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AN ECONOMIC ANALYSIS OF BULLOCK LABOUR USE ON DELHI FARMS

Kirpal Singh

and

J. P. Hrabovszky*

This study aims at demonstrating analytic possibilities with a view to provide information leading to a more economical utilisation of bullock labour in the cultivation of crops on Delhi farms. At present, bullocks are almost the sole source of motive power in the cultivation of crops on these farms. Their importance is further emphasised by the fact that the cost of maintenance of bullocks represents, on the average, 28 per cent of the total costs incurred in crop cultivation on these farms. The predominantly fixed nature of these costs creates additional interest in their economic analysis.

The basic data for this study came from a farm account survey project on 60 farms in eight villages situated in the Kanjhawla and Najafgarh blocks of Delhi Territory. The respondents were chosen non-randomly, by selecting two farmers each from four size-groups of holdings in each of the eight villages. These size-groups were : up to 5 acres, 5 to 9.9 acres, 10 to 14.9 acres and 15 acres and above. In selecting the respondents one of the major criteria was to choose those who were willing to co-operate in the detailed survey for a period of three years. The data were collected by fortnightly visits. The project was carried out from 1958-59 to 1961-62 by the Agricultural Economics Section of the Division of Agronomy, Indian Agricultural Research Institute. The study relates to the agricultural year 1961-62.

This study deals with four different aspects of the problem. Some of the findings are reported below under the following headings :

I. Estimates of productivity of bullock labour.

II. Estimates of costs of bullock labour.

III. Estimates of optimal use of bullock labour.

IV. Analysis of possibilities for minimising costs, with special respect to (*a*) total yearly costs, (*b*) feed costs, (*c*) seasonal utilisation of bullock labour.

I

In order to estimate the marginal productivity of bullock labour together with other inputs, a whole farm production function of the Cobb-Douglas type

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was fitted. In this preliminary function, for which no representativeness is claimed, Y is gross income, expressed as the money equivalent in rupees of the income from all crops, whether sold or consumed in the household. X_1 represents the total cropped area, measured in acres. X_2 represents bullock labour (pairs) days utilised in crop production, and X_3 represents total human labour days (other than driving bullocks) utilised in crop production.

The function fitted was[1] :

$$Y = 74.495\, X_1^{0.6893} \quad X_2^{0.2463} \quad X_3^{0.1423}$$

$$R^2 = 0.8687$$

Marginal products of individual inputs were calculated for the whole group of 60 farms at the geometric mean values of the inputs. These are given in Table I.

TABLE I—MARGINAL VALUE PRODUCTS OF INPUTS AT THE GEOMETRIC MEAN LEVEL OF USE

Inputs	Marginal Value Products (in Rs.) at geometric mean
X_1, Land	184·90 per acre per year.
X_2, Bullock labour	5·92 per pair per day worked.
X_3, Human labour	1·27 per male adult equivalent per day worked.

From this overall function, estimate of marginal productivity for bullock labour was made for different groups of farms. Four groups were formed on the basis of size of holding, and marginal product was calculated for each group, using input levels at the geometric mean of the groups themselves. These are shown in Table II.

TABLE II—MARGINAL VALUE PRODUCTIVITY OF BULLOCK LABOUR AT THE GEOMETRIC MEAN USE LEVELS FOR FOUR SIZE-GROUPS OF FARMS

Size-group of holdings (acres)	Number of farms in the group	Marginal value product of bullock labour day in Rs.	Average number of bullock labour days used per acre
0—5	14	4.49	26
5—10	16	5.24	18
10—15	14	6.62	14
15 and above	16	7.66	11
Average	—	5.92	14

1. None of the regression coefficients were found to be statistically significant, this is assumed to be so because of problems of specification bias and multi-collinearity among the assumedly independent inputs.

From Table II it may be seen that marginal value product increases with the size of holding, partly because use levels per acre decline as holding size increases.

