	0.12	0.04	0.16	0.01	1.67		1.17	0.09	0.01		0.01	0.01	3.30
June 3rd	0.17	0.04	0.01	0.19		1.28		1.34	0.10	0.03		0.01	0.02	3.19
10th	0.11	0.03	0.01	0.15		0.86	0.01	1.01	0.26	0.01		0.01		2.45
17th	0.08	0.15	0.04	0.31		0.71	0.01	0.60	0.27	0.01		0.02		2.18
24th	0.08	0.19		0.61		1.14	0.02	0.42	0.23	0.01		0.01	0.01	2.71
July 1st	0.02	0.10	0.01	0.70		1.53	0.02	0.24	0.05	0.01		0.01		2.69
8th		0.07	0.02	0.20		0.87	0.01	0.23	0.04	0.01			0.01	1.47
15th		0.10		0.38	0.01	0.40		0.58	0.06	0.01				1.53
22nd	0.03	0.11		0.45		0.27	0.01	0.72	0.15	0.03			0.01	1.78
29th		0.15		0.40		0.22	0.01	0.26	0.22	0.02		0.01	0.01	1.31
Aug. 5th		0.08		0.47		0.13		0.65	0.28	0.01		0.01		1.64
12th		0.03		0.13		0.05		0.99	0.20			0.01	0.01	1.42
19th		0.01		0.06		0.05		0.22	0.38				0.04	0.75
26th								0.10	0.43				0.02	0.55
Sept. 2nd								0.03	0.07					0.11
TOTAL	13.36	19.14	7.29	29.90	1.49	44.60	2.85	47.57	11.05	2.13	0.17	0.70	1.95	182.19

TABLE 7.3: WEEKLY EMPLOYMENT OF CASUAL LABOUR BY TYPE OF WORK, 1978-79 (Mean No. of Man-days Hired per Farm - Rangpur)

Date (Week-ending)	Land Improvement	Land Prepn.	Planting & Sowing	Trans-planting	Fert. & Manure Appl'n	Weeding	Irrig. & Drainage	Harvesting	Crop Processing	Transportation	Marketing	Care of Live-stock	Other	Total
	TYPE OF WORK													
July 2nd	0.03	0.32		0.32	0.12	0.90	0.08	0.33				0.03		2.14
9th	0.04	1.04	0.01	2.86	0.17	1.90	0.18	0.36		0.06		0.04		6.66
16th	0.06	0.58	0.06	1.51	0.15	1.24	0.06	0.43	0.36	0.55				4.98
23rd	0.06	0.41	0.12	1.64	0.06	1.50		0.90	0.22	0.03		0.02	0.17	5.13
30th	0.11	0.39	0.02	1.71	0.06	1.19	0.01	0.67	0.47	0.06				4.69
Aug. 6th		0.71		2.12	0.03	1.19		0.75	0.40	0.25		0.03		5.49
13th	0.17	0.57		3.08		1.11	0.03	2.29	0.56		0.01			7.81
20th	0.24	0.54	0.03	2.97	0.03	0.92	0.14	1.47	0.69	0.08				7.11
27th	0.16	0.34		1.93		2.06	0.06	0.96	1.10	0.37	0.03			6.99
Sept. 3rd	0.07	0.43		0.76	0.10	1.74		0.49	0.26	0.28	0.01	0.01	0.03	4.18
10th	0.03	0.41		0.60		1.77		0.22	0.13		0.01		0.03	3.22
17th		0.04		0.02	0.03	2.07		0.22	0.35	0.15			0.11	2.99
24th		0.21		0.31	0.03	0.72		0.06	0.29	0.11			0.03	1.75
Oct. 1st	0.07	0.14				2.75		0.22	0.64	0.15			0.03	4.00
8th	0.03	0.01				0.78		0.04	0.43	0.01			0.11	1.42
15th	0.36	0.12		0.11	0.06	2.06		0.17	0.31	0.17				3.35
22nd	0.08	0.37	0.04		0.22	0.22		0.01	0.75	0.24			0.04	1.98
29th	0.29	0.31		0.08	0.14	0.75		0.33	0.17	0.79				2.86
Nov. 5th	0.39	0.32	0.78	0.14	0.14	0.06		0.44	0.17	0.11		0.39		2.93
12th	0.36	0.10	0.42	0.11		0.83		1.56	0.11	0.06		0.44	0.08	4.08
19th	0.11	0.10	0.42	0.11		0.14		2.14	0.21			0.11		3.34
26th	0.11	0.01	0.11	0.11		0.50		3.52	0.50	0.22			0.03	5.12
Dec. 3rd	0.11	0.05				0.64	0.06	6.03	0.90	0.48				8.28
10th		0.06	0.25			0.03		4.00	1.39	0.58		0.11	0.01	6.43
17th			0.22	0.03		0.14		5.86	0.44	0.14				6.83
24th	0.11	0.14		0.11		0.06	0.17	4.64	0.28	0.17				5.67
31st	0.53	0.22	0.06	0.42		0.14	0.14	1.81	0.76	0.44				4.51
Jan. 7th	0.19	0.40	0.22	0.11	0.11	0.11	0.04	1.79	0.33	0.21		0.03		3.56
14th	0.11	0.24		0.76	0.08	0.04	0.14	0.69	0.82	0.08			0.11	3.08
21st	0.11	0.07		0.53			0.26	0.76	0.17	0.17			0.03	2.10
28th	0.12	0.24		0.43		0.11	0.36	0.90		0.14	0.08		0.06	2.45
Feb. 4th	0.21	0.35		0.31		0.03	0.36	0.67		0.08				2.01
11th	0.08	0.25		0.14		0.17	0.25	0.18		0.26				1.33

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TABLE 7.3 (continued)

Date (Week-Ending)	TYPE OF WORK: Land Improvement	Land Prepn.	Planting & Sowing	Trans-planting	Fert. & Manure Appl'n	Weeding	Irrig. & Drainage	Harvesting	Crop Processing	Trans-portation	Marketing	Care of Live-stock	Other	Total
Feb. 18th	0.17	0.38		0.08		0.17	0.06	1.01		0.15	0.06			2.08
25th	0.83	0.32		0.36		0.32	0.22	0.44	0.02	0.18			0.03	2.73
Mar. 4th	0.42	0.29		0.75			0.12	0.92						2.50
11th	0.53	0.37		0.94		0.33	0.04	0.42		0.17				2.81
18th	0.19	0.36		0.92	0.19	0.42	0.01	0.28	0.08	0.11				2.57
25th	0.25	0.47		0.53		0.81		0.28	0.08	0.06				2.47
Apr. 1st	0.17	0.45		0.25		0.39		0.15	0.08	0.06			0.06	1.60
8th	0.72	0.07		0.19		0.14	0.11	0.03					0.03	1.30
15th	0.33	0.07				1.47		0.06		0.19	0.17			1.29
22nd	0.06	0.19		0.56		0.56		0.19		0.06				1.61
29th	0.17	0.19		0.11	0.03			0.06						0.55
May 6th	0.22	0.42	0.03			0.53								1.20
13th		1.08	0,01	0.31		0.78				0.08				2.25
20th	0.14	0.54		0.25		1.03		0.22	0.25	0.28				2.71
27th		0.20				2.79		1.06	0.11					4.15
June 3rd		0.01	0.01			2.86		0.89	0.22	0.14				4.12
10th						2.61		0.50	0.44					3.56
17th	0.42	0.06		0.11		1.96			0.08					2.63
24th	0.56	0.03		0.22		4.39			0.03	0.06				5.28
July 1st	0.08	0.11		1.00		1.86		0.17						3.22
8th		0.03			0.03	0.42		0.17		0.08				0.72
15th		0.14		0.72	0.03	0.06		0.96	0.22	0.08				2.20
22nd	0.11	0.16		1.47	0.04	0.33		0.78	0.08	0.08				3.06
29th		0.28		1.62	0.01	0.06	0.10	0.60	0.11	0.06		0.06		2.89
Aug. 5th	0.03	0.28		0.92				0.14	0.10	0.06		0.11		1.62
TOTAL	9.74	16.01	2.81	34.65	1.84	51.11	3.00	54.24	15.15	8.33	0.37	1.38	0.97	199.60

TABLE 7.4: WEEKLY EMPLOYMENT OF CASUAL LABOUR BY THE TYPE OF WORK, 1978-79 (Mean No. of Man-days Hired per Farm - Bogra)

Date (Week-Ending)	TYPE OF WORK													
	Land Improvement	Land Prep'n	Planting & Sowing	Trans-planting	Fert. & Manure Appl'n	Weeding	Irrig. & Drainage	Harvesting	Crop Processing	Trans-portation	Marketing	Care of Live-stock	Other	Total
June 25th		0.25		0.03										0.28
July 2nd	0.14	0.06	0.06			0.53		0.17	0.06				0.01	1.01
9th	0.31	0.08		0.03		0.43		0.53	0.06					1.43
16th	0.28	0.12		0.14		0.26		0.78	0.25	0.03			0.06	1.92
23rd	0.14	0.11	0.11	0.19		0.03		1.37	0.31	0.11				2.37
30th	0.07	0.01		0.01		0.07		0.56	0.33	0.11			0.03	1.19
Aug. 6th		0.22		0.11				1.07	0.42	0.07	0.01		0.03	1.93
13th		0.26		0.14				0.99	0.44	0.11				1.95
20th	0.06	0.60	0.08	1.10			0.08	0.51	0.90					3.32
27th		1.31		1.90				0.25	0.83	0.03				4.32
Sept. 3rd	0.03	0.36	0.01	2.03		0.11		0.17	0.79	0.08				3.58
10th		0.01		0.46					0.06					0.53
17th	0.19	0.14		0.22			0.03		0.47	0.03				1.08
24th	0.09	0.57		0.44	0.03	0.14			0.06	0.22				1.54
Oct. 1st	0.49	0.93		0.12		0.26			0.03	0.17			0.06	2.06
8th	0.11	0.31	0.03			0.64		0.06	0.14	0.03	0.01		0.06	1.37
15th	0.06	0.17		0.08		2.08			0.03	0.06	0.04			2.51
22nd	0.08	0.03	0.44	0.06		5.32		0.08	0.03		0.04	0.03		6.11
29th	0.22	0.19	0.14	0.03		4.26	0.42	0.22		0.03	0.06	0.04		5.61
Nov. 5th	0.14	0.17	0.17	0.03		1.60	0.79				0.04	0.03		2.96
12th	0.11	0.03		0.06		0.69	0.01	0.17			0.10			1.17
19th	0.03	0.15	0.11	0.08		1.47	0.25	0.58			0.06	0.01		2.75
26th	0.31	0.26	0.08			0.90	0.53	0.92		0.03	0.01		0.11	3.15
Dec. 3rd	0.07	0.15			0.08	1.18	0.47	2.24	0.17	0.08				4.44
10th	0.26	0.67	0.04		0.03	0.50	0.25	2.47	0.17	0.08				4.47
17th	0.10	0.56	0.20		0.10	0.11		1.96	0.32	0.14				3.49
24th	0.06	0.29	0.03		0.04	0.94	0.14	0.93	0.07	0.08				2.58
31st	0.14	0.22	0.06			0.93	0.53	0.53	0.25	0.19			0.06	2.90
Jan. 7th	0.14	0.12		0.19		0.89	0.50		0.08	0.06			0.19	2.18
14th	1.11	0.07	0.01	0.28		0.75	0.72							2.94
21st	1.25	0.46		0.19	0.11	0.96	0.75	0.22				0.01		3.96
28th	0.89	0.39	0.11	0.19	0.07	0.58	0.76				0.04	0.03		3.07
Feb. 4th	1.01	0.51	0.01	0.54			0.29	0.28			0.07	0.04	0.03	2.79

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TABLE 7.4. (continued)

Date (Week-Ending)	Land Improve-ment	Land Prep'n	Planting & Sowing	Trans-planting	Fert. & Manure Appl'n	Weeding	Irrig. & Drainage	Harvesting	Crop Processing	Trans-porta-tion	Marketing	Care of Live-stock	Other	Total
	TYPE OF WORK													
Feb. 11th	0.17	0.32		1.10			0.40	0.28			0.07	0.08	0.06	2.47
18th	0.12	0.37	0.03	0.49		0.03	0.25	0.25			0.06	0.07	0.06	1.72
25th	0.19	0.23	0.06	0.43		0.11		0.44			0.04			1.51
Mar. 4th	0.22	0.74	0.01	0.21	0.07	0.03	0.12	0.06			0.01			1.47
11th	0.11	0.56	0.03	0.08	0.36	0.08	0.38							1.63
18th	0.25	0.37	0.04	0.14	0.08	0.67		0.28	0.03				0.03	1.89
25th	0.56	0.19	0.03	0.14	0.08	0.50		0.21					0.03	1.74
Apr. 1st	0.25	0.33			0.01	0.42		0.79	0.01				0.08	1.90
8th	0.33	0.19			0.08	0.92		0.37	0.03				0.08	2.01
15th	0.26	0.04			0.08	1.50		0.06					0.06	2.00
22nd	0.69	0.59			0.19	0.71							0.03	2.22
29th	0.22	0.97	0.12			0.89		0.06						2.26
May 6th	0.06	0.22	0.03		0.03	1.83		0.07						2.24
13th	0.64	0.03				4.40								5.07
20th	0.44	0.67			0.25	2.92		0.53					0.06	4.86
27th	0.25	0.51	0.01		0.06	2.69		0.63	0.03					4.18
June 3rd	1.08	0.06		0.33		1.42		0.11						3.00
10th	0.81	0.03	0.06			0.42	0.03	0.06						1.39
17th	0.33	0.33	0.03	0.54		0.24	0.03							1.50
24th	0.21	0.50	0.01	1.23		1.23	0.07				0.01		0.07	3.33
July 1st	0.11	0.22	0.11	0.43		1.71	0.15							2.74
8th	0.03	0.08	0.01	0.07		1.03								1.22
15th						0.71								0.71
22nd	0.08	0.10	0.01	0.11		0.67		0.31	0.17				0.08	1.53
29th	0.03	0.06		0.46		0.39		0.06	0.17				0.03	1.18
Aug. 5th						0.03			0.06					0.08
TOTAL	15.32	17.51	2.31	14.40	1.49	51.45	7.67	21.97	6.72	1.73	0.68	0.35	1.28	142.88

TABLE 7.5: WEEKLY EMPLOYMENT OF CASUAL LABOUR BY THE TYPE OF WORK, 1978-79 (Mean No. of Man-days Hired per Farm - Dacca)

Date (Week-Ending)	TYPE OF WORK: Land Improvement	Land Prep'n	Planting & Sowing	Trans-planting	Fert. & Manure Appl'n	Weeding	Irrig. & Drainage	Harvesting	Crop Processing	Trans-portation	Marketing	Care of Live-stock	Other	Total
June 4th												0.01		0.01
11th		0.05		0.49		0.17								0.71
18th		0.20		0.87		0.91	0.01	0.08	0.08					2.16
25th	0.03	0.08		0.17		1.21	0.01	0.28	0.15			0.01	0.01	1.95
July 2nd	0.04	0.13	0.10	0.37	0.02	1.96		0.38		0.01	0.03	0.01		3.05
9th	0.01	0.26		0.78	0.12	0.75		0.05	0.01	0.01				2.00
16th		0.23	0.04	1.01	0.21	0.49		0.17	0.02					2.17
23rd	0.02	0.18	0.04	0.44		0.31		0.15	0.06					1.20
30th		0.12	0.01	1.48	0.07	0.30		0.36	0.20	0.01			0.01	2.57
Aug. 6th	0.01	0.19		0.63		0.10	0.02	0.76		0.21			0.03	1.95
13th	0.12	0.33		0.73		0.53		1.06	0.29	0.01		0.01	0.01	3.11
20th		0.14		0.76	0.01	0.15		1.19	0.32					2.58
27th	0.14	0.36	0.07	0.94		0.16		2.21	0.55					4.42
Sept. 3rd		0.30		0.51		0.02		1.52	0.59			0.03		2.98
10th	0.04	0.22		1.45		0.15		0.63	0.77					3.25
17th	0.01	0.19		0.98	0.11	0.07		1.06	0.46		0.01	0.01	0.01	2.92
24th	0.03	0.19		1.17	0.12	0.32		0.82	0.37	0.01			0.01	3.04
Oct. 1st		0.15		0.50	0.12	0.37		0.26	0.07				0.03	1.50
8th		0.03		0.04		0.08		0.22	0.03					0.40
15th		0.03				0.06		0.56				0.02		0.66
22nd	0.01	0.11		0.06	0.08	0.12		1.66	0.06			0.04		2.14
29th		0.14	0.07		0.13			1.03				0.04		1.41
Nov. 5th		0.19	0.14		0.04	0.03		0.60	0.16			0.06		1.22
12th		0.02				0.19	0.01	0.48	0.09			0.06		0.85
19th		0.09		0.06				0.55	0.35			0.02		1.07
26th	0.06	0.08		0.11		0.08		1.31	0.39			0.03		2.07
Dec. 3rd	0.03	0.21		0.06				1.95	0.71			0.05	0.06	3.06
10th		0.42		0.03	0.03			1.24	0.24			0.05		2.00
17th		0.10		0.57				0.98	0.93			0.05		2.63
24th	0.06	0.40	0.83	1.25				1.51	0.62			0.05		4.72
31st	0.08	0.30	1.74	1.62	0.03			0.40	0.14			0.06		4.36
Jan. 7th	0.08	0.55	1.29	1.96								0.07	0.04	4.00
14th	0.01	0.45	0.11	1.31				0.17	0.03			0.05		2.12
21st	0.21	0.28		0.64	0.06	0.03						0.05	0.04	1.32

.... continued

TABLE 7.5 (continued)

Date (Week-Ending)		TYPE OF WORK: Land Improvement	Land Prep'n	Planting & Sowing	Transplanting	Fert. & Manure Appl'n	Weeding	Irrig. & Drainage	Harvesting	Crop Processing	Transportation	Marketing	Care of Live-stock	Other	Total
Jan.	28th	0.03	0.12		0.28	0.17	0.17						0.05		0.83
Feb.	4th	0.10	0.19		0.19	0.25	0.25						0.05		1.03
	11th	0.01	0.13	0.03	0.29	0.09	0.17			0.01			0.03		0.77
	18th	0.54	0.37		0.83	0.15	0.83						0.05		2.77
	25th	1.61	1.28		0.42		0.33						0.05		3.69
Mar.	4th	2.39	0.89		0.64		0.01						0.05		3.98
	11th	1.74	0.82				0.06		0.21				0.05		2.87
	18th	1.40	0.93				0.14		1.36				0.05		3.88
	25th	1.10	0.76			0.01	1.09		2.35	0.10			0.05		5.47
Apr.	1st	0.92	0.85						4.55	0.30			0.05	0.10	6.76
	8th	0.87	0.60						3.22	0.12			0.05	0.62	5.48
	15th	0.76	0.48	0.01	0.01				1.04				0.04	0.49	2.84
	22nd	0.61	0.79			0.09	0.22						0.04		1.76
	29th	0.75	0.59	0.01	0.15	0.05							0.06		1.60
May	6th	0.33	0.59		0.28	0.04	0.22						0.03		1.50
	13th		0.60		1.41	0.01	0.33	0.01	0.03	0.03			0.01		2.45
	20th	0.01	0.38		2.06		0.10	0.05	0.24	0.03			0.05		2.92
	27th		0.24		0.73			0.01	0.14	0.14			0.04		1.31
June	3rd	0.01	0.14	0.01	0.77				0.20	0.20			0.05		1.38
	10th		0.10		0.76		0.26		0.15	0.15			0.05		1.46
	17th		0.17		0.99		1.10	0.03	0.25	0.25			0.08		2.86
	24th		0.41	0.01	1.47		1.67	0.08	0.42	0.42			0.06		4.53
July	1st		0.21	0.01	2.69		2.65	0.02	0.04	0.04			0.03		5.70
	8th		0.19		0.94		1.70	0.04					0.02		2.91
	15th		0.15		1.54	0.01	0.62								2.33
	22nd	0.01	0.14		1.47		0.57	0.03	0.08						2.30
	29th		0.50		0.94		0.39		0.19	0.08			0.02		2.13
Aug.	5th		0.24		1.88		0.52	0.02	0.22	0.03			0.01		2.94
	12th	0.01	0.13		0.66		0.25		0.93	0.30			0.03	0.03	2.34
	19th		0.05		0.30		0.24		0.42	0.17			0.02		1.19
TOTAL		14.21	19.76	4.52	42.67	2.06	22.47	0.35	39.70	10.06	0.26	0.04	1.94	1.50	159.55

TABLE 7.6: WEEKLY EMPLOYMENT OF CASUAL LABOUR BY THE TYPE OF WORK, 1978-79 (Mean No. of Man-days Hired per Farm - Comilla)

Date (Week-Ending)	Land Improvement	Land Prep'n	Planting & Sowing	Transplanting	Fert. & Manure Appl'n	Weeding	Irrig. & Drainage	Harvesting	Crop Processing	Transportation	Marketing	Care of Livestock	Other	Total
	TYPE OF WORK													
July 16th					0.03									0.03
23rd	0.03	5.22		0.03		0.08		0.06		0.01		0.03	0.05	5.53
30th		6.53		0.05		1.28		0.14		0.05		0.10		8.15
Aug. 6th		1.82		0.70				0.10	0.06	0.04		0.07	0.09	2.88
13th		0.67		1.92				0.27	0.03	0.10		0.02	0.03	3.03
20th		0.71		1.50	0.01	0.12		0.35	0.06	0.09		0.01		2.82
27th	0.01	0.49		1.97	0.02	1.15	0.05	0.57	0.09	0.17			0.07	4.58
Sept. 3rd	0.19	0.85		1.02	0.01	1.38		0.36		0.03			0.01	3.86
10th	0.11	0.30		1.18		0.86		0.11	0.01	0.03				2.61
17th		0.12		0.39	0.03	0.23		0.25	0.01				0.01	1.04
24th	0.04	0.17		0.83	0.02	0.76		0.12				0.01		1.95
Oct. 1st		0.06		0.45	0.05	1.06			0.01					1.63
8th		0.04		0.61	0.01	0.53						0.01		1.20
15th	0.03			0.07	0.02	0.11				0.04		0.01		0.29
22nd		0.03				0.05		0.01	0.02	0.02			0.01	0.13
29th		0.05				0.02								0.07
Nov. 5th		0.02					0.04						0.03	0.09
12th	0.04	0.03		0.03			0.28	0.02	0.01					0.41
19th	0.05						0.10	0.23	0.03	0.02				0.44
26th								0.24	0.16	0.18				2.80
Dec. 3rd		0.02		0.01			0.04	3.27	0.73	0.55				4.62
10th		0.06	0.01		0.01		0.08	2.53	0.55	0.44		0.01		3.69
17th		0.03					0.01	2.21	0.41	0.28	0.01			2.96
24th		0.07	0.02				0.01	0.86	0.24	0.21		0.04	0.01	1.46
31st	0.01	0.08		0.01	0.01			0.02	0.07	0.02		0.02	0.02	0.26
Jan. 7th	0.05	0.02			0.01			0.01	0.01					0.09
14th		0.11			0.01		0.04	0.02		0.02				0.21
21st		0.02		0.29	0.11		0.10							0.52
28th	0.10	0.06		0.62	0.68		0.02						0.01	1.49
Feb. 4th	0.08	0.08		1.39	0.37		0.01							1.94
11th	0.03	0.30		1.94	0.16									2.43
18th	0.11	0.25		2.55	0.11		0.04	0.09				0.01		3.16
25th	0.08	0.11		1.73	0.09	0.24	0.05							2.30

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TABLE 7.6 (continued)

Date (Week-Ending)	TYPE OF WORK													
	Land Improvement	Land Prep'n	Planting & Sowing	Trans-planting	Fert. & Manure App'n	Weeding	Irrig. & Drainage	Harvesting	Crop Processing	Transportation	Marketing	Care of Live-stock	Other	Total
Mar. 4th		0.18		1.10	0.13	0.64	0.05							2.09
11th		0.12		0.79		1.08							0.02	2.00
18th		0.02		0.24		0.89	0.01							1.16
25th						0.30	0.01							0.31
Apr. 1st				0.05										0.05
8th	0.01			0.03										0.05
15th	0.22					0.10								0.32
22nd	0.10				0.01									0.11
29th				0.02	0.06	0.07								0.15
May 6th				0.03				0.03						0.06
13th	0.03	0.01		0.21	0.01	0.07		0.34	0.02					0.68
20th	0.03	0.02		0.09				0.35	0.08	0.01	0.01			0.60
27th				0.05				1.24	0.24	0.06				1.58
June 3rd		0.01						1.05	0.15	0.06				1.27
10th				0.01				1.75	0.43	0.04				2.23
17th		0.08		0.21	0.01			0.31	0.16	0.03				0.81
24th		0.12		0.37	0.01			0.02		0.02				0.54
July 1st		0.07		0.04				0.03		0.03				0.19
8th		0.10						0.01		0.01				0.12
15th		0.17						0.02		0.02				0.20
22nd		0.19						0.07	0.01	0.07				0.34
29th		0.05						0.06		0.06				0.16
Aug. 5th		0.01												0.02
TOTAL	1.34	19.46	0.04	22.54	2.01	10.99	0.95	19.33	3.57	2.71	0.05	0.35	0.36	83.68

TABLE 7.7: WEEKLY EMPLOYMENT OF CASUAL LABOUR BY THE TYPE OF WORK, 1978-79 (Mean No. of Man-days Hired per Farm - Noakhali)

Date (Week-Ending)	TYPE OF WORK													
	Land Improvement	Land Prep'n	Planting & Sowing	Trans-planting	Fert. & Manure Appl'n	Weeding	Irrig & Drainage	Harvesting	Crop Processing	Trans-portation	Marketing	Care of Live-stock	Other	Total
June 4th									0.07					0.07
11th								0.03						0.03
18th	0.28	0.14				0.11							0.28	0.81
25th	0.81	0.08				1.21	0.09						1.25	3.44
July 2nd	0.30	0.18			0.01	0.39	0.08	0.03					0.44	1.44
9th	0.44	0.25				1.03							0.17	1.89
16th	0.32	0.30				0.53		0.13		0.05			0.06	1.39
23rd	0.14	0.45		1.37		0.50	0.06	1.46	0.06			0.06	0.28	4.37
30th		0.37		1.33		0.03		4.35		0.08				6.16
Aug. 6th	0.03	0.49		3.72		0.22	0.08	2.97						7.51
13th	0.03	0.72		4.90		0.08		4.45						10.19
20th	0.08	0.93		6.13		1.00		4.37	0.19				0.44	13.13
27th	0.02	1.63		8.33		0.67		4.64	0.04				1.36	16.69
Sept. 3rd	0.18	1.59		4.51		0.44		3.01					0.06	9.80
10th	0.21	0.56		10.79		0.60		0.25						12.40
17th		0.42		6.26		2.52	0.14							9.33
24th				1.44		1.31	0.25							3.00
Oct. 1st	0.03	0.03		0.06		0.39								0.50
8th		0.11		0.06		0.09								0.26
15th					0.02	0.76								0.78
22nd						0.44								0.45
29th		0.11				0.44								0.56
Nov. 5th						0.31								0.31
12th								1.41	0.10					1.51
19th		0.04				0.31		2.83						3.19
26th		0.11				0.22		2.64	0.04					3.00
Dec. 3rd		0.56	0.11	0.19		0.64		0.76	0.32					2.58
10th		0.08				0.19		0.37	0.11					0.76
17th		0.14		0.03				3.09						3.25
24th		0.13	0.06			0.40		6.97	0.33					7.89
31st		0.07	0.46			0.01		3.73	0.28					4.55
Jan. 7th	0.07	0.10	0.15	0.26		0.15		0.26	0.24					1.25
14th		0.18	0.04	0.37		0.15			0.08					1.25
21st		0.24	0.03	0.10		0.10			0.06					0.52

......continued

TABLE 7.7 (continued)

Date (Week-Ending)	TYPE OF WORK: Land Improve-ment	Land Prep'n	Planting & Sowing	Trans-planting	Fert. & Manure Appl'n	Weeding	Irrig. & Drainage	Harvesting	Crop Processing	Trans-porta-tion	Marketing	Care of Live-stock	Other	Total
Jan. 28th		0.34		0.22		0.02								0.58
Feb. 4th		0.23				0.05	0.01							0.30
11th		0.13				0.01								0.14
18th	0.08	0.17				0.01								0.27
25th		0.43				0.03								0.46
Mar. 4th		0.32	0.92	0.04		0.14								1.42
11th	0.18	0.21	1.81	0.40		0.13								2.74
18th	0.01	0.30	0.75	0.07		0.03	0.07	0.11						1.34
25th	0.01	0.28	0.65	0.63		0.11								1.69
Apr. 1st		0.22	0.21	0.69		0.31								1.44
8th		0.07	0.24	0.53		0.08								0.91
15th		0.01	0.11	0.21		0.79								1.13
22nd				0.10		2.37								2.47
29th		0.06		0.11		0.92								1.09
May 6th						1.56		0.06			0.01			1.63
13th						2.57		0.04						2.62
20th						0.92		0.34					0.04	1.29
27th						0.97		0.58						1.55
June 4th						1.15		0.11						1.26
11th	0.14	0.01				0.84		0.01						1.00
18th		0.33				0.03		0.08						0.44
25th		0.06		0.46		0.12		0.03						0.66
July 2nd		0.01		0.04		0.07		0.01						0.14
9th		0.03				0.19								0.22
16th		0.08				0.22								0.30
23rd	0.01	0.01				0.15								0.18
30th		0.04				0.19								0.23
Aug. 6th		0.02				0.03		0.12						0.18
13th								0.42						0.42
TOTAL	3.40	13.36	5.54	53.36	0.04	29.30	0.78	49.75	1.92	0.15	0.01	0.06	4.37	162.02

TABLE 7.8: WEEKLY EMPLOYMENT OF CASUAL LABOUR BY THE TYPE OF WORK, 1978-79 (Mean No. of Man-days Hired per Farm - Munshiganj)

Date (Week-Ending)	TYPE OF WORK: Land Improvement	Land Prep'n	Planting & Sowing	Transplanting	Fert. & Manure Appl'n	Weeding	Irrig. & Drainage	Harvesting	Crop Processing	Transportation	Marketing	Care of Livestock	Other	Total
Nov. 5th	0.14	0.20				0.13		8.25	7.82	0.01				16.55
12th	0.14	2.14	0.60		0.01	0.15		10.28	9.10	0.62				23.06
19th	0.81	4.72	2.98		0.17	0.14	0.02	0.56	0.61	0.69			0.06	10.73
26th	2.17	5.51	3.96		0.48	0.01			0.06	0.06				12.26
Dec. 3rd	2.33	3.59	6.55	0.13	0.27	1.44	0.04			0.07	0.03			14.45
10th	2.54	1.44	3.37	0.06	2.77	1.23			0.01	0.06				11.75
17th	3.99	0.43	1.82	0.02	0.04	3.06	1.70	0.07	0.03	0.01				11.17
24th	4.69	0.55	1.42	0.67		0.99	1.69			0.06				10.07
31st	4.21	0.12	0.23	0.33	0.09	1.03	1.08					0.01		7.11
Jan. 7th	2.55			0.35	0.13	0.65	0.53			0.03			0.22	4.46
14th	2.43	0.09	0.06	0.22	0.07	0.73	0.08	0.54	0.10			0.25		4.56
21st	0.65	0.09	0.14	0.97	0.06	0.83	0.25	1.62		0.11			0.05	4.77
28th	1.06	0.48	0.13	1.04	0.02	0.15	0.11	2.32	0.01				0.16	5.49
Feb. 4th	0.19	0.67	0.14	0.77	0.03	0.15		3.27	0.11				0.03	5.37
11th	0.06	0.69	0.01	0.44		0.58		5.90	0.04				0.01	7.73
18th	0.49	0.39		0.83		0.65		6.66		0.06			0.03	9.11
25th	0.46	0.63	0.06	0.25		2.79		3.94		0.14			0.07	8.34
Mar. 4th	0.62	0.64		0.11		1.62		2.91		0.37				6.27
11th	0.69	0.46	0.01	0.15		0.91	0.01	1.99	0.08	0.04	0.07		0.51	4.91
18th	2.13	0.40	0.01		0.02	0.92	0.03	1.02	0.10				0.28	4.89
25th	1.36	0.47	0.11	0.03		1.75	0.02	0.79	0.06		0.11		0.30	5.00
Apr. 1st	0.76	0.72	0.02			1.41	0.01	1.41	0.02				0.02	4.37
8th	0.16	0.91	0.17			5.97		1.41		0.17		0.02	0.08	8.88
15th	0.13	0.30	0.05			11.66		0.98	0.03					13.15
22nd	0.10	0.10	0.01			14.08		0.11						14.40
29th	0.02	0.08	0.04			11.34		0.11						11.59
May 6th	0.05	0.09	0.40			9.17		0.54	0.01				0.02	10.28
13th	0.07	0.08	0.42		0.03	7.80		0.94						9.35
20th		0.13	0.61	0.03		8.00		0.58						9.35
27th			0.18			4.64		3.04					0.03	7.89
June 3rd	0.30		0.03			3.12		4.85	0.06				0.10	8.46
10th						1.67	0.01	2.85	0.52					5.06

...... continued

TABLE 7.8 (continued)

Date (Week-Ending)	Land Improvement	Land Prep'n	Planting & Sowing	Trans-planting	Fert. & Manure Appl'n	Weeding	Irrig. & Drainage	Harvesting	Crop Processing	Trans-portation	Marketing	Care of Live-stock	Other	Total
	TYPE OF WORK													
June 17th			0.17			1.31		2.35	0.90					4.73
24th		0.80				1.08		1.62	0.74					3.52
July 1st		0.06				3.13		1.02	0.22					4.43
8th			0.08			1.73		1.05	0.22				0.06	3.14
15th		0.01				0.79		2.39	0.17					3.37
22nd	0.01	0.07				0.11		2.92	0.64	0.02				3.78
29th						0.32		0.75	0.89				0.03	1.98
Aug. 5th						0.09		2.81	1.30					4.20
12th		0.02				0.02		3.61	0.69				0.01	4.35
19th								0.65	1.72				0.21	2.58
26th								0.49	2.15				0.11	2.75
Sept. 2nd								0.17	0.35				0.01	0.53
TOTAL	35.30	26.38	23.77	6.40	1.67	108.94	6.84	90.96	28.77	2.52	0.21	0.28	2.41	334.46

Notes on Tables 7.2 to 7.8

The type of work described by the farmers ran to 543 different categories in total, which clearly had to be reduced to more management proportions! The main activity categories used as headings in the tables subsume the following:

FARM IMPROVEMENT: Permanent or semi-permanent alternations to the farm's land and buildings. These activities are mainly concerned with the building construction and maintenance of bunds, hedges, fences, ponds, drains and boundaries; making and repairing of stores and buildings; moving earth around for purposes of field heightening and levelling.

LAND PREPARATION: Ploughing, harrowing ('laddering'), puddling and planking; clearing the land of of crop residues (esp. b. aman straw).

PLANTING & SOWING and TRANSPLANTING: These two activities were separated in order to demonstrate the employment implications of transplanting paddy relative to broadcasting it and other crops. With other crops, particularly vegetables (notably potato), the distinction between the two categories is somewhat blurred. Some crops, other than paddy may be either direct seeded or transplanted (e.g. onion).

FERTILISER and MANURE APPLICATION: Includes compost making, mulching and the application of pesticides.

WEEDING: Nearly always exactly that, usually by hand but occasionally by animal-drawn hoe ('asra'): also includes thinning, intertillage and hoeing up the earth around plants.

IRRIGATION & DRAINAGE: Includes operating manual irrigation devices; carrying water to the fields; opening up and closing off irrigation and drain ditches.

HARVESTING: Essentially reaping, picking fruit vegetables and pan and digging up rootcrops; also includes baling food grains and jute; (also recovering grain from rodents' burrows).

CROP PROCESSING: In the case of food grains pulses and oilseeds includes threshing, winnowing, drying, milling, etc; in the case of jute retting and decorticating.

TRANSPORTATION: Both within and off the farm; both porterage and carting.

OTHERS: Includes non-agricultural work on the farm and unspecified tasks.

The Survey in Munshiganj was launched several months later than elsewhere (see Chapter 1). In all districts the figures for the first and last weeks are incomplete because of missing observations as the regular data collection programme was phased in (out). The employment data include tractor drivers and power tiller operators, since these workers are employed along with the machine. Similarly the ploughman is also included when he is hired as part of a ploughing team.

Column totals may sometimes be slightly larger than the sum of the weekly observations since the former sometimes include data that cannot be assigned to specific weeks.

There are two basic reasons for the very large difference between the figures for Munshiganj and those for other areas. First, the area is traditionally one of high seasonal employment opportunity and large camps of migratory labourers can be seen there at peak employment periods, particularly in the rabi season. Second, the figures for Munshiganj are probably more representative of a 'normal' year than those of the other areas, where drought undoubtedly caused a sharp reduction in agricultural activity and therefore labour demand. Munshiganj, which is a fairly wet area at all times, was not seriously affected by drought.

The cycle of farming operations is quite clearly reflected in Tables 7.3 to 7.8. Again taking Munshiganj, where the figures are most 'typical', the figures show first the peak in employment for harvesting and processing the b. aman crop in early November. This is quickly followed by another peak as the land is prepared for and sown to rabi crops. The first major period for weeding and the annual peak period in irrigation are in turn followed by the rabi harvest which produces an employment peak in mid-February. The period of greatest demand for any single operation occurs in weeding the mixed aus-aman and jute crops, and the series ends with the harvesting and processing of aus and jute.

Comparison of farm operations with respect to the employment opportunities they provide, is an invaluable guide when prognosticating the impact of mechanisation on employment opportunities. Table 7.9 summarises the relative importance of different types of employment from this viewpoint. Clearly the operations which create the greatest demand for labour are harvesting, weeding and transplanting, which among them provide about two-thirds of all casual employment. Land preparation is generally placed about fourth, with about ten per cent of employment overall, but in Comilla where land preparation is evidently an important constraint, this operation provides almost a quarter of all casual employment. This distinction is certainly in keeping with the fact that the Comilla area is one with a high proportion of heavy clayey soils which are difficult to work.