II

Average cost estimates were made, following the same grouping according to size of holding and the average total costs of bullock maintenance per work day, costs per day maintained, and bullock cost per acre are given in Table III. The various components of cost included are : feed, both fodder and concentrates at village prices, human labour at a price ranging according to operations from Rs. 1 to 2 per male adult equivalent, interest at 6 per cent and depreciation on the value of the bullocks and bullock-shed. Depreciation was calculated at the rate of 5 per cent (*pucca*) and 10 per cent (*kacha*) on buildings and depreciation on bullocks was calculated at varying ratio depending on the age of the animal.[2]

TABLE III—AVERAGE TOTAL COST PER BULLOCK PAIR PER WORK DAY, PER DAY MAINTAINED AND COST PER ACRE ACCORDING TO SIZE-GROUPS OF HOLDINGS

(in Rupees)

Size-group of holdings (acres)	Average per day maintained	Cost per pair per work day	Annual cost on bullocks per acre
0—5	3.20	12.76	326.00
5—10	3.05	8.92	147.00
10—15	3.66	9.11	112.00
15 and above	4.75	6.17	70.00
Average	3.66	9.13	112.00

Average total cost per day of maintenance increases generally with the size of holding. This cost increases because annual cost of maintenance increases due to the increasing amount of feed as shown by further analysis of the data. Both cost per work day and cost per acre decrease rapidly as the size of holding increases because of higher levels of utilisation and possibilities for spreading fixed costs over a large number of days worked and acres cultivated.

III

Having estimated the productivity and cost structures for bullock labour, the two are compared in this section for estimating the optimal labour of bullock labour use.

2. Estimation of depreciation, etc.: up to one year age—Nil.
1—2 years @ 25 per cent appreciation over first year value.
2—3 years @ 50 per cent appreciation over second year value.
3—8 years — Nil.
Beyond 8 years—Depreciation @ 12.5 per cent of the eighth year value.

Marginal value product at the geometric mean for the group as a whole at Rs. 5.92 per day per pair was found to be less than its average cost of Rs. 9.13. Hence if all costs of bullock maintenance are considered variable, then, on the average, for the group as a whole the bullock resource is being used uneconomically. This holds even more for individual groups of holdings below 15 acres and above size-group. However, a large part of the average total cost of maintenance for bullocks is a fixed cost, thus optimal use comparisons ought to be made between the marginal product and the marginal cost which is variable costs only. The fixed nature of a large part of the average total cost may be seen from the changes occurring in average total cost with various levels of utilisation. While cost per working day and cost per acre decrease with increase in the size of holding, reflecting a higher level of utilisation, cost per day of maintenance continues to increase as was seen from Table III. All these relationships between fixed cost and size of holding reflect the indivisibility of a pair of bullocks. Indivisibility of a pair of bullocks, resulting in fixity of costs is, therefore, responsible for (1) decreasing average total cost per work day, (2) decreasing average total bullock cost per acre, and (3) increasing marginal productivity with increasing size of holding because of lower per acre levels of bullock use with larger sized holdings. Thus the estimation of an optimal use level for bullock labour would require an estimate of fixed and variable costs involved in bullock maintenance. An attempt is made in the direction of this separation of fixed from variable costs in bullock maintenance in the section dealing with feed costs.

IV

Our next problem is to analyse alternative possibilities for minimising costs. One possibility for doing this stems from the inequality of the marginal value product with the average total cost of bullock labour. For farmers having holdings below 15 acres, the spreading of the fixed costs of bullock maintenance over a large number of productive bullock labour days could be achieved by either hiring in additional land, or by hiring out bullock labour, or by an intensification of land use. All three of these are practised in the area, but the data used were not sufficient to permit quantitative correlative statements on the extent of these adjustment efforts. Possibilities for adjustment involving an increase in the land area of the farm are strongly limited by the extremely small volume of land sales and by the restrictive effect of Government of India land reform legislation concerning the renting of land. The hiring in and hiring out of bullocks is limited also by the strongly seasonal nature of the bullock labour utilisation peaks, creating a demand for hire-bullocks at a time when the owners wish to fully utilise them also. A further possibility would be to keep only one bullock on smaller farms. However, inter-personal problems of co-operation and the timing problems of use limit this alternative also to a large degree.