The final column of Tables 7.3 to 7.8 show how the interaction of a pattern of highly peaked seasonal labour demand for various tasks can produce a much smoother overall employment curve. The importance of a fairly steady source of employment and income is obvious, yet mechanisation of any part of the cycle, to the extent that it reduces employment opportunities in that and related tasks will exaggerate the amplitude of the employment cycle, even - indeed especially - if it creates offsetting employment opportunities at other points in the farming year. This important consideration will be taken up in some detail in Chapter 9.

TABLE 7.9: RELATIVE IMPORTANCE OF FARM OPERATIONS FOR CASUAL EMPLOYMENT

		Land Improvement	Land Prep'n	Planting & Sowing	Transplanting	Fert. & Manure Appl'n	Weeding	Irrig. & Drainage	Harvesting	Crop Processing	Transporting	Marketing	Animal Care
ALL AREAS	Rank Order	5	4	7	3	10	2	8	1	6	9	12	11
	%	7.3	10.4	4.0	16.4	0.8	24.5	1.6	26.1	6.1	1.2	0.1	0.4
RANGPUR	Rank Order	6	4	9	3	10	2	8	1	5	7	12	11
	%	4.9	7.9	1.4	17.4	0.9	25.6	1.5	27.2	7.6	4.2	0.2	0.7
BOGRA	Rank Order	4	3	8	5	10	1	6	2	7	9	11	12
	%	10.7	12.3	1.6	10.1	1.0	36.0	5.4	15.4	4.7	1.2	0.5	0.2
DACCA	Rank Order	5	4	7	1	8	3	10	2	6	11	12	9
	%	8.9	12.3	2.8	26.8	1.3	14.1	0.2	24.9	6.3	0.2	-	1.2
COMILLA	Rank Order	8	2	12	1	7	4	9	3	5	6	11	10
	%	1.6	23.2	-	27.0	2.4	13.1	1.1	23.1	4.3	3.2	0.1	0.4
NOAKHALI	Rank Order	6	4	5	1	11	3	8	2	7	9	12	10
	%	2.1	8.2	3.4	32.9	-	18.1	0.5	30.7	1.2	0.1	-	-
MUNSHIGANJ	Rank Order	3	5	6	8	10	1	7	2	4	9	12	11
	%	10.6	7.7	7.1	1.9	0.5	32.6	2.0	27.2	8.6	0.8	0.1	0.1

Notes: Percentages and Rank Orders are derived from the last row of Tables 7.2 to 7.8 respectively
- = negligible percentage (less than 0.05%)

7.2. CASUAL EMPLOYMENT BY TYPE OF CROP

In so far as different crop enterprises differ in their labour requirements, a programme of mechanisation which induces a change in cropping patterns may by this reason alone tend to induce corresponding changes in the pattern of employment. It is therefore necessary to investigate the inputs of paid labour associated with different crops. The position is summarised in Table 7.10, which shows for each crop type first the proportion of net cropped area and second the proportion of total paid casual labour (measured in man-equivalent days), which is devoted to it. Since these figures include zero observations, they also provide a useful guide to the relative acreages of the various crop types across the sample as a whole and in the individual sample areas. Comparing these figures with those on labour distribution it appears that some crops do indeed provide a disproportionate share of casual employment opportunity.

Since the two variables in Table 7.10 have been reduced to a common unit of measurement, it is possible to pair them with respect to each farm so as to produce a 'self paired' sample. A t-test can then be used to test the significance of the observed differences in means. Since both relatively low and relatively high 'employment intensity' is of interest in this analysis, a 'two-tailed' test of significance is appropriate. The results of this analysis are presented in Tables 7.11 to 7.17.

Taking the sample as a whole, roughly half of the cases produce significant results. The most important of the relatively labour intensive crops is HYV paddy, followed by potato. Traditional crops, especially those grown for subsistence, tend to provide few employment opportunities for casual labour, as can be seen in the cases of traditional varieties of paddy together with pulses and oilseeds. An exception is mixed <u>aus-aman</u> which as is shown in Tables 7.8 and 7.17 receives relatively high inputs of hired labour at least where it is most common (in the sample), Munshiganj.

In other areas the case of paddy is beset by an unfortunate problem of nomenclature which tends to obscure the traditional-HYV contrast with respect to labour intensity. Many farmers tend to use the old names for HYV paddy grown in a particular season, so that, for example, IRRI varieties grown in <u>aus</u> will sometimes be referred to simply as '<u>aus</u>'. The relative degree of labour intensity of HYV paddy is probably therefore higher than that indicated in the tables. This relative labour intensity comparing HYV with traditional varieties of paddy is hardly surprising in view of the higher yields of the former. Moreover if the switch entails a change from broadcasting to transplanting, as is generally the case in <u>aus</u>, labour demands will increase correspondingly.

The case of potato is an especially interesting one from the present viewpoint, since as was shown in Chapter 5, it is one crop which can be positively and unequivocally associated with mechanised land preparation. In both areas, Dacca and Munshiganj, where potato is grown as a commercial rather than subsistence crop, the

TABLE 7.10: DISTRIBUTION OF LAND AND CASUAL LABOUR AMONG CROP TYPES (Percentages)

CROP TYPE	ALL AREAS		RANGPUR		BOGRA		DACCA		COMILLA		NOAKHALI		MUNSHIGANJ	
	Net Cropped Area	Casual Labour	Net Cropped Area	Casual Labour	Net Cropped Area	Casual Labour	Net Cropped Area	Casual Labour	Net Cropped Area	Casual Labour	Net Cropped Area	Casual Labour	Net Cropped Area	Casual Labour
Paddy Aman	28.9	23.3	29.3	26.1	31.2	22.9	16.2	19.9	41.1	39.3	55.5	51.9	-	-
Aus	9.9	6.5	19.0	15.0	4.9	14.4	14.6	11.3	2.2	1.2	18.2	10.9	-	-
HYV	23.8	27.2	24.1	33.0	10.9	11.6	34.5	39.3	51.9	54.0	13.9	19.3	1.2	0.9
Boro	0.5	2.8	0.1	0.5	2.5	1.4	0.3	0.6	-	-	-	-	0.7	0.4
Wheat	4.6	1.4	0.5	0.1	20.2	6.8	7.4	1.6	-	-	-	-	5.4	2.2
Millet	0.4	0.2	-	-	1.2	0.2	0.2	-	-	-	-	-	1.2	0.8
Other Cereals	-	-	-	-	-	-	0.2	0.1	-	0.1	-	-	-	-
Pulses	1.5	0.3	6.0	0.8	1.4	0.2	3.0	0.3	0.2	-	0.5	0.7	-	-
Mustard	4.3	1.9	7.0	3.6	1.1	-	0.2	0.1	0.1	-	-	-	17.1	7.6
Other Oilseeds	1.3	0.9	0.1	0.1	-	-	1.8	1.5	0.6	-	0.3	1.5	3.8	1.3
Potato	5.1	6.1	0.6	0.6	2.4	1.7	13.3	14.6	-	-	0.1	-	10.6	14.8
Other Rootcrops	0.7	0.9	0.3	0.6	2.9	2.5	0.1	-	-	0.2	0.1	-	1.7	2.6
Other Vegetables	0.8	0.4	0.4	0.6	-	1.0	2.8	0.8	0.5	0.1	-	-	0.2	0.3
Spices	2.8	3.6	1.0	3.1	8.3	14.6	0.1	0.6	-	-	2.9	2.0	6.4	6.9
Jute	9.7	8.7	4.9	6.9	13.1	16.9	5.1	4.5	-	-	0.1	0.1	34.3	27.1
Other Indus. Crops	0.7	1.2	6.7	9.6	-	-	-	0.1	-	0.1	-	0.2	0.2	0.7
Mixed Rabi Crops	-	0.2	-	-	-	-	-	-	-	-	-	-	0.1	0.7
Mixed Aus-Aman	3.2	12.0	-	-	-	-	-	0.1	2.4	3.1	-	0.9	17.0	31.4
Others/ Not Stated[a]	1.8	2.4	-	0.3	-	0.4	-	0.6	0.3	0.4	8.4	9.7	0.1	0.8

(Notes appear after Table 7.17)

TABLE 7.11: SIGNIFICANCE TESTS ON LAND AND CASUAL LABOUR DISTRIBUTION AMONG CROP TYPES (All Areas)

Crop Type	Net Cropped Area : Mean (Std.error)	Casual Labour : Mean (Std.error)	No. of Pairs	Correlation Coefficient (Probability)	T-Test : T Value (Probability)
Paddy Aman	32.8 (1.37)	34.8 (1.41)	328	0.525 (.001)	1.46 (.146)
Paddy Aus	17.2 (1.08)	13.2 (0.99)	243	0.135 (0.35)	-2.93 (.004)
Paddy HYV	32.7 (1.53)	32.3 (1.64)	262	0.658(.001)	3.52 (.001)
Paddy Boro	5.41(1.43)	4.41(1.42)	31	0.411 (.022)	-0.64 (.524)
Wheat	12.93(1.08)	4.04(0.50)	129	0.198 (.025)	-8.09 (.001)
Millet	4.07(0.55)	1.96(0.52)	35	0.272 (.114)	-3.29 (.002)
Other Cereals	3.44(1.63)	2.09(1.23)	4	0.321 (.679)	-0.79 (.486)
Pulses	7.30(0.77)	1.54(0.40)	74	0.045 (.705)	-6.79 (.001)
Mustard	15.81(1.10)	7.02(0.71)	98	0.626 (.001)	-9.42 (.001)
Other Oilseeds	5.45(0.66)	3.61(1.20)	88	-0.083 (.441)	-1.30 (.197)
Potato	15.08(1.42)	18.07(1.66)	122	0.686 (.001)	2.41 (.018)
Other Rootcrops	3.51(0.48)	4.22(0.75)	73	0.409 (.001)	1.01 (.315)
Other Vegetables	4.58(1.06)	2.34(0.46)	59	-0.076 (.570)	-1.89 (.063)
Spices	7.01(0.69)	8.94(1.01)	144	0.471 (.001)	2.11 (.037)
Jute	20.32(1.51)	18.22(1.44)	172	0.558 (.001)	-1.15 (.132)
Other Industrial Crops	6.83(1.71)	11.51(2.37)	37	0.865 (.001)	3.78 (.001)
Mixed Rabi Crops	0.29(0.28)	3.02(0.59)	18	0.244 (.329)	4.66 (.001)
Mixed Aus-Aman	2.89(0.83)	7.53(1.16)	59	0.312 (0.16)	3.87 (.001)

TABLE 7.12: SIGNIFICANCE TESTS ON LAND AND CASUAL LABOUR DISTRIBUTION AMONG CROP TYPES (Rangpur)

Crop Type	Net Cropped Area : Mean (Std.error)	Casual Labour : Mean (Std.error)	No. of Pairs	Correlation Coefficient (Probability)	T-Test T Value (Probability)
Paddy Aman	30.1 (7.59)	26.8 (2.67)	35	.726 (.001)	-1.69 (.099)
Paddy Aus	19.0 (1.76)	15.0 (1.83)	36	.645 (.001)	-2.62 (.013)
Paddy HYV	24.1 (2.83)	33.0 (3.68)	36	.892 (.001)	5.18 (.001)
Paddy Boro	0.4 (0.42)	4.9 (2.21)	4	-.184 (.816)	1.91 (.152)
Wheat	4.5 (3.20)	2.1 (0.88)	4	-.614 (.386)	-0.88 (.445)
Pulses	8.7 (1.22)	1.2 (0.32)	25	-.003 (.989)	-5.92 (.001)
Mustard	10.1 (1.33)	5.2 (1.06)	25	.562 (.003)	-4.21 (.001)
Potato	2.0 (0.52)	2.0 (0.48)	11	.695 (.018)	0.21 (.837)
Other Rootcrops	1.3 (0.69)	2.2 (0.87)	9	-.276 (.473)	0.70 (.501)
Other Vegetables[b]	1.2 (0.71)	1.7 (0.73)	12	-.052 (.871)	0.48 (.643)
Spices	2.6 (1.10)	5.4 (1.71)	14	.694 (.006)	2.24 (.043)
Jute	6.6 (1.35)	9.1 (1.68)	27	.620 (.001)	1.89 (.071)
Other Industrial Crops[c]	10.5 (2.44)	15.1 (3.56)	23	.880 (.001)	2.52 (.019)

(Notes appear after Table 7.17)

TABLE 7.13: SIGNIFICANCE TESTS ON LAND AND CASUAL LABOUR DISTRIBUTION AMONG CROP TYPES (Bogra)

Crop Type	Net Cropped Area : Mean (Std.error)	Casual Labour : Mean (Std.error)	No. of Pairs	Correlation Coefficient (Probability)	T-Test T Value (Probability)
Paddy Aman	31.2 (2.47)	22.9 (3.77)	36	.533 (.001)	-2.57 (.015)
Paddy Aus	6.1 (1.57)	17.9 (2.96)	29	-.151 (.433)	3.31 (.003)
Paddy HYV	15.7 (2.54)	16.7 (2.74)	75	.412 (.041)	0.33 (.742)
Paddy Boro	6.4 (1.75)	4.5 (2.34)	14	.566 (.035)	-1.46 (.168)
Wheat	20.8 (2.76)	7.0 (1.36)	35	-.048 (.785)	-4.42 (.001)
Millet	4.7 (0.93)	0.8 (0.43)	9	-.267 (.488)	-3.45 (.009)
Pulses	5.5 (1.36)	0.8 (0.49)	9	.306 (.423)	-3.61 (.007)
Mustard	13.4(11.88)	0.3 (0.34)	3	-.565 (.618)	-1.08 (.391)
Potato	7.1 (1.94)	5.0 (2.12)	12	.958 (.001)	-3.43 (.006)
Other Rootcrops	5.1 (1.08)	4.5 (1.81)	20	.680 (.001)	-0.52 (.611)
Spices	9.6 (1.26)	16.9 (2.70)	31	-.078 (.678)	2.38 (.024)
Jute	13.9 (2.13)	17.9 (2.71)	34	.163 (.357)	1.27 (.212)

TABLE 7.14: SIGNIFICANCE TESTS ON LAND AND CASUAL LABOUR DISTRIBUTION AMONG CROP TYPES (Dacca)

Crop Type	Net Cropped Area : Mean (Std.error)	Casual Labour : Mean (Std.error)	No. of Pairs	Correlation Coefficient (Probability)	T-Test T Value (Probability)
Paddy Aman	21.1 (2.49)	26.0 (3.12)	55	.631 (.001)	1.96 (.055)
Paddy Aus	23.3 (2.65)	18.1 (2.71)	45	.211 (.165)	-1.56 (.126)
Paddy HYV	37.6 (3.45)	42.8 (3.14)	66	.601 (.001)	1.78 (.080)
Paddy Boro	5.7 (3.47)	10.1 (5.84)	4	.984 (.016)	1.72 (.184)
Wheat	14.1 (1.40)	3.0 (0.72)	38	.367 (.023)	-8.46 (.001)
Other Cereals	4.6 (1.64)	1.6 (1.60)	3	.926 (.247)	-4.78 (.041)
Pulses	12.2 (1.75)	1.3 (0.62)	18	.101 (.691)	-6.06 (.001)
Mustard	2.0 (0.98)	0.8 (0.51)	6	-.664 (.150)	-0.86 (.427)
Other Oilseeds	8.1 (2.01)	6.9 (6.22)	16	-.262 (.327)	-0.17 (.864)
Potato	30.9 (3.61)	34.0 (3.46)	31	.663 (.001)	1.05 (.300)
Other Rootcrops	2.0 (0.87)	0.1 (0.07)	5	-.581 (.304)	-2.15 (.098)
Other Vegetables	8.2 (1.94)	2.2 (0.60)	25	.053 (.800)	-3.00 (.006)
Spices	0.6 (0.25)	2.6 (0.88)	17	.044 (.868)	2.22 (.041)
Jute	10.3 (3.82)	8.9 (2.92)	36	.620 (.001)	-0.45 (.656)

(Notes appear after Table 7.17)

TABLE 7.15: SIGNIFICANCE TESTS ON LAND AND CASUAL LABOUR DISTRIBUTION AMONG CROP TYPES
(Comilla)

Crop Type	Net Cropped Area : Mean (Std.error)	Casual Labour : Mean (Std.error)	No. of Pairs	Correlation Coefficient (Probability)	T-Test T Value (Probability)
Paddy Aman	41.7 (2.16)	39.9 (2.99)	71	.448 (.001)	-0.66 (.514)
Paddy Aus	8.4 (1.33)	3.8 (0.95)	23	.289 (.181)	-3.34 (.003)
Paddy HYV	51.9 (2.30)	54.0 (3.11)	72	.385 (.001)	0.70 (.489)
Pulses	2.6 (0.34)	0.0 (0.00)	6	- (-)	-7.63 (.001)
Mustard	2.7 (2.34)	0.6 (0.26)	4	-.781 (.219)	0.81 (.476)
Other Oilseeds[d]	3.1 (0.64)	0.0 (-)	14	- (-)	-4.94 (.001)
Other Vegetables	4.4 (3.31)	0.9 (0.41)	9	-.367 (.331)	-1.00 (.347)
Jute	0.6 (0.57)	0.8 (0.29)	4	-.875 (.125)	0.23 (.530)
Other Crops	1.3 (1.11)	1.6 (0.39)	18	-.284 (.253)	0.23 (.820)
Mixed Aus-Aman	6.1 (1.55)	8.1 (1.83)	28	.440 (.019)	1.09 (.284)

TABLE 7.16: SIGNIFICANCE TESTS ON LAND AND CASUAL LABOUR DISTRIBUTION AMONG CROP TYPES
(Noakhali)

Crop Types	Net Cropped Area : Mean (Std.error)	Casual Labour : Mean (Std.error)	No. of Pairs	Correlation Coefficient (Probability)	T-Test T Value (Probability)
Paddy Aman	57.9 (3.08)	54.1 (2.96)	69	.074 (.544)	-0.93 (.358)
Paddy Aus	23.4 (3.15)	14.0 (2.47)	56	-.135 (.321)	-2.22 (.031)
Paddy HYV	18.6 (2.21)	25.7 (2.65)	54	.408 (.002)	2.68 (.010)
Pulses	2.6 (1.00)	3.5 (1.65)	15	.367 (.178)	0.56 (.586)
Other Oilseeds[d]	1.4 (0.59)	6.0 (1.84)	18	-.174 (.489)	2.27 (.036)
Potato	1.1 (0.52)	0.3 (0.17)	6	-.161 (.760)	-1.40 (.221)
Other Rootcrops	1.4 (0.56)	0.0 (-)	5	- (-)	-2.48 (.068)
Spices	6.6 (1.45)	4.6 (2.09)	31	.761 (.001)	-1.46 (.155)

(Notes appear after Table 7.17)

TABLE 7.17: SIGNIFICANCE TESTS ON LAND AND CASUAL LABOUR DISTRIBUTION AMONG CROP TYPES (Munshiganj)

Crop Type	Net Cropped Area : Mean (Std.error)	Casual Labour : Mean (Std.error)	No. of Pairs	Correlation Coefficient (Probability)	T-Test T Value (Probability)
Paddy HYV	9.4 (3.94)	7.1 (2.42)	9	.684 (.059)	-0.77 (.461)
Paddy Boro	6.0 (3.57)	3.1 (1.91)	9	.262 (.495)	-0.74 (.479)
Mixed Aus-Aman[e]	17.5 (1.21)	32.2 (2.43)	70	.297 (.015)	6.02 (.001)
Wheat	7.4 (1.13)	3.1 (0.52)	52	.218 (.121)	-3.84 (.001)
Millet	3.5 (0.65)	2.5 (0.71)	24	.507 (.011)	-1.38 (.181)
Mustard	20.6 (1.46)	9.1 (0.96)	60	.577 (.001)	-9.54 (.001)
Other Oilseeds[f]	7.1 (1.04)	2.5 (0.39)	39	.546 (.001)	-5.19 (.001)
Potato	12.5 (1.18)	17.5 (1.96)	61	.300 (.019)	2.53 (.014)
Other Rootcrops	3.9 (0.75)	5.8 (1.16)	32	.184 (.314)	1.54 (.135)
Other Vegetables	3.0 (1.70)	5.2 (5.21)	4	-.577 (.423)	0.36 (.746)
Spices	9.0 (1.36)	9.8 (1.51)	51	.553 (.001)	0.57 (.569)
Jute	35.8 (1.66)	28.3 (2.35)	69	.290 (.016)	-3.07 (.003)
Other Industrial Crops[g]	1.4 (0.86)	6.7 (2.16)	8	-.074 (.863)	2.20 (.064)
Mixed Rabi Crops	0.3 (0.36)	3.4 (0.66)	15	.222 (.426)	4.60 (.001)

Notes on Tables 7.10 to 7.17

1. In order to provide an overall picture of both distributions, all observations (including zeros) are included in Table 7.10. In the other tables however farms which did not produce a particular crop have been excluded in order to avoid biasing the tests. (Obviously a farm which does not produce a given crop will devote no labour to it!) This means that the percentages in the latter tables relate only to farms producing the crop type in question and therefore total more than 100.
2. Where the difference in the proportions of land and casual labour devoted to a particular crop is significant at the five per cent level or better (t-test) the crop type is underlined in Tables 7.11 to 7.17.
3. On all areas, except perhaps Munshiganj, the figures on labour hired for jute may be unusually low because of the drought which adversely affected this crop in 1979, thus reducing the demand for labour. Low jute prices may have had a similar effect.

[a] (Table 7.10) This includes both permanent crops which are of little interest as far as mechanisation is concerned and cases where the crop type has not been identified. One special case which arises in the Noakhali sample is pan, which is a very important cash crop in the area. In the case of hired labour non-identification of crop type is most likely to occur in the case of land preparation where farmers are often undecided as to which variety, or even which crop, to grow at the time the land is cultivated. The final decision rests on a number of factors, the most important of which are weather conditions and the availability of planting material at the time the land is sown. This category is not included in the significance tests for obvious reasons.

[b] (Tables 7.12 and 7.13) Mainly chillie

[c] (Table 7.12) Mainly sugar, but includes some cotton and tobacco

[d] (Tables 7.15 and 7.16) Mainly groundnut

[e] (Table 7.17) These figures should be treated with some caution as the figures are incomplete as regard the b.aman harvest (see text 7.1.) The figures may also include some observations of b.aman grown in pure stand

[f] (Table 7.17) Mainly sesame

[g] Mainly sugar

mean proportion of labour devoted to it is greater than the mean proportion of land; over the sample as a whole and in the most mechanised area, Munshiganj, these differences are statistically significant. These figures suggest quite strongly that, at least as far as this particular crop is concerned, mechanised land preparation, insofar as it induces a shift from other rabi crops such as wheat or mustard to potato, will have the effect of creating offsetting employment opportunities. This important point will also be taken up later in the analysis.

7.3. CASUAL EMPLOYMENT BY TYPE OF FARM.

A number of farm characteristics were investigated as possible 'explanatory' variables relative to the hiring of casual labour for various on-farm tasks. It is worth noting however that hiring of farm labour for these different tasks tends to be complementary rather than competing; that is, farmers who hire relatively high numbers of workers for any one task are likely to hire labour for many tasks. This can be seen from Tables 7.18 to 7.21 which show that all of the statistically significant correlations are positive, and in some cases quite high. It will be noted that the number of categories of employment has been reduced compared with earlier tables in the present chapter. First, minor categories have been amalgamated with the 'others'. Second, sowing and transplanting have been combined in view of their essentially similar nature as have harvesting and crop processing in view of their essential complementarity. This reduction enables sharper focus to be concentrated on the employment issues which are of immediate concern to the present study. It is important to note that the raw data for these tables were converted to a unit area basis in order to avoid problems of multicollinearity in the subsequent multiple regression analysis.

The relationship between labour requirements for land preparation and for weeding is an interesting one. Under certain circumstances they might be thought of as alternatives, since proper tillage will destroy weeds and hence reduce the need for weeding at a later stage.[1] In this case, however, the correlation between labour hiring for the two tasks, although not as strong as in other cases is generally positive, which suggests that relationships are more complex than the simple one postulated above. One labourer employed for land preparation is frequently part of a complete team (hal) of two animals, plough and ploughman, a point which will be taken up later.

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[1]There are basically three sources of weed infestation: those which are in the field before the crop is seeded, those which are sown along with the crop because the seed is contaminated with weed seeds, and those which are carried into the field after the crop has been seeded. Tillage operations can deal only with the first of these. The use of fertilisers and irrigation can make it more difficult to control weeds.

TABLE 7.18: HIRING OF CASUAL LABOUR FOR VARIOUS TASKS (BIVARIATE CORRELATION COEFFICIENTS): All Areas

	Land Improvement	Land Preparation	Sowing/ Transplanting	Weeding	Harvesting & Processing	Others
Land Improvement	...	0.129^{5}	0.239$^{.1}$	0.395$^{.1}$	0.498$^{.1}$	0.502$^{.1}$
Land Preparation		...	0.307$^{.1}$	0.142$^{.1}$	0.240$^{.1}$	0.092^{ns}
Sowing/Transplanting			...	0.222$^{.1}$	0.316$^{.1}$	0.243$^{.1}$
Weeding				...	0.557$^{.1}$	0.333$^{.1}$
Harvesting & Processing					...	0.297$^{.1}$
Others						...

Notes: (a) Superscripts are the percentage levels of significance; ns = not significant at 5% level

(b) Raw data are total man-equivalent days hired per acre.

TABLE 7.19: HIRING OF CASUAL LABOUR FOR VARIOUS TASKS (BIVARIATE CORRELATION COEFFICIENTS): Rangpur and Bogra

	Land Improvement	Land Preparation	Sowing/ Transplanting	Weeding	Harvesting & Processing	Others
Land Improvement	...	0.004^{ns}	0.099^{ns}	0.803$^{.1}$	0.242^{ns}	0.264^{ns}
Land Preparation	-0.052^{ns}	...	0.113^{ns}	0.089^{ns}	0.068^{ns}	0.073^{ns}
Sowing/Transplanting	0.215^{ns}	0.089^{ns}	...	0.310^{ns}	0.479^{1}	0.453^{1}
Weeding	0.351^{5}	-0.037^{ns}	0.282^{ns}	...	0.521^{1}	0.297^{ns}
Harvesting & Processing	0.519^{1}	-0.024^{ns}	0.238^{ns}	0.676$^{.1}$	...	0.324^{ns}
Others	0.387^{1}	-0.065^{ns}	0.184^{ns}	0.616$^{.1}$	0.518$^{.1}$	...

See Table 7.18 for Notes. Rangpur: Upper Right Triangle; Bogra: Lower Left Triangle.

TABLE 7.20: HIRING OF CASUAL LABOUR FOR VARIOUS TASKS (BIVARIATE CORRELATION COEFFICIENTS): Dacca and Comilla

	Land Improvement	Land Preparation	Sowing/ Transplanting	Weeding	Harvesting & Processing	Others
Land Improvement	...	-0.028^{ns}	0.027^{ns}	0.242^{5}	0.280^{5}	0.335^{1}
Land Preparation	-0.046^{ns}	...	0.229^{ns}	0.100^{ns}	0.119^{ns}	0.028^{ns}
Sowing/Transplanting	0.121^{ns}	0.347^{1}	...	0.385$^{.1}$	0.658$^{.1}$	0.151^{ns}
Weeding	0.140^{ns}	0.586$^{.1}$	0.685$^{.1}$	...	0.432$^{.1}$	0.282^{5}
Harvesting & Processing	0.038^{ns}	0.337^{1}	0.837$^{.1}$	0.779$^{.1}$	...	0.268^{5}
Others	0.119^{ns}	0.058^{ns}	0.441$^{.1}$	0.372^{1}	0.445$^{.1}$	...

See Table 7.18 for Notes. Dacca: Upper Right Triangle; Comilla: Lower Left Triangle

TABLE 7.21: HIRING OF CASUAL LABOUR FOR VARIOUS TASKS (BIVARIATE CORRELATION COEFFICIENTS): Noakhali and Munshiganj

	Land Improvement	Land Preparation	Sowing/ Transplanting	Weeding	Harvesting & Processing	Others
Land Improvement	...	0.068^{ns}	0.340^{1}	0.338^{1}	0.171^{ns}	0.611$^{.1}$
Land Preparation	0.674$^{.1}$	...	0.420$^{.1}$	0.071^{ns}	0.526$^{.1}$	0.050^{ns}
Sowing/Transplanting	0.677$^{.1}$	0.337^{1}	...	0.180^{ns}	0.596$^{.1}$	0.075^{ns}
Weeding	0.239^{5}	0.247^{5}	0.486$^{.1}$	...	0.124^{ns}	0.408$^{.1}$
Harvesting & Processing	0.554$^{.1}$	0.483$^{.1}$	0.354^{1}	0.277^{5}	...	0.053^{ns}
Others	0.710$^{.1}$	0.422$^{.1}$	0.653$^{.1}$	0.069^{ns}	0.322^{1}	...

See Table 7.18 for Notes. Noakhali: Upper Right Triangle; Munshiganj: Lower Left Triangle.

What factors influence a given farmer in deciding whether to employ casual labour? Such a decision is manifestly the outcome of a multitude of technical, economic, social, religious, (etc.) circumstances, as well as of personal preferences. Only a few of these can be quantified. It is hypothesised that the following set of independent variables will help determine demand for casual labour.[1]

1. Tractor user status: this is entered as a dummy variable (0 = non-user, 1 = user) and could be presumed to correlate negatively with overall labour requirements for land preparation and weeding and positively with requirements for harvesting and crop processing (on the hypothesis that tractor use improves cultivation standards thus reducing weed infestation and increasing yields).
2. Permanent on-farm labour force per unit area: requirements for casual labour will presumably tend to correlate negatively with this variable since the two types of labour are obviously mutual substitutes.
3. Installed horsepower per acre: as was noted earlier casual labour hired for cultivation is generally part of a complete ploughing team - and many farmers will only hire out their draught animals together with a ploughman with whom the animals are used to working and who will not ill-treat them. Thus labour, (as distinct from animals) hired for land preparation may be surplus to the farmer's actual requirements and tend therefore to be found mainly on farms with insufficient draught resources.
4. Total operated acreage: it is hypothesised that labour intensity is negatively related to farm size, since studies in many countries have shown this to be the case.
5. Percentage of land sharecropped-in: a negative correlation is expected since theory predicts that the optimum level of variable inputs on sharecropped land is lower than on owner-cultivated or fixed rent land, other things being equal. This is because of the higher marginal cost of production in the former case imposed by the share rent. (See for example Heady (1952), chs. 20-21).
6. Cropping intensity: a positive relationship with labour use is hypothesised, for obvious reasons.
7. Cropping patterns: it was shown earlier in the present chapter that certain crops, such as HYV paddy and potato are relatively labour-intensive. This variable is the percentage of net cropped area under such crops in the area in question and a positive relationship is hypothesised.

Table 7.22 shows the correlation coefficients between each pair from the above set of 'explanatory' variables. Clearly no major problem of multicollinearity arises. The same can also be said of

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[1] Strictly speaking what is being tested is the 'null' hypothesis - i.e. that <u>no</u> significant relationship exists between (or among) the variables in question.

TABLE 7.22: DETERMINANTS OF CASUAL LABOUR DEMAND? : INTERCORRELATIONS (All Areas)

	Tractor User Status	Perm. Labour/ Acre	Installed HP/Acre	Total Operated Acreage	% of Land Share-cropped	Cropping Intensity	Cropping Pattern
Tractor User Status	...	-0.116	0.013	0.185	-0.000	0.090	0.295
Perm. Labour/ Acre		...	0.193	-0.435	-0.063	0.006	-0.040
Installed HP/ Acre			...	-0.083	0.014	0.109	-0.008
Total Operated Acreage				...	0.046	-0.070	0.024
% of Land Sharecropped					...	0.080	-0.019
Cropping Intensity						...	0.037
Cropping Pattern							...

Note: Underlined coefficients are significant at the 5% level or better.

the intercorrelations for each specific area, which figures, although calculated, are not reproduced here. The above hypotheses were tested using multiple regression analysis, the results of which appear in Tables 7.23 to 7.26.

With the exception of weeding, where the null hypothesis cannot be rejected, the analysis appears to lend some support to the first hypothesis (Section 7.3). Over the sample as a whole tractor use correlates negatively with casual labour inputs for land preparation and positively with those for harvesting and crop processing.[1] When these figures are broken down by region, however, in only one area in each case is the relationship in question found to be statistically significant. The figure for Munshiganj is very much in accordance with evidence presented in an earlier report, which suggested that a single power tiller would replace around three thousand man-equivalent days of labour per annum when used to cultivate for potato.[2]

[1] It should be noted that the labour input of tractor drivers - as that of ploughmen hired along with draught animals - is included in the figures for labour hired for cultivation.

[2] See Gill (1979) p.32.

TABLE 7.23: DETERMINANTS OF DEMAND FOR CASUAL LABOUR (All Operations)

Equation No.	Area		REGRESSION EQUATION: Constant	Tractor User?	Perm. Labour	I.H.P.	Operated Acreage	% Share-cropped	Cropping Intensity	Cropping Pattern	Degrees of Freedom	Standard Error	R^2	F-Statistic	Signif- (%)
	All Areas	Ya=	34.4		-6.8		-1.7	-0.20	+10.9	+0.85	5,	46.1	0.129	10.509	0.1
		(SE)			(4.2)		(0.7)	(0.08)	(4.6)	(0.15)					
7.23.1		F									354				
	Rangpur	Yr=	7.2			-71.5					1,	19.1	0.206	8.81	1.0
		(SE)				(24.1)									
7.23.2		F				8.81b					34				
	Bogra	Yb=	67.2		-32.9			-0.47			2,	26.0	0.285	6.58	1.0
		(SE)			(16.1)			(0.15)			33				
7.23.3		F			4.16c			9.55a							
	Dacca	Yd=	5.7			-35.0			+17.3		2,	26.5	0.139	5.57	1.0
		(SE)				(13.8)			(6.1)		69				
7.23.4		F				6.44b			8.09a						
	Comilla	Yc=	45.4		-18.4						1,	33.9	0.077	5.80	2.5
		(SE)			(7.6)						70				
7.23.5		F			5.80c										
	Noakhali	Yn=	74.3				-2.4	-0.46			2,	37.3	0.272	12.91	0.1
		(SE)					(0.87)	(0.14)			69				
7.23.6		F					7.73a	11.68a							
	Munshiganj	Ym=	149.8	-37.5	-30.0						2,	57.3	0.164	6.76	1.0
		(SE)		(13.7)	(10.8)										
7.23.7		F		7.46b	7.79a										

See Notes after Table 7.26.

TABLE 7.24: DETERMINANTS OF DEMAND FOR CASUAL LABOUR (Land Preparation)

Equation No.	Area		REGRESSION EQUATION								Degrees of Freedom	Standard Error	R^2	F-Statistic	Signif. (%)
			Constant	Tractor User?	Perm. Labour	I.H.P.	Operated Acreage	% Share-Cropped	Cropping Intensity	Cropping Pattern					
	All Areas	Ya=	7.7	-3.5	+2.6	-22.8	-3.5	-0.056	+3.0	+0.093					
		(SE)		(1.6)	(1.3)	(4.0)	(1.6)	(0.025)	(1.4)	(0.046)	6, 347	13.7	0.150	8.75	0.1
7.24.1		F		4.57a	4.06a	32.5a	4.57a	5.06a	4.45a	4.03a					
	Rangpur	Yr=	7.7			-20.2									
		(SE)				(6.8)					1, 34	5.4	0.205	8.79	1.0
7.24.2		F				8.79b									
	Bogra	Yb=	32.6			-61.3	-3.3	-0.14							
		(SE)				(17.5)	(1.1)	(0.066)			3,	11.4	0.397	7.01	0.1
7.24.3		F				12.28a	9.37a	4.65b							
	Dacca	Yd=	-4.1		+6.0	-29.5		-0.087	+7.0						
		(SE)			(2.2)	(8.9)		(0.051)	(2.8)		4, 67	11.1	0.193	4.00	1.0
7.24.4		F			7.62a	10.86a		2.86d	6.07a						
	Comilla	Yc=	12.3			-24.7									
		(SE)				(13.4)					1, 70	21.5	0.046	3.38	10.0
7.24.5		F				3.38e									
	Noakhali	Yn=	8.4		+6.6		-0.59	-0.091		+0.25					
		(SE)			(2.8)		(0.33)	(0.046)		(0.094)	4, 67	12.2	0.404	11.34	0.1
7.24.6		F			5.42a		3.22c	3.83b		7.23a					
	Munshiganj	Ym=	14.1	-4.6		-14.5									
		(SE)		(2.3)		(4.7)					2, 64	9.1	0.145	5.40	1.0
7.24.7		F		3.95c		9.37a									

See Notes after Table 7.26.

TABLE 7.25: DETERMINANTS OF DEMAND FOR CASUAL LABOUR (Weeding)

Equation No.	Area		REGRESSION EQUATION: Constant	Tractor User?	Perm. Labour	I.H.P.	Operated Acreage	% Share-cropped	Cropping Intensity	Cropping Pattern	Degrees of Freedom	Standard Error	R^2	F-Statistic	Signif. (%)
	All Areas	Ya=	7.9							+0.29	1, 358	16.0	0.086	33.67	0.1
		(SE)								(0.05)					
7.25.1		F								33.67a					
	Rangpur	Yr=	10.5		-23.9					+0.23	2, 33	7.7	0.295	4.46	2.5
		(SE)			(11.1)					(0.087)					
7.25.2		F			4.59c					6.92b					
	Bogra	Yb=	-3.3				+3.9				1, 34	9.5	0.387	21.40	0.1
		(SE)					(0.85)								
7.25.3		F					21.43a								
	Dacca	Yd=	2.9				+0.35				1, 70	4.5	0.066	4.93	5.0
		(SE)					(0.16)								
7.25.4		F					4.93d								
	Comilla	Yc=	6.4		-3.6						1, 70	4.6	0.148	12.15	0.1
		(SE)			(1.0)										
7.25.5		F			12.15a										
	Noakhali	Yn=	28.0				-0.74		-9.3		2, 69	15.5	0.204	8.82	0.1
		(SE)					(0.35)		(2.6)						
7.25.6		F					4.45c		13.02a						
	Munshiganj	Ym=	39.2		-9.8						1, 70	20.1	0.089	6.82	2.5
		(SE)			(3.9)										
7.25.7		F			6.82c										

See Notes after Table .7.26.

TABLE 7.26: DETERMINANTS OF DEMAND FOR CASUAL LABOUR (Harvesting)

Equation No.	Area		REGRESSION EQUATION: Constant	Tractor User?	Perm. Labour	I.H.P.	Operated Acreage	% Share-cropped	Cropping Intensity	Cropping Pattern	Degrees of Freedom	Standard Error	R^2	F-Statistic	Signif. (%)
	All Areas	Ya=	8.1	+2.9	-2.4			-0.072	+1.9	+0.051					
		(SE)		(1.1)	(0.77)			(0.016)	(0.89)	(0.033)	5, 282	8.3	0.132	8.59	0.1
7.26.1		F		6.79a	9.51a			18.75a	4.58a	2.47d					
	Rangpur	Yr=	2.6				+1.5								
		(SE)					(0.37)				1, 34	0.4	0.320	16.0	0.1
7.26.2		F					16.0a								
	Bogra	Yb=	2.1				+1.3								
		(SE)					(0.37)				1, 34	4.1	0.272	12.68	1.0
7.26.3		F					12.68b								
	Dacca	Yd=	5.5		-2.4				+3.1						
		(SE)			(0.92)				(1.6)		2, 69	7.4	0.143	5.75	1.0
7.26.4		F			6.89b				3.70d						
	Comilla	Yc=	-1.0	+7.9	-6.0	+10.2		-0.050	+5.8						
		(SE)		(1.9)	(1.4)	(4.0)		(0.026)	(3.2)		5, 66	6.2	0.397	8.68	0.1
7.26.5		F		16.51a	17.52a	6.52a		3.55c	3.14c						
	Noakhali	Yn=	11.0					-0.085		+0.23					
		(SE)						(0.039)		(0.08)	2, 69	10.5	0.215	9.43	0.1
7.26.6		F						4.83c		8.62a					

NOTES ON TABLES 7.23-7.26

1. VARIABLES (see also text Section 7.3)

DEPENDENT VARIABLE: number of man-equivalent days hired per acre per annum for the operation(s) in question

TRACTOR USER?: Tractor user status (1=user; 0=non-user)

PERM. LABOUR: The size of the farm's permanent labour force (family, plus permanent employees) measured in man-equivalents per acre

I H P : Installed horsepower per acre

OPERATED ACREAGE: Total operated acreage

% SHARECROPPED: Per cent of total operated acreage sharecropped in

CROPPING INTENSITY: Average cropping intensity of the farm (see Chapter 5)

CROPPING PATTERN: Percentage of net cropped area under 'employment intensive' crops (see Section 7.2 and Section 7.3)

2. ABBREVIATIONS

SE = Standard error of the coefficient in question

F = F statistic for the coefficient in question. The lower case letters indicate the significance level;

a=statistically significant at 0.1% or better
b= " " " 1.0% " "
c= " " " 2.5% " "
d= " " " 5.0% " "
e= " " " 10.0% " "

These F statistics can be used to assess the relative 'explanatory' power of the independent variables for any given equation, since this is in direct proportion to the F-statistic. Thus in the first equation of Table 7.23 cropping pattern is the most important variable of the set and permanent labour per acre the least. Independent variables which do not add significantly to the 'explanatory power' of the equation (5% level) are assumed not to differ significantly from zero (i.e. the null hypothesis is not rejected) and are therefore omitted. The equation for land preparation labour for Comilla (Table 7.24) has a significance of slightly over five per cent but is included for illustrative purposes.

3. TABLE 7.24

The values of IHP associated with the five power tiller owners are relatively very large and have a distorting effect in equations where this is an important explanatory variable. These five sets of observations have therefore been omitted from the 'All Areas' and Munshiganj figures in this particular Table.

4. TABLE 7.26

Figures on labour hiring for harvesting in Munshiganj are incomplete (see Section 7.1). This missing data particularly affects the more mechanised village where the b.aman harvest is completed earlier than in the other village. There were also data collection problems in this village at the time of the rabi harvest so that again the data are less than complete for this particular operation. These figures have therefore been omitted from Table 7.26.

The positive relationship between tractor use and labour input for harvesting in Comilla is rather puzzling, since there is no other evidence to suggest that yields are higher where tractors have been used for cultivation. Nevertheless, the relationship is a reasonably strong one, with tractor use 'explaining' around ten per cent of variation in the volume of casual labour hired for harvesting in Comilla,[1] - but not elsewhere. It is of course possible that demand for casual labour for harvesting and tractor user status are associated without being causally related. Both variables might be dependent on a third - leisure preference is an obvious candidate - which could not be included in the present analysis.

The test of the relationship between permanent farm labour force and the degree of hiring of casual labour produces some very interesting and highly consistent results. In most cases the hypothesis of a negative relationship is confirmed, as would be expected. The exception is in land preparation where in every case where a significant relation is found to exist the relevant parameter is positive. This is in fact a result of small farms with high labour-land ratios already being obliged to hire in labour for cultivation as a condition of hiring the animals (see Section 7.3 above). This same point emerges with even greater clarity when the coefficients for installed horsepower per acre are examined. These show in most cases a strong negative correlation with the amount of labour hired for land preparation.

The effect of farm size on hired labour is most interesting. Equation 7.23.1 shows a significantly negative relationship between this variable and the hiring of casual labour, taking all areas and all tasks together. This fact, in conjunction with the significant negative correlation between farm size and permanent labour per acre (r^2=0.19; level of significance 0.1 per cent), does indicate that larger farms are less labour intensive than smaller ones. However when the figures are disaggregated by task and by region this relationship transpires to be less clearcut. First, in the case of land preparation there is no positive relationship and several significant negative relationships between hiring of casual labour and operated acreage. However, at least part of the explanation for this presumably lies in the fact noted rearlier that smallholders without animals are forced to hire more labour for land preparation than they really require. The second point concerns Noakhali, where all of the significant parameters in questions are negative (Equations 7.23.6, 7.24.6, and 7.25.6). This is an area where labour intensity is undoubtedly inversely proportionate to farm size, since large farms tend to include relatively high proportions of char lands which by reason of their distance from the farmstead and consequent lack of security attract very low standards of husbandry (see Chapter 2 above and James (1979).

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[1] i.e. the value of the coefficient of multiple determination (R^2) increases from 0.150 to 0.252 when this variable is entered (that is in the second step after the variable which has the stronger bivariate correlation with Yc, namely permanent labour per acre).

For weeding (with the exception of Noakhali) and harvesting, casual labour hired per acre correlates positively (if at all) with farm size. There is evidently a substitution effect here, since farms without adequate permanent labour must hire in casual labour for certain tasks, particularly those like harvesting where a serious time constraint is in operation.[1]

The remaining relationships shown in the tables are quite straightforward and fairly consistent. The most consistent finding applies in the case of sharecropping where every significant relationship is negative. Thus the hypothesised negative effect of sharecropping on labour intensity is supported. Both cropping intensity and cropping pattern correlate positively with the volume of casual labour hired, taking the sample as a whole. In the individual areas too, any significant relationships tend to be positive. An exception is weeding, where the only signficant relationship found was a negative one between cropping intensity and the hiring of casual labour, again in Noakhali.

7.4. WAGES

The expression 'bewildering variety' is frequently encountered in descriptions of Bengali agriculture, but nowhere is it more appropriate than when applied to the systems used to hiring and paying casual labour. It was noted earlier (Section 2.3) that the system of land leasing is presently in a state of transition with traditional share lease arrangements tending to give way to fixed cash rents. The same is broadly true of casual labour contracts, although here existing complications are aggravated by the existence of bands of migratory labourers which not only facilitates change (because they enable employers to circumvent traditional share wage systems and other obligations favourable to local labourers) but also introduces chance supply factors which make the market for casual labour a highly imperfect one (see Clay, 1976).

This work by Clay, which is of particular relevance here since it was located in an area very close to the Dacca sample of the present study, shows that the system of wage payments was then in a state of transition with the traditional arrangement whereby wages are paid in kind (generally a share of the harvest) in process of being replaced by cash wages paid either on a daily or on a piece rate ('contract' labour).[2] The distribution of labour contracts by mode of payment from the present study is shown in Table 7.27.

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[1]Tables 7.25 and 7.26 show that the equations tend to contain either a (negative) term for permanent labour per acre or a (positive) one for total operated acreage, but not both. This is a result of multicollinearity which can be seen in the bivariate correlation coefficients of Table 7.22.

[2]The use of the word 'contract' in this and subsequent tables and text relates to all (verbal) labour contracts and not just to piece rate work.

TABLE 7.27: MODES OF WAGE PAYMENT (No. and percentage of all contracts)

		RANGPUR	BOGRA	DACCA	COMILLA	NOAKHALI	MUNSHIGANJ	ALL AREAS
Cash	No.	3,593	3,075	3,642	3,512	3,098	7,592	24,512
	%	98.8	99.8	85.9	99.7	100.0	91.4	94.7
Crop Share	No.	14	0	514	0	0	545	1,073
	%	0.4	0.0	12.1	0.0	0.0	6.6	4.1
Crop Residues	No.	0	0	17	0	0	163	180
	%	0.0	0.0	0.4	0.0	0.0	2.0	0.7
Exchange Labour (No Payment)	No.	29	7	69	9	0	4	118
	%	0.8	0.2	1.6	0.3	0.0	-	0.5
TOTAL	No.	3,636	3,082	4,242	3,521	3,098	8,304	25,883
	%	100.0	100.0	100.0	100.0	100.0	100.0	100.0

- = negligible (less than 0.05 per cent).

(It must be noted that these figures relate to the main wage payment only: supplementary payments in kind are often made to cash wage labourers, as will be shown later.) These figures show quite clearly that at least as far as the sample areas are concerned the transition is by now almost complete and that traditional share wage arrangements are by now almost a thing of the past. Vestiges of the old system still remain, however, notably in Dacca District (of the sample areas).[1] Here comparisons over time can be made. As Clay has observed, traditional share wages had been the only method of payment for harvest labour in that area until 1971, while his own figures imply that by the mid 1970's around a quarter of all contracts with harvesters had been placed on a non-traditional basis. These figures cannot however be compared directly with those in Table 7.27, since the latter cover all types of work, while share payments for pre-harvest operations are unusual. When allowance is made for this factor, the figures from the present study show that by the late 1970's the proportion of non-traditional harvesting contracts had grown to about 50 per cent. This continuing process has, as Clay pointed out, very serious implications for the rural poor, since traditional modes of payment are generally the more advantageous for the labourer and the transition therefore represents a change for the worse from his viewpoint.

The distribution of share wages actually paid is shown in Table 7.28. Although there is considerable variability in these rates, particularly in the Dacca sample, a clear pattern is nonetheless obvious with a pronounced peak in each distribution. Custom obviously determines the modal rate, but why is there variation around this mode? There is no discernible pattern by crop type (nearly always paddy) or by time of year or type of work (nearly always harvesting/threshing). Many factors, few of which can be

[1]Munshiganj is also presently within Dacca District.

TABLE 7.28: SHARE WAGES FOR HARVESTING (Percentage of all contracts)

CROP SHARE PAID	DACCA	MUNSHIGANJ
one-sixteenth	1.9	0.0
one-fifteenth	2.5	0.0
one-fourteenth	1.4	0.0
one-thirteenth	9.1	0.0
one-twelfth	68.1	0.0
one-eleventh	4.4	0.0
one-tenth	12.1	0.0
one-eighth	0.3	0.6
one-sixth	0.0	94.1
one-fifth	0.0	5.3
TOTAL	100.0	100.0

investigated in a study such as this, are at work here, both economic (especially the labour supply-demand relationship on the day in question) and social (for example, the relationship between farmer and labourer). Clay's work suggests that share wages correlate negatively with yields and reports of farmers in the present study tend to confirm this. The relationship derives from two factors. First, labour requirements for harvesting are inelastic with respect to yield (Clay reports an elasticity of 0.5), so that for example if a particular field produces a very poor crop the farmer will often have to offer an unusually high share to the labourer to get him to harvest it. Second, high yields generally result from high pre-harvest labour and inputs - good seed, high seeding rate, fertiliser, irrigation, weeding, etc., so that the proportion of value added which is attributable to harvest labour is relatively low and this correspondingly is reflected in the share wage. The large difference in rates comparing Dacca and Munshiganj is probably attributable to the type of crop. In Dacca the paddy is mainly t. <u>aman</u>; in Munshiganj it is b. <u>aman</u>. The above yield and input factors therefore operate to help push up the rate in Munshiganj. B. <u>aman</u> is also the more difficult crop to harvest.

One exception to the general rule that share wages are paid for harvesting only paddy is found in Munshiganj where groups of women contract to harvest and dry chillies on this basis - also at a rate of one-sixth of the crop. The high rate in this instance reflects a number of factors: the crop is harvested repeatedly as it ripens although the women are not paid until the whole process is complete, second it is a rather unpleasant crop to work with and finally the work is not contracted out to outsiders (who often work for low wages) because it is almost entirely unsupervised. This results from the protracted nature of the harvesting process and the fact that the crop is dried in the employee's home, so that the farmer must know her sufficiently well to trust her not to retain more than the agreed proportion of the crop. Women's work is not generally so well paid, however. In Table 7.27 it was shown that in a number of cases the wages take the form of crop residues. Where such payments are made it is almost invariably to women who are engaged in processing the crop in question. Three such arrangements were found, the most common (all cases in Dacca, 86 per cent in Munshiganj), being payment in the form of jute sticks to the women who decorticate this crop. The other examples are b. aman straw in exchange for help in threshing the crop and the residues of mustard, also paid in exchange for threshing. The latter job is normally done by women using a flail. The residues are used mainly as fuel for cooking, which is of course women's work.[1]

The bulk of wage labour is obviously paid in cash, but supplementary payments in kind to such labour is commonplace. Table 7.29 shows the distribution of such payments. Taking the sample as a whole, only seventeen per cent of contracts provide for no payments in kind while even in Noakhali where such payments are relatively unimportant almost two-thirds of farmers provide them. Of such payments, however, the most important is pan or tobacco which are consumed by the labourers as they work. This is not a very important item of expenditure for employers since it costs only about 50 poisha per man-day. By far the most important such item in terms of cost is prepared food, which must be regarded as an important wage good and which is supplied in 43 per cent of contracts. Such payments are unfortunately particularly difficult to evaluate in cash terms since, quite apart from the usual difficulties inherent in the process of conversion, it would be necessary to check each individual contract in order to establish the quantity and quality of food supplied. Two general points can be made in this regard: first, the food supplied to the labourers is generally the same as that consumed by the farm family and, second, the number of meals supplied is usually proportionate to the length of the working day: one full meal and possibly an additional light meal for half a day's work, with a further full meal for a full day. From the employer's viewpoint of course an advantage of supplying part of the wage in the form of prepared food is that part of its energy value can be returned to him in the form of enhanced work capacity on the part of the labourer. The corresponding disadvantage for the labourer is of course that such payments do not form part of the income which can be shared with the rest of the family.[2]

The distribution of mean total wage rates across the period of the Study is shown in Table 7.30. Table 7.31 shows the same figures disaggregated into cash and kind. Clearly wages paid in kind

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[1] Jute sticks are also sometimes used for building huts, but more commonly for fuel usually threaded with pats of dry cowdung. The straw of b. aman is not all suitable for feeding to cattle.

[2] Cases were reported among sample farmers during the 1979 drought of labourers offering to work in exchange for their food only. This would at least have reduced the burden on family resources, but tragically even on those terms work was not normally available.

TABLE 7.29: SUPPLEMENTARY WAGE PAYMENTS IN KIND (No. and percentage of all contracts)

GOODS PROVIDED		RANGPUR	BOGRA	DACCA	COMILLA	NOAKHALI	MUNSHIGANJ	ALL AREAS
None	No.	179	620	813	350	1,120	1,354	4,436
	%	4.8	20.0	19.1	9.9	36.1	16.1	17.0
Food only	No.	102	230	5	220	266	3	826
	%	2.8	7.4	0.1	6.2	8.6	-	3.2
Pan, Tobacco Only	No.	876	1,255	272	442	1,091	6,442	10,378
	%	23.7	40.5	6.4	12.5	35.1	76.9	39.8
Other Goods	No.	1	15	3	10	29	0	58
	%	-	0.5	0.1	0.3	0.9	0.0	0.2
Food + Pan/Tobacco	No.	2,287	957	1,894	1,140	534	569	7,381
	%	61.9	30.9	44.4	32.2	17.2	6.8	28.3
Food + Other Goods	No.	43	15	18	0	0	0	76
	%	1.2	0.5	0.4	0.0	0.0	0.0	0.3
Food, Lodging + Pan/Tobacco	No.	6	0	109	545	65	6	731
	%	0.2	0.0	2.6	15.4	2.1	0.1	2.8
Food, Pan/ Tobacco + Other Goods	No.	203	3	705	91	0	0	1,002
	%	5.5	0.1	16.5	2.6	0.0	0.0	3.8
Food, Lodging, Pan/Tobacco + Other Goods	No.	0	0	442	734	0	0	1,176
	%	0.0	0.0	10.4	20.8	0.0	0.0	4.5
Other Combinations	No.	0	0	4	3	0	2	9
	%	0.0	0.0	0.1	0.1	0.0	-	-
TOTAL	No.	3,697	3,095	4,265	3,535	3,105	8,376	26,073
	%	100.0	100.0	100.0	100.0	100.0	100.0	100.0

form a very substantial part of total emoluments, almost 30 per cent overall, and are proportionately more important in some areas and at certain times of the year. For all areas except Munshiganj there is a strong negative correlation between the amount of the daily wage paid in cash and the value of payments in kind (Table 7.32) - an important finding since it indicates that payments in kind (mainly in the form of food and pan or tobacco tend to substitute for those in cash which can be so shared. In the case of Munshiganj where no significant relationship was found to exist between the two forms of payment, it will be remembered that payments in kind are of relatively little importance (Table 7.31), consisting as they do almost entirely of pan/tobacco (Table 7.29). This presumably explains the absence of a strong relationship here. An exception can however be seen towards the end of the series for Munshiganj (Table 7.31), where mean payments in kind (and to a lesser degree those in cash) show a marked increase. This period corresponds with the jute harvest which is regarded as heavy work for which employers are expected to provide meals.

TABLE 7.30: MEAN WAGE RATES 1978-79 (Taka per man-equivalent day : all payments)

Date (Week-ending)	RANGPUR	BOGRA	DACCA	COMILLA	NOAKHALI	MUNSHIGANJ	ALL AREAS
4th June			16.15		10.00		15.89
11th			18.03		10.50		15.65
18th		11.10	17.95		13.47		14.41
25th	12.58	13.30	15.60		10.72		13.25
2nd July	14.39	12.90	16.82	21.00	12.28		14.25
9th	14.23	13.47	16.72		11.41		14.18
16th	12.04	12.77	15.97	10.59	10.85		11.36
23rd	11.80	12.66	16.04	10.43	9.61		10.90
30th	12.06	11.59	16.50	13.78	12.13		12.65
6th August	12.99	14.14	16.71	18.35	13.46		14.31
13th	12.60	13.90	15.71	18.57	12.76		13.56
20th	10.98	14.39	16.33	18.23	11.35		12.40
27th	11.42	11.00	14.10	18.75	10.74		11.71
3rd September	12.06	17.95	15.94	16.85	10.99		12.27
10th	10.40	14.79	17.55	17.35	11.07		12.10
17th	11.56	13.76	16.77	17.51	13.00		14.23
24th	9.45	13.02	17.15	17.42	11.69		13.01
1st October	8.86	9.83	16.23	15.22	12.11		12.23
8th	8.55	11.09	12.67	17.74	11.37		10.56
15th	9.94	9.84	15.60	17.45	10.45		11.14
22nd	10.65	10.47	15.75	18.10	12.90		11.39
29th	11.17	11.35	15.83	17.10	12.26	4.47	8.55
5th November	13.65	12.12	15.50	16.47	16.06	7.10	10.38
12th	11.34	11.42	15.50	16.92	12.10	14.92	13.69
19th	11.14	11.82	12.79	21.32	14.59	12.78	13.25
26th	13.71	10.90	11.37	22.25	13.76	12.66	13.69
3rd December	13.32	13.34	14.79	22.82	14.62	14.29	14.84
10th	12.48	12.63	11.31	22.47	17.08	9.87	12.29
17th	12.29	12.43	15.34	20.59	14.99	10.95	13.19
24th	14.38	13.94	15.29	22.30	13.91	8.99	12.51
31st	14.74	11.86	13.23	23.58	16.11	8.07	11.65
7th January	14.48	10.68	11.70	21.31	14.25	8.37	10.85
14th	14.13	11.59	12.05	19.87	16.25	8.83	11.03
21st	14.92	12.87	15.50	19.57	15.74	9.63	12.02
28th	17.43	12.06	15.11	18.78	14.57	9.21	12.12
4th February	16.74	13.54	12.01	20.38	20.50	9.89	11.89
11th	14.17	12.71	13.12	19.94	19.07	11.07	12.89
18th	17.37	10.52	13.57	21.82	20.50	10.63	12.80
25th	17.45	13.69	12.70	19.40	16.17	10.93	13.34
4th March	17.59	12.85	13.37	18.92	14.45	12.75	14.13
11th	17.88	12.44	13.71	19.66	14.20	11.52	13.49
18th	17.89	12.93	14.21	18.99	11.10	11.38	13.16
25th	17.06	11.28	15.05	30.80	13.16	13.79	14.42
1st April	18.13	14.28	15.16	18.96	12.27	12.48	13.64
8th	17.98	13.62	14.72	15.50	13.92	14.52	14.56
15th	17.34	12.64	13.49	15.50	15.61	14.63	14.64
22nd	15.47	15.27	12.61	18.27	13.53	10.74	11.45
29th	27.50	12.88	15.09	20.85	13.78	11.34	12.43

... continued

TABLE 7.30 (Continued)

Date (Week-ending)		RANGPUR	BOGRA	DACCA	COMILLA	NOAKHALI	MUNSHIGANJ	ALL AREAS
6th May		29.04	11.42	16.58	18.17	14.58	10.88	13.14
13th		20.94	11.35	15.85	23.76	14.55	10.92	12.89
20th		18.95	12.16	16.27	23.89	13.23	11.40	14.08
27th		18.52	13.54	12.95	22.42	14.02	10.68	13.28
3rd June		17.17	14.16	15.75	24.46	11.40	10.61	14.41
10th		16.87	14.66	16.02	21.44	15.77	9.98	14.46
17th		16.71	12.56	16.19	21.42	17.58	10.08	15.13
24th		16.50	12.86	16.58	18.65	17.40	10.68	13.98
1st July		15.52	13.28	16.63	21.83	19.00	10.76	13.98
8th		15.33	13.25	16.49	21.83	18.62	17.91	16.83
15th		15.71	11.89	16.01	21.34	19.33	22.79	18.65
22nd		16.77	11.79	15.57	25.59	18.07	19.12	16.97
29th		17.52	10.50	15.30	16.97	15.18	23.63	20.23
5th August				16.34		15.00	27.19	23.87
12th				16.60			19.91	19.31
19th							17.02	17.02
26th							22.37	22.37
	TOTAL	14.12	12.33	15.03	17.19	12.68	12.21	13.29

TABLE 7.31: MEAN WAGE RATES 1978-79 (Taka per man-equivalent day in cash and kind)

Date (Week-ending)	RANGPUR CASH	RANGPUR (KIND)	BOGRA CASH	BOGRA (KIND)	DACCA CASH	DACCA (KIND)	COMILLA CASH	COMILLA (KIND)	NOAKHALI CASH	NOAKHALI (KIND)	MUNSHIGANJ CASH	MUNSHIGANJ (KIND)	ALL AREAS CASH	ALL AREAS (KIND)
4th June					7.48	(8.68)			10.00	(0.00)			7.59	(8.30)
11th					8.12	(9.91)			10.00	(0.50)			8.71	(6.94)
18th			9.60	(1.50)	7.40	(10.55)			9.24	(4.23)			8.83	(5.58)
25th	5.69	(6.89)	7.89	(5.41)	7.05	(8.55)			7.46	(3.26)			6.97	(6.28)
2nd July	6.53	(7.87)	8.00	(4.90)	6.53	(10.29)	10.50	(10.50)	8.42	(3.87)			7.15	(7.10)
9th	5.98	(8.25)	6.45	(7.02)	6.22	(10.50)			7.63	(3.79)			6.45	(7.73)
16th	5.85	(6.20)	7.51	(5.26)	7.01	(8.96)	0.73	(9.87)	7.80	(3.05)			4.56	(6.80)
23rd	6.00	(5.79)	7.64	(5.02)	5.90	(10.14)	0.59	(9.84)	7.81	(1.80)			4.22	(6.68)
30th	5.78	(6.29)	7.81	(3.78)	6.00	(10.50)	4.34	(9.43)	9.39	(2.73)			7.49	(5.16)
6th August	7.01	(5.99)	7.69	(6.45)	6.21	(10.50)	10.24	(8.11)	10.38	(3.08)			9.21	(5.11)
13th	7.25	(5.35)	8.94	(4.96)	6.05	(9.67)	11.31	(7.26)	10.77	(1.99)			9.86	(3.70)
20th	7.72	(3.26)	12.43	(1.96)	6.70	(8.64)	10.13	(8.09)	10.32	(1.03)			9.90	(2.50)
27th	7.40	(4.03)	10.47	(0.53)	6.07	(8.03)	10.17	(8.58)	10.44	(0.31)			9.78	(1.94)
3rd Sept.	5.04	(7.03)	17.89	(0.05)	6.18	(9.76)	11.57	(5.27)	10.89	(0.10)			10.12	(2.15)
10th	7.53	(2.88)	14.51	(0.28)	6.84	(10.71)	12.17	(5.18)	9.30	(1.77)			9.31	(2.78)
17th	7.19	(4.37)	11.68	(2.08)	7.22	(9.55)	10.76	(6.75)	10.82	(2.18)			9.85	(4.38)
24th	5.87	(3.58)	12.68	(0.34)	6.65	(10.50)	13.24	(4.18)	9.67	(2.03)			9.13	(3.87)
1st Oct.	7.00	(1.86)	8.65	(1.18)	5.73	(10.50)	12.25	(2.97)	7.26	(4.85)			9.46	(2.78)
8th	4.58	(3.97)	8.09	(3.00)	5.50	(7.17)	10.68	(7.06)	10.75	(0.62)			7.29	(3.27)
15th	4.43	(5.52)	8.54	(1.30)	5.77	(9.83)	6.95	(10.50)	9.96	(0.49)			7.40	(3.74)
22nd	4.79	(5.86)	8.56	(1.90)	5.16	(10.59	7.40	(10.70)	5.40	(7.50)			6.87	(4.52)
29th	5.08	(6.09)	7.71	(3.64)	5.33	(10.50)	9.60	(7.50)	7.43	(4.82)	3.99	(0.48)	5.33	(3.22)
5th Nov.	5.44	(8.21)	6.71	(5.40)	5.00	(10.50)	9.12	(7.35)	7.72	(8.35)	6.55	(0.56)	6.53	(3.85)
12th	5.11	(6.23)	8.45	(2.98)	5.00	(10.50)	9.16	(7.76)	8.11	(3.99)	14.42	(0.50)	11.42	(2.27)
19th	6.18	(4.96)	8.90	(2.92)	6.47	(6.32)	13.83	(7.49)	8.50	(6.09)	12.24	(0.54)	10.80	(2.45)
26th	6.86	(6.84)	8.13	(2.77)	4.78	(6.58)	12.85	(9.40)	7.09	(6.66)	12.20	(0.47)	10.50	(3.19)
3rd Dec.	6.90	(6.42)	10.79	(2.55)	5.47	(9.32)	12.30	(10.51)	10.32	(4.30)	13.81	(0.48)	12.31	(2.53)
10th	7.84	(4.64)	10.59	(2.05)	8.48	(2.83)	12.88	(9.59)	13.12	(3.95)	9.39	(0.48)	10.07	(2.22)
17th	9.04	(3.26)	7.96	(4.47)	7.47	(7.87)	12.26	(8.33)	13.55	(1.44)	9.95	(1.00)	10.70	(2.49)
24th	8.99	(5.38)	7.54	(6.40)	9.36	(5.94)	12.59	(9.71)	12.68	(1.23)	8.20	(0.79)	9.56	(2.94)
31st	8.80	(5.94)	7.62	(4.23)	9.94	(3.74)	14.74	(8.83)	10.98	(5.13)	7.54	(0.54)	8.64	(3.01)
7th Jan.	8.36	(6.12)	8.48	(2.21)	8.91	(2.79)	11.27	(10.40)	9.51	(4.73)	7.83	(0.53)	8.39	(2.46)
14th	7.14	(6.99)	9.23	(2.36)	7.99	(4.07)	10.32	(.55)	9.00	(7.25)	8.48	(0.35)	8.55	(2.48)
21st	7.14	(7.79)	8.51	(4.36)	5.00	(10.50)	9.11	(10.46)	8.92	(6.82)	9.18	(0.45)	8.68	(3.34)

.... continued

TABLE 7.31 (continued)

Date (Week-ending)	RANGPUR CASH	RANGPUR (KIND)	BOGRA CASH	BOGRA (KIND)	DACCA CASH	DACCA (KIND)	COMILLA CASH	COMILLA (KIND)	NOAKHALI CASH	NOAKHALI (KIND)	MUNSHIGANJ CASH	MUNSHIGANJ (KIND)	ALL AREAS CASH	ALL AREAS (KIND)
28th Jan.	7.03	(10.40)	7.29	(4.78)	6.57	(8.54)	9.16	(9.63)	12.00	(2.57)	8.81	(0.39)	8.33	(3.78)
4th Feb.	6.85	(9.89)	6.59	(6.95)	7.95	(4.06)	11.05	(9.33)	10.00	(10.50)	9.55	(0.34)	9.17	(2.72)
11th	6.71	(7.46)	7.60	(5.11)	9.67	(3.45)	12.17	(7.77)	10.00	(9.07)	10.77	(0.30)	10.40	(2.49)
18th	6.87	(10.50)	7.71	(2.81)	11.69	(1.88)	12.58	(9.24)	10.00	(10.50)	10.45	(0.18)	10.46	(2.35)
25th	7.33	(10.13)	7.88	(5.81)	10.57	(2.13)	11.59	(7.82)	7.57	(8.59)	10.68	(0.26)	10.05	(3.29)
4th March	7.09	(10.50)	9.96	(2.88)	11.30	(2.07)	12.47	(6.45)	7.56	(6.88)	12.41	(0.34)	10.58	(3.54)
11th	7.38	(10.50)	7.95	(4.49)	9.54	(4.16)	11.38	(8.28)	8.41	(5.79)	11.28	(0.24)	9.90	(3.59)
18th	7.39	(10.50)	8.47	(4.46)	7.59	(6.62)	12.00	(6.99)	9.65	(1.45)	11.11	(0.27)	9.20	(3.95)
25th	6.79	(10.27)	8.17	(3.12)	7.37	(7.68)	22.78	(8.02)	9.14	(4.02)	13.54	(0.25)	9.37	(5.05)
1st April	7.63	(10.50)	8.61	(5.67)	7.61	(7.55)	18.46	(0.50)	8.37	(3.90)	12.11	(0.37)	10.12	(3.53)
8th	7.48	(10.50)	5.69	(7.92)	8.35	(6.37)	15.00	(0.50)	8.52	(5.40)	14.10	(0.41)	12.38	(2.18)
15th	6.84	(10.50)	8.29	(4.35)	10.51	(2.99)	15.00	(0.50)	8.09	(7.51)	14.27	(0.36)	12.76	(1.88)
22nd	4.97	(10.50)	11.66	(3.61)	11.12	(1.49)	14.06	(4.20)	8.79	(4.74)	10.43	(0.31)	10.40	(1.05)
29th	17.00	(10.50)	7.69	(5.19)	8.41	(6.68)	18.00	(2.85)	8.41	(5.37)	10.97	(0.38)	10.44	(1.99)
6th May	18.54	(10.50)	7.89	(3.53)	6.06	(10.52)	14.84	(3.32)	7.06	(8.52)	10.50	(0.38)	9.64	(3.51)
13th	10.44	(10.50)	7.90	(3.45)	6.25	(9.60)	14.57	(9.20)	8.26	(6.28)	10.57	(0.35)	9.63	(3.26)
20th	8.45	(10.50)	8.25	(3.91)	5.77	(10.50)	14.97	(8.92)	9.63	(3.60)	11.03	(0.37)	10.28	(3.80)
27th	8.02	(10.50)	6.56	(6.98)	6.95	(6.00)	14.08	(8.34)	10.47	(3.55)	10.33	(0.35)	9.56	(3.72)
3rd June	7.69	(9.48)	6.48	(7.68)	5.92	(9.83)	14.84	(9.62)	9.13	(2.27)	10.25	(0.36)	9.29	(5.13)
10th	6.37	(10.50)	9.44	(5.21)	6.30	(9.72)	16.42	(5.03)	7.58	(8.19)	9.56	(0.42)	8.53	(5.93)
17th	6.21	(10.50)	7.69	(4.86)	6.32	(9.87)	18.79	(2.63)	9.95	(7.63)	9.62	(0.46)	7.88	(7.25)
24th	6.00	(10.50	6.65	(6.21)	7.03	(9.55)	13.64	(5.01)	11.20	(6.20)	10.19	(0.49)	8.11	(5.87)
1st July	5.02	(10.50)	5.12	(8.16)	7.01	(9.62)	21.33	(0.50)	10.00	(9.00)	10.02	(0.74)	8.05	(5.94)
8th	6.03	(9.30)	2.75	(10.50)	5.86	(10.63)	21.33	(0.50)	8.12	(10.50)	12.41	(5.50)	8.72	(8.11)
15th	6.71	(9.00)	7.42	(4.47)	6.07	(9.94)	19.79	(1.55)	8.83	(10.50)	14.81	(7.98)	10.53	(8.11)
22nd	8.00	(8.77)	9.29	(2.50)	7.25	(8.32)	23.08	(2.51)	7.57	(10.50)	11.75	(7.33)	9.52	(7.44)
29th	8.68	(8.84)	10.00	(0.50)	5.96	(9.34)	21.60	(5.37)	13.27	(1.91)	15.40	(8.23)	11.80	(8.42)
5th August					6.28	(10.06)			15.00	(0.00)	19.05	(8.14)	15.87	(7.99)
12th					6.35	(10.25)					13.60	(6.32)	12.28	(7.03)
19th											11.29	(5.73)	11.29	(5.73)
26th											12.96	(9.41)	12.96	(9.41)
TOTAL	7.40	(7.08)	8.50	(3.83)	7.76	(7.27)	8.89	(8.30)	9.89	(2.79)	11.25	(0.95)	9.56	(3.73)

NOTES ON TABLES 7.30 and 7.31

1. Payments in kind were evaluated by estimating from respondents' reports of 'typical' meals, etc. valued at current local market prices. In the case of food, its value was taken as being proportionate to the amount of time worked on the day in question (see Section 7.4). These figures are therefore fairly rough estimates and are obviously not as accurate as those on payments in cash.
2. The early figures on Munshiganj exclude fairly substantial 'contract' (piece rate) payments for harvesting b. aman in the 1978 season. Since much of the work was done before commencement of the Survey in that area no reliable estimates of the number of man-days spent are available.

TABLE 7.32: REGRESSION OF DAILY WAGE PAYMENTS IN CASH ON THOSE IN KIND

Equation Number	Area	Regression Equation	Standard Error of Estimate	r^2	Significance (%)
7.32.1	All Areas	Ca = 10.9 - 0.4 Ka	4.99	0.147	0.1
7.32.2	Rangpur	Cr = 8.2 - 0.1 Kr	3.78	0.016	0.1
7.32.3	Bogra	Cb = 12.3 - 0.7 Kb	5.46	0.283	0.1
7.32.4	Dacca	Cd = 11.6 - 0.5 Kd	2.94	0.348	0.1
7.32.5	Comilla	Cc = 17.6 - 0.6 Kc	5.13	0.225	0.1
7.32.6	Noakhali	Cn = 12.6 - 0.5 Kn	4.88	0.163	0.1
7.32.7	Munshiganj	Cm = 16.6 - 0.1 Km	16.08	0.001	n.s.

Notes: Dependent variable: amount paid in cash (taka per man-equivalent day)
Independent variable: value of payments in kind (taka per man-equivalent day).
n.s. = not statistically significant at the 5% level.

TABLE 7.33: REGRESSION OF DEMAND FOR LABOUR ON WAGE RATES

Equation Number	Area	Regression Equation	Standard error of Estimate	r^2	Significance (%)
7.33.1	All Areas	Da = 15.5 - 0.002 Wa	2.52	0.117	1.0
7.33.2	Rangpur	Dr = 17.5 - 0.02 Wr	3.61	0.136	1.0
7.33.3	Bogra	Db = 13.5 - 0.01 Wb	1.38	0.117	1.0
7.33.4	Dacca	Dd = 15.3 - 0.01 Wd	1.68	0.006	n.s.
7.33.5	Comilla	Dc = 21.0 - 0.02 Wc	3.05	0.269	0.1
7.33.6	Noakhali	Dn = 17.0 - 0.009 Wn	11.12	0.034	n.s.
7.33.7	Munshiganj	Dm = 14.5 - 0.004 Wm	4.63	0.046	n.s.

Notes: Dependent variable: total number of man-equivalent days of casual labour hired by all sample farmers in a given week;
Independent variable: mean wage (cash and kind) per man-day equivalent in the same week.
n.s. = not statistically significant at the 5% level.