We found the second adjustment possibilities for minimising costs in the variability of feed costs incurred in the maintenance per pair of bullocks. Feed cost considered included the value of fodder and concentrates fed, whether grown on the farm or purchased. Our first step was to examine what sort of relationship exists between feed and bullock labour output.

It was hoped that the value of feed at zero work days, representing the intercept of the function explaining the relationship between feed and work output, will provide an estimate of the proportion of feed which could be regarded as fixed and the other part as the variable component of the average total feed co t. For estimating this relationship, holdings having each one pair of bullocks were selected, resulting in the inclusion of 40 holdings. The remaining 20 holdings had either one bullock or more than a pair of bullocks or had camels in addition to/or without bullocks.

A linear function was fitted between feed and bullock labour days worked. Feed input was expressed in terms of value of the feed. Regression equations of feed on bullock labour days were fitted separately for different months.

Values of the intercept 'a' were calculated. The values of 'a', coefficient of correlation, (r) regression coefficients 'b' and their standard errors 'S_b' are given for all the months in Table IV.

TABLE IV—MONTH-WISE VALUES OF THE 'a' INTERCEPTS REPRESENTING FIXED FEED COSTS, COEFFICIENTS OF CORRELATION, (r) VALUES OF THE REGRESSION COEFFICIENTS (b) THE STANDARD ERROR (S_b) AND ESTIMATED VARIABLE COMPONENT OF FEED COSTS FOR THE FEED-BULLOCK LABOUR OUTPUT RELATIONSHIP

Month	Value of 'a'	Variable cost	(r)	(b)	(S_b)
July	63.99	8.88	0.33	0.69	0.31
August	60.70	1.81	0.20	1.66	1.32
September	45.06	12.52	0.51	0.90	0.25
October	43.76	17.14	0.49	0.73	0.07
November	70.62	−3.89	−0.17	−0.36	0.34
December	70.74	−0.52	−0.01	−0.07	1.16
January	67.84	4.29	0.15	0.35	0.36
February	66.34	−1.88	−0.10	−0.20	0.33
March	77.41	−0.75	−0.06	−0.13	0.37
April	76.21	−0.63	−0.03	−0.04	0.25
May	70.30	4.89	0.30	0.54	0.28
June	78.37	−2.51	−0.11	−0.21	0.31

From Table IV it can be seen that the regression coefficients are significant and the values of the coefficient of correlation somewhat higher only for the months of July, September and October. These three months, as we shall see later from the analysis of seasonal variations in use, are the high peaks in the seasonal utilisation pattern for bullock labour. This is mainly due to soil preparation and sowing operations for the *kharif* and *rabi* seasons respectively.

As an alternative simple estimate of the values of 'a', the average of the feed costs for bullocks were also calculated on holdings having zero bullock labour use in a given month. These are as follows:

	(Rs.)		(Rs.)
August	69.21	February	70.45
November	66.57	March	79.26
December	72.30	May	76.38
		June	81.50

The minimum maintenance feeds as indicated by the 'a' values tend to be low for September and October, *i.e.*, two out of three months for which the relationship was statistically significant and the coefficient of correlation relatively high. During the off-work months, feed costs tend to be high indicating thereby a scope for some economising on the cost of feed in these periods. However, this cannot be asserted decisively without a knowledge of the nutrient content of the feeds. Although the negative regression coefficients were statistically not significant and being negative they appear nonsensible, the negative variable costs for the off-work months may indicate an over-feeding of non-working animals which in a sense is required if the object of it is to compensate for the losses in body-weight incurred during high work periods. The differences in feeding costs per animal with differences in total yearly utilisation for different sizes of holdings also indicate a way by which farmers with relatively small holdings attempt to adjust their feed cost to lower utilisation possibilities for bullocks on their limited acreage. The level of feeding of these bullocks was also compared to recommended standards. For this purpose the daily average feed costs for bullocks, as found on these farms was compared with the price of a recommended ration, using the same prices as in the calculation of feed costs for the bullocks in the survey.[3]

It was found that while the average daily feed cost per pair of bullocks came to Rs. 2.30, the cost of the recommended daily ration was slightly lower at Rs. 2.16. These two figures seem to be close enough to indicate only a minor difference from the cost of the recommended ration, by the feeding practices of the farmers in the survey.

Lastly, we come to the monthly utilisation of bullock power. So far the scope for economising in the use of bullock power was discussed in the light of yearly output and fixed and variable costs. Here we may consider a different source for economising which could arise from the uneven utilisation of bullock labour during the year. From our empirical analysis, we shall try to derive ways of improving seasonal utilisation, firstly, by making utilisation more uniform, and secondly, by raising the total utilisation curve. This rests partly upon the relationship of seasonal utilisation of bullock power with the following factors : (1) size of holding; (2) intensity of cropping; (3) source of irrigation, whether

3. The recommended feeding ration was chosen from K. C. Sen : Nutritive Values of Indian Cattle Feeds and Feeding of Animals, Indian Council of Agricultural Research, Bulletin No. 25, New Delhi, p. 15, "Calculation of the ration for a bullock weighing 400 kg. and doing normal work."

canal or well; (4) sugarcane cultivation as part of the cropping pattern; and (5) degree of specialisation as shown by the percentage of the total cropped area under wheat.

These relationships were studied by means of utilisation charts. Here again those holdings which had a single pair of bullocks only were selected in order to eliminate the complications arising from the relative performance of camels and the effect of more than one or less than one pair of bullocks on the utilisation pattern. These graphs are shown in Figures 1 to 4.

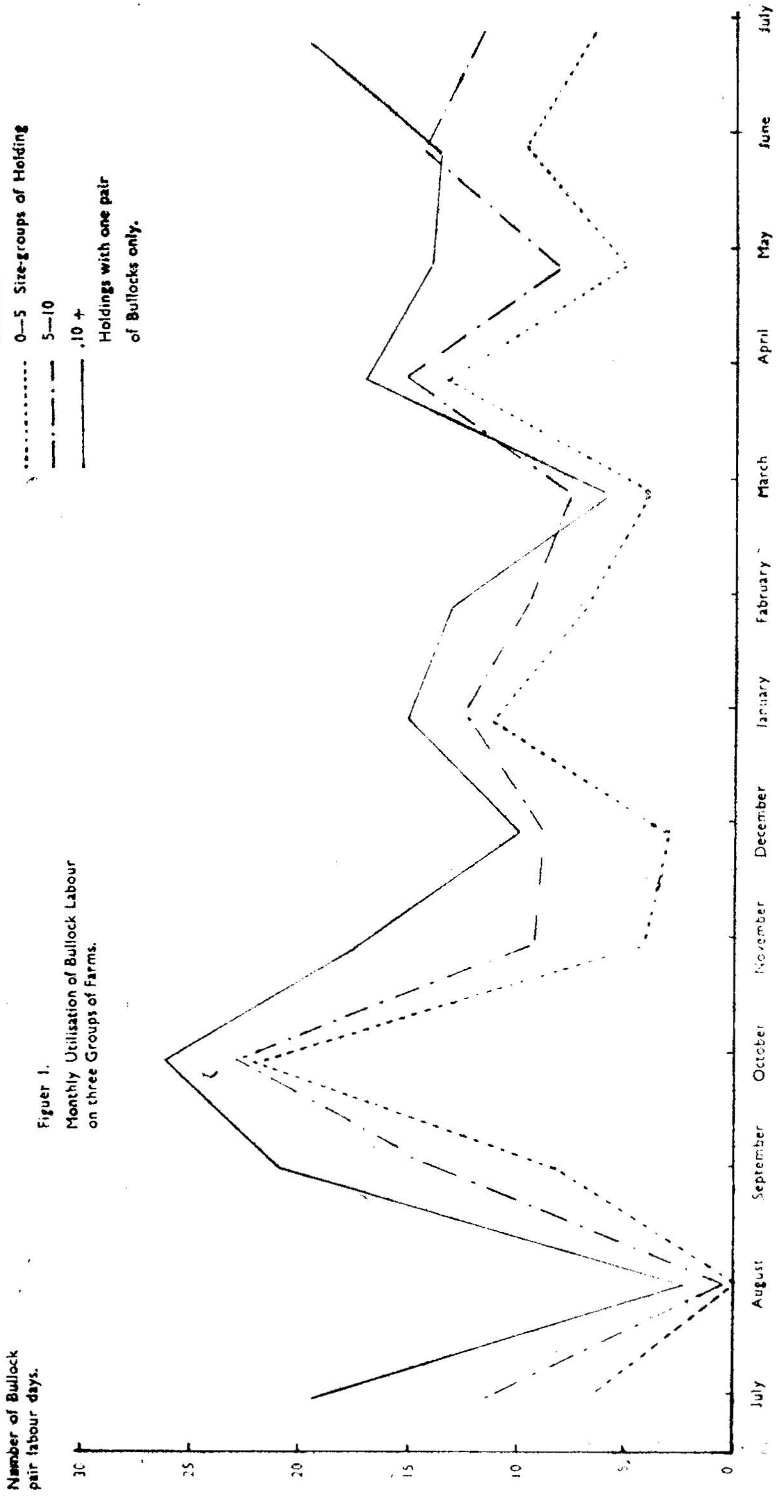
In Figure 1, the monthly utilisation of bullock labour on different size-groups of holdings is shown. Three groups were formed according to size of holding, those having less than 5 acres, those having 5 to 10 acres and those having over 10 acres. It was found that the pattern of seasonal fluctuations in bullock labour utilisation is not very different for the different size-groups. Only in the size-group less than 5 acres is there a very low utilisation shown for the months of November and December. Otherwise, generally the utilisation curve is higher the larger the size of holdings.