In the absence of data on the supply side of casual labour and given the imperfect and rather volatile nature of at least this side of the equation, it is not possible to conduct a very searching examination of the relationship between the level of wages and that of employment. However, an investigation on the demand side at least is possible, and the results of this are presented in Table 7.33. As with the previous table these results show a high degree of internal consistency in that the signs of both intercept and slope are the same for all seven equations, although the relationship is not in all cases statistically significant.

If the above findings are in any way representative they are extremely important. The situation usually postulated in a country like Bangladesh is one of highly peaked labour demand such that at certain times of the year, even with a population density as high as that of present day Bangladesh, there are seasonal shortages of labour. If this is the case the excess of demand over supply at these times could be expected to drive up the wage rate so that periods of high employment would be associated with relatively high wages also. The above figures however lend no support to this view and in fact suggest the opposite, that is that high labour demand is associated with periods of cheap labour. It is quite possible of course that the above relationship is not representative and derives at least in part from the fact that drought conditions, and consequently unusually low labour demand, prevailed during part of the Survey period. With a very poor crop only very cheap labour would induce farmers to hire it for operations such as weeding - in severe cases even harvesting - the return to which could be expected to be low.[1] These findings do, nonetheless, set a lower bound on labour demand and indicate that in a bad year at least, even at peak periods, the supply of labour can exceed this demand at the (to some extent institutionally determined) going rate.

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[1] Available time did not permit a more sophisticated analysis including for example leads and lags in the system. In view of the lack of data on the supply side this could not in any case have been much more conclusive than the results presented in Table 7.31. Disaggregating the wage into cash and kind did however show a tendency for a fairly strong negative relationship with the latter and a weaker positive one with the former. This suggests that the farm family finds it difficult to supply prepared food (the major wage good for this type of contract) to large numbers of workers and therefore substitutes additional cash payments for this.

CHAPTER 8: INDIRECT EMPLOYMENT CONSIDERATIONS

It is an important finding of the present study that labour intensity in Bangladesh agriculture correlates negatively with farm size. This suggests that, in addition to any direct labour displacement effect of mechanisation, indirect displacement may also occur if the mechanisation process leads to land transfers, hence land accumulation and a consequent increase in average operated acreage. Three questions will be investigated in this context. First, what, if any, is the relationship between mechanisation and land accumulation? Second, if such a relationship exists, what is the mechanism of land transfer between farmers? Finally, what is the extent of inequality in land ownership comparing farms at the present time? This last variable will presumably affect the rate at which future land transfers may potentially occur.

8.1. MECHANISATION AND LAND ACCUMULATION

The theoretical relationship between mechanisation and increasing farm size was demonstrated in Chapter 1, and the present study has confirmed that at least in some areas (particularly the power tiller area, Munshiganj) tractor users have significantly larger average operated acreages than non-users (see Table 4.2). In the BADC tractor-hire areas the situation is somewhat complicated by the institutional factors mentioned earlier (Section 4.1),[1] but at least in Munshiganj where distribution of power tillers and power tiller services is determined by predominantly commercial criteria, not only are operated acreages significantly larger comparing power tiller users with non-users, but the same holds true when power tiller owners are compared with those who merely hire them, the arithmetic means being 7.3 acres for the former group compared with 3.1 acres for the latter.[2]

The above association does not, of course, by itself demonstrate causality in either direction, but investigation has in fact shown that the power tiller owners have increased their operated acreages subsequently to and, they report, as a direct result of, purchasing their machines. Four methods were reportedly used for this purpose: (i) failing to renew a land lease on its expiry, (ii) renting in additional land, (iii) mortgaging in of others' land, and (iv) outright purchase. Details for five power tiller owners in the Munshiganj sample are provided in Table 8.1.

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[1] Nevertheless a number of users of the BADC tractor-hire service have reported increasing their operated acreages since beginning to use the service. This assertion tends to be confirmed by the analysis presented in Table 8.8.

[2] ANOVA: level of significance = 0.1%.

TABLE 8.1: INCREASES IN OPERATED ACREAGE AS A RESULT OF POWER TILLER PURCHASE

Farm	Area Acquired (Acres)				Increase in size of holding (%)
	Previously Rented Out, now cultivated by Owner	Newly Rented In	Newly Mortgaged In	Purchased	
A	-	0.40	0.40	-	42
B	1.0	-	-	1.72	92
C	-	2.40	-	-	28
D	-	3.20	-	-	47
E[a]	4.0	-	-	-	88

[a]The figure for this farmer excludes 0.48 acres purchased during the period in question. The farmer was not sure whether to attribute this particular acquisition to income from the machine or from his activities as a trader.

The above conclusions are consistent with earlier findings of the present study deriving from interviews with power tiller owners in two other quite distinct parts of the country from Munshiganj - Sylhet and Jessore.[1] In both of these areas tiller owners reported that the main method by which they increased their total operated acreages was by the displacement of sharecroppers, a process which is particularly easy in Bangladesh given that share lease arrangements are typically only of one season's duration. Sharecroppers do not therefore need to be evicted (with possible attendant social or legal implications), merely refused a lease in subsequent seasons. The same basic argument applies to cash leasing arrangements (see Section 2.3 above) which generally last for one year.

It is most important in this context to note that the increases in question are in operated rather than owned acreage. An increase in land ownership alone (resulting perhaps from the investment of the profits of power tiller hiring), need not result in labour displacement if such land acquisitions resulted in a net increase in leasing out rather than in operated acreage. Two major economic reasons why the latter variable might in theory increase with tractor acquisitions are, as indicated in Chapter 1, the need to maximise the capacity utilisation of such a 'lumpy' investment and second the easing of managerial constraints resulting from replacing a large number of labourers and/or animals with a smaller number of machines. The power tiller owners almost unanimously named the second of these as the decisive factor in the decision to increase operated acreage. Mechanisation, they report, frees them from the difficulty of locating a sufficient supply of labour and draught animals during the peak cultivation season and subsequently from the necessity of supervising them once acquired. They also report, as was noted earlier,

[1]Details were provided in the Second Progress Report of the present study.

that engine powered cultivation reduces the need for labour for weeding with its consequent burden of supervision. Nevertheless, any labour supply/supervision problem for harvesting and post-harvest operations is in no way eased by mechanised tillage, and yet labour requirements for these tasks are just as great as those for weeding and much greater than for land preparation (see Tables 7.2-7.8). For operated acreage to have expanded in the face of this remaining difficulty suggests that the supply constraint in land preparation relates more to draught animals than to labour. This interpretation is certainly borne out by farmers' reports. Alternatively (or additionally) the farmer may be able or willing either to increase managerial inputs or accept lower standards of husbandry in one task but not in several.

The reason that the owners of power tillers have not mentioned capacity utilisation as a factor determining increases in their operated acreage is quite simply that no such problem exists during the ploughing season.[1] The balance of demand and supply for draught power during busy seasons is such that they can hire out any excess capacity with the greatest of ease and very profitably (Chapter 9). The only power tiller owners who do not hire out such capacity operate what are by Bangladesh standards very large holdings of 30 to 50 acres. This latter range therefore suggests an upper limit to the area which can be operated with a single power tiller and hence a similar limit on land acquisition induced by power tiller ownership.

These last figures suggest that in Munshiganj there is still considerable scope for increases in the acreage operated by the power tiller owners should they wish to do so. Land acquisition is of necessity a gradual process in a situation of land scarcity, since it is then dictated largely by supply factors. It is not therefore known whether the transfer process has yet reached its limit among the power tiller owners of Munshiganj. Additional incentive to acquire cultivation rights would be provided if at some future date the market for machine hire became less attractive as a result, say, of falling charges consequent upon increased draught supply. This would be the case if the present relatively small number of operating tillers were to increase substantially, since it would produce a situation in which (a) land acquisition became more attractive relative to hiring out as a method of improving capacity utilisation and (b) there would be a greater number of power tiller owners than previously in the business of trying to increase their operated acreages. This would in turn produce a situation in which the pressure on the land resources of small cultivators increased markedly, with all of the consequent implications for labour displacement.

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[1] The power tillers are largely idle during many months of the year and capacity utilisation could undoubtedly be increased by adapting them, using existing technology, for such tasks as irrigation. Chapter 9 will deal with this topic.

8.2. THE MECHANISM OF LAND TRANSFER

The most important mechanism for transferring land between holdings is the traditional system of mortgaging (bondhok) described in Chapter 2.[1] Smallholders in urgent need of cash do not normally sell land, but tend to mortgage it out in the hope of reclaiming it at some future date when family fortunes will, they hope, have improved.

Table 8.2 summarises the reasons given by some sixty sample farmers who reported having mortgaged out farm land under the traditional system whereby they lost cultivation rights.[2] Obviously the most common reason, the purchase of food and medicines, indicates distress mortgaging, as does loan repayment, but the other explanations are not quite so clearcut. It may seem strange at first sight that a farmer would mortgage out one piece of land in order to purchase another, but this in fact usually represents rationalisation of a holding by mortgaging out a more distant plot (perhaps an inherited one from the mother's family) in order to acquire one closer to the farmstead. House construction is usually the result of a new couple setting up home after marriage and this together with repair of an existing house can be regarded as cases of at least pressing urgency if not serious distress. 'Social obligations' are also connected with marriage ceremonies and entail the expense of the ceremony itself, or of providing a dowry for a daughter of the family. The cases of land mortgaged out to finance purchases of agricultural inputs are almost certainly indicative of distress, since they represent farmers forced to exchange one scarce productive asset for another which is presumably in even shorter supply. The same is equally true in the case of mortgaging land so as to purchase draught animals.

Tables 8.3 and 8.4 provide some indication of the duration of traditional mortgage agreements. The minimal nature of these figures must, however, be stressed, since (i) they relate to current agreements, that is ones which have not yet been redeemed by the mortgagor, and (ii) there is a tendency, reported earlier, for land which has been mortgaged in for a long period of time increasingly to be regarded by the mortgagee as owner-operated, so that agreements

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[1] It is extremely difficult in a cross-sectional study such as this to chart long-term changes in rented land since as has been stated many times this usually occurs on a seasonal basis, the land regularly reverting to its owner for part of each year. The reasons given for renting land out on such a basis are nearly always basically concerned with the expensiveness of cultivation in the aus or boro seasons, although social obligations are also occasionally cited.

[2] Land is also sometimes mortgaged out in the more modern sense, as security for loans, the major mortgagees being organisations such as the Bangladesh Krishi Bank, a co-operative or, occasionally, a commercial bank. In this case, however, the mortgagor retains cultivation rights and the mortgage is clearly not designed as a vehicle for land transfers. Such mortgages have been excluded from the present analysis.

TABLE 8.2: REASONS FOR MORTGAGING OUT LAND (% of all contracts)

Food and Medicines	33.0
Land Purchase/improvement	16.7
House construction/repair	16.7
Purchase of animals	10.8
Loan repayments	5.0
Purchase of inputs	4.7
Social obligations	4.7
Litigation	4.2
Other non-agricultural	4.2
	100.0

TABLE 8.3: LENGTH OF TIME CURRENT MORTGAGE AGREEMENT OUTSTANDING (Percentage Distribution of Contracts)[a]

	Percentage	Cumulative Percentage		Percentage	Cumulative Percentage
Less than 1 year	6.2	6.2	4 to 5 years	7.2	87.6
1 to 2 years	37.1	43.3	5 to 10 years	5.2	92.8
2 to 3 years	27.8	71.1	More than 10 years	7.2	100.0
3 to 4 years	9.3	80.4			

[a]No. of observations = 97.

TABLE 8.4: LENGTH OF TIME CURRENT MORTGAGE OUTSTANDING (Summary Statistics)

Area	Number of Years Outstanding						Standard Error	Skewness	Kurtosis	No.
	Mean	Median	Mode	Min.	Max.	Standard Deviation				
All Areas	2.9	1.7	1	0	20	3.88	0.39	2.78	7.33	97
Rangpur	1.6	1.4	1	0	4	0.87	0.24	1.83	4.13	13
Dacca	2.2	2.0	2	0	5	1.39	0.34	0.78	0.25	17
Comilla	1.4	1.2	1	0	5	0.99	0.17	1.56	4.47	34
Noakhali	9.0	4.5	15	0	20	7.17	1.92	0.05	-1.94	14
Munshiganj	2.8	2.3	2	1	8	2.09	0.48	1.67	2.47	19

Note: No such arrangements were found in the Bogra sample

TABLE 8.5: RELATIONSHIP BETWEEN LAND MORTGAGING AND TRACTOR USER STATUS

Equation Number	Area[a]	Regression Equation	Degrees of Freedom	Standard Error	F-Statistic	Signif. (%)	r^2
8.8.1.	All Areas	Na=0.23+0.19T (0.057)	358	0.515	10.276	0.1	0.028
8.8.2.	Rangpur	Nr=0.16T (0.062)	34	0.184	6.755	2.5	0.166
8.8.3.	Munshiganj	Nm=0.01+0.30T (0.167)	70	0.702	3.128	6.0	0.043

Variables: N=net acreage mortgaged in under traditional arrangement (i.e. acreage mortgaged in minus acreage mortgaged out)
T=Tractor user status (dummy variable: 1=user, 0=non-user).

[a]The equation for Noakhali also showed net acreage mortgaged in to correlate most closely (and positively) with tractor user status, but only at the 10 per cent significance level.

which have been outstanding for a relatively long period will tend to be under-represented by the figures in Tables 8.3 and 8.4. It is clear from the second of these two tables that Noakhali once again proves to be an exceptional case with the 'typical' (that is modal) current mortgage agreement having been outstanding for as much as fifteen years, compared with one or two years for the other areas. Taking the sample as a whole it can be seen that the overwhelming majority of current mortgage agreements are already of more than one year's duration and one in eight has been outstanding for more than five years.

It would unfortunately be unwise to assume that all mortgage arrangements operate in strict accordance with the agreement entered into by the parties. In particular, despite the fact (or, more likely, because of the fact) that the agreement is so much more favourable to the mortgagee (the lender) than to the mortgagor, the latter can sometimes find it extremely difficult to recover his land even if he is able to repay the original loan. A case, which cannot be regarded as atypical, from the Munshiganj area will help illustrate this point. Farmer A had mortgaged out three acres of land to a much more wealthy and influential farmer, B, for Tk.1,600/- several years previously. Farmer B had subsequently refused to accept repayment and had kept the land, trying to force A to sell it for Tk.10,000/-. The latter refused claiming the land in question was worth three times as much: other farmers in the area had reportedly been prepared to pay the higher price, but had subsequently withdrawn, afraid of B's power and influence. Finally, A persuaded another influential farmer to purchase the land in question for Tk.15,000/-, plus repayment of the mortgage.

In an attempt to identify the factors determining the mortgaging in and out of land, a composite dependent variable, Net Area Mortgaged In (that is area mortgaged in minus area mortgaged out) was regressed against a number of potential 'explanatory' variables. These were: area owner-operated, installed horsepower per acre, permanent labour per acre and tractor user status. In fact only the last of these variables was found to correlate significantly with net acreage mortgaged in. The results of this analysis are presented in Table 8.5 which shows that in all cases where there is a statistically significant relationship between tractor user status and net mortgaging in of land that relationship is positive (the tractor user group tend to mortgage in more land (net) than non-users). The equation for Rangpur is especially interesting in that it contains a zero intercept value, suggesting that non-tractor users do not mortgage in land (net). The consistency of these regression findings with those from the informal studies reported in Section 8.1 above are most important, indicating that even in its present embryonic state in Bangladesh tractorisation could well be responsible for a degree of land accumulation with all the attendant implications for employment prospects.

8.3. INEQUALITY OF LAND HOLDINGS

The problem of landlessness is one which receives a great deal of well-merited attention in discussions of equity issues in Bangladesh agriculture. Definitions vary,[1] but one distinction, and one which is not always in fact made, is based on whether or not the income of a given landless individual is mainly derived from agriculture. The fact that a village shopkeeper, for example, or a thana level government official may be landless is not in itself a factor of any particular economic or social significance. This distinction is an important one, as can be seen from the figures in Table 8.6 which indicate that over the sample as a whole around a quarter of all rural landless are non-agricultural workers. The overall figure for rural landlessness shown in Table 8.6, 36.3 per cent of households, corresponds quite closely to the offical estimate (32.8%) for the country as a whole,[2] but only three quarters of the former group can be described as landless agricultural labourers.

The above figure is nonetheless disturbingly high in a country which employs 80 per cent of its population in, and derives at least half of its gross domestic product from, the agricultural sector. Moreover in addition to the completely landless, households similarly placed, if to a lesser degree, are those with marginal or submarginal holdings, that is (respectively) those whose holdings are insufficiently large to provide a surplus to cover a bad year or a sudden large item of expenditure and those whose income from farming requires supplementation even in normal circumstances. Reference back to Tables 2.11 and 2.14 shows that almost ten per cent of all farms are of less than one acre and 44 per cent comprise less than 2.5 acres. About 70 per cent of all farm land is owner-operated, but the degree of variability in both operated and owned acreage is very marked, with coefficients of variation sometimes in excess of 100 per cent.[3]

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[1] Government statisticians provide the following alternative definitions of landlessness:

Landless 1: "a rural household that claims ownership of no land either homestead land or other land".

Landless 2: "a rural household that does not claim ownership of homestead land but which may or may not claim ownership of land other than homestead land".

Landless 3: "a rural household that does not claim ownership of any land other than homestead land. Such a household may or may not claim ownership to homestead land".

Landless 4: "a rural household that claims ownership to some land other than the homestead but no more than 0.5 acres of land other than the homestead". (Bangladesh Government (1979) Table 4.5).

[2] Bangladesh Government (1979) Table 4.5, p.145.

[3] Coefficient of variation = (100 x St. Deviation)/Mean.

TABLE 8.6: LANDLESSNESS (Percentage of Households)[a]

Area	Of Those In Agriculture	Of All Villagers[b]
All Areas	27.4	36.3
Rangpur	28.3	54.3
Bogra	41.5	46.6
Dacca	20.1	14.0
Comilla	27.5	40.2
Noakhali	29.4	32.6
Munshiganj	13.9	19.5

Notes: [a]Landless households are here defined as those which do not own any land except in some cases homestead land. It thus corresponds with "Landless 3" in the official statistics.

[b]Not all landowners are themselves engaged in agriculture, so that the percentage in column 2 may be less than that in column 1.

The extent of inequality in land ownership is depicted in Figures 8.1.1 to 8.1.7. Each of these diagrams comprises two Lorenz curves and their associated Gini coefficients. The upper curve in each figure represents only those farmers who own some land, even if very little, the lower one all those normally engaged in agriculture, including landless farm labourers.[1] Thus, the horizontal intercept of the lower Lorenz curve of each diagram shows the proportion of agriculturally employed households which are landless. Table 8.7 brings together the Gini coefficients for all areas.

[1]A Lorenz curve is a graphical illustration of inequality. Individuals (in this case: I : Farming Households Owning Some Land and II : All Households Primarily Engaged in Agriculture) are ranked in terms of the area of farm land owned and the two sets of cumulative percentages calculated and graphed. The 45^{o} line in each graph represents absolute equality - e.g. ten per cent of individuals owning ten per cent of land. The more bowed the Lorenz curve the more reality departs from this; for example Figure 8.1.1 shows that the lowest fifty per cent of all landowning farm households own only 16.8 per cent of all farm land, while the bottom 50 per cent of all agricultural households owns only 6.7 per cent of such land. The Gini coefficient (G) is a numerical representation of such inequality. It is the ratio of the 'bow-shaped' area under the 45^{o} diagonal to that of the right-angled triangle which contains it. Thus the Gini coefficient varies from 0 (perfect equality) to 1 (perfect inequality). The coefficient can be derived by graphical methods or, if the parameters of the Lorenz curve are known, by integration. Almost all (97.2 per cent) of farm, as distinct from labourer, households own some land.

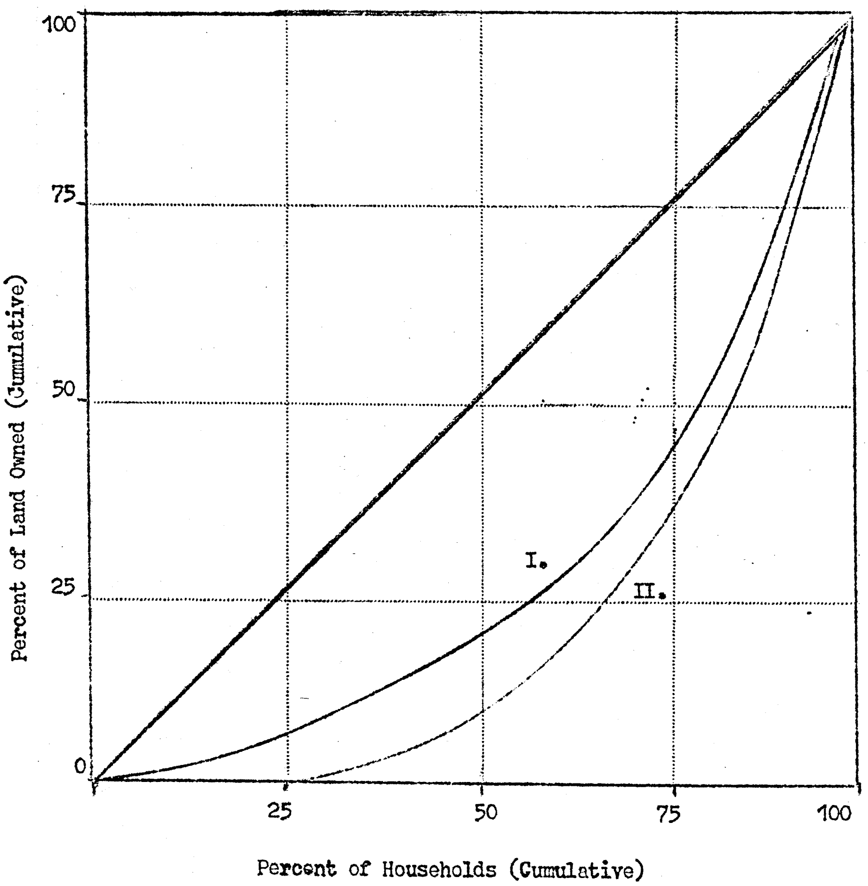
TABLE 8.7: INEQUALITY OF LAND OWNERSHIP (GINI COEFFICIENTS)

	Farm Households Owning Some Land	All Agricultural Households	Difference
All Areas	0.499	0.637	0.138
Rangpur	0.370	0.574	0.204
Bogra	0.403	0.659	0.256
Dacca	0.426	0.542	0.126
Comilla	0.486	0.649	0.163
Noakhali	0.554	0.696	0.142
Munshiganj	0.490	0.584	0.094

These data illustrate quite vividly the degree of inequality in land distribution which exists even in the absence of any substantial degree of farm mechanisation. Moreover the true picture might for two reasons be even more skewed than that presented above. First, the landless are in all probability underrepresented in the sample since many of them may have migrated away from their home village in search of work, and would therefore have thereby excluded themselves from the sample. Second, at the other end of the scale to the extent that absentee landlordism exists some large landowners may have similarly been excluded.

While the Gini coefficient indicates the relative degree of inequality in a distribution the shape of the Lorenz curve also independently conveys important information. There is no reason that the Lorenz curve should necessarily be symmetrical and for a given G value the closer its apogee (with respect to the line of absolute equality) lies to the north east corner the greater must be the influence of a few relatively large farms. The opposite of this last position can be seen in the figures for Bogra, where the influence of a relatively large number of medium-sized farms has pulled the apogee of the Lorenz curves downwards. Where large farms are relatively important, and hence the value of G is highest, is Noakhali. The special circumstance of the large tracts of <u>char</u> lands mentioned already does however play a major role here.

FIGURE 8.1: INEQUALITY IN LAND OWNERSHIP (LORENZ CURVES AND GINI COEFFICIENTS) ALL AREAS



I. LANDOWNERS ONLY (G=0.499)

II. ALL AGRICULTURAL HOUSEHOLDS (G=0.637)

FIGURE 8.2: RANGPUR

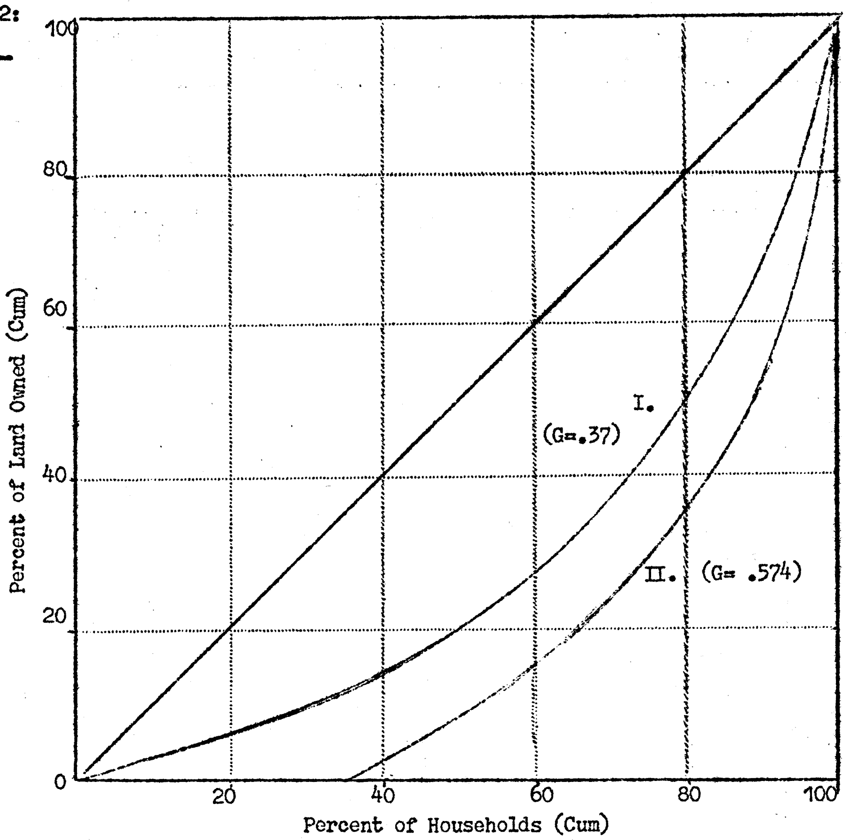


FIGURE 8.3:

BOGRA

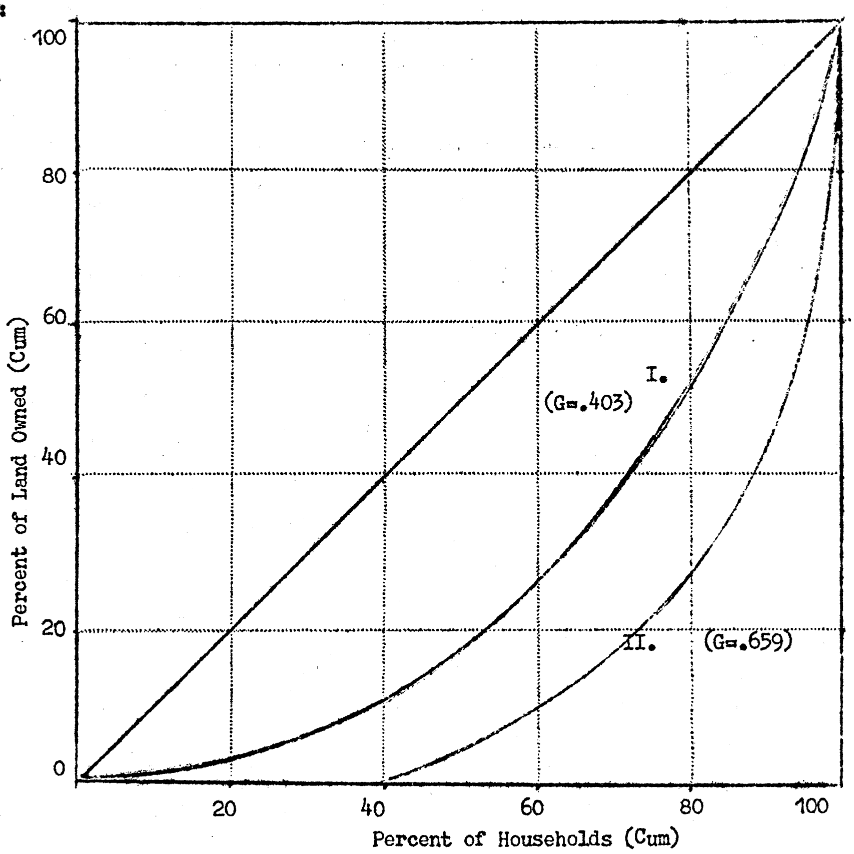


FIGURE 8.4:
DACCA

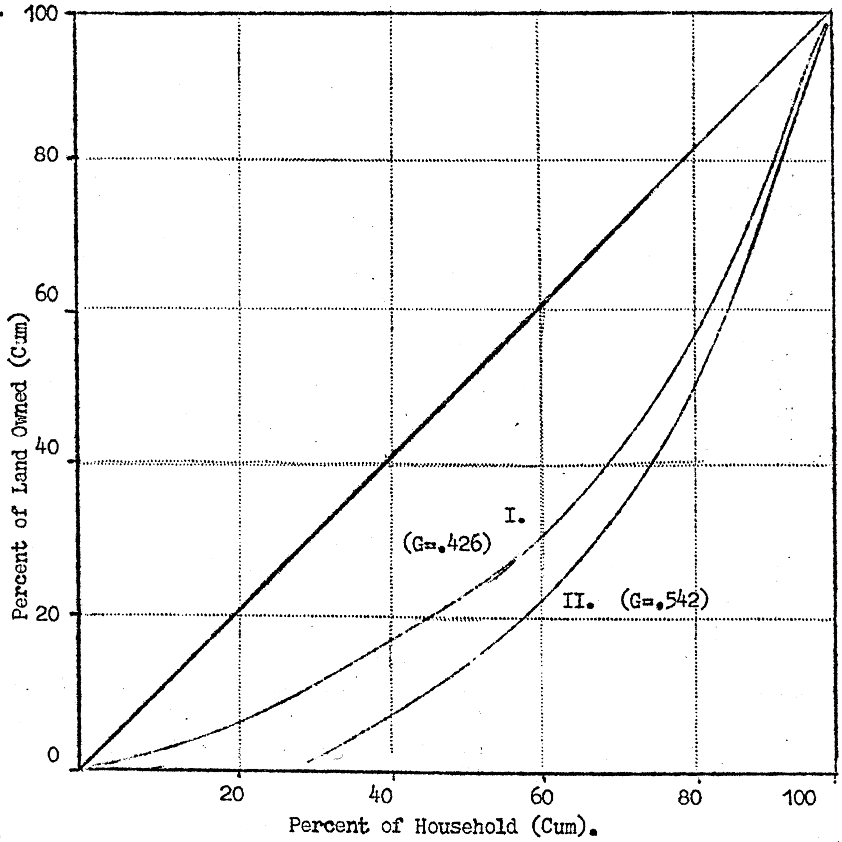


FIGURE 8.5:
COMILLA

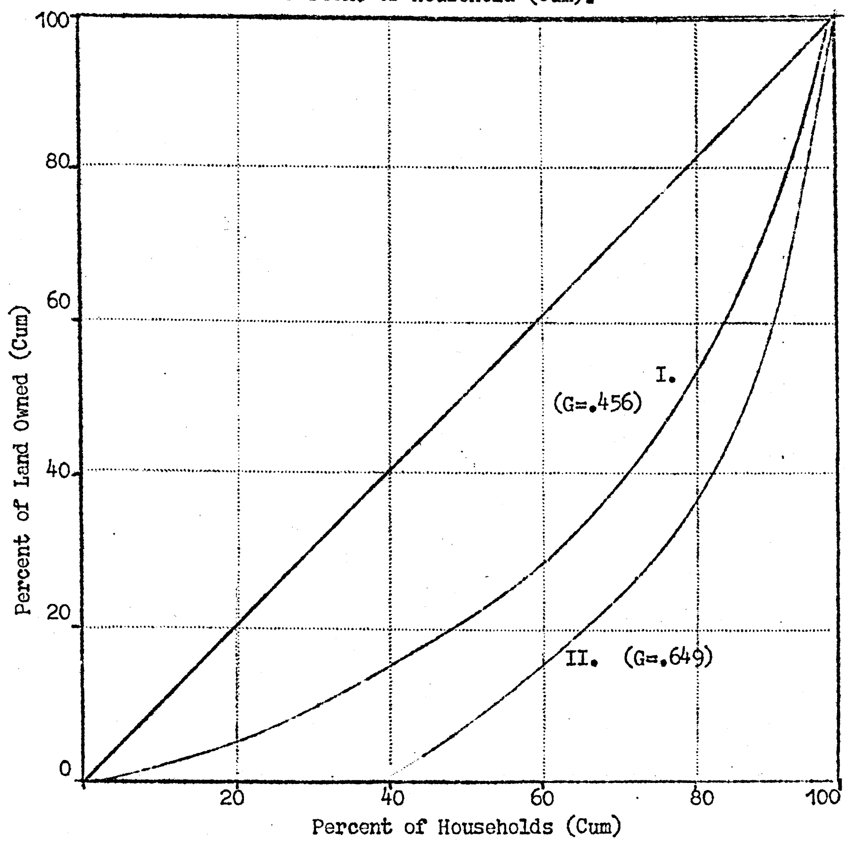


FIGURE 8.6:
NOAKHALI

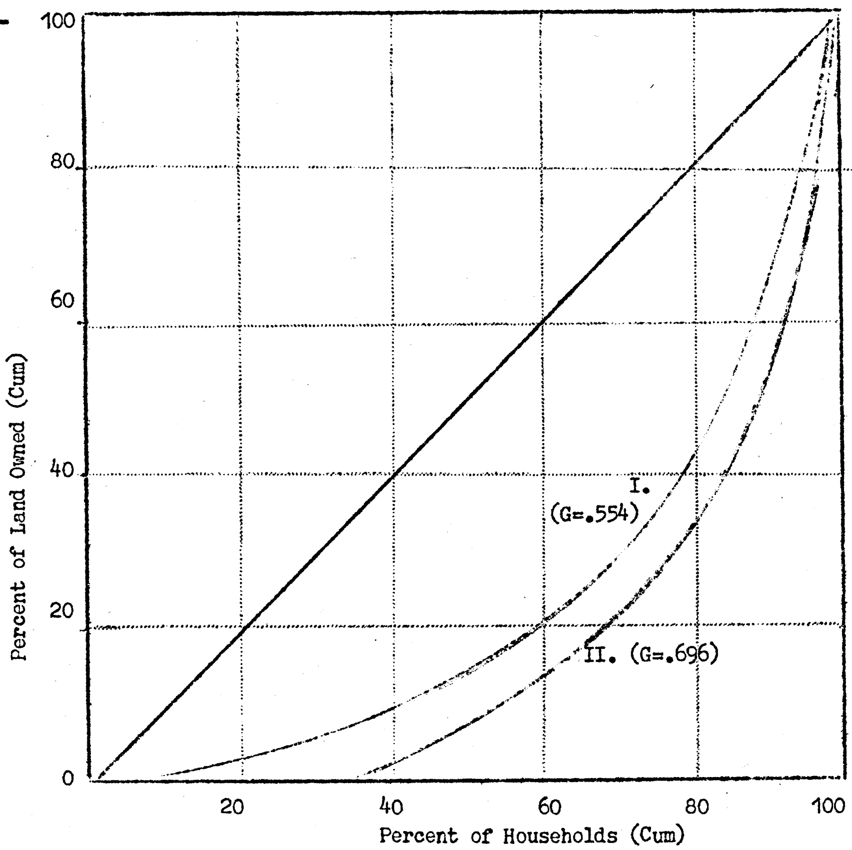
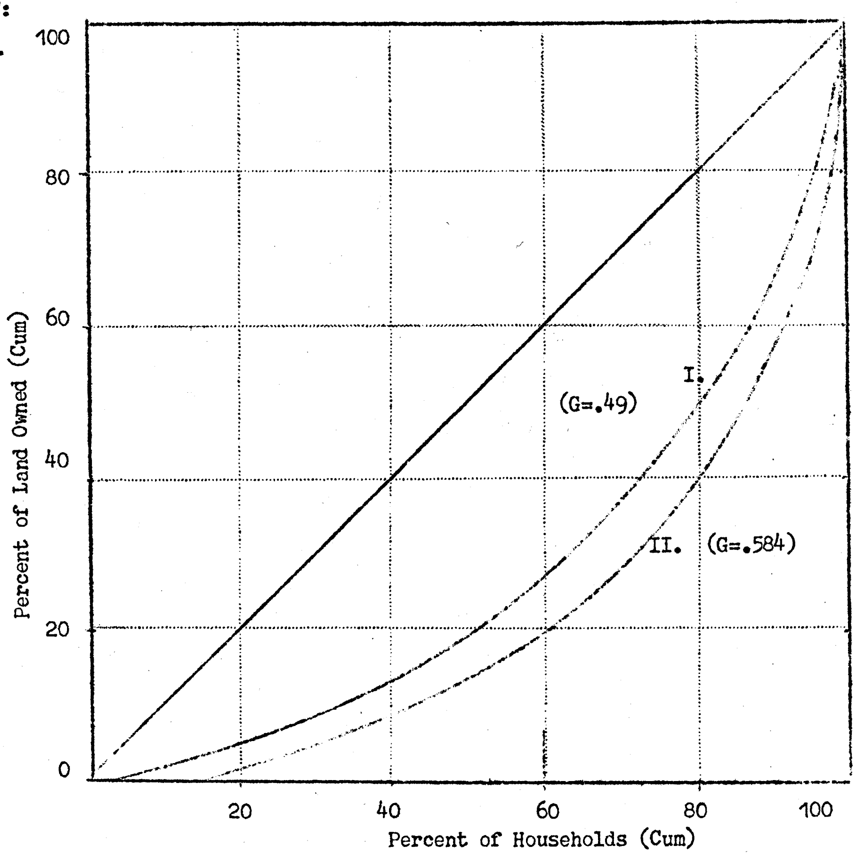


FIGURE 8.7:
MUNSHIGANJ



CHAPTER 9: SUMMARY AND CONCLUSIONS

SUMMARY

9.1. INTRODUCTION (1.1-1.3)[1]

The debate concerning agricultural mechanisation in general and tractorisation in particular in developing countries has been confused and bitter and is as yet unresolved. In theory tractorisation can confer the advantages listed below. (It should be noted that the word tractors throughout this report is meant to include both two-axle tractors and single-axle 'power tillers'. The distinction is made specific whenever necessary).

a. More thorough cultivation and therefore higher yields;
b. Cultivation of dry and difficult soils;
c. Faster operation permitting an increase in yields through more timely planting and an increase in cropping intensities, and the introduction of new cropping patterns through, for instance, faster turnaround between crops;
d. Release of land which is no longer required to maintain draught animals;
e. Increased crop production producing new employment opportunities;
f. Possible reduction in cultivation costs;
g. Easing of management constraints;
h. Reduction in human toil and drudgery;
i. Prestige and other non-economic considerations.