The seasonal peaks of the year may be explained by the seasonality of the different agricultural operations. In September, there is preparatory tillage for *rabi* lands and also carting of the harvested *kharif* crops. The high October utilisation is due to *rabi* ploughing and seeding. There are peaks in January and April also. The January peak reflects the need for bullock power for irrigation of wheat on well irrigated farms, and land preparation and seeding of sugarcane on the canal irrigated farms. The April peak reflects harvesting and threshing of the wheat crop. The July peak is the result of the land preparation and sowing operations for *kharif* crops.

For the purpose of exploring the relationship between intensity of cropping and seasonal bullock utilisation, three groups were formed with the first one having holdings with a cropping intensity of 100—140, the second with 141—155 and the third with cropping intensities over 155. The utilisation curves of bullock labour for these groups are shown in Figure 2. From this figure, it can be seen that the utilisation of bullock labour for the group of 156 + intensity is perceptibly lower during November, December and January compared to the other groups. The average height of the utilisation survey does not seem to be related to the intensity of cropping. However, the performance of the group with 141—155 intensity is slightly better than the other, judged on the relative evenness of the utilisation over the year.

As Figure 3 indicates, farms with well irrigation show a more uniform seasonal utilisation pattern for bullock labour as compared with the canal irrigated farms. However the peaks and troughs sequence is almost identical for the two groups.

Holdings growing sugarcane turned out to be the same as those which have canal irrigation, thus the relation exhibited in Figure 3 is the same for them. The near identity of the level of bullock labour use in January-February for these two groups shows that in this otherwise slack period bullocks are used for irrigation of wheat on well irrigated farms and for land preparation and planting of sugarcane on canal irrigated farms.



Figuer 1.
Monthly Utilisation of Bullock Labour on three Groups of Farms.