Opponents of unrestricted mechanisation in developing countries argue the following disadvantages of tractorisation:

a. Direct labour displacement in land preparation and possibly also weeding;
b. Even where compensating job opportunities are created, increased seasonality of employment, which will provide the stimulus for further mechanisation;
c. Indirect labour displacement, for instance through tenant eviction, as mechanisaed holdings expand in pursuit of scale economies;
d. The substitution of foreign exchange and other scarce resources for plentiful labour;
e. The above processes tending to foster an increasingly unequal distribution of wealth.

The issues of agricultural production and employment are both of unusually vital concern in Bangladesh: Production because per capita levels of food intake, as well as of other agricultural produce, are well below accepted minima, and employment because such a high proportion of the population depends on agriculture for its livelihood and

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[1] Since the Summary does not follow exactly the same sequence as the text of the main Report, the relevant section number(s) (2-digits) of the main body are indicated in parentheses after the section headings in the Summary.

agriculture is unusually labour intensive. Labour displacement is therefore correspondingly easy and non-agricultural employment opportunities extremely limited.

In order to be of practical value, testing of the above hypotheses must take place at the point in the economy where mechanised cultivation is expected to make its impact on agricultural production and employment - that is, in the farmers' fields, not the experiment station. In the former environment, economic and institutional factors, which do not operate in research stations, come into play and can radically diminish, negate or even reverse any theoretical advantages or disadvantages of technological change. At this level the vital questions which must be answered concern the end result of mechanised cultivation; that is: not whether it achieves deeper or more thorough tillage and weed destruction, but whether it actually results in higher yields, increased cropping intensities or new cropping patterns; not whether the tractor moves across the land at a faster pace than draught animals but whether in practice it does or does not result in direct or indirect labour displacement.

The present study was therefore designed to test the relevant hypotheses at field level in Bangladesh. Five different and widely separated parts of the country were selected for this purpose and in each area two villages were chosen in order to provide 'experiment' and 'control' environments: that is, in a given area the two villages were similar except that one had access to mechanised cultivation while the other did not.[1] This mechanised cultivation included both two-axle tractors and single-axle power tillers.

In each of the ten villages a random sample of 36 farmers was selected and these people were interviewed every week for a period of up to 15 months. Data were collected on the use of both family and hired labour, draught animals and farm machinery (both owned and hired), input levels and production and disposal of output. In addition to this weekly schedule, information was collected through a village census, two inventories of farm resources and sample crop cuts at harvest. Other information was compiled through non-structured interviews with selected farmers throughout the course of the study both in Sample Villages and elsewhere.

The present chapter is organised as follows: Sections 9.2 and 9.3 respectively examine the existing draught power situation and the extent to which the present land tenure situation is conducive to mechanised cultivation. This is followed by a summary and assessment of sample farmers' views of tractorisation. The next four sections present the findings of the Survey on the impact of mechanisation on land productivity while Sections 9.9 and 9.10 respectively examine its direct and indirect impact on employment. A comparison of hire charges is summarised in 9.11 and the remainder of the Chapter presents the Study's conclusions and recommendations for future research. It should be noted that wherever correlations, differences in means, etc. are reported these are statistically significant at the five per cent level or better.

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[1] For exceptions to this and other generalisations see Section 1.3 of Chapter 1.

9.2. THE DRAUGHT POWER SITUATION (3.2)

Behind the arguments for tractorisation which were listed earlier lies an implicit assumption that the existing draught power situation is an inadequate base from which to launch a major drive towards increased land productivity. Most of the energy used in Bangladesh agriculture today comes from human and animal muscle: only in irrigation has significant mechanisation occurred.

The situation as regards draught power availability is extremely variable comparing both geographical areas and farming groups within these areas. Over the sample as a whole draught availability could be said to be adequate on the grounds that there is on average one pair of draught animals to every 3.7 acres of cultivated land. This compares favourably with the familiar 'rule of thumb' that two animals can cultivate four or five acres. However the use of cows and immature animals is very common in Bangladesh, so that converted to a horse power basis the average availability is only 0.16 hp per acre, which is 20 per cent less than the above rule suggests to be adequate.

Geographically speaking, by far the worst off area in the Sample is Noakhali, where the figure is only 0.08 hp per acre. This is largely the result of successive natural calamities which both reduce and prevent the regeneration of the herd. In this area too the animals are noticeably weaker and their working day shorter than elsewhere.

Comparing farms, too, the distribution of draught animals is very uneven. Thirty-seven per cent of sample farmers have no draught animals at all, and 10 per cent have only one, being thereby obliged to share. Thus just over half the farms could be described as self-sufficient in draught power, insofar as they have the two animals needed to pull a plough. It is of course the smaller farms which lack draught power and there is a strong positive correlation between operated acreage and the level of installed horsepower. Smaller farms are also the more likely to use cows for draught purposes: farms using only bullocks average 5.5 acres, those using only cows 3.3 acres, while those using one of each average 4.4 acres. Farms without draught animals operated on average only 2.4 acres. It is also noticeable that draught animals on the smaller farms are relatively small and weak and are hence relatively inefficient users of feedstuffs, having to use a higher proportion of their total feed intake simply to maintain their metabolism.

9.3. FARM SIZE, FRAGMENTATION AND TENURE (2.2.-2.3; 4.1)

The commonly held view of the Bangladesh farm is that it is typically small and highly fragmented, a view which the present survey confirms. The operated acreage of sample farms ranged from one-third to 27½ acres with a mean value of four acres. The distribution, moreover, is positively skewed: one farm in ten is of less than one acre, 44 per cent are less than 2½ and only a quarter comprise more than five acres.

The degree of fragmentation is high, with an average of 11 plots per holding and an average plot size, therefore, of only one-third of an acre. Again the distribution is skewed: 15 per cent of all plots are of less than a tenth of an acre and a majority (53 per cent) less than a quarter acre. Only five per cent comprise an acre or more - the minimum area on which a two-axle tractor can operate efficiently, without excessive loss of time in turning. An additional facet of farm fragmentation is the area over which the plots are scattered, since the smaller and more scattered the plots the less efficiently can they be serviced by large machines. Also the more scattered the plots the greater is the likelihood that the machine will have either to cross fields of growing crops, causing damage, or spend even more time negotiating round such fields. Mean farmstead-to-plot distance is 500 yards, but ranges up to 20 miles in the 'char' lands and four or five miles elsewhere.

Farmers who use large two-axle tractors tend, very rationally, to use them on their larger plots. Comparing plot size on such farms only, the mean tractor-cultivated plot is half an acre, compared with one-third of an acre for those cultivated by animals. Even the former average, however, is only half the recommended field size for this type of machine. There is no significant difference in plot size in the case of power tillers. Both types of machine do, however, tend to be used on plots which are relatively close to the farmstead, averaging 340 yards compared with 570 yards for animal-cultivated plots, so that both travelling time and problems of supervision are minimised. Some element of compromise is required here, however, since the closer a plot is to the farmstead the smaller it tends to be.

Virtually all of the farmers own at least some land, but more than half (59 per cent) rent in additional plots. The majority (78 per cent) of these are on sharecrop leases, almost always 50-50. In theory the sharecropping system can be a powerful disincentive to investments which increase land productivity, but in practice in present day Bangladesh this is unlikely to materialise. In seasons where the demand for leases exceeds supply, landlords are in a position to insist on high standards of husbandry. In seasons where the reverse situation obtains they tend to supply a high proportion of inputs and thus produce a close approximation to the 'perfect share lease'. There is no significant association between tractor use and the tenurial status of plots.

9.4. FARMERS' VIEWS ON TRACTORISATION (4.2.-4.8)

The view of farmers familiar with mechanised cultivation, although obviously neither objective nor disinterested, are, if interpreted with caution, an invaluable guide to reality and constitute an important addition to the data collected during the course of the Survey. These opinions did, however, sometimes differ quite sharply depending upon whether the farmer in question was familiar with 2-axle tractors or power tillers. Institutional factors impinge here, since the 2-axle tractors came under a goverment (BADC) hire scheme, whereas the power tillers are privately owned and hired. The data presented in this Section were collected in the course of both structured and non-structured interviews, both within the sample villages and in other parts of the country.

One powerful advantage of cattle as far as the farmers are concerned is their availability and reliability when compared with tractors. This is an extremely important point as it strongly challenges the theory that tractorisation will lead to greater timeliness of operation. Farmers appreciate of course that once the machine is in the field it does the job much faster than animals: the problem is getting it there and delays can mean that the machine-cultivated plot is actually seeded the later of the two. The above feeling was especially strong in the areas covered by the government tractor hire services and complaints about reliability were sometimes accompanied by allegations of excessive bureaucracy and malpractice. In these areas installed horsepower in the form of draught animals per cultivated acre is as high among tractor hirers as among non-users, a sure indication that the service is not greatly relied upon. In the power tiller areas too, hirers still maintain draught animals but fewer than non-hirers, while none of the power tiller owners maintained any. Problems of reliability still exist with the power tillers however, because it is often very difficult to obtain unadulterated fuel and lubricants, a fact which combined with very intensive machine use leads to frequent breakdowns. When a machine is out of order it is difficult to find either qualified mechanics or quality spare parts. Emergency spares made by local artisans are used, but are of poor quality and therefore short working life.

In addition to reliability and availability, draught animals are seen as a more versatile power source than tractors and power tillers, being used for cultivation, weeding, transport and crop processing (threshing, oil extraction and sugar cane crushing). Important by-products of animals draught are manure and (ultimately) hides and beef as well as milk and calves if females are used. Two-axle tractors on the other hand are almost exclusively used for cultivation and transport, and power tillers for cultivation only (and occasionally threshing). This factor has important implications for capacity utilisation.

Farmers who have used 2-axle tractors on the heavy soils of the Barind and Madhupur tracts tend to commend the superior tilth achieved by the machine. On lighter floodplain soils, however, this was not noted as an advantage. With the power tiller the general view is that it produces a much finer tilth than the bullock plough, but cultivates to a shallower depth. As a fine tilth is typically prized by the Bangladeshi farmer, the machine's standard of cultivation is generally preferred. The number of cultivations is at least halved where the power tiller is substituted for draught animals.

There have to be three important modifications to the generalisation that mechanised cultivation produces a better tilth than animals - especially applicable in the case of 2-axle tractors. First the machines do not leave a surface which is sufficiently level for planting, so that the final cultivation is nearly always done by the animal-drawn 'ladder' or harrow - often with an additional ploughing of drainage furrows. Second, it is noted that the tractor leaves an uncultivated strip round the edge of the plot and round obstructions such as trees, which must later be ploughed by animals. The width of this strip is reportedly in direct proportion to that of the machine and the uncultivated proportion is in inverse relation to plot size. Third, tractor cultivation in the wet is said to be deficient. The machine can actually destroy the bearing capacity of the land if it ploughs to more than a few inches in fields with a ploughpan.

In view of the theoretical advantages of tractors it is perhaps surprising that only a small minority of farmers (11 per cent) in the 'mechanised' areas were of the opinion that the machine contributes to increased output. Farmers in many parts of the country both in and outside the sample were specifically asked to comment on the effect of mechanised cultivation on cropping intensities, but with only one exception in all areas reported that there was no such effect. The exception was again the Barind Tract area, where just a quarter of tractor users reported that either increased cropping intensities or the introduction of new crops was attributable to mechanisation. Soils in this area are often impossible to work with cattle or even power tillers when they are dry.

The negative employment effect of mechanisation was mentioned by a number of farmers (40 per cent in the structured interviews). In the case of family labour this can be equated with a reduction of toil and drudgery, but in the case of employees it is obviously accompanied by loss of income. Intensive non-structured interviews among power tiller owners and hirers in many parts of Bangladesh revealed that a reduction in the need for casual labour (including management economies) is seen as a major advantage of the machine.

Reduced cost of cultivation is an important advantage of mechanisation for many farmers. The comparison is hardly fair, however, since mechanised cultivation receives very considerable direct and indirect subsidies in Bangladesh. More realistic estimates of comparative costs will be presented in Section 9.15 below.

9.5. TIMELINESS OF OPERATION (5.1)

The situation regarding timeliness is rather different, although equally important, comparing the tractor and power tiller areas of the Study. In the former an important desideratum often is to minimise the turnaround period between successive crops such as aus and transplanted aman paddy (subject to certain constraints). However in no case was tractor cultivation found to reduce this period. Similarly when comparing sowing dates of a given crop variety no significant difference was found between tractor-cultivated and animal-cultivated plots in the same area.

It is much more surprising that an analogous situation was encountered in the power tiller areas, since, being under private operation, institutional rigidities are minimised there. This area is deeply flooded during the monsoon and the most crucial period for timely planting is after the recession of the floodwaters. The altitude of the land relative to flooding regime is a crucial determinant of planting dates here and statistical analysis of the plot histories confirms that early-draining plots are planted significantly earlier (by two weeks on average) than late-draining ones. When this factor is controlled for, those who cultivate by animal draught were found on average to sow their crops four days after one group of power tiller users but three to four days ahead of the others, so that there is obviously no clear cut advantage for the machine.

A moment's reflection will show that the above result should not come as a surprise. A power tiller or tractor cultivates a piece of land much faster than a pair of draught animals, but the capital investment in the machine is also much higher, so that in order to justify this investment and utilise its capacity to the full the owner must cultivate a much higher total area than a farmer who has only a pair of bullocks. The period over which the machine is kept operational is correspondingly extended. Thus the first tractor-cultivated plots can be planted before the first animal-cultivated ones, but the later ones are planted afterwards, so that the overall timeliness situation does not improve. This is precisely the type of factor that is liable to be left out of consideration in experiment station trials, since economic questions such as capacity utilisation are not usually under investigation there.

9.6. CROPPING INTENSITIES (5.2)

Detailed cropping histories of the 4,000 or so plots comprising the sample farms have been compiled for the period of the Survey. In every sample area the actual cropping intensity was found to be higher than the official estimates for the thana in which it is situated; over the sample as a whole the multiple cropping index was 207, compared with the official national average of 165 (Bangladesh Government (1980a) p.20). In a situation of high cropping intensity it could be expected that timing of operations would be unusually critical, yet the above evidence suggests that tractorisation has not played a role here in practice. The relationship between tractorisation and cropping intensity was investigated at both farm and plot levels.

At the farm level and over the sample as a whole the most important 'explanatory' variable of cropping intensity was found to be labour intensity in the form of permanent labour force per acre. The relationship is positive. In some sample areas cropping intensities were found to correlate with either installed horsepower per acre (positive) or farm size (negative). In only one area was there a significant correlation between tractor use and cropping intensity and that was negative. Thus it is the smaller more labour intensive farms which emerge as the most intensively cropped also. This finding incidentally confirms those of the recent Agricultural Census, which found mean multiple cropping indices of 181 for small, 167 for medium and 152 for large farms. (The dividing lines between the three categories are set at 2.5 and 7.5 acres.) The m.c. indices for 1960 were 167, 152 and 135 respectively (Bangladesh Government, 1980a, Annexure III).

At plot level cropping intensity was found to relate most closely to the physical properties of the land - its height and permeability - and whether or not it is irrigated. Irrigated land is the more intensively cropped and higher land more intensively than lower. In no case was cropping intensity at plot level found to correlate with the method of cultivation, whether power tiller, two-axle tractor or draught animal.

9.7. CROPPING PATTERNS (5.3.)

On a very few farms industrial crops such as cotton are associated with mechanised cultivation, but by far the most important such association is with potato. There is also a degree of association between tractor use and the use of irrigation facilities - indeed the adoption of a particular crop or cropping pattern is obviously the outcome of a great many factors, of which cultivation technique is only one. Moreover cause and effect are not always easily separable: does a farmer try to get a tractor because he has decided on a particular crop or cropping pattern, or vice versa? Ability to predict the one, given the other, can however be improved by as much as 35 per cent in some cases.

In the case of potato the causative relation is fairly clear and many farmers state that they would not grow potato unless they could get a tractor or power tiller. The reason is that cultivation for this crop by traditional means is expensive, and mechanised cultivation, by eliminating for example the need for manual clod-breaking, reduces cultivation costs. Potato is however a high-value high-input crop which on a commercial scale at least is grown only by the relatively well-off farmers, who also tend to have the contacts necessary to secure tractor services.

9.8. CROP YIELDS (Ch. 6).

In view of the very large number of variables which can influence crop yields, experiment station trials here provided a useful guide to the potential contribution of factors such as mechanisation - even if only under 'ideal' conditions. Response trials of this type which have been conducted in Bangladesh in recent years indicate that in almost no case does mechanised cultivation significantly affect yields. In the single exception the yield response to tractorisation was just six per cent. In no case was mechanised cultivation found to reduce weed infestation when compared with animal tillage.

Thus even the potential for mechanised cultivation to contribute to higher yields seems at best severely limited. Farmers' reports of yields in the Survey were checked on a sample basis by crop cuts. Statistical analysis of both farmers' reported yields and crop cuts indicate that tractor-cultivated plots did not produce significantly higher yields than animal-cultivated plots of the same crop in the same season.

9.9. DIRECT EMPLOYMENT EFFECTS (3.1; Ch. 7)

In Bangladesh the permanent field labour force of most farms comprises the farm family males (typically a father and two or more sons). Permanent employees are found on only 19 per cent of the holdings and comprise just nine per cent of the total permanently-employed labour force. Although there is a positive correlation between total farm size and total permanent labour force, permanent labour force per acre correlates negatively with farm size, indicating that, as far as this type of labour is concerned, smaller farms are more labour intensive than larger ones.

On all but the very smallest farms casual labour is h red to supplement permanent labour at peak periods. It is among these workers that any direct labour displacement is likely to occur, since by definition they do not have security of employment. Hiring of casual labour is presently extensive, a minimum figure being around 40-50 man-equivalent days per acre per annum.

Comparison of farm operations with respect to the amount of casual labour employment shows that three operations, harvesting (which employs 26 per cent of all casual labour), weeding (25 per cent), and transplanting (16 per cent), are the most important farm operations from the viewpoint of employment generation. Land preparation is next in importance, employing ten per cent over the sample as a whole. One important point which emerges from analysis of the seasonal distribution of employment is the way in which peak employment periods for different operations combine somewhat to smooth out the overall employment opportunity curve.

Inputs of casual labour vary quite substantially comparing different crops. Generally speaking, high-input crops like HYV paddy and potato are associated with disproportionately high inputs of casual labour. Traditional, low (purchased) input crops on the other hand tend to receive proportionately less of such labour.

The following variables were hypothesised to be important determinants of demand for casual labour: tractor user status, permanent labour force per acre, installed horsepower per acre, total operated acreage, proportion of land sharecropped in, and cropping intensity. In view of the above observed relationship between crop type and casual labour employment, this factor too was included in the models.

The analysis shows that over the Sample as a whole tractor use correlates negatively with the level of casual labour hired for land preparation, with tractor users hiring on average 3½ fewer man-days per acre for cultivation than non-users. In the power tiller area, where mechanisation has had a far greater impact than elsewhere, the corresponding reduction is 4.6 man-days per acre. In no area was labour demand for weeding found to be lower on tractor-using farms, a finding which challenges the argument that tractors reduce weed infestation by improving the standard of tillage (under farmers' field conditions). Tractor user status correlates positively with casual labour employment in only one task, harvesting, and that in only one sample area (Comilla). Since no yield effect of tractorisation was found in this or any other part of the country, it is concluded that the observed relationship is not causative and that some other non-measured variable (leisure preference?)intervenes.

A very strong negative correlation was found to exist in almost every area between casual labour-hiring for land preparation and installed horsepower per acre. This results from the fact that it is smaller farms which have the highest estimated installed horsepower per acre and which more frequently hire-in animal draught. When animals are hired-in, it is customary to hire a complete ploughing team - animals, plough and ploughman. The reason for this is that the animals usually work best with a man they know. In any case owners are understandably reluctant to entrust their animals to a stranger who may maltreat and possibly incapacitate them. Similarly farmers with their own draught animals do not tend to hire strangers to work with them.

It was shown earlier that with respect to the permanent on-farm labour force, labour intensity is inversely related to farm size. The picture with regard to casual labour is less clearcut, but the data do not support the view that large farms compensate for having a lower level of 'installed' labour by employing significantly more casual labour per acre. Thus by any definition labour intensity correlates negatively with farm size. The relationship between cropping intensity and casual labour use is, as one would expect, positive and significant in most cases, as is the relationship with the 'labour intensive' crops mentioned earlier. Finally, the hypothesised negative relation between sharecropping and labour-hiring is supported by the analysis.

Analysis of the Survey data on agricultural wages supports the view that traditional modes of payment, which are relatively favourable to the labourer, are on the decline and in process of being replaced by less favourable forms - mainly cash. Women's work is generally poorly paid and frequently takes the form of crop residues - jute sticks, straw, oil seed pods - which they require for fuel. For male workers cash wages are often supplemented by payments in kind, but generally only in the form of pan or tobacco. In only a quarter of contracts were meals provided as part of the wage. The value of such wage goods generally correlates negatively with the level of cash wages.

9.10. INDIRECT EMPLOYMENT EFFECTS

Since labour intensity in Bangladesh agriculture correlates negatively with farm size, any innovation which tends to increase average farm size can be viewed as potentially labour displacing. It was shown earlier that holdings which become mechanised would in theory benefit from consolidation and expansion since they could thereby take full advantage of scale economies and the easing of management constraints. Two basic issues must be examined here. The first concerns the supply of land from smallholders, i.e. do they tend to lose control of land, and if so why and how? The second issue is the mirror image of this on the demand side - is there a tendency for mechanised holdings to expand and if so why and how?

It was shown earlier that the smallest holdings in Bangladesh are very small indeed. The distribution of land is also very unequal with the lowest ten per cent of farms having only 1.1 per cent of the land while the top ten per cent have 35 per cent. (The Gini coefficient is 0.5). Farmers at the lower end of the scale are clearly in the marginal to sub-marginal category, that is (respectively) those whose holdings are too small to provide surplus to provide for emergencies and those whose income from farming must be supplemented in every year.

Smallholders do in fact lose control of land. The most important mechanism for land transfer is the 'bondhok' or mortgage system by which land is pledged as security for a loan and is then used by the lender until repayment is made. In times of distress smallholders prefer this system to outright sale, even though it reduces their capacity to generate income and hence eventually make repayment. Such arrangements are entered into generally for reasons of distress, but social obligations (such as dowry provisions) also play a part. Most current mortgage agreements among Sample farmers had been outstanding for between one and three years while one in eight had been so for more than five. Cases were also reported and verified of farmers being unable to regain possession of mortgaged land even when they had the necessary cash. The reason for this was the superior power and influence of the mortgagor.

Tractor users - even those in some of the government tractor service areas - tend to be the larger farmers. Over the Sample as a whole the average tractor-using farm comprises five acres compared with three acres for the others. In the power tiller areas there is a threefold classification with owners' holdings averaging nearly eight, hirers' three, and non-users' two acres. Extensive investigation among power tiller owners in different parts of the country has shown that acquisition of the machine induces the owners to bring more land under their control. This is done by (a) declining to renew share or other leases when they expire, (b) leasing in additional land, (c) mortgaging in land, and (d) outright land purchases. All of the power tiller owners in the sample reported having increased their holdings - by proportions ranging from 28 to 92 per cent - since, and as a result of, purchasing their machines. In every case the reason given was the easing of management constraints - that is, elimination of the need to supervise the large number of draught animal teams which would otherwise have been required to cultivate the expanded operated acreage. Given the capacity of the power tillers, there is scope for a good deal of further expansion in most owners' operated acreage, but land acquisition is a necessarily slow process.

The importance of tractorisation as a factor in land transfers is further illustrated by the fact that over the Sample as a whole net mortgaged-in land correlates positively and strongly with tractor use.

9.11. COST COMPARISONS (4.9)

The Government tractor hire service is, on paper, by far the least expensive method of cultivation, comparing very favourably with private sector charges for hiring both draught animals and power tillers. The official charge was found to vary (according to the system of charging and the implement used) from Tk.25/- to Tk.60/- per cultivation per acre (p.c.p.a.). Power tillers are hired out by their owners for Tk.150/- p.c.p.a. in the peak cultivation period and Tk.100/- at other times.

The hiring of draught animals is very common in Bangladesh: 82 per cent of Sample farmers hired them in and 54 per cent hired them out at some time during the course of the Survey (part of this overlap is accounted for by exchange between farmers having only one draught animal - some 10 per cent of the Sample). The structure of rates is complex and shows marked variation as between both seasons and districts. Rates can also peak quite dramatically if conditions suddenly become just right for ploughing.

The Noakhali sample area provides an unusual case. This is an area in which the depredations of successive cyclones and tidal bores have drastically reduced the supply of draught animals. The conditions of those remaining is also unusually poor. These factors combine to make cultivation costs unusually high in this particular area, so that the tractor hire service was also unusually attractive there.

At the other end of the spectrum, a comparison of hire charges in the power tiller area shows that power tiller hire rates are very much in line with those for draught animals. Taking two ploughings and two harrowings ('ladderings') with animals as the approximate equivalent of one power tiller cultivation (a norm which is fairly generally accepted), the rate per acre varies from Tk.90/- to Tk.160/- for draught animals (depending upon the season)compared with the Tk.100/- to Tk.150/- power tiller range quoted above.

Analysis of costs and returns for power tiller owners reveals this machine to be an extremely attractive investment, given the heavily subsidised costs at present obtaining. Payback period is less than one year and the internal rate of return, assuming a six-year life, is 264 per cent - higher than the interest rates charged by many village money lenders! Assuming discount rates of 11.5 and 15.5 per cent respectively, gross benefit-cost ratios of 2.12 and 2.09 per cent and net present values of Tk.127,000/- and Tk.113,000/- are obtained. Even taking a discount rate as high as 50 per cent, NPV is Tk.50,000/-, and the benefit-cost ratio 1.86 (gross).

CONCLUSIONS

9.12. TRACTORS VERSUS POWER TILLERS: TECHNICAL ASPECTS

In 1970 the Pakistan Government Mechanisation Committee recommended that power tillers rather than two-axle tractors were technically the more suited to farming conditions in the then East Wing (Pakistan Government, 1970). Since then the population of the area has radically increased and fields are smaller and even more fragmented than they were a decade earlier, so that the relative merits of power tillers have increased rather than diminished. The physical dimensions of a conventional two-axle tractor of 40 hp or so make it quite unsuited to the small, fragmented and frequently waterlogged plots which typify so much of Bangladeshi agriculture. Its width makes it unsuitable for manoeuvring along paths and field bunds, so that it must travel across the open field. However, given the overlapping, complex, and intensive cropping system of Bangladesh, this means that very often the machine must pass over growing crops in order to reach the field to be cultivated and it therefore tends to leave a trail of damaged crops and sometimes also broken bunds in its wake. In addition, the size of the tractor and its relatively large turning circle result in an untouched strip being left around the boundaries of the plot and in the vicinity of trees, ditches and other obstructions: the smaller the plot the greater the proportion left uncultivated.

A conventional answer to the above problem is land consolidation, that is the amalgamation of neighbouring plots into large blocks in which the tractor can operate with optimum economic and technical efficiency. This would, theoretically, also improve accessibility and reduce the amount of land devoted to access paths, bunds and plot boundaries. If this argument were to be applied to Bangladesh, however, it would have to be modified to take account of the reasons for land fragmentation. This is not, as is sometimes supposed, for purely non-agricultural reasons such as the Muslim laws of inheritance. Farmers in fact often deliberately split up their fields into smaller plots separated by bunds. This is done for purpose of water control and water management and in order to facilitate levelling.[1] If these plots were to be amalgamated in order to tractor-cultivate them, the bunds would have to be rebuilt and the land relevelled afterwards, thus negating any time- and labour-saving effects of the tractor.

In accepting the power tiller as technically the more appropriate machine for Bangladesh, it must be appreciated that, at least with the machine presently in use, one of the advantages of engine-powered cultivation, namely superior draught power, will thereby effectively be sacrificed: the power tiller transmits its power to the soil through a revolving 'scroll' set at right angles to the direction of forward motion. This roll is equipped with 18 tines arranged at intervals along the shaft, and as the shaft revolves they churn up the soil. Thus the seven or eight horsepower of the machine is divided among its 'furrows', so that the power supplied to each is not very different from that supplied to the animal plough.

Since completion of field work on the present project, the Bangladesh Government has decided in principle to support local manufacture of power tillers, at least on a trial basis. Imports of these machines have now been discontinued. Since the local project, which is based on the IRRI design, is not yet fully operational, clearly a 'farmer's field' appraisal is not feasible.

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[1]The system of flood irrigation used in Bangladesh makes small bunded plots essential. On large plots the water would seep away before reaching the points furthest from the irrigation inlet.

Some observations on this machine will be found in Appendix 1. Meanwhile, however, since the imported power tiller is still very much operational and since it is not impossible that the above decision may at some time in the future be reversed, an evaluation of the existing power tiller is still of great policy interest - the more so in view of the lessons which can be learned and hopefully applied to the new, domestic, project. In view of its technical unsuitability, much less attention will be paid to the large two-axle tractor as a possible alternative.

9.13. POTENTIAL PRODUCTION EFFECTS OF MECHANISING CULTIVATION

Neither experiment station findings nor those of the Survey support the view that mechanising cultivation will produce noticeable increases in yields. Nor has any overall improvement in timeliness resulted: some fields are cultivated earlier and some later than with animal ploughs. Any effect on cropping patterns has been minimal - being largely limited to the substitution of potato for other rabi crops. There is no evidence of increased cropping intensities except in a few instances on the heavy soils of the Barind Tract where a 40 horse power tractor can reportedly cultivate dry compacted soils before the rains and thereby facilitate either increased cropping intensities or the introduction of new, high value crops. However, as has just been demonstrated, such machines are unsuited to farming conditions in Bangladesh while at least the present power tillers are unsuited to this particular task.

In Bangladesh land which could grow food is not generally set aside for the maintenance of livestock. An exception is the bathans, low-lying areas which are put under fodder crops in the dry season - but basically for milk production only. Analysis of the Survey data on feeding regimes confirm that draught animals in Bangladesh are fed on rough grazing, crop thinnings and crop residues - mainly rice straw, supplemented seasonally by rice polishings, oilcake, pulse residues, etc. Thus their competition with humans for food supplies is indirect rather than direct since the feed they consume could only be fed to other livestock and would therefore produce expensive animal proteins such as meat and dairy produce that only the relatively well-off can afford.[1]

It must be appreciated that mechanisation too competes indirectly with humans for food supply. Bangladesh relies substantially upon imports of both food and agricultural inputs to meet her

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[1] Draught animals also produce manure as well as meat and hides as their 'salvage' value, although less as far as salvage value is concerned than where the feed in question is used only for raising beef. Dairy cattle and cattle raised for sacrifice in Bangladesh are by far the best-fed and receive a much higher ratio of purchased feeds, such as concentrates, and a much lower proportion of roughage like rice straw than is the case with draught bullocks. Thus the trade-off between the production of, say, milk and that of draught power is not very straightforward. This topic is presently under intensive investigation at the Bangladesh Cattle Development Project and results are expected in the near future.

production/consumption needs. A significant part of these requirements is commercially purchased upon the world market, so that to the extent that mechanisation represents the substitution of imported resources for domestic ones it occurs at the expense of the food and farm inputs on which the necessary foreign exchange could otherwise have been spent. A few examples will illustrate the magnitudes involved. By themselves they do not, of course, constitute an argument against mechanisation but simply help quantify the opportunity costs.

The major foodgrain import of Bangladesh is not rice, but wheat - which costs less than half as much per ton. At recent world market prices each power tiller imported into the country costs almost as much as 17 metric tons (MT) of wheat.[1] This is sufficient foodgrain at present average consumption rates for more than 100 people for a year.[2] This, however, underestimates the opportunity cost of power tillers. If the foreign exchange in question were spent on agricultural inputs, the returns would be greater still.

Fertiliser consumption in Bangladesh is presently very low, averaging according to official estimates only 22 seers per acre (50 kg per hecatre).[3] Response to fertiliser is correspondingly high: it is conservatively estimated that under farmers' field conditions the application of one maund of balanced fertilisers will increase rice yields by 3.5 maunds (Brammer, 1980, p.19). The cif price of a power tiller is equal to that of ten tons of urea or nine tons of triple super phosphate (TSP) or 14 tons of muriate of potash (MP), so that the opportunity cost of the machine is of the order of 33 tons of rice, which is sufficient of the preferred foodgrain for

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[1] In the most recent year for which data are available (1979-80), Yanmar power tillers - the type covered in the Survey and by far the most common in use in Bangladesh - cost Tk.35,000/- cif Chittagong (data supplied by Yanmar's agent). In the same year the cif (Chittagong) price of wheat averaged Tk.2,115/- per MT (Bangladesh Government, 1980b, Table 8.11).

[2] Per capita foodgrain consumption is presently estimated to be 15.4 ounces per day (Bangladesh Government, 1980, p.III-9).

[3] The Honourable Md. Nurul Islam, Minister of Agriculture, in reply to a Parliamentary Question, May 25th, 1981. A recent World Bank report offered the following comment on the availability of fertiliser in Bangladesh: "Considerable excess demand, long lines of waiting farmers at supply points, empty warehouses, farmers' complaints of inability to obtain sufficient fertilizer, and widespread incidence of black marketeering in fertilizer, provided ample indication that the demand for fertilizer throughout the country was progressively outstripping supply at the prevailing prices:" (IBRD, 1980, p.34).

more than 200 people for a year at present average consumption rates. By the same token, for foreign exchange required to import enough diesel and lubricants for a power tiller for a year would produce seven tons of rice.[1]

A still more direct estimate of opportunity cost can be made. The World Bank report quoted earlier identified low capacity utilisation as a major reason for the disappointing performance of engine-powered irrigation in Bangladesh (IBRD, 1980, pp. 27-31). A number of reasons were identified, but very important among them was a chronic insufficiency of diesel fuel supply for the pumps. The introduction of power tillers on a wide scale can only exacerbate this problem, especially to the extent that both machines operate in the same season. Even if they do not, the opportunity cost of importing diesel fuel for power tillers is the foreign exchange and other facilities required to supply diesel for irrigation. These opportunity costs are very considerable indeed. As can be seen from Table 9.1 the amount of diesel required to operate one power tiller for a year at present utilisation rates could have delivered up to 6.3 million gallons of water and irrigated up to 47 acres of land under existing command area coverage.

TABLE 9.1: POWER TILLERS: FUEL SUPPLY IMPLICATIONS FOR IRRIGATION

	Deep Tubewell	Shallow Tubewell	Low-Lift Pumps
Present Utilisation Rates (hours per pump per annum)	1000	700	700
Fuel Consumption (gals/hour)	1.0	0.3	0.625
Running Time on 550 gallons Diesel (hours)	550	1833	880
Water Flow from 550 gallons Diesel (million gallons)	3.96	4.95	6.3
Area Irrigable with 550 gallons Diesel (acres)	34	29	47

Notes: Power tiller operation rates average 1,560 hours/annum at 0.35 gals. of diesel per hour, i.e. 550 gals. per annum approx. Data on running times and fuel consumption of diesel-powered irrigation equipment derive from Ahmed (1981), Appendices A, B and C. Deep tubewells (DTW's) and low lift pumps (LLP's) are rated at 2 cusecs and shallow tubewells (STW's) at 0.75 cusecs. Estimated of command areas are taken from Siddique and Pray (1980), Table 1; they average 61 acres per DTW, 11.1 per STW and 37 per LLP in the areas surveyed.

[1] In the case of the power tiller comparison, the 1979-80 fertiliser prices are used; in the case of the fuel and lubricants trade-off 1980-81 prices are used for both these and fertilisers. The price of diesel is Tk.17.44 per imperial gallon cif Chittagong and of high viscosity index oil Tk. 34.06 per IG. At a consumption rate of 550 and 16½ IG per annum respectively, the annual foreign exchange cost of fuel and lubricants is Tk. 10,154/-. The 1980/81 (1979-80) prices of the major fertilisers averaged as follows:
TSP: Tk. 5,476 (Tk.3,910); Urea: Tk.4,900*(Tk.3,482); MP: Tk. 3,427 (Tk.2,479) (USAID unpublished data; *=estimate). Thus the annual cost of fuel and lubricants for a power tiller is roughly the equivalent of one ton each of urea and triple superphosphate (N and P being the most commonly applied nutrients).

9.14: EMPLOYMENT IMPLICATIONS OF MECHANISED CULTIVATION

It is probably impossible for any country to achieve a significant degree of economic growth without some measure of mechanisation.[1] It is equally unlikely that this can be accomplished without some degree of labour displacement. The problem for policy makers in a situation in which human labour is practically the only plentiful resource is to achieve an optimum working balance between any (positive) production effects of mechanisation and its (negative) employment effects, taking all relevant factors into account.

In Bangladesh, as in other developing countries, mechanisation in any sector of the economy is likely to have employment implications for the bulk of the agricultural (and indeed national) labour force, which comprises small farmers and landless agricultural labourers. Three sectors can be identified for their separate mechanisation impact on such people: the urban, the rural non-agricultural, and the agricultural. In the urban sector, increasing capital intensity in, for example, large-scale manufacturing reduces the value of industrialisation as a potential safety valve which otherwise could have reduced population pressures on farm land by providing alternative employment opportunities. The rural non-farm sector in Bangladesh constitutes a major source of supplementary employment and income, particularly on a seasonal basis, for smallholders, especially those with holdings which are too small to be viable. However as, for example, rural or small town transportation, crop processing and so forth become increasingly mechanised, so traditional job opportunities for both men and women of small farmsteads diminish. Thus the question of agricultural mechanisation becomes an increasingly crucial one for rural labourers and smallholders.

In the course of the present study three potential labour displacement effects of mechanised cultivation, short-, medium-, and long-term, have been identified. The short-term effect is the immediate impact deriving from the fact that tractors simply require less labour than bullock ploughs to cultivate an acre of land. The medium-term effect springs from the observed tendency of mechanised holdings to grow at the expense of neighbouring smallholdings, and the long-term effect derives from the fact that mechanisation is a process rather than a single phenomenon and is likely to acquire a momentum and logic of its own.

The short-term effects are easiest to discern. The study has shown that during the peak season the power tiller cultivates around 5½ acres and employs three men per day. In the slack season the daily rates are around 2½ acres, when only one man is employed. Total employment at present utilisation rates is thus 240 man-days

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[1]Mechanisation should be defined in its broadest sense as a process of introducing machines or implements where none were previously used or of replacing relatively simple pieces of equipment with those which are more mechanically complex. Such a technological change will tend to have a positive impact on land- or labour-productivity or both.

per year. To cultivate the same acreage to the same standard using draught animals would require 960 man-days of labour. Thus, the immediate labour displacement effect is 720 man-days per annum per machine, this is 75 per cent.[1]

In the medium-term it has been shown that the holdings of power tiller owners show a tendency to grow as management constraints are eased. At $5\frac{1}{2}$ acres per day the machine could comfortably cultivate a 50 acre farm in 9 days or in less than three weeks if, as is normal, the land is cultivated twice. Even if no illegal methods are used to deprive smallholders of their own land, their operated holdings can still be reduced by increased pressure on the land rental market. This pressure comes from both supply and demand sides as mechanising farmers in the process of expansion either withdraw their own land from the rental market or enter this market themselves as potential lessees (or both). As the operated acreage of smallholdings in general falls some holdings at the lower end of the scale will drop from the marginal to the submarginal category and hence become vulnerable to forces which eventually may force the owners either to sell or mortgage their land.

The tendency of mechanising farms to grow in size at the expense of smallholders will probably have negative production as well as employment effects, since, as this Study and others have shown, cropping intensity in Bangladesh is negatively related to farm size. Thus if average farm size increases, average cropping intensity can be expected to fall.

Of the two employment effects of tractorisation outlined above it is the second, indirect, effect which is likely to prove the more serious in terms of labour displacement in the long run. On the direct displacement side, the present study has indicated that about ten per cent of all casual labour is hired for land preparation, but that it is usually the complete ploughing team that is hired. Those who rent out draught animals in this way are not the landless or the smallest (cattle-less) farmers, but owners of medium-sized holdings with surplus ploughing capacity.[2] There is conceivably a linkage between the two types of labour displacement here: as these farmers lose the source of supplementary income they presently derive from hiring out their bullocks, they could thereby be launched on the process which will ultimately force them to sell or mortgage their land.

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[1]Again taking two ploughings plus two 'ladderings' as the equivalent of one rotary tillage, the draught animals require four days to cultivate an acre to this standard. Thus the power tiller displaces 22 pairs of draught animals in the busy season, which is the overall draught animal displacement effect, since there is surplus capacity at other times of the year. With labour the proportionate displacement effect is much smaller, partly because the power tiller employs more than one man-day per day and partly because the animal plough requires less - only half a man-day. Thus two full man-days per acre are required with animal draught, or 960 to cultivate the same acreage as 240 man-days accomplish with the machine.

[2]See James and Mettrick (1981).

The long-term labour displacement effect of mechanised cultivation could transpire to be the most serious of all three. As has been shown by this study, mechanising cultivation eases a management constraint, thus making it possible for the adopter to bring more land under his direct control. In the process, however, new management constraints will tend to emerge - especially in labour supervision during the presently labour intensive tasks of weeding, transplanting and harvesting. Thus new pressures will be generated for mechanisation of these tasks in turn.

The process outlined above is likely to acquire its own momentum. As successive tasks are mechanised and employment opportunities shrink, the distribution of remaining labour demand will become increasingly seasonal. This will tend to throw unmechanised tasks into sharper relief in the eye of the semi-mechanised farmer - the more so since the labour in question, with its reduced employment opportunities, is quite likely to become correspondingly more militant at those times when job opportunities exist, as a result of having to earn a year's income from fewer working days.

The technology already exists for such further mechanisation, some of it relatively simple, hand-powered equipment capable of local manufacture. The machines include the inter-row cultivator and the rotary weeder already in use in Bangladesh, and IRRI's manually-powered transplanter. Alternatively farmers who presently own engine-powered devices such as power tillers could adapt them for additional farming purposes, and indeed have demonstrated great ingenuity in doing so already.[1] The Survey findings show that the three operations mentioned above (weeding, transplanting and harvesting) between them employ two-thirds of all casual labour used in agriculture. Assuming (conservatively) that mechanisation of these three tasks would cause the same proportionate labour displacement as has been found in land preparation (that is 75 per cent), no less than half of all existing employment opportunities for casual labourers would be placed in jeopardy, with all of the attendant social, economic and political effects that could readily be predicted.

9.15. IS THERE A "DRAUGHT POWER CONSTRAINT"?

The study findings on the production side have clearly discredited what Binswanger calls the "net contributor" view of tractorisation (see Section 1.1 above); that is, the view that tractors and power tillers have a unique contribution to make to increased land

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[1] Two examples of the way in which power tiller owners have increased the versatility of their machines were encountered in the course of the Study. The first is to tie the traditional bamboo 'ladder' behind the machine and use it for levelling. The second is to raise the tail wheel to maximum elevation and run the tiller over a flat heap of wheat heads, so that the revolving tines flail the crop, thereby threshing it. This reportedly takes only half as much time as draught animals and results in much less spoilage. Techniques already exist for converting a power tiller for pumping and transportation and it would not be too difficult to devise a means of using it to harvest root crops like potato.

productivity which could not be achieved by biological sources of draught. Instead the findings support the alternative view that the machines and animals are mutual substitutes. Acceptance of this does not however necessarily invalidate the argument for tractorisation: it is still possible to argue that tractors are needed to supplement rather than replace existing draught sources on the grounds that in Bangladesh today there is a shortage of draught power in the aggregate. This is one version of the familiar argument that there is a "draught power constraint" in Bangladesh. The question comprises three elements, however, each of which must be considered separately: (a) is there a draught power constraint? (b) if so, what is its nature? and (c) how best can it be tackled? The mere assertion should not point automatically to any particular solution.

The question of draught power shortage should be examined at both a macro and micro level. On the macro level, estimates of the number of draught animals vary, but recent official figures put the national herd at between 10.3 and 10.9 million head (Bangladesh Government, 1980, P.S11-69, and 1980a P.21 respectively). Given about 20 million acres of cultivated land, this gives on average 3.8 acres per pair of animals against a rule of thumb that one pair can handle from four to five acres, regardless of the level of cropping intensity.[1] At the aggregate level therefore there would appear to be no draught power constraint, at least as far as overall numbers are concerned. The picture as regards quality, however, is very different. A large proportion of the animals used for cultivation are undersized, underfed and under-aged. Cows, too are used for cultivation, sometimes into advanced stages of pregnancy, which is highly undesirable.[2] The result is that, compared with what could be achieved with better animals, the working day is short, ploughing is shallow and 'breakdowns' frequent.

At the micro level the 'draught power constraint' assumes a different aspect. As the findings of the Study suggest and national estimates confirm, many of the smallest farms have no work animals at all and a number of others have only one.[3] While it is true that farms with insufficient draught can hire in animals, they are less secure than those with their own beasts and must wait at the "end of the queue" to obtain them.[4] Given the poor quality of the animals this queue can be a long one! For such farmers there is indeed a draught power constraint, but there is no evidence that tractorisation specifically addresses their particular problems. On the

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[1] FAO (1977) suggests the lower figure to be appropriate for Bangladesh.

[2] Jabbar (1980) infers a draught power shortage partly from the use of cows for cultivation under any circumstances. Later (Section 9.18) it will be argued that this view is perhaps too rigid.

[3] Preliminary results of the 1977 Census of Agriculture suggest that there were 10.9 million draught animals for 6.3 million holdings in that year, i.e. an average of 1.7 draught animals per holding (Bangladesh Government (1980a) pp. 19-21).

[4] Jabbar (1980) too, infers a draught power shortage from this observation.

contrary, as the Study has shown, those who receive power tillers or mechanised cultivation services tend to be either the larger farmers or (in some instances in the case of the tractor-hire service) their clients.

The concept of a constraint as used in the above context requires some critical examination before moving from the nature of the problem to possible solutions. In any area of an economy lack of investment may loosely be described as a 'constraint' if there is a positive net return to investment. Scarce resources must, however, be invested where returns (however defined) are maximised, not merely positive. As was shown in 9.13 above, there is in a very real sense in Bangladesh a 'fertiliser constraint' and an 'irrigation constraint'. Not all constraints are equally constraining at any given point in time and given chronic shortage of investment resources the opportunity cost of each investment must be calculated, as the following illustration will show.[1]

The Draft Second Five Year Plan for Bangladesh quotes the following opinion: "It is estimated that about 11.3 million draught animals are required for ploughing our agricultural land at the present level of cropping intensity. As against this there are only about 10.3 million draught animals (including about 0.7 million cows) of which about 11% are not usable for cultivation"(Bangladesh Government, 1980, p.XII-69).[2] Although this statement was not originally advanced as a justification for tractorisation, it will serve for purposes of illustration. Calculations reported earlier indicate that one power tiller can substitute for 22 pairs of draught animals. Assuming this figure to be representative, it would require 48½ thousand power tillers to 'fill the gap' left by the 2.133 million draught animal shortfall implied in the above quotation. These machines could be imported at an opportunity cost of 800 thousand tonnes of wheat. Alternatively, the foreign exchange cost of the machines could, if spent on fertilisers, produce

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[1] 'Package' is another concept which is often misused in this context. In this particular setting it came into widespread use early in the 'green revoluation', when it was demonstrated that HYV seed, fertiliser, irrigation and perhaps pesticides could yield a higher return if used together than if used separately. This concept is a useful one, but it must not be allowed to become a straight-jacket. Not all investments are necessarily components of such a 'package': some effects are merely additive.

[2] This statement implies that there is an insufficient number of animals, but is somewhat inconsistent: either there are sufficient animals to maintain the present level of cropping intensity or it is not maintained. The resolution presumably lies in the difference between the desirable and the actual standards of cultivation, although this is not made explicit.

1.6 million tonnes of rice, which is sufficient at present per capita consumption rates for 10 million people (11 per cent of total population) for a year. Similarly the 27 million gallon annual fuel requirements of this number of power tillers would cost as much as 93 thousand tonnes of fertilisers, which could produce 327 thousand tonnes of rice - sufficient to keep perhaps two-thirds of the population of Dacca city supplied for a year! If this volume of diesel fuel were instead switched to low-lift pumps, they could potentially irrigate up to 2.3 million acres of land.[1] Methods of tackling the "draught power constraint" without incurring this level of opportunity cost will be considered in Section 9.18 below.

9.16: COSTS AND SUBSIDIES

The current (draught) Five Year Plan of Bangladesh spells out nine major objectives, the 'major thrust' of which 'is on a significant reduction of poverty' (Bangladesh Government, 1980, p. ii-1). This, then, is the criterion against which the employment, income and distributional implications of a major technological innovation such as tractorisation must be measured. If, however, such considerations were to be set aside or if a purely *laissez-faire* approach were to be adopted, the importation of tractors and power tillers could be justified on exactly the same basis as that of any other commodity, namely that there is a demand for them. In fact, however, these machines have in the past been imported on highly concessionary terms, totally out of keeping with the principles of *laissez-faire*.

Most of the power tillers and tractors in use in Bangladesh today were received under various forms of economic assistance, so that in selling them off to the private sector, problems of pricing inevitably arise. The most recent import of power tillers was received under a Japanese commodity grant in 1977. They were costed at the then ruling world (yen) price converted to taka; a markup was added for duties and taxes and for handling, and the machines were then distributed to the public through Bangladesh Krishi Bank. The Bank, however, in order to evaluate both this procedure and the social and economic impact of the machines, agreed to co-sponsor the present study.

Since the Study has shown that the power tiller increases labour productivity but not land productivity, the machine may be regarded as, at best, of doubtful value at the macro-economic level.[2] At the micro level however, it represents an enormously

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[1] See Section 9.13 above for the basis of these calculations. The number of pumps too would have to be increased, but they cost less than power tillers under local manufacture, so that this represents a further opportunity cost of the power tiller. Of course other inputs would have to be supplied to cultivate these 2.3 million acres.

[2] That is the value of the machine *per se* rather than simply as an addition to the total supply of draught power.

profitable investment for those fortunate individual farmers to whom it is accessible, partly, as will be shown below, because of the concessionary element in the pricing of both the machines and associated consumables (especially fuel). Subsidies are a familiar and controversial feature of the Bangladesh economy in general and of the agricultural sector in particular. Their proponents tend to argue, at least in the case of agricultural inputs, that they provide an incentive to increase production. Whatever the merits of this argument in other cases, in this particular case, where no appreciable production effect can be discerned, this would be an unusually difficult argument to sustain. The various subsidy and other concessionary elements applying at the time of the last distribution of power tillers will now be discussed in turn.

The first element derives from the rate of exchange used. This was the official one which, as is the case in most developing countries, overstates the relative value of the national currency on the open market. In Bangladesh, however, unlike many countries, it is possible to arrive at a close approximation to the true market value of the currency by using the "Wage-Earners' Scheme" (WES) rate under which foreign exchange is auctioned to the public. The exchange rate under this scheme fluctuates more than the official rate, but averages around 25 per cent higher.

A "concessionary rate of duty on articles intended for use exclusively for agricultural purposes or component parts of spare parts of agricultural machinery or equipment" obtains in Bangladesh (Bangladesh Government, 1976, p.iii). This concession is presumably granted for the same reason that subsidies are paid on inputs. When the machines in question do not increase land productivity the same counter argument therefore applies. The concession is quite handsome: the duty on tractors (including power tillers) and spares, for example, is 15 per cent *ad valorem*, whereas that on trucks and buses is 75 per cent *ad val*. This presumably explains why two-axle tractors are so often used for road transport in Bangladesh, as in other countries where this type of discriminatory system is in operation. Since this is the 'opportunity cost' (to the Treasury) of a tractor's being used, it seems a reasonable rate to apply if the concession is withdrawn.

The markup employed to cover handling charges, eight per cent, may have covered the variable cost of distribution, but it would hardly take overheads adequately in to account. Investigations among private sector importers of the same machine show that private sector handling charges alone would have been in the region of 14 per cent, while the dealer's markup would total around ten per cent - a compound margin of 25.4 per cent (of a much higher basic price).

Accepting the above rates of exchange, duty and margin as a basis for realistic costing, the delivered price of the power tiller

TABLE 9.2: REVISED COSTS FOR A SIX YEAR POWER TILLER INVESTMENT

	YEAR							
	0	1	2	3	4	5	6	TOTAL
Capital[a]	62,000	-	-	-	-	-	-	62,000
Fuel[b]	-	16,000	15,800	15,200	14,200	11,600	8,200	81,000
Repair & Maint.[c]	-	1,000	2,000	3,000	4,000	5,000	7,000	22,000
Others[d]	-	8,900	8,900	8,800	8,800	8,700	8,600	52,700

Notes: (See also Table 4.19)

[a]No concessionary 'hire purchase' system is assumed to be available; cash investment only is obtainable.

[b]Double the figures of Table 4.19

[c]Spares cost 120% more than in 4.19, but labour costs are assumed to be the same

[d]i.e. all other items of 4.19: no other changes are assumed.

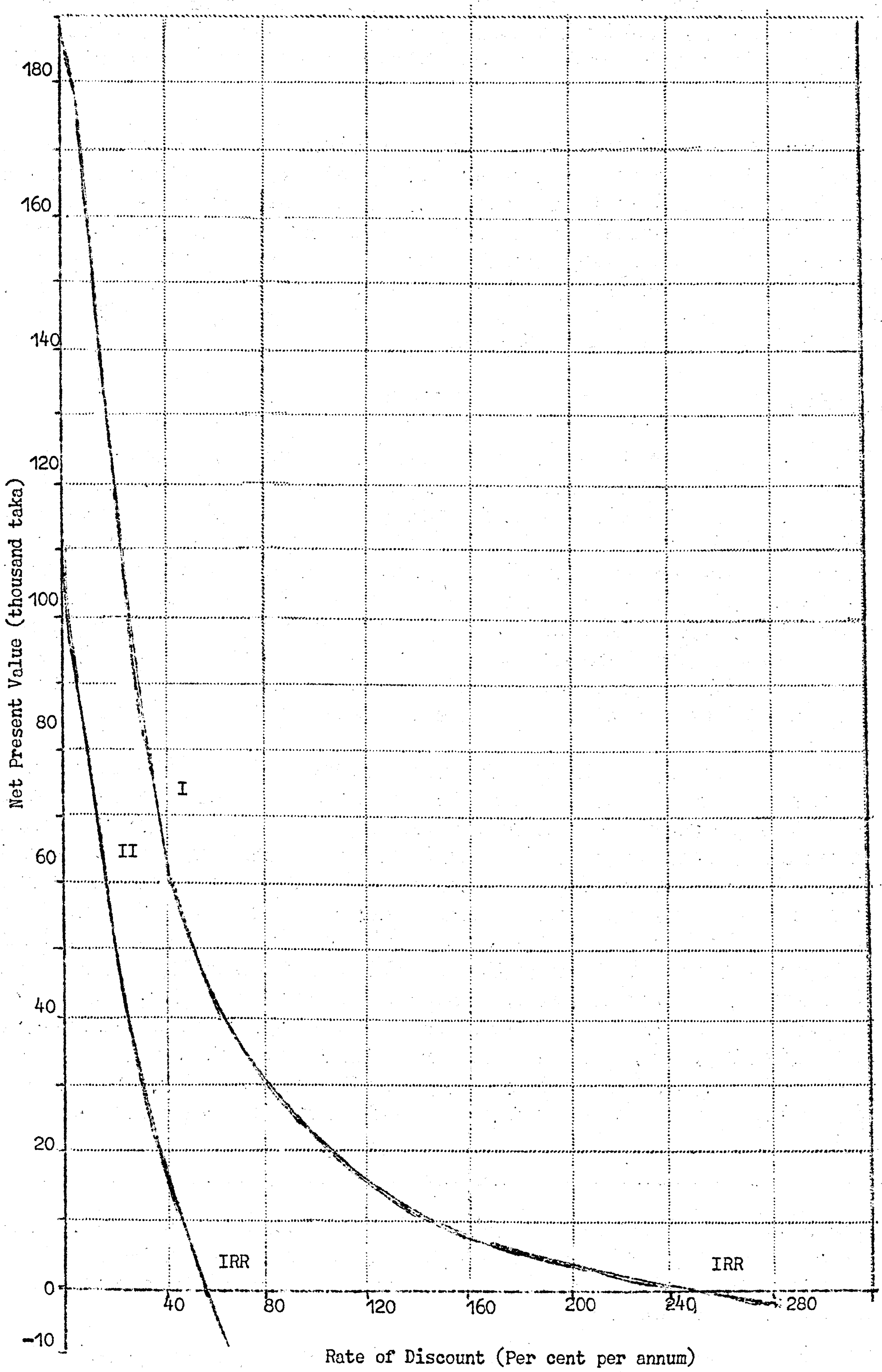
becomes not Tk.28,200/- but Tk.62,000/-, an increase of 120 per cent.[1] the concessions do not however presently end at the point of sale. Two more sets of subsidies or other allowances must be dealth with. First, those on spare parts which are similar to those on the machine, and second, those on fuel. The price of high speed diesel fuel in Bangladesh is extremely low, the price at the pumps being less than half that of petroleum, largely because of differential rates of duty. The price of diesel is also extremely low by international standards, being for example less than half that of a major oil producer like the United Kingdom.[2] It will be assumed here that the price of diesel should be at least doubled, in order to reflect the increasing scarcity of such fossil fuels.

These more realistic cost estimates have been used to adjust those of Table 4.19 (Chapter 4) and the results appear in Table 9.2 above. Projected revenues are unchanged, since given the fact that power tiller owners do not pass on cost savings to hirers, but charge the full market rate, they will be equally unable to pass on cost increases but will be limited by what the market can bear. Again an unsubsidised rate of discount should be used, in this case the 15½ per cent level suggested in Section 4.9 rather than the 11½ per cent concessional rate. Discounting the revised cash flow at this rate gives a net present value of 52 thousand taka and a (gross) benefit-cost ratio of 1.33; the internal rate of return is now 48 per cent. Figure 9.1, which provides the net present value profiles of the investment under the two sets of cost assumptions, illustrates the magnitude of the gap. Although these revised figures fall far below those obtaining at present, they still represent an attractive investment and illustrate how, even if a draught power strategy based on tractorisation were adopted it could proceed without undue assistance from the taxpayer.

[1](Tk.22,500a x 1.25b x 1.76c x 1.254d)= Tk.62,073/-;
a= Yen price at official exchange rate; b= conversion to WES rate;
c= 75 per cent duty plus 1 per cent documentation fee;
d= 25.4 per cent dealers' markup.

[2]At the official rate of exchange.

FIGURE 9.1: PRESENT VALUE PROFILE OF POWER TILLER INVESTMENT WITH(CURVE I) AND WITHOUT (CURVE II) SUBSIDIES AND CONCESSIONS



9.17. NON-ECONOMIC FACTORS

The non-economic advantages of tractorisation postulated at the start of this chapter have not been dealt with so far, but should not require too lengthy a deliberation. There is undoubtedly great prestige value attaching to the concept of being a 'modern farmer' in the sense of using (or, even better, owning) bright, shiny, modern equipment.[1] It is, however, a phenomenon which would be difficult to quantify and of doubtful value even if this were done, since such a perceived advantage hardly constitutes a basis for rational policy formulation.

It is also undoubtedly true that tractorisation directly reduces human toil and drudgery. However, if it simply substitutes unemployment (and all attendant ills) instead, it can scarcely be said to have added to the sum of human happiness. Presumably the reason that people accept tedious, even backbreaking, work is that the alternative of no work is even worse. This is not to say that the reduction of human toil and drudgery is not a very desirable aim, but only to argue that the cost must be counted.

9.18. PRIORITIES FOR FUTURE RESEARCH

There are two basic ways of countering a draught power constraint: reducing the demand for draught power or increasing the supply. Some interesting work is being done on the first of these approaches through zero and minimum tillage experiments and early results have been encouraging.[2] A great deal of work remains to be done in this field, not only on agronomic practices, but also on the economics of cultivation standards: for instance, on the trade-off between the costs and benefits of additional or marginal tillage operations. This is especially true of new crops and varieties with whose tillage requirements the farmers are unfamiliar.

A second way in which draught requirements can be reduced is by making more efficient use of what is available. The present method of transmitting power from animal to implement seems very inefficient. This is particularly true of the traditional yoking system, which is basically a bamboo or wooden pole resting on the animals' humps and which causes often severe hump galls. Apart from the cruelty aspect and danger to the health of the animal which this represents, it is difficult to believe that an animal will exercise maximum thrust on what is virtually an open sore. Some kind of alternative simple and inexpensive yoking device, such as an ox collar, is urgently required. Implement design, too, may be inappropriate; this is particularly true of the flat-soled country plough which may be quite unsuited to dryland cultivation, for example in the important <u>rabi</u> season.

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[1] One suspects that this is a major reason for adoption of power tillers by hirers: an assumption, based perhaps on their experience with fertilisers and pesticides, that modern methods are inherently superior to traditional ones.

[2] For example, encouraging work has been done at the Bangladesh Rice research Institute on minimum tillage techniques in the transplanted <u>aus</u> - transplanted <u>aman</u> turnaround period which speed up planting apparently without adverse effect on yields.

Turning from the demand to the supply side, it has often, and rightly, been observed that animals provide virtually all of the (non-human) draught power presently used in Bangladesh agriculture; it follows from this that a small proportionate increase in animal draught will produce the same addition to aggregate draught supply as multiplying the supply of engine draught many times over.[1] Moreover, since animal draught comes in smaller and less 'lumpy' units, its ownership can be spread more widely (lower capital cost) and its coverage more evenly at any given point in time.

Most estimates imply that the absolute number of draught animals in Bangladesh is adequate.[2] The main problem is one of providing adequate feeding in order to enable these animals to increase their work output. Bangladesh is now actually in a position in which, after a secular deterioration, the animal feed supply situation can actually improve. In a situation of high population growth, food supplies are first increased by bringing more land under the plough, generally at the expense of pasture. When the limit of this process is reached, as it almost has been in Bangladesh, further increases in food production must come from increasingly intensive land use: that is, through higher yields and increased cropping intensities. Thus the intensification process will tend to increase the supply of crop residues too and animals feed supply can thus begin to grow. A limitation is placed on this essentially symbiotic relationship, however, by the fact that many of the new high yield varieties (HYV) of cereals have short, stiff straws which are bred for resistance to lodging but which increase the grain-straw ratio and in addition produce an inferior straw as far as cattle feed is concerned.

This question might be taken into account when specifications are given to plant breeders, but perhaps this will not be necessary if recent work, for example, on straw treatment in Bangladesh and elsewhere, lives up to its early promise. Such treatment aims at improving the nutritive qualities of straw, other crop residues and weeds. The methods so far devised are cheap, reliable and straightforward and can be practised at farm level using readily

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[1] Jabbar (1980), for example, estimates that 99 per cent of the land is presently cultivated by draught animals. The total number of power tillers ever imported into Bangladesh (or East Pakistan) is about 4,500 (Jabbar, 1980, Table 8, and Bangladesh Government, 1980c, Table 278). It was suggested earlier (Section 9.15) that 48½ thousand power tillers would be required to fill an estimated shortfall of 2.133 million draught animals, i.e. a more than ten-fold increase in power tillers to make up a twenty per cent shortage in animal draught.

[2] Although Mettrick (1981) considers the dynamics of the national herd.

available materials, such as urea.[1] This work deserves every possible encouragement, particularly in so far as it is directed to the problems of utilising HYV straws. The social and economic dimensions of the question are examined in some detail in Appendix 10 of this report.

Another way in which the supply of draught power in agriculture can be increased, in terms of both number of animals and quality of feed, is mechanisation in other sectors, particularly road haulage. Large numbers of superior quality and relatively well-fed animals are used in road transport and the economics of further mechanisation in this sector ought to be investigated.

Finally, the question of versatility of use and therefore capacity utilisation of work animals should be considered, since this has implications for both the demand and supply sides of the animal draught question. As was mentioned earlier, draught animals are currently used for cultivation, threshing, haulage and for operating machinery. They are not used in irrigation. This is strange, both in view of their widespread use for this purpose in other countries of the Region, and given that manual irrigation is still common in Bangladesh - hence, it could be supposed, providing an incentive for animal-powered mechanisation.

A more important aspect of the question of versatility concerns the apparently increasing use of cows for cultivation. The use of cows into advanced stages of pregnancy is obviously undesirable - and is only done as a measure of desperation, not as a general rule. Arguments can be presented both for and against the use of cows. Against it, it does seem to cause a reduction in milk yields while the animal is working, but this may be a reasonable price to pay for a multi-purpose beast. The practice is also said to cause a reduction in fertility, although to what extent is not clear; this could be important. On the positive side there is less work to be done on a smaller farm and a pair of cows could help pay for their upkeep (in milk and calves) where bullocks could not. The smaller the workload the fewer also would be the problems of lactation and fertility. Preliminary opinion among veterinarians presently working in Bangladesh is that if pregnancies were planned so as to harmonise with the major cultivation seasons, many of the existing problems could be avoided. This would obviously require considerable extension work as well as research.

The greater part of the present Section has described ways of improving the aggregate draught power situation by increasing its supply in relation to demand. If successfully implemented, such a strategy, in addition to assisting farmers who have their own work animals, would also in two ways assist those who do not. First,

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[1] See the proceedings of the First (1980) and Second (1981) Seminars on maximum Livestock Production from Minimum Land, Bangladesh Agricultural University, Mymensingh. See also Dolberg (1981), Pharo (1981), Khan and Davis (1981), Sayeed and Davis (1981), and Saadullah et al (1981).

better fed animals could complete the work on their owners' farms earlier and hence come earlier on to the hire market. Second, an overall improvement in draught supply vis à vis demand (and this by no means necessarily implies an increased number of working animals) would tend to drive down hire rates. This is more likely to be the case with animal hire than with power tillers: since there are many potential suppliers of animal draught it would be correspondingly more difficult for them to form a cartel to keep prices high in the way that the few power tiller owners have managed to do.

A more interventionist approach, that of directing draught power specifically towards disadvantaged farming groups, would not be ruled out by the adoption of the above strategy: the two could certainly coexist. One such approach, that of conducting research on the milk-draught relationship, has already been mentioned.[1] Beyond this, however, it would be easy to underestimate the difficulties involved in implementing the second type of model. As has been clearly shown by the present Study, efforts to direct draught power in the form of tractor hire service towards small farms have not succeeded, the basic problem being that market forces and social pressures in practice seem effectively to be able to combine to counteract interventionist institutional arrangements. This has of course been the case in a great many countries in the course of co-operative formation, especially with those sponsored from above. Further efforts in this direction, such as a strategy of supplying draught animals to individual farmers or farmers' groups, would have to be built on very firm institutional foundations if they were effectively to counteract these opposing forces. In devising such institutions it would have to be kept in mind that the market 'pull' of draught power resources away from such farmers might be assisted by a resource constraint 'push' insofar as these farmers may not have access to sufficient crop residues to feed the animals in question (Appendix 10).

The above argument has been applied to different socio-economic groups within a specific location, but it is equally applicable to the different geographical regions within the country. Attempts to divert draught resources towards areas - such as Southern Noakhali - which have unusually low draught availability, could founder unless sufficiently strong institutions were devised to hold these resources in place against the potentially powerful social and economic pull of better endowed regions. This study has shown that farmers will travel literally hundreds of miles to obtain power tillers, a fact which illustrates both the strength of the market and the quality of market intelligence that already exists. This same process could conceivably be repeated in the case of draught animals.

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[1] Devising appropriate minimum and zero tillage techniques would also be of special benefit to farmers in this category.

Thus, the final conclusions of this Study must be: if we take into account the full costs to society of deploying and using tractors, there must be serious doubt whether substantial expansion of mechanisation of this kind is desirable; on the other hand there is a strong case for applying considerable effort to the improvement of animal power, associated equipment and techniques in the agriculture of Bangladesh.

APPENDIX 1: A NOTE ON THE IRRI PT3 POWER TILLER[1]

As was noted in the body of the Report (Section 9.12), the Bangladesh Government has decided in principle to support local manufacture of power tillers, for which the IRRI PT3 design has been adopted. The major design differences between this machine and the Japanese Yanmars which were evaluated in the present study is that the former (a) is less sophisticated, (b) has a lower horsepower rating (6 hp rather than 8 hp at 2200 rpm), and (c) is fitted with a mouldboard plough interchangeable with a comb harrow instead of the Yanmar's rotary tiller ('rotavator'). The fact of local manufacture makes the difference that foreign exchange costs should be reduced in proportion to domestic value added, and that there is an employment generating effect in manufacturing to set against any labour displacement effect in agriculture. While a comprehensive evaluation of this project is beyond the scope of the present report - and would not be possible at 'farmer's field' level in any case since the Project is so new - a number of observations can nevertheless be offered which may help in determining the applicability of the present study's findings in the light of changed circumstances.

The Yanmar power tiller engine is, judging by the two manufacturers' specifications, slightly more fuel-efficent that the Mitsubishi NM75 used in the Bangladesh version of the IRRI PT3. The figures are respectively 192 and 200 grammes per horsepower-hour. The Yanmar consumes 1.05 gallons of diesel per acre per cultivation. Comparisons of quality of cultivation are not available, but if one ploughing plus one harrowing with the PT3 are taken as equivalent to one cultivation with the Yanmar's rotary tiller, then the fuel consumption of the two machines is the same.[2] There is, therefore, no reason to alter the conclusions presented in Chapter 9 regarding the opportunity costs of diesel for cultivation.

The price ex-factory of the PT3 power tiller is Tk.36,000/- (Tk.6,000/- per horsepower) with the NM75 (6 hp) engine. It was Tk.28,500/- (Tk.6,333/- per horsepower) with the previous TS50c (4.5 hp) engine. Since they are no longer imported, the current price of the Yanmar tiller is not known, but the last available price reported by the dealers (1979/80) was Tk.35,000/-, duty not paid, or Tk.40,600/- duty paid (Tk.4,375/- and Tk.5,075/- per horsepower respectively).

The domestic value added content of the PT3 is rather difficult to compute without a fairly searching evaluation. Most of the engine parts are currently imported, although there are plans

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[1] The data on the PT3 derive from the Bangladesh Machine Tools Factory which manufactures it and from the Bangladesh Rice Research Institute which tests it.

[2] 200 grammes per hp-hour (Mitsubishi NM75) or 1.2 grammes (0.2625 gallons) per hour with a 6 hp engine. At three hours per acre ploughing and one hour per acre harrowing, fuel consumption is 1.05 gallons per acre.

progressively to scale this down as local manufacture increases. In addition to engine parts, most of the raw materials for the machine, as well as the machinery and energy used in transporting these materials to and within Bangladesh and in the process of manufacturing itself, are presently also imported.

On the employment/production questions which are at the centre of the present study, obviously little can be said of the PT3's performance in the farmer's fields, except that if this machine's productivity is similar to that of the Yanmar, then presumably its direct and indirect employment impact will also be similar.[1] The direct labour displacement effect of the Yanmar was shown to be around 720 man-days per annum (Section 9.14). Against this should be set an average employment creation effect at the factory of 50 man-days per machine. Accepting the minimum eight-year useful life of the power tiller estimated by the manufacturers, the employment creation effect in manufacturing becomes 6.25 man-days per annum. This figure is, however, based on an output averaging 14 (maximum 20) machines per month over the first 11 months of production. On a mass-production scale labour productivity could be expected to rise substantially and the employment generating effect per machine would correspondingly fall.

APPENDIX 2: MECHANISATION AND FARM SIZE

David (1966, pp. 9-20) has provided an analytical approach which can be adapted to demonstrate theoretically the argument referred to in the text of the Report concerning the relationship between farm size and the incentive to introduce machinery (Chapter 1).

Consider the case of a farmer who has a given size of holding and has to choose between two alternative ways of performing a certain farm operation, one using a relatively high input of casual labour with simple equipment, the other a mechanised technique using relatively more capital and less labour. Figure A2.1 shows a comparison of hypothetical cost curves for the labour-intensive

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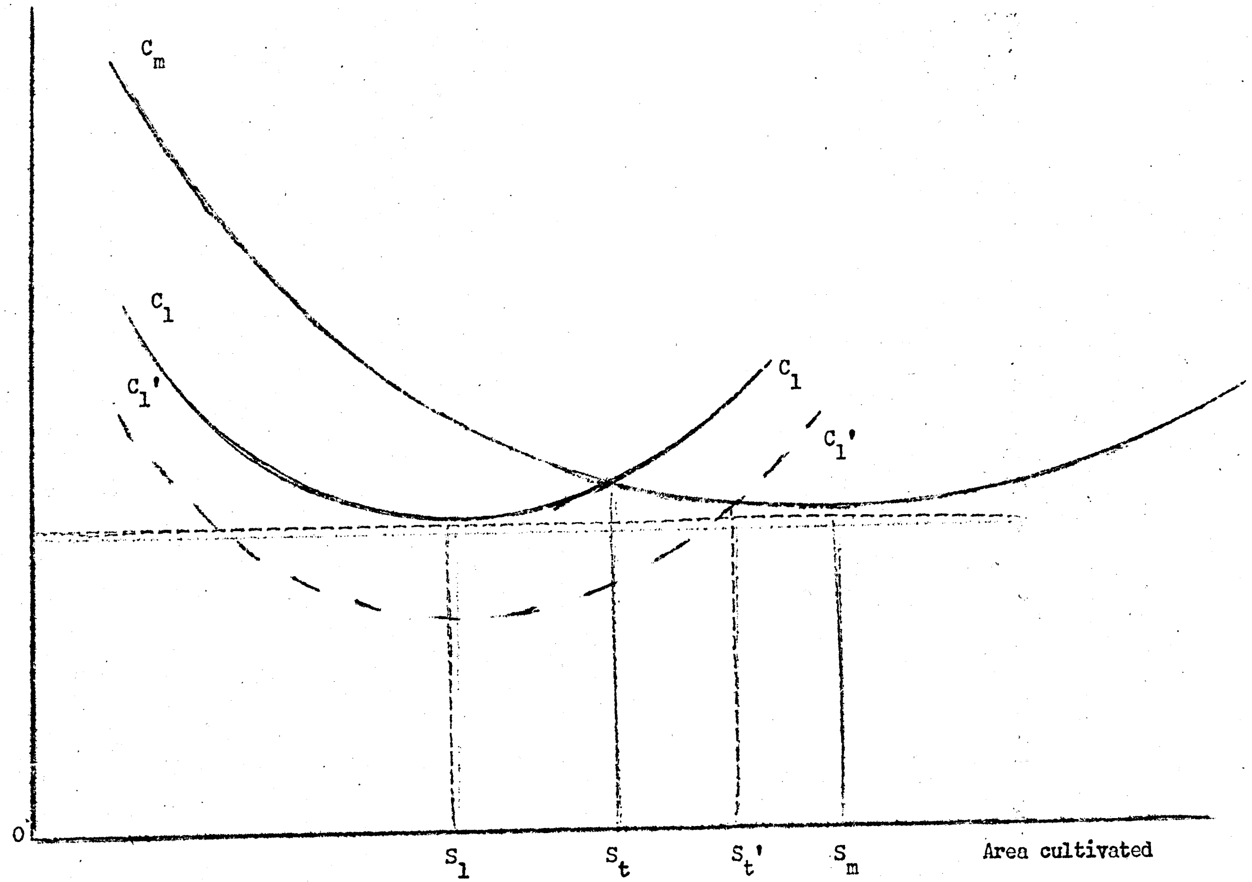
[1] One way in which the IRRI machine could increase productivity in comparison with the Yanmar is through the type of implement used - in this case a single mouldboard plough for primary cultivation - so that the constraints noted in Chapter 9 may not apply. However, compared to the traditional bullock-plough, the plough pulled by this machine presents a large frontal area to the soil and also inverts it, so that soil resistance is much higher. No details are available at the moment on this topic, although pre-irrigation is recommended with the IRRI PT3 when soils are hard and compacted.

FIGURE A.2.1: HYPOTHETICAL LONG-RUN AVERAGE COST CURVES



method (Cl-Cl) and the mechanised method (Cm-Cm).[1] Both methods include some element of fixed costs, so that initially cost per unit area declines with increasing acreage. Fixed costs are of course higher with the machine method, so that average costs with this method are the higher initially but continue to decline after Cl-Cl has begun to rise. The reason that unit costs begin to rise is the limitation on the farmer's capacity to organise and supervise labour, a constraint which will obviously begin to be felt at a lower acreage with the more labour-intensive method. Thus there is a 'threshold' size of farm (St in Figure A2.1) below which the labour-intensive method is least-cost but above which this is replaced by the mechanised technique. In this diagram each method is shown as incurring the same average cost per unit area at its particular low (Sl and Sm respectively), but there is of course no reason why this need be so. It is at least theoretically possible that there could exist a labour-intensive technique (with cost curve Cl'-Cl') whose lowest point was below that of the machine method without altering the fact that the large scale farmer with limited supervisory capacity would find the machine method the least-cost technique.

APPENDIX 3: A NOTE ON LOGISTICS

The volume of information collected in the Weekly Survey was very large. For example, a total of more than 600 W1 forms (see Appendix 5) was completed each week. While non-sampling errors cannot be eliminated from work of this nature, persistent checking and re-checking can help both reduce the incidence of such errors and indicate gaps and inconsistencies in the data base which can often subsequently be resolved. Some of our sample farmers were able to provide reasonably accurate cultivation histories of their plots even after a lapse of several months: sometimes, but not invariably, by reference to outstanding events such as natural disasters and religious festivals.

Every piece of information on the schedules was checked at least twice, once in the field and once in coding. Additional checks were made on a sample basis. The first complete check was made at weekly or fortnightly intervals when the forms were collected from the villages. The person supervising the enumerators went

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[1] It is assumed for the moment that output per unit area is the same for both techniques. In fact yields tend to correlate negatively with farm size, at least in developing countries.

through each W1 form (Family and Permanent Hired Labour - see Appendix 5) with the enumerator concerned, checking for correct and full completion and for consistency with other schedules. (For example if a household head has stated that his tasks included the supervision of temporary labour, the W2 schedule was checked for a corresponding entry.) This process alone consumed a total of roughly eighty man-hours each week.

The second field check was employed by the Bengalis among the supervisory staff who occasionally re-interviewed sample farmers. As a matter of policy, however, these re-interviews were kept to an absolute minimum in order both to avoid overburdening the patience of farmers and to minimise the suspicion of mistrust implicit in such a procedure. These checks were used only when there were reasonable grounds for questioning the work of a particular enumerator.

In order to exercise physical control over the large number of completed questionnaires to be processed, a system of registration of all such documents was operated, there being one such register for each of the ten villages in the Sample, duplicates being kept in the coding office in Dacca. An entry was made in the appropriate register each time a questionnarie changed hands, so that responsibility for it could be assigned at any given moment, thereby minimising the possibility of loss of data.

In an on-going survey the time penalty of centralised post-coding is not very serious because of the very large time overlap between the collection of information and the coding of it. On the other hand, the additional cost of this approach is more than compensated by the invaluable additional opportunities it affords for re-checking under close supervision. Queries can very quickly be sent out to field staff. This centralised coding process constituted the second complete checking of all survey data. The code-sheets are themselves checked by re-coding on a sample basis.

APPENDIX 4: 'INITIAL INVENTORY' SCHEDULES

FORM I1

FARM IDENTIFICATION

1.00 Complete the following table.
1.10 List all family members living on and off the farm.
1.20 List all permanent employees

Name (1)	Relationship to Head of Household (2)	Age (3)	Normal Place of Residence (4)	Does Family Member Normally Work on Farm (5)	Sex (6)
....					

FORM I2

FARM IDENTIFICATION

2.00 Reciprocal labour exchange groups:
2.01 (Discuss the concept of 'exchange groups' with the farmer)
2.10 Do you currently belong to such a group?
1 YES 2 NO
If YES, move to question 2.30; If NO, move to question 2.20

2.20 Did you ever belong to such a group?
1 YES 2 NO. (If NO, begin FORM I3)
If YES, How many years ago?
(Begin Form I3)

2.30 Complete the following table

Type (Name) of Group (1)	Operation(s) Normally Performed by the Group (2)	No. of Members (3)	Size of Normal Working Group (4)
....			

FORM I3

FARM IDENTIFICATION

1.00 List all buildings and yards on the farm that are either owned by individual members of the household or are owned jointly with other households

Building	s/j	Building	s/j	Building	s/j
		....			

2.00 List the number of bovines the household owns

	Number of Cattle	Number of Buffalo
Male, 3 years and over		
Male, 1 or 2 years		
Male less than 1 year		
Female, 3 years and over		
Female, 1 or 2 years		
Female, less than 1 year		
TOTAL		

FORM I4

FARM IDENTIFICATION

3.00 Engine-Powered Equipment: Does the household own either solely or jointly with other households any of the following engine-powered machinery?

TRACTOR	1 YES	2 NO	SHALLOW TUBE WELL	1 YES	2 NO
TILLER	1 YES	2 NO	DEEP TUBE WELL	1 YES	2 NO
	1 YES	2 NO			
LOW-LIFT PUMP					
OTHER (Specify)					

4.00 Hand and Animal-powered Equipment: Does the household own either solely or jointly with other households any of the following hand- or animal-powered equipment?

EQUIPMENT	Number Owned	No Operational	Other Such Equipment (Specify)	Owned	Operat.[1]
01 Deshi Plough					
02 Improved Plough					
03 Ladder					
04 Spade					
05 Sickle					
06 Hand Sprayer					
07 Hand Hoe					
08 Kurpi					
09 Weeding Hook					
10 Boat					
11 Dhon					
12 Hand Tubewell					
13 Bullock Cart					
14 Sugar Cane Crusher					
15 Pedal Thresher					
16 Winnower					
17 Drier					
18 Japanese Weeder					
19 Dheki					

FORM I5

FARM IDENTIFICATION

	ACRES	DECIMALS
1.00 TOTAL Land Area, including homestead owned by members of this household		
1.10 Total Land Area not Owned but cultivated by members of this household		
TOTAL		

1.20 In how many mouzas does the household own and cultivate land? (Specify)..
List them:

1.30 Number of fragments of land (both owned and non-owned) cultivated by this household (Sepecify)...

1.40 Does the household have grazing rights to land not included in the above?
1 YES 2 NO
If YES, please give details:

FORM I6, Sheet ...

FARM IDENTIFICATION
2.00 List all plots
1. Owned and cultivated by members of this household
2. Owned by this household, but currently lying fallow
3. Owned by this household but cultivated by others, and
4. Cultivated, but not owned, by this household

Name of Mouza (1)	Name(which the farmer uses) to Identify Plot (2)	Area in Decimals (3)	Ownership (4)	(For Office Use)

....

N.B. If there are insufficient spaces on this form to include all of the farmer's plots, a fresh FORM I6 should be added. Remember to fill in the appropriate sheet no. at the top of the form.

FORM I7

FARM IDENTIFICATION
1.00 TABLE OF PLOTS OWNED BY THIS HOUSEHOLD

Farmer's Name for Plot (Note 1)	Flooding in a Normal Year (Note 2)	Mean of Irrig'n (if any) (Note 3)	Permanent Crop (N. Type 4) (Note 5)	Is Plot 'Mortgaged Out'? (Note 6)	Is Plot Cult. by H'hold or 'Given to Others'? (Note 7)	Dist. of Plot from House-hold (Note 8)	Amnt. of Rent or Share Recei-ved (Note 9)	Contri-bution (if any) made to Inputs (Note 10)

....

FORM I8

FARM IDENTIFICATION

2.00 Table of plots cultivated, but not owned, by this household

Farmer's Name for Plot (Note 1)	Flooding in a Normal Year (Note 2)	Mean of Irrig'n (if any) (Note 3)	Permanent Crop (N. 4)	Permanent Crop Type (Note 5)	Is Plot Mortgaged In? (Note 6)	Amnt. of Rent or Share Paid to Landlord (Note 7)	Contribn. (if any) Landlord makes to Inputs (Note 8)	Distance of Plot from Household (Note 9)
				....				

APPENDIX 5: 'WEEKLY SURVEY' SCHEDULES

NOTES

1. In the originals questions actually asked of the farmers are in Bengali; instructions to the enumerators are in English.
2. In the originals the instructions appear "upside down" on the reverse of the appropriate form in order to facilitate consultation on the clipboard and to prevent their early loss or discard.
3. The instructions are aides memoires only; more complex verbal instructions were given during training and have subsequently been reiterated.

FORM W1: TO BE COMPLETED AT EVERY INTERVIEW: ASK HOUSEHOLD HEAD, FAMILY FARM WORKERS AND PERMANENT EMPLOYEES: USE A FRESH FORM FOR EACH PERSON.

Name of Enumerator Farm Identification
Date of last Interview Date of this Interview
N ame of Worker Type Age
Name of Informant Type Age
(If different from worker; otherwise write SAME) (TYPE See Note 1)
Please give the following information about your work since the previous interview:

Day & Date (Note 2)	Type Work (Note 3)	Crop & Variety (Note 4)	Time Taken (Note 5)	No. & Type of Animals Used (Note 6)	No. & Type of Implements Used (Note 6)	Plot No. (If Applicable) (Note 7)

....

If the respondent is the household head (see Note 8), ask the following question. Otherwise go to the next form.
Did you appoint any new permanent employee, or did any family worker return to the farm since the previous interview?
If Yes, an additional FORM W1 must be completed for each of these workers.

WEEKLY FARM SURVEY

NOTES ON FORM W1

NB: This is the only form which is completed by other people as well as by the household head. It is also the only form which is replaced after each interview. All other forms are replaced only when all available spaces have been used up. Before going out to interview any family include one FORM W1 for each member of the family who works on the farm (including children). One form must also be included for each permanent employee who works on the farm. Fill in the appropriate details at the head of each FORM W1, ie your own name, the farm identification, date of the last interview, date of this interview, name of the worker, his 'type' (see Note 1) and his age. Other details will be filled in during the interview itself.

NOTE 1: There are five 'types' of workers; use the following codes:
1 = household head; 2 = other family member (male); 3 = other family member (female); 4 = permanent employee (male); 5 = permanent employee (female).

NOTE 2: Day and Date - Start with the day and date immediately after the previous interview, then ask about all days since then up to the present. Include days when the worker did NOT work on the farm because for example of sickness (in which case write SICK under 'Type of Work'). Include work done off the farm (eg marketing) and work done on other people's farms. Include even work which is non-agricultural.

NOTE 3: Include all types of work even if done off the farm and even if the work was non-agricultural.

NOTE 4: Where this applies, write the variety if known.

NOTE 5: Try to be as exact as possible here, but it may be possible only to record ½ day, 1 day, or whatever the respondent tells you. Make sure that for each day all the periods add up to the full working day.

NOTE 6: Draft Animals and Implements Used: IT IS MOST IMPORTANT TO AVOID DOUBLE COUNTING HERE. Report only the animals or implements which were under the respondent's direct control. If, for example, two workers worked together with four bullocks, enter two bullocks for each. If one 'ladder' was used in the process, enter it for the senior worker only.

Notes on Form W1 (continued)

NOTE 7: Enter the plot identification in the case of field work.

NOTE 8: If the household head is not available on any occasion interview the person who is left in charge of the farm in his absence and ask this question and all others which you would normally ask the household head.

FORM W2: ASK HOUSEHOLD HEAD ONLY

FARM IDENTIFICATION FORM W2/

Did you hire any temporary labourers in the period since the previous interview?
If YES, please give the following details:

Day & Date (Note 2)	No. & Type of Workers (Note 3)	Type of Work	Did the Labourers supply any animals or implements?		Crop Variety (Note 5)	Time Taken (Note 6)	Plot No. if applicable (Note 7)	Details of Payments	
			Animals	Implements				Cash or Crop Share	Other Tobacco or Pan Lodging Food

....

When this sheet is completed, start a fresh FORM W2

WEEKLY FARM SURVEY

NOTES ON FORM W2

NOTE 1: "Temporary" labourers are those who are hired for a given operation or for a period shorter than a year at a time. It is important to include labour obtained under mutual agreements here. Take one line in the table for each worker (or group of workers if they work as a team and are paid as a team).

NOTE 2: Record both the day and the date on which the work was done.

NOTE 3: The number will be ONE if the workers are hired individually; but if a team is employed (see Note 1), enter the number of persons in the team. "Type of worker" refers to four categories; MEN (Code M); WOMEN (Code W); BOYS (Code B); and GIRLS (G). Thus, one man is entered 1M, five women as 5W if the latter work as a team. A team of two men and five boys for example will be recorded as 2M+5B on one line if they are paid as a team or on two separate lines if the men and boys are paid separately.

NOTE 4: Enter the number of animals and/or implements (if any) supplied by the individual worker or team of workers.

NOTE 5: Where this applies, write the variety if known.

NOTE 6: Try to be as exact as possible here, but it may be possible only to record $\frac{1}{2}$ day, 1 day, or whatever the respondent tells you.

NOTE 7: Enter the plot identification number in the case of cash or crop share payments (eg "per day", "per acre", etc). In the case of other payments, tick the appropriate box as required. The exact nature of these payments will be investigated later.

NOTE 8: Units must be recorded in the case of cash or crop share payments (eg "per day", "per acre", etc.). In the case of other payments, tick the appropriate box as required. The exact nature of these payments will be investigated later.

FORM W3: ASK HOUSEHOLD HEAD ONLY

FARM IDENTIFICATION FORM W3/

Did you hire or borrow any draft animals in the period since the previous interview? (See Note 1)

If YES, please give the following details:

Day & Date (Note 2)	No. & Type of Animals (Note 3)	Type of Work	Time Taken (Note 4)	Plot No. if applicable (Note 5)	Amount Paid (Note 6)	Reason for Hiring (Note 7)

....

When this sheet is completed, start a fresh FORM W3

NOTES ON FORM W3

NOTE 1: Note that this question relates to animals belonging to others which the respondent has obtained to work for him whether paid for or free of charge.

NOTE 2: Record both the day and date on which the animals were hired. If they were hired for more than one day take a fresh line for each day.

NOTE 3: Enter the number of animals, eg 2 buffaloes, 1 bullock, etc. Take a separate line for each different type of animal.

NOTE 4: Try to be as exact as possible here, but it may be possible only to record ½ day, 1 day, or whatever the respondent tells you.

NOTE 5: Enter the plot identification number in the case of field operations.

NOTE 6: State whether cash payment, crop share, etc. and state unit. If animals were free of charge, write "0". If exchanged on a reciprocal help basis, write "Reciprocal".

NOTE 7: Try to obtain as specific an answer as possible here.

FORM W4: ASK HOUSEHOLD HEAD ONLY

FARM IDENTIFICATION FORM W4/

Did you hire out or lend any draft animals in the period since the previous interview?

If YES, please give the following details:

Day & Date (Note 2)	No. & Type of Animals (Note 3)	Type of Work	Time Taken (Note 4)	Amount Received (Note 5)	Reason for Lending (Note 6)

....

When this sheet is completed, start a fresh FORM W4

NOTES ON FORM W4

NOTE 1: Note that this question relates to animals belonging to this household and given or hired out to work for others, whether paid for or free of charge.

NOTE 2: Record both the day and date on which the animals were hired. If they were hired for more than one day take a fresh line for each day.

NOTE 3: Enter the number of animals, eg 2 buffaloes, 1 bullock, etc. Take a separate line for each different type of animal.

NOTE 4: Try to be as exact as possible here, but it may be possible only to record ½ day, 1 day, or whatever the respondent tells you.

NOTE 5: State whether cash payment, crop share, etc. and state unit. If animals were free of charge, write "0". If exchanged on a reciprocal basis write "reciprocal".

NOTE 6: Try to obtain as specific an answer as possible here.

FORM W5: ASK HOUSEHOLD HEAD ONLY

FARM IDENTIFICATION FORM W5/

Were any of your draft animals unable to work in the period since the previous interview? If YES, please give the following details:

Date of Interview	Number of Animals (Note 2)	Number of days lose (Note 3)	Reason

....

Was any feed (apart from grazing) given to draft animals in the period since the previous interview? If YES, please give the following details: (Note 4)

Date of Interview	No. & Type of Animals	Type of Feed	Quantity	Cost (Note 5)

....

When either this table or table 1.1 is completed, start a fresh FORM W5.

Do you intend to harvest any crops in the next week or so? (Note 6)

NOTES ON FORM W5

NOTE 1: Notice that this question relates only to animals which were unable to work (for some reason such as sickness) and not to animals for which there was no work.

NOTE 2: Only working animals should be included here. Use a different line for each different animal (not just each different type of animal).

NOTE 3: The number of days lost refers only to the period since the previous interview and not before it. Thus, for example, if a particular animal has been sick for five weeks and the previous interview took place seven days ago, the correct answer to write in this column is "7 days".

NOTE 4: This question relates to feed when it is given to animals. Include feed such as crop residues which are produced on the farm as well as those purchased or otherwise obtained from outside. (See also NOTE 5 below).

NOTE 5: If the feed was produced on the farm itself, write "0" here.

FORM W6: ASK HOUSEHOLD HEAD ONLY

FARM IDENTIFICATION FORM W6/

Please give the following information about any agricultural inputs used by this household since the previous interview:

Day & Date (Note 2)	Type of Input (Note 3)	Amount Used (Note 4)	Price Paid (Note 5)	Where Obtained (Note 6)	Plot No. if applic-able (Note 7)	Means of Transport (Note 8)	Cost of Transport (Note 9)

....

When this sheet is completed, start a fresh FORM W6

NOTES ON FORM W6

NOTE 1: This question refers to inputs at the time of use, not at the time of purchase (if they were in fact purchased) and refers to materials used in the process of crop production and processing: eg seeds, seedlings, chemical fertiliser, manure, pesticide, chemicals for protecting stored grain, etc. Include inputs produced on the farm or otherwise obtained without cash payments, eg seedlings, seed, manure, water hyacinth.

NOTE 2: Record as exactly as possible the day and date on which the inputs in question were used.

NOTE 3: Be as exact as possible here; eg in the case of seed or seedlings state type and variety if known, in the case of fertiliser state type.

NOTE 4: Remember to state the units in question, eg "taka per seer"; if only the total amount paid is given, write "total" after the amount paid, eg "25 taka total".

NOTE 5: (see also Note 4); again state units; include farm-produced inputs or other goods for which no payment was made by writing "0" here. If goods were given in exchange for other goods (eg paddy given in exchange for fertiliser) state what was given in this column.

NOTE 6: State place obtained and supplier if possible; include goods produced on the farm itself by writing "this farm" here.

NOTE 7: Write the plot identification number in the case of inputs used in the field.

NOTE 8: This refers to transport from the place of purchase to the farm. If more than one type of transport was used, list all types.

NOTE 9: This refers to the total cost of transport by all types of conveyance. Remember to state units or write"total" in this column (see Note 4 also). If no payment was made for transport write "0" here (eg if the farmer carried the inputs or if his own vehicle was used).

FORM W7: ASK HOUSEHOLD HEAD ONLY

FARM IDENTIFICATION FORM W7/

Was any farm produce sold in the period since the previous interview?

If YES, please give the following details:

Day & Date (Note 2)	Type of Produce (Note 3)	Quantity Sold (Note 4)	Total Amount Received (Note 5)	Place Sold (Note 6)	Means of Transport (Note 7)	Cost of Transport (Note 8)

....

When this sheet is completed, start a fresh FORM W7

NOTES ON FORM W7

NOTE 1: This question refers to all farm produce, not only to crops; produce such as eggs, fruits, etc. should also be included.

NOTE 2: Record as closely as possible the day and date on which the produce was sold.

NOTE 3: State the type of produce sold; be as exact as possible; in the case of crops, state the variety also if possible.

NOTE 4: Remember to state units, eg seers, maunds, etc.

NOTE 5: The amount received relates to the total quantity sold, as show in the previous column.

NOTE 6: Give the place of sale and identify the buyer if possible (eg "BADC", "merchant"). In the case of sales in a village hat or bazaar, give the name of the village.

NOTE 7: This refers to the means of transport from the farm to the place of sale. If more than one type of transport was used, list all types. Further details will be sought later.

NOTE 8: This question refers to the total cost of transport by all conveyances; state all units (eg "taka per mile", "taka total", etc.). If no payment was made for transport, write "0" here (eg if the farmer's own vehicle was used).

FORM W8: ASK HOUSEHOLD HEAD ONLY

FARM IDENTIFICATION FORM W8/

Was any hired machinery used in the period since the previous interview?

If YES, Please give the following details:

Day & Date (Note 2)	Machine & Implement (Note 3)	From whom obtained (Note 4)	Plot No. (if Applicable) (Note 5)	Time Taken (Note 6)	Amount Paid (Note 7)	Office Use

....

When this form is completed, start a fresh FORM W8

NOTES ON FORM W8

NOTE 1: This refers to modern machinery such as tractors, power tillers, low-lift pumps, etc. Include engine-powered vehicles if especially hired by the household.

NOTE 2: Record both the day and date on which the machinery was used. If more than one day, take a separate line for each.

NOTE 3: If a tractor was used, record the type of implement used with it, eg harrow, rotavator, etc.

NOTE 4: eg KTCCA, BADC, private hirer, another farmer, etc. If the hire was private (ie private hirer or another farmer), record his name and village.

NOTE 5: Record the plot identification in the case of field operations.

NOTE 6: Try to be as exact as possible. Include only time spent in the field. It may be possible only to record $\frac{1}{2}$ day, 1 day, or whatever the respondent tells you. It is most important to discover the number of times a plot was cultivated: obviously it takes much longer to cultivate twice than once.

NOTE 7: In some cases there may be separate rates charged for working and travelling. If so record them separately. If the same rate is charged, write "total" after the amount paid. If units are stated, record these (eg taka per mile, taka per acre, taka per hour).

FORM W8A: ASK OWNERS OF POWER TILLERS ONLY

FARM IDENTIFICATION

FORM W8A/

Did you hire out or lend your power tiller in the period since the previous interview? (Note 1)
If YES, please give the following details:

Day & Date (Note 2)	Type of Work (Note 3)	Village Worked in (Note 4)	Machine Time Taken (Note 5)	Area Cultivated (Note 6)	Amount Charged	
					Working Time (Note 7)	Travelling Time (Note 9)

....

When this sheet is complete, start a fresh FORM W8A

NOTES ON FORM W8A

NOTE 1: Note that this question relates to power tillers which belong to this household and are given or hired out to others, whether paid for or free of charge.

NOTE 2: Record both the day and the date on which the power tiller was hired out. If it was hired out to more than one farmer on the same day, take a fresh line for each of these farmers. If the tiller was hired out to the same farmer for more than one day, take a fresh line for each such day.

NOTE 3: This will normally be "cultivation" (although a power tiller can also be used for other operations, such as irrigating if the appropriate attachment is used). Try to give as much detail of cultivation as possible, eg "first cultivation", "second cultivation" etc.

NOTE 4: If it is hired to someone in this village, write "same", otherwise give the name of the village.

NOTE 5: Try to be as accurate as possible here, but it may be possible only to record ½ day, 1 day, or whatever the respondent tells you.

NOTE 6: Try to be as exact as possible here; if necessary ask the power tiller operator. It is most important to discover the number of times the plot was cultivated: obviously it takes much longer to cultivate twice than once.

NOTE 7: In some cases there may be separate rates charged for working and travelling. If so

NOTE 8: record them separately. If the same rate is charged (eg if a rate per hour away from the owner's farm is charged) record all charges under "working". In all cases the unit must be stated, eg "taka per hour", "taka per acre", "taka per mile", etc. If only the total amount paid is stated, write "total" after the amount paid, for example, "250,000 taka total", etc.

FORM W9: ASK HOUSEHOLD HEAD ONLY

FARM IDENTIFICATION

FORM W9/

During the period since the last interview was any farm operation performed either earlier or later than it should have been in your opinion, or was any such operation not performed at all? (Note 1). If YES, (ie some operation was performed early or late or was not performed at all), please give the following information:

Type of Work	Crop/Variety (Note 2)	Plot No. if applicable (Note 3)	Day Work was done (Note 4)	Day work should have been done (Note 5)	Reason Work was Early or Late

....

When this sheet is completed, start a fresh FORM W9

NOTES ON FORM W9

NOTE 1: This question is designed to find out whether the farmer was prevented by circumstances outside his control from performing any farm operation at the time he considers best for it. If even a single operation was performed at the wrong time, or was not performed at all, then the answer to this question is YES and the table must be completed accordingly. Take a fresh line for every such operation. Remember that what you are looking for here is THE FARMER'S OWN OPINION.

NOTE 2: Crop or variety (if known) name should be entered; use the standard codes wherever possible.

NOTE 3: In the case of field operations enter the plot identification number.

..... (continued)

Notes on Form W9 (continued)

NOTE 4: ie the date on which the operation in question was actually performed. If it has not yet been performed at the time of the interview, the question must be asked again at the next and all subsequent interviews until it has been performed. If the operation is never in fact performed, then eventually (ie when the farmer says so) the word "never" should be entered here.

NOTE 5: Notice that you are looking for the farmer's best estimate here; do not prompt or suggest answers - HE IS THE EXPERT, NOT YOU!

FORM H1: ASK HOUSEHOLD HEAD

FARM IDENTIFICATION

FORM H1/

Were any crops harvested in the period since the previous interview? (Note 1)

If YES, please give the following details: Complete a new line for each different crop/variety OR different plot:

Plot No. (Note 2)	Date Harvested (Note 3)	Crop & Variety (Note 4)	Amount Harvested (Note 5)	How does this yield compare with normal? (Note 6)

....

When this sheet is completed, start a fresh FORM H1

NOTES ON FORM H1

NOTE 1: A new line must be completed for every crop and every plot. Thus if the same crop is planted in two different plots, a different line is used for each. Similarly, if two different crops are planted in the same plot (for example mixed aus and amon, or onion inter-cropped with chillies) a different line must be used for each.

NOTE 2: Use the standard plot identification number (from FORM 16)

NOTE 3: If the harvest required more than one day for completion, write in the starting date and the finishing date for that plot and crop (eg 14-16 July 1978).

NOTE 4: Enter the crop name and the variety name if this is known.

NOTE 5: This figure relates to the total amount produced from the plot in question (the "yield") after the crop has been threshed, etc. If the crop has not yet been threshed, ensure that this information is collected at the next interview.

NOTE 6: You are looking here for an indication of how typical this year's yield was. A "normal" year must therefore relate to the same crop in the same plot, or in a plot which the farmer considers to be similar. Use the following scale when writing in the answers:

VP = this crop is very poor when compared with a normal year;
P = this crop is poor when compared with a normal year;
N = this crop is normal;
G = this crop is good when compared with a normal year;
VG = This crop is very good when compared with a normal year.

If the farmer can give a more precise answer, write down this answer; if he does not know the answer, write "don't know".

FORM H2: TO BE COMPLETED BY ENUMERATOR AT TIME OF TAKING SAMPLE CROP CUTS

Name of Enumerator

To be entered by the Enumerator (Note 1)	For Office Use Only (Note 1)	NOTE Decimal points must be punched COLUMNS
	0308	1 to 4
Farm Identification No.		5 to 8
Plot Number		9 to 11
Date Samle was taken (Note 2)		12 to 14
Crop and Variety (Note 3)		15 to 17
Area Cut (square metres) (Note 4)		18 to 22
Weight of Sample (Kilos) (Note 5)		23 to 27
Moisture Reading (%) (Note 6)		28 to 32
Scale Used A B C (Note 7)		33
Temperature (°Centigrade) (Note 8)		34 to 38

NOTES ON FORM H2

NOTE 1: Do not use the columns to the right of the double line. Write your answers on the lines provided to the left of this line.

NOTE 2: It is important to take the sample on the same day as the farmer is harvesting. Arrange this with him in advance.

NOTE 3: It is essential to find out from the farmer the name of the variety being harvested; do NOT simply write "aus" or "IRRI", for example.

NOTE 4: The exact area to be harvested will depend on the crop itself. The more uniform the stand the smaller is the minimum acceptable size of sample. The minimum size of sample is five square metres. This can be used with a uniform crop of transplanted paddy. With a direct seeded crop, however, take four separate samples (ie at different points in the field) of four square metres each.

NOTE 5: Thresh and weigh the crop immediately after harvest. Make sure that you reset the pointer of the weighing scale to zero WITH THE CONTAINER IN PLACE before you weigh the crop.

NOTE 6: Remember to reset the pointer of the moisture meter to the "R" mark before beginning. Do this by holding the switch to the right and if necessary turning the "reset" knob until the pointer is in the proper position. Fill the hopper with grain and tighten the screw, holding the switch to the left as you do so. When there is a deflection, turn the screw one half of a complete turn and then take the reading (still with the switch hold to the left). Remember to use the correct scale, eg the blue "A" scale for paddy and the red "B" scale for wheat. If the reading goes above the top of the scale (ie to the right of the "R" mark) insert the ranger extender and repeat the reading.

NOTE 7: On the left hand side of the dial of the moisture meter the three scales are identified. These are "A" (blue), "B" (red) and "C" (green). Circle the letter which corresponds to the scale from which you took the reading. (eg if you were sampling wheat and used scale B, your result will look like this:

A (B) C

NOTE 8: Insert the thermometer into the hopper before removing the grain. Leave it in position for at least one minute before taking the reading.

MAKE ABSOLUTELY CERTAIN THAT THE GRAIN IS RETURNED TO THE FARMER AFTER YOU HAVE FINISHED WITH IT. UNDER NO CIRCUMSTANCES SHOULD IT BE DISCARDED OR LEFT LYING ABOUT OR ENTRUSTED TO ANYONE ELSE.

APPENDIX 6: THE 'FINAL INVENTORY'

This 'inventory' comprised two parts: first details of land and livestock resources and second a detailed survey of social and attitudinal factors. The second component was under the supervision of P. D. James of War on Want. For details see James and Mettrick (1981). The data collected in the first part of the Inventory comprised the following.

1. PHYSICAL CHARACTERISTICS OF PLOTS: area; distance from farmstead; type of irrigation (if applicable) - seasons irrigation available; susceptibility to flash flooding; land height in relation to flooding; relative permeability of soil; time of year land is clear of floodwaters; soil type (local name); date plot was acquired.

2. OWNERSHIP CHARACTERISTICS OF PLOTS:
   (i) OWNED PLOTS: how plot was acquired; amount paid (if applicable); how disposed of (if applicable); amount received (if applicable).
   (ii) RENTED PLOTS: Type of lease; date of termination; length of long-term lease (if any); when rent is payable; amount paid; inputs provided by landlord.
   (iii) MORTGAGED PLOTS: Type of agreement; length of agreement; amount paid; interest payments (if any).

3. LIVESTOCK: Breed of animal; sex, age, relative condition; purpose(s) for which used; when acquired; if purchased, amount paid; if subsequently disposed of, why and how; amount received (if applicable).

APPENDIX 7: STANDARDISATION OF MEASUREMENT UNITS FOR LABOUR AND DRAUGHT ANIMALS.

LABOUR

Common practice is to convert child labour into adult-equivalents by applying a standard conversion coefficient, commonly 0.5 (see for example Clark and Haswell (1970)). Female adult equivalents are converted into man-equivalents in a similar way - 0.8 being the most familiar coefficient. This was done in the present study in the case of casual labour, which was reported in the four age-sex categories: boy, girl, man, woman. The actual coefficients used do not matter a great deal in practice however since the overwhelming majority of labourers are in fact men.

In the case of the permanent farm labour force a complication arises over deciding on an appropriate cut-off age to separate men from boys (no female permanent labour is employed in the fields). The problem is twofold: first, ages are not known with any great degree of accuracy and second, there is no clear-cut dividing line between the duties of men and boys. In order to avoid serious error, a series of coefficients has been used. Adult men were assumed to be those of 18 years or over,[1] and the coefficient for younger boys was his own age divided by 18; for example, a fifteen-year-old would be regarded as 0.83 (16/18) men-equivalents and a nine-year-old as 0.5 m.e. The coefficients for older men (that is, those over the age of 50 years) were graded in exactly the same way but with a minimum value of 0.1 for anyone reported as working on the farm, even in a purely decision-making or supervisory role.

DRAUGHT ANIMALS

The standard cultivation animal of Bangladesh is the indigenous bovine, either bullock or cow. As in the case of human labour, there are quantitative differences in power output depending upon age and sex. In the absence of any means of direct measurement, data from other sources have been used in helping to estimate the power output of animals. The typical draught bovine used in Bangladesh is rather small, generally in the range of 200-250 kg in the case of bullocks and 160-170 kg for cows. Its working life extends roughly from the age of 5 to 11 years.[2] Odend'hal (1972) rated rather heavier animals in West Bengal at 0.6 to 0.7 h.p., while Makhijani (1975) rates a 250 kg developing country bullock at 0.5 h.p., as do Rao and Singh (1977) in the case of India. This latter estimate has therefore been used here. The norm for the cow has been set at 0.3 h.p. in accordance with FAO calculations which rate it at an average of 60 per cent of the power output of the bullock (Cockrill (1974), Table 66).

Bangladeshi farmers can tell the ages of their cattle, particularly youngstock, from the number and condition of the teeth. Animals outside of the usual 5-11 years are sometimes used for cultivating, particularly by the poorer farmers, obviously with some loss of power. Age has been discounted for here in the same way it was the human labour, subtracting 1/5 from the coefficient for each year below and 1/10 for each year over the 'normal' age range. The lower proportion was used in the latter case because of the greater

---

[1] This age was chosen because it is generally associated with the achievement of full bodily growth. See, for example, Sinclair and Hollingsworth (1969) ch. 3.

[2] These figures relate to working animals on small farms and are from R. P. Mack, Bangladesh Central Cattle Breeding Station (personal communication).

difficulty farmers find in ageing older beasts. There is an evident tendency to over-report in some cases. However, a minimum of one half of the 'norm' has been assumed if an animal is capable of working at all. These minima have also been used if the animal in question was said to be in poor condition.

APPENDIX 8: BANGLA AND WESTERN CALENDARS

Dates were recorded in two ways during the course of the Survey. When field staff themselves filled in details of the week just completed the Western calendar was used, but when farmers were asked to recall dates the Bangla calendar was used. This latter calendar has twelve months of a varying number of days but running from approximately mid-month to mid-month in the Western calendar. The year is based on the Hagira. One New Year's Day in the Bangla calendar was celebrated during the field work phase of the Survey: 1.1.1386, which was 15th April, 1979, in the Western calendar. The Bengali months are as follows (transliterations may vary):

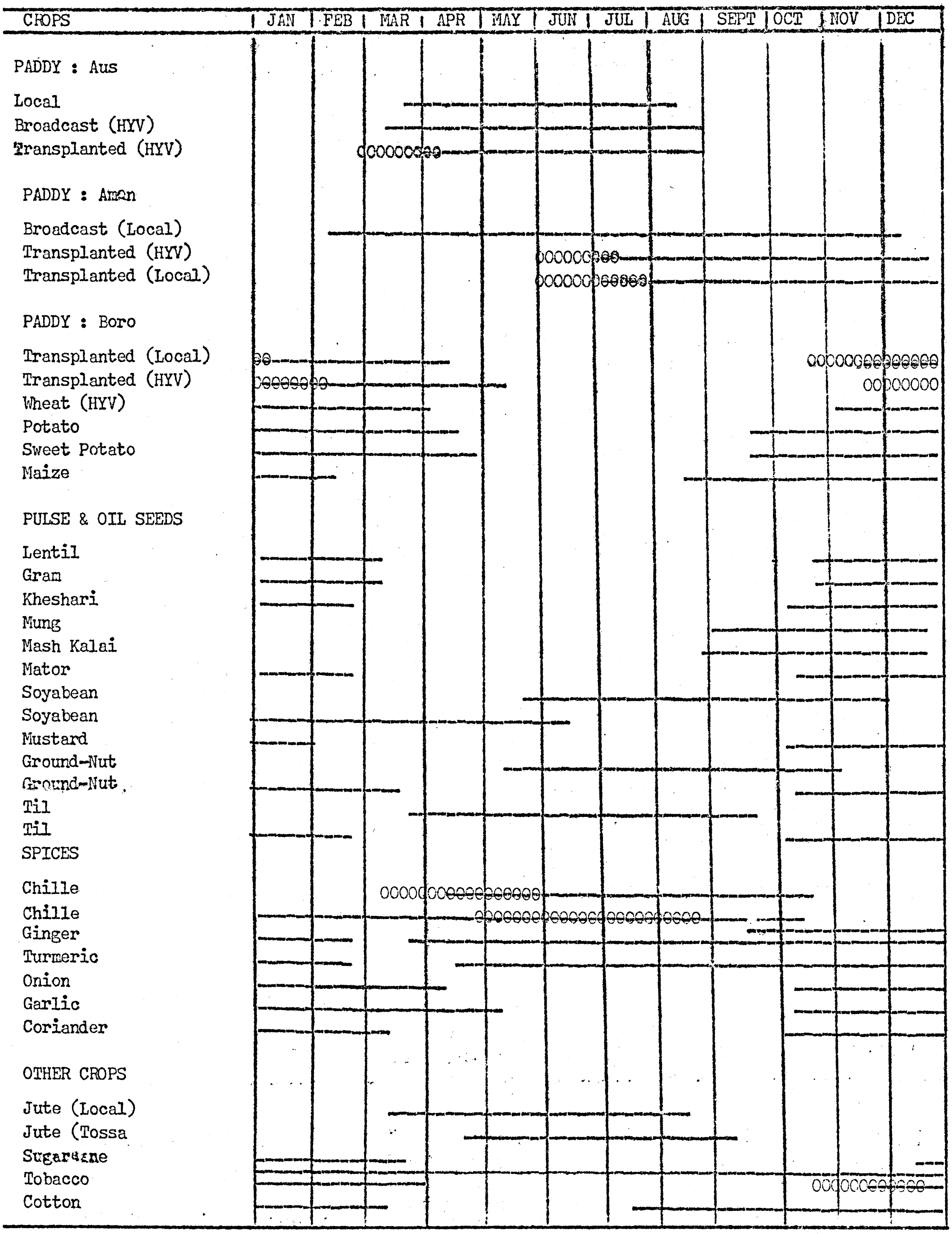
1. Baisakh (April - May)
2. Jaistha (May - June)
3. Ashar (June - July)
4. Shraban (July - August)
5. Bhaddra (August - September)
6. Ashin (September - October)
7. Kartique (October - November)
8. Agrahion (November - December)
9. Paus (December - January)
10. Magh (January - February)
11. Falgun (February - March)
12. Chattra (March - April).

APPENDIX 9: METHODOLOGY USED FOR SAMPLE CROP CUTTING

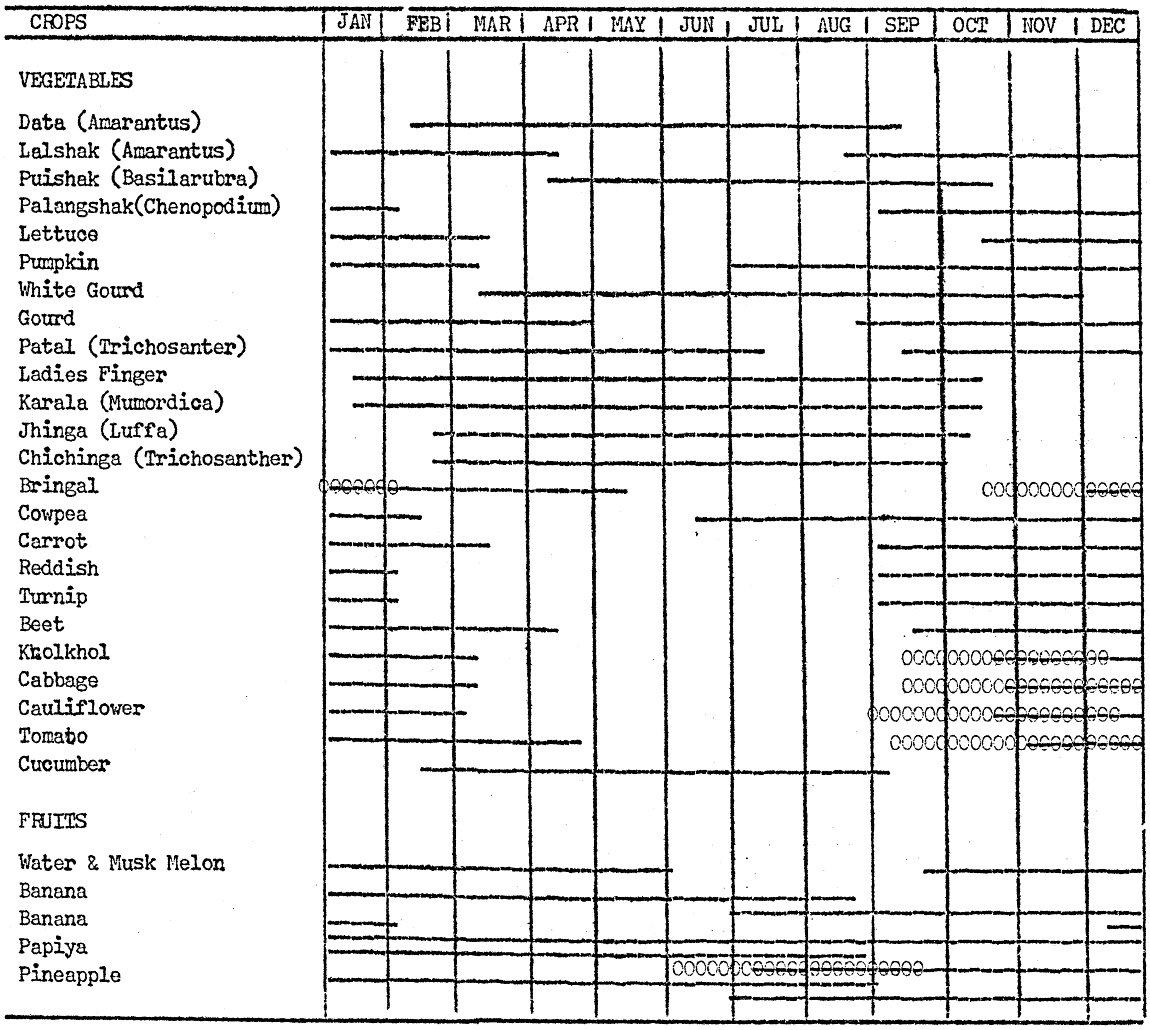
This methodology is based on one developed by Dr. Peter Hobbs of the Bangladesh Rice Research Institute.

This size of sample taken depended upon the uniformity of the crop stand - the more uniform the stand the smaller the sample. With a plot of transplanted paddy, a single strip measuring 1 m x 5 m was harvested; with a direct-seeded crop, four separate strips of 1 m x 4 m were taken at different points in the field. Enumerators were provided with a heavy-duty steel gauge comprising three sides of a 1 metre square. This was thrust into the standing

CROP CALENDAR OF BANGLADESH: EXISTING CROPPING PATTERNS



CROP CALENDAR OF BANGLADESH (Continued)



Existing Cropping Patterns:

1. Aus/Jute + T. Amon
2. Aus + T. Amon + Khesari (Lathyrus)
3. Jute + Kalai (Pulse)
4. Aus and T. Amon Mixed
5. Aus + Mustard/Pulses/Rabi Vegetables/Tobacco/Cotton/Potato
6. Aus and Arhar (Cajanus)/Til (Sesamum) Mixed
7. B. Amon
8. Aus and B. Amon Mixed
9. Boro
10. Sugarcane
11. Summer Vegetables + Mustard/Pulses

ooooo = Seed bed

(HYV) = High Yield Variety

Source: USAID.

crop (open end forwards) from a point where the harvestors had already cut a swath, with care being taken to avoid 'edge effect' and other potential sources of bias. The area inside the square was then harvested, the gauge pushed forwards and the operation repeated. The sample was then threshed, winnowed and weighed, its temperature noted and the moisture content of a ground sample measured. The grain was then returned to the farmer. Results were recorded on a special form (Form H2), details of which are included in Appendix 5.

APPENDIX 10: SOCIAL AND ECONOMIC ASPECTS OF INTEGRATED CROP-LIVESTOCK-ENERGY MODELS IN BANGLADESH

1. Introduction

The current drive to achieve food self-sufficiency in Bangladesh involves all sectors of the agricultural economy. Recent efforts at improving the feed situation in the livestock sector were the subject of the Second of two international seminars on Maximum Livestock Production from Minimum Land at the Bangladesh Agricultural University in February, 1981. The major finding of this seminar was that an appropriate overall livestock production strategy for Bangladesh would be "based on models in which livestock would be fully integrated into the farming system" with the development of multi-purpose crops and animals which are mutually supportive, each utilising the other's by-products. An illustration of the model which was adopted at the conclusion of the Seminar is reproduced here as Figure 1. Adoption of this type of approach would require a reversal of traditional agricultural research objectives which have tended towards increasing specialisation of both crops and livestock, specialised types which often compete for the same scarce resources - especially land.

Considerable success was reported in the course of the Seminar in testing part of the above model, namely urea treatment of paddy straw in order to improve its nutritive qualities. Based on this early success and on reports of similarly encouraging experimentation on similar models in other parts of the world, a schedule of experimental work on the model was adopted for the succeeding year. The level of interest so far generated suggests that a major programme of experimental and teaching work in this area might soon be forthcoming.

One element necessarily missing from the model illustrated in Figure 1 is the social and economic dimension, without which it could not operate in the real world. The history of 'Development' in the Third World is littered with examples of technologically attractive innovations which in practice have had severely negative social and economic consequences. Mechanisation of agriculture is

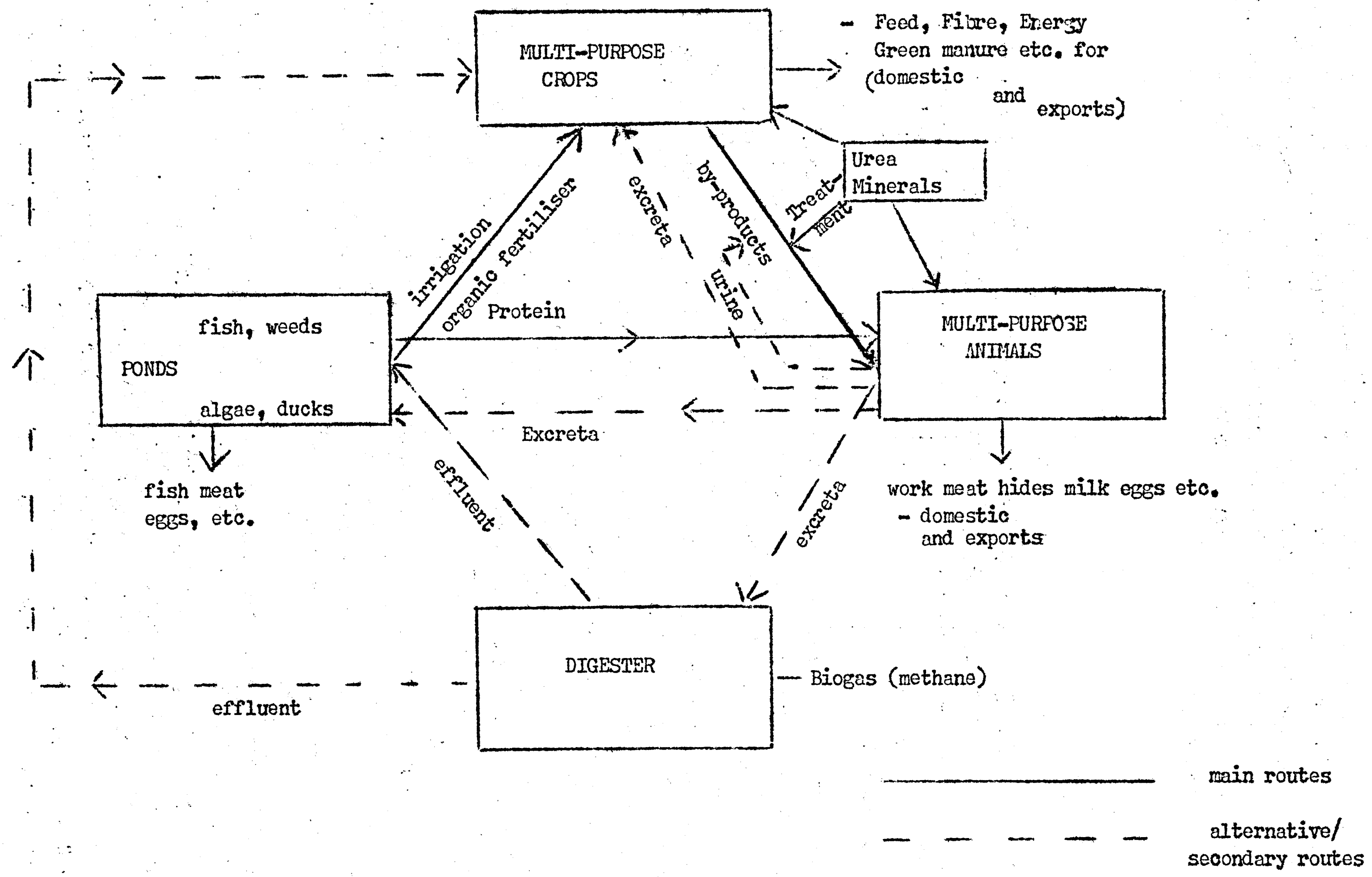


FIGURE 1: AN INTEGRATED SYSTEM FOR AGRICULTURE, LIVESTOCK & ENERGY. (After Jackson & Preston)

a case in point, having frequently been accompanied by tenant eviction and labour displacement. Even the 'Green Revolution' has by now generated a vast literature chronicling its often negative social and economic impact. It is therefore imperative to gain an understanding of the social and economic characteristics of the environment into which a model such as that proposed at BAU will be introduced in order better to be able to predict the likely total impact of such innovations and if necessary to modify either the model itself or the strategy for its introduction in order to be able to avoid undesirable economic and social consequences.

2. The Traditional Bangladesh System

There is, of course, no single traditional crop, livestock and energy production/consumption system in Bangladesh, but the degree of variation is not so great that a representative model cannot be described. The major technical features of this model are illustrated in Figure 2, while Table 1 lists the main by-products of the system and their various end uses. Inspection shows that although it has fewer elements and is not so highly integrated or scientifically based as that of Figure 1, the degree of integration and utilisation of by-products in the traditional system is already high, with multi purpose by-products existing alongside multi purpose crops and animals. In theory at least the endogenous component of the system could be viewed as operating at any level of the economy. Traditionally, however, the scale probably ranged from farm to not far above village level.

The salient features of the model should be fairly clear from Figure 2. Human energy is used directly in the production of crops and livestock (including fish and ducks) and indirectly on crops via draught animals. Animals and crops provide both human food and fuel to cook it, including parboiling. Animals and crops are also mutually supportive through fertiliser and residue production respectively. The model in addition shows how various flows leave and join the system: off-farm work by humans and draught animals, sales of produce and purchases of food, inputs and stock.

3. Dynamics of the Traditional System

The parameters of the traditional system are far from static. Their dynamism derives basically from three sources: commercialisation of agriculture, technological change and increasing population pressures. Commercialisation will increase the flows into and out of the system as sales and purchases increase relatively to internal flows. Commercialisation is also a major vehicle through which exogenous technological change is introduced, through for example the introduction of purchased inputs such as inorganic fertilisers and other agro-chemicals, new varieties, farm machinery and so forth. Innovations which increase land productivity (fertiliser, irrigation, etc.) can usually be expected to increase the volume of resulting by-products (which may or may not then be utilised within the system) but not necessarily to improve their quality. For example the

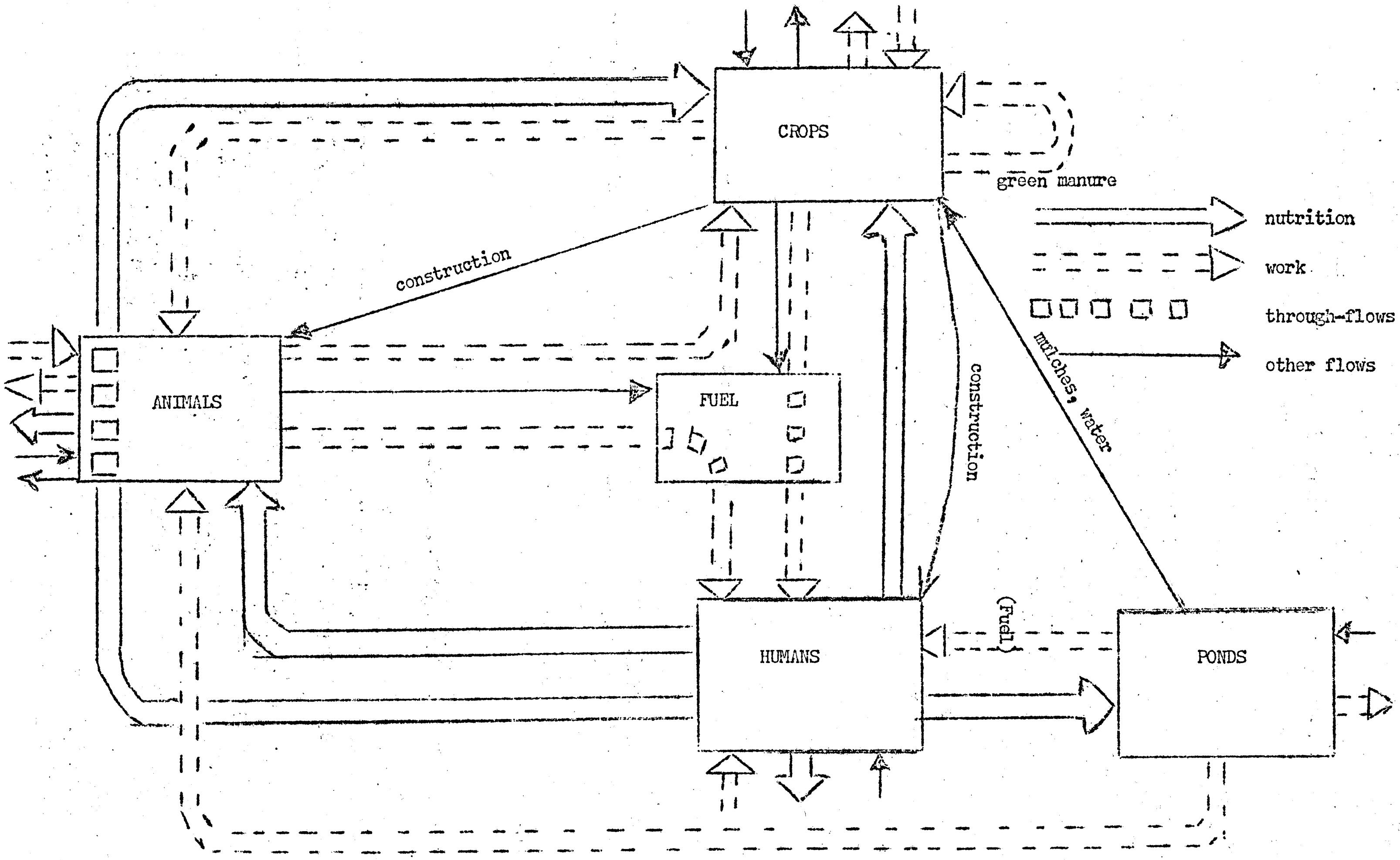


FIGURE 2: TRADITIONAL CROP-LIVESTOCK-ENERGY SYSTEM OF BANGLADESH

TABLE 1: MAJOR ANIMAL AND CROP BY-PRODUCTS AND THEIR END USES IN BANGLADESH AGRICULTURE

Purpose	By-Products
Fuel	Jute sticks, Cow dung, Oilseed residues, Straw, Rice husks
Feed	Straw, Rice bran, Molasses, Pulse residues, Water weeds
Fertiliser	Cow dung, Crop residues (sometimes burnt in the fields)
Construction	Jute sticks, Straw
Mulching	Straw, Water weeds

short straw bred into many high yielding food grain varieties for lodging resistance makes an unusually poor cattle feed. This, incidentally, provides a good example of (plant) breeding for a specialised purpose (grain yield) without taking adequately into account the total end use of the crop in question.

The effect of population pressure on the system is more likely to be noticed initially at the level of the individual farm than on a village-wide scale. First, at the village level increasing population presses first on communally owned resources such as forest and common grazing, so that crop and animal by-products which substitute for these come under increasing demand and hence tend to become increasingly valuable. Second, as the individual farm family grows in relation to other elements of its crop-livestock-energy system diminishing returns to labour result in either disguised unemployment on the farm or, if non-farm employment opportunities exist, an increase in the flow of labour out of the farm-level system. Severe such problems of this kind may eventually force disinvestment through sales of livestock and land (or through mortgaging) so that the non-human elements of the model again tend to shrink as for example draught animals must be hired in rather than owned or the land and animal resources of the farm become increasingly inadequate to meet the growing family need for food, fuel, etc.

The village level model is evidently more stable than that of the farm. As one farm family disinvests, another may acquire these assets,[1] particularly immobile assets like land - so that the village model continues to operate with redistributed assets, surplus labour on the smaller holdings being traded for surplus land and other assets on the larger ones without the need for cash. Sharecropping agreements are an illustration of this (in the absence of absentee landlordism - see below). Such agreements usually

[1]The Muslim laws of inheritance which entail equal subdivision among sons help to create an ebb and flow of resources within the same generations of a given family. As sons grow up and bring in additional income, assets like land can be built up - only to be redivided on the death or retirement of the father.

result from families with more land resources than they can manage renting out to those with surplus labour. Within the Bangladeshi sharecropping system today can be seen the effects of increasingly valuable by-products. Straw provides a good example: older farmers in various parts of the country report that paddy straw used to be of little or no commercial value. Today, however, it sells in the market for Tk.20/- per maund or more. This development is reflected in landlord-tenant relationships. Straw was traditionally regarded as a sharecropper's perquisite, whereas there is now a tendency to divide it in the same proportion as the crop, generally 50-50. In cases where the landlord has provided seed the agreement often stipulates that he shall receive all of the straw in return. An alternative, and probably older, arrangement in this case is for the seed to be returned to the landlord before the crop is divided in the agreed proportion. The implication of such a change is that a field of paddy straw is now more valuable than the seed which produced it.

The above arrangement shows how by-product flows may move out of the farm level system yet stay within the village system. Another way of retaining flows is through the employment of poor women, since all but the very poorest would refuse to work outside of their villages. These women are normally paid at least partly in kind - which unlike cash tends to be used within the village system. The most familiar instance is probably paddy-husking. A poor woman will husk a neighbour's paddy on the <u>dheki</u> and receive a portion of the output as pay (often the broken grains). She may also receive the paddy husks to use as fuel. Payment of women in crop residues for use as fuel is indeed quite common in rural Bangladesh, presumably because it is a woman's responsibility to obtain the fuel she needs for cooking. Thus women who decorticate the jute crop may be given the jute sticks in payment; those who thresh the mustard crop (they use sticks as flails) will receive the pods and stems in return, while women helping to thresh a deep-water <u>aman</u> paddy crop are paid in straw - often only the lower portion of the straw which is useless as cattle feed and can only be burnt. This again illustrates the value that is placed on crop residues.

If only women normally receive only by-products as wage-goods, male labourers too often receive at least part of their wages in kind. Most permanent employees receive almost all of their compensation in kind, but casual workers may also do so. One such traditional system is to pay labourers - especially harvesters - a share of the crop. Even when cash wages are paid, many labourers - particularly local people - receive the balance of their wage in the form of food.[1] From the employer's viewpoint one potential advantage of such an arrangement (whether he realises it or not) is to ensure that the entire wage good is consumed by the labourer himself, rather than shared with his family. This in turn maximises the energy value which can be returned to the employer in the form of enhanced work capacity.

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[1] Where non-local casual labour is employed it generally takes the form of migrant work gangs. The logistics of feeding so many would defeat the typical farmer's wife.

Available evidence suggests, however, that even at village level the traditional crop-livestock-energy system of Bangladesh is tending to disintegrate, although it might of course simultaneously be reforming at a higher geographical level (albeit at the price of some additional transaction costs). Commercialisation is by definition a part of this process, although as was shown earlier in the case of land-augmenting purchased inputs it can increase the flows within the system as well as between the system and the rest of the world. One facet of this is the apparently increasing use of cash wages and cash rents to replace such payments in kind. The case of changes in wage structures at least has to some extent been documented, by Clay (1976), who found in the part of Dacca District which he studied that traditional wage payments in crop shares were in process of being replaced by cash payment on either a time or a piece rate basis. From a position of almost entirely non-cash payment at Liberation (1971), Clay's figures suggest that by the mid 1970's almost a quarter of all contracts were on a cash basis. The present author's work in the same area indicated that by the end of the 1970's this proportion had grown to as much as three quarters. In other parts of the country studied by the latter, the process of monetisation of share wages seems virtually complete, although part payment in food still persists.

In the case of rents, monetisation has in part been associated with the growth of absentee landlordism. This latter process represents, in addition to enforced commercialisation (sales of produce to pay the rent), an uncompensated growth in the flow of resources out of the village-level system. This applies even in those cases where the absentee landlord continues to receive rent in kind, since it too represents a one-way flow.

The growth in mechanised processing is an analogous case. If produce such as paddy, oilseed and pulses are sent outside of the village for processing, there is not only a loss of employment opportunity and of opportunity to increase value added at village level, but it is quite likely that the by-products too will be lost to the village-based system. In this case, however, unlike rents, there is an inflow of cash at least in part compensation. The by-products in question may of course still be utilised within the regional or national level crop-livestock-energy system, but again with some measure of transaction cost.

4. Implications

To describe the dynamics of the traditional crop-livestock-energy system of Bangladesh as it moves from farm to village level and beyond is to begin to add the missing socio-economic dimension. At the farm level problems are mainly economic, concerning as they do the allocation of scarce resources among competing end uses. Table 1 listed a number of such alternatives for (increasingly valuable) crop and animal by-products. If a model such as that proposed in Figure 1 is adopted, the range of possible end uses of by-products will be widened still further and the problems of choice could be correspondingly increased. For example, if urea treatment makes straw more valuable as a cattle feed, this could affect its supply for use in mulching, thatching and cooking. Similar questions will arise if methods of treating for example bagasse for the same purpose are devised. A further innovation might be the introduction of new varieties of mustardseed which are lower in erucic acid than are traditional ones, thus making their oilcake suitable for use as concentrate rather than fertiliser. The extent to which questions of choice would arise at farm level with the newer model will depend to a large extent on its success in improving the technical efficiency of flows through the system.

Socio-economic problems, however, increase in direct proportion to the system's scale of operation. As scale increases, the economic linkages become more complex and, at least at village level, are strongly influenced by complicated social relationships which are less clearly understood than are the relevant economic factors. Sharecropping arrangements, for example, have been found to be extremely complex and diversified, but even less well understood is an analogous Bangladeshi 'sharestock' system for livestock management. Under this arrangement an animal which is the property of one individual is cared for and fed by another. The value of the animal's produce (e.g. milk) is divided 50-50 between owner and manager. Offspring are either sold and the proceeds divided equally or they are assigned to owner and manager alternately (generally owner first); offspring acquired by the owner in this fashion are frequently the subject of further sharestock arrangements. When the animal is sold its original value is returned to the owner and the balance then divided equally. If the animal is stolen, this is deemed to be the fault of the manager, who must then make restitution to the owner, but there are complex arrangements for arbitration and settlement in case the animal falls ill or dies. This arrangement is generally called '<u>adha-adhi</u>' in Bangla, which literally means 'half and half', but there may be alternative proportions as in sharecropping. It has been translated here as 'sharestock' in view of its obvious affinity to traditional sharecrop system.

The likely impact of the proposed new crop-livestock-energy systems on arrangements such as that described above would be very difficult to predict without a good deal more information than is presently available as to their nature and extent. Like sharecropping, the sharestock system is a means of combining the assets of those with fixed capital but insufficient labour (or working capital or perhaps skill) with those having complementary resources. Like the sharecropping system its basic rationale could be fundamentally altered by technological changes in techniques of livestock care and maintenance, just as landlord-tenant relationships were fundamentally altered by the 'Green Revolution'.

Moving beyond the village level, social factors probably play a diminishing role, since with increasing scale and distances, relationships will tend to become increasingly impersonal. The sharecrop and sharestock systems, for example, would be difficult (but not impossible) to maintain by proxy, in view of the degree of mutual confidence implied by the type of landlord-tenant and owner-manager relationships described above. Economic factors on the other hand would tend to increase in complexity with the intervention of traders, increasing transaction costs and growing need for market intelligence.

A cliché which is often used in ex ante evaluations of proposed innovations is that they "represent both a challenge and an opportunity". It is nonetheless often true for all that, and is in this instance particularly apt. The proposed model has several very attractive features from an economic and social viewpoint, the most important perhaps being the aim of maximising utilisation of scarce resources and, implicitly, the retention of the necessary inputs as close as possible to the farm level so as to maximise farm- or village-level value added and employment opportunity. If the first of these aims presents mainly technical challenges, the second, representing as it does a reversal of evident present trends towards increasing scale of operation, presents an economic and institutional challenge. Too little is known about the socio-economic features of the existing system to be able to predict with any confidence the likely degree of success in attaining the second of the above goals: even less that would enable confident design of alternative economic or institutional approaches to achieve this aim, or to explore possible implications if it is not achieved. From a socio-economic viewpoint the opportunity is twofold: first, we know that there already exists a system which closely approximates to many of the essential features of that which is now being proposed and which can therefore be explored, analysed and hopefully modelled so as to provide answers to the above questions. Second, since the technical dimensions of the new model have not been fully designed or proved, there is perhaps still sufficient breathing space to collect the necessary information.

REFERENCES

AHMED, A. U. (1981) "Diesel and Electric Powered Irrigation: A Comparative Cost Analysis", USAID, Dacca (May)

ANSELL, D. J. (1976) "Mechanised Rice Production in Northern Ghana", Barclays Bank International Development Fund

BANGLADESH GOVERNMENT (1976) "Bangladesh Customs, Excise and Sales Tax Tariff", Ministry of Finance, Dacca

BANGLADESH GOVERNMENT (1979) "Statistical Yearbook of Bangladesh", Bangladesh Bureau of Statistics, Dacca

BANGLADESH GOVERNMENT (1980) "Draft Second Five Year Plan 1980-85", Planning Commission, Dacca

BANGLADESH GOVERNMENT (1980a) "Bangladesh Agricultural Census, 1977: Preliminary Results", Bangladesh Bureau of Statistics, Dacca (November)

BANGLADESH GOVERNMENT (1980b) "Bangladesh Economic Survey 1979-80", Ministry of Finance, Dacca

BANGLADESH GOVERNMENT (1980c) "The Yearbook of Agricultural Statistics of Bangladesh", Bangladesh Bureau of Statistics, Dacca

BAUTISTA, Fe and WICKHAM, T. (1979) "The Tractor and the Carabau: A Socio-Economic Study of Choice of Power Source for Land Preparation in Nueva Ecija", FAO Farm Management Notes No. 6, (January)

BENGAL GOVERNMENT (1913) "Bengal Famine Code" (Revised Edition), Bengal Secretariat Book Depot, Calcutta, (Reprinted by NIPA, Dacca, 1967)

BHATIA, R. (1977) "Energy and Rural Development in India: Some Issues", IN LOCKERETZ, W. (1977) (Ed) "Agriculture and Energy", Academic Press

BINSWANGER, H. P. (1978) "The Economics of Tractors in South Asia", A/D/C, New York and ICRISAT, Hyderabad

BRAMMER, H. (1976a) "Cropping Patterns and Land Types", Paper prepared for the Bangladesh Agricultural Development Corporation (Mimeo) (August)

BRAMMER, H. (1976b) "Incorporation of Physical Departments in Cropping Pattern Design", Paper presented at the Cropping Systems Symposium, IRRI, Los Banos, Philippines (September)

BRAMMER, H. (1980) "Increased Fertilizer Price Means Farms Must Increase Efficiency", ADAB News, Vol. VII, No. 11, (November)

BRRI (1976) Bangladesh Rice Research Institute "Annual Report for 1973-74", Joydepur, Dacca

BRRI (1979) Bangladesh Rice Research Institute "Annual Report for 1975-76", Joydepur, Dacca

BRRI (1981) Bangladesh Rice Research Institute "Annual Report for 1976-77", Joydepur, Dacca

CHEUNG, S. (1969) "Theory of Share Tenancy", University of Chicago

CLARK, C. and HASWELL, M. (1970) "The Economics of Subsistence Agriculture", Macmillan, London

CLAY, E. J. (1976) "Institutional Change and Agricultural Wages in Bangladesh", The Bangladesh Development Studies, Vol. IV, No. 4, (October)

COCKRILL, W. R. (1974) "The Husbandry and Health of the Domestic Buffalo", FAO, Rome

COCKRILL, W. R. (1974) "The Working Buffalo", IN COCKRILL, W. R. (op. cit.)

DALTON, G. E. (1976) "British Aid Tractors in India: An ex-post Evaluation", ODM

DAVID P. (1966) "The Mechanisation of Reaping in the Ante-Bellum Midwest", IN ROSOVSKY, H. (Ed) "Industrialisation in Two Systems: Essays in Honor of Alexander Gerschenkron", Wiley, New York

DOLBERG, F. (1981) "Availability of Feeds in Bangladesh in Relation to Cattle Numbers", ADAB News, Vol. VIII, No. 1, (January-February)

FAO (1977) "Livestock and Draught Power Development", Working Paper No. V, Government of Bangladesh-FAO-UNDP Mission, Dacca (Mimeo)

FAO (1979) "Production Yearbook 1978", FAO, Rome

FINNEY, C. E. (1972) "Farm Power in West Pakistan", University of Reading Development Study No. 11

GILL, G. J. (1979) "Preliminary Report on Land Preparation", Dacca (Subsequently published in summary form in ADAB News, Vol. VI, No. 12 and Vol. VII, Nos. 1 and 2 (December, 1979-February, 1980)

GOE, M. R. and McDOWELL, R. E. (1980) "Animal Traction: Guidelines for Utilisation", Department of Animal Science, Cornell University, Ithaca

HEADY, E. O. (1952) "The Economics of Agricultural Production and Resource Use", Prentice Hall Engelwood Cliffs, New Jersey

IBRD (1971) "Bangladesh Sector Review", Washington

IBRD (1980) "Bangladesh: Current Economic Position and Short-Term Outlook", Washington (March)

JABBAR, M. A. (1980) "Draft Power Shortage and Mechanization of Tillage Operations in Bangladesh", The Bangladesh Journal of Agricultural Economics Vol. III, No. 1 (June)

JAMES, D. P. (1979) "Interim Report", War on Want Agricultural Mechanisation and Evaluation Programme, Dacca

JOHNSTON, J. J. (1972) "Econometric Methods" (Second Edition), McGraw-Hill, Kogakusha, Tokyo

KHAN, A. K. M. N. and DAVIS, C. H. (1981) "Chemical Treatment of Straw...", ADAB News, Vol. VIII, No. 1 (January-February)

KLINE, GREEN, DONAHUE, and STOUT, (1969) "Agricultural Mechanisation in Equatorial Africa", Research Report No. 6, Institute of International Agriculture, Michigan State University, East Lansing

LLEWELLYN-JONES, A. D. (1979) "Interim Report to the Chairman of BADC", War on Want Agricultural Mechanisation Programme, Dacca, (February)

LOCKERETZ, W. (Ed) (1976) "Agriculture and Energy", Academic Press, New York

MAKHIGANI, A. (with POOLE, A.) (1975) "Energy and Agriculture in the Third World", Ballinger, Cambridge, Mass.

MASSEY-FERGUSON LTD. (1974) "The Pace and Form of Farm Mechanisation in Developing Countries", Toronto

METTRICK, H. (1978) "Oxenisation in The Gambia", Ministry of Overseas Development, (January)

METTRICK, H. and JAMES, D. P. (1981) "Farm Power in Bangladesh" Volume II, University of Reading Development Study No. 20 (Forthcoming)

METTRICK, H., ROY, S. and THORNTON, D. S. (1976) "Agricultural Mechanisation in South Asia", Department of Agricultural Economics and Management, University of Reading

MINISTRY OF AGRICULTURE (1975) "Basic Statistics of Bangladesh Agriculture", Agro-Economic Research Section, Bangladesh Government Ministry of Agriculture, Dacca

MOSEMAN, et al (1980) "Bangladesh Agricultural Research System", Report of the Research Review Team, Dacca.

ODEND'HAL, S. (1972) "Energetics of Indian Cattle in their Environment", Human Ecology, Vol. 1, No. 1

ORCUTT, G.,GREENBERGER, KORBEL, and RIVLIN (1961) "Micro Analysis of Socioeconomic Systems: A Simulation Study", Harper and Row, New York

PAKISTAN GOVERNMENT (1970) "Farm Mechanisation in East Pakistan", Draft Report of the Farm Mechanisation Committee, Dacca

PHARO, H. (1981) "Cattle Production and Management ...", ADAB News, Vol. VIII, No. 1 (January-February)

RAO, A. R. and SINGH, I. J. (1977) "Bullocks - The Mainstay of Farm Power in India", IN LOCKERETZ, W. (op. cit.)

ROSOVSKY, H. (Ed) (1966) "Industrialisation in Two Systems: Essays in Honor of Alexander Gerschenkron", Wiley, New York

SAADULLAH, HAQUE, and DOLBERG, F. (1981) "Improving the Feeding Value of Rice Straw ...", ADAB News, Vol. VIII, No. 1 (January-February)

SATTAR, S. A. (1978) "Land Preparation for Transplanted Rice", Bangladesh Rice Research Institute, Joydepur, Dacca (Mimeo)

SAYEED, A. and DAVIS, C. H. (1981) "Extension of Ammonia-Treated Paddy Straw ...", ADAB News, Vol. VIII, No. 1 (January-February)

SHOARD, M. (1980) "The Theft of the Countryside", Smith, London

SIDDIQUE, M. and PRAY, C. E. (1980) "Survey of Irrigated Cropping Patterns in Bangladesh and Implications for the Draft Second Five Year Plan", Agricultural Development Council, Dacca, (November)

SINCLAIR, H. M. and HOLLINGSWORTH, D. F. (1979) "Huchinson's Food and the Principles of Nutrition", (12th Edition), Arnold, London

SMITH, A. J. (1979) "The Role of Draught Animals in Agricultural Systems in Developing Countries", University of Edinburgh Centre for Tropical Veterinary Medicine (Mimeo)

UNITED NATIONS (1979) "United Nations Demographic Yearbook 1978", New York

ZAMAN, M. A. (1976) "Land Reform in Bangladesh", Land Tenure Center, University of Wisconsin, Madison.

DEVELOPMENT STUDY SERIES *Out of print.

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D. S. Thornton

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