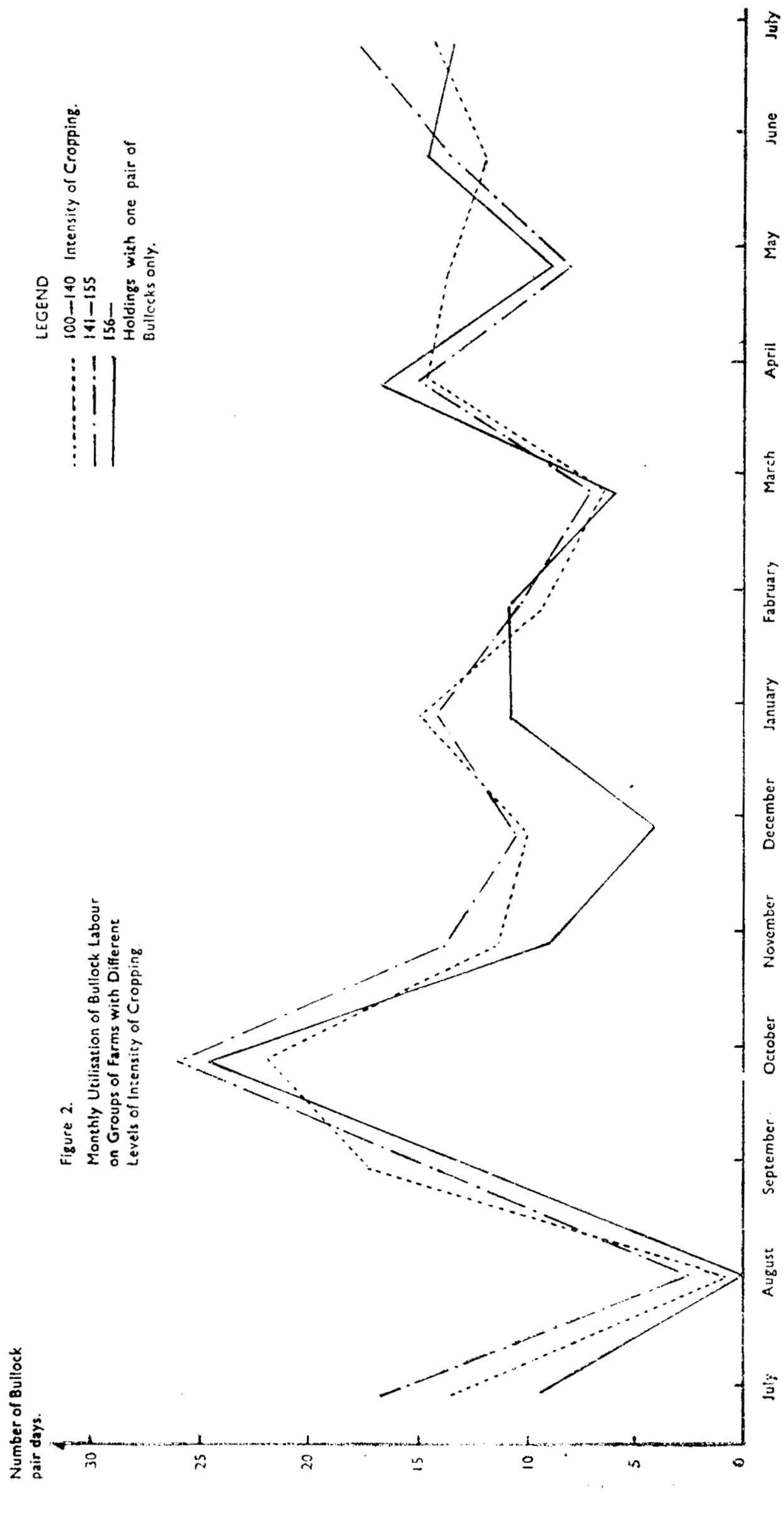


Figure 2.
Monthly Utilisation of Bullock Labour on Groups of Farms with Different Levels of Intensity of Cropping.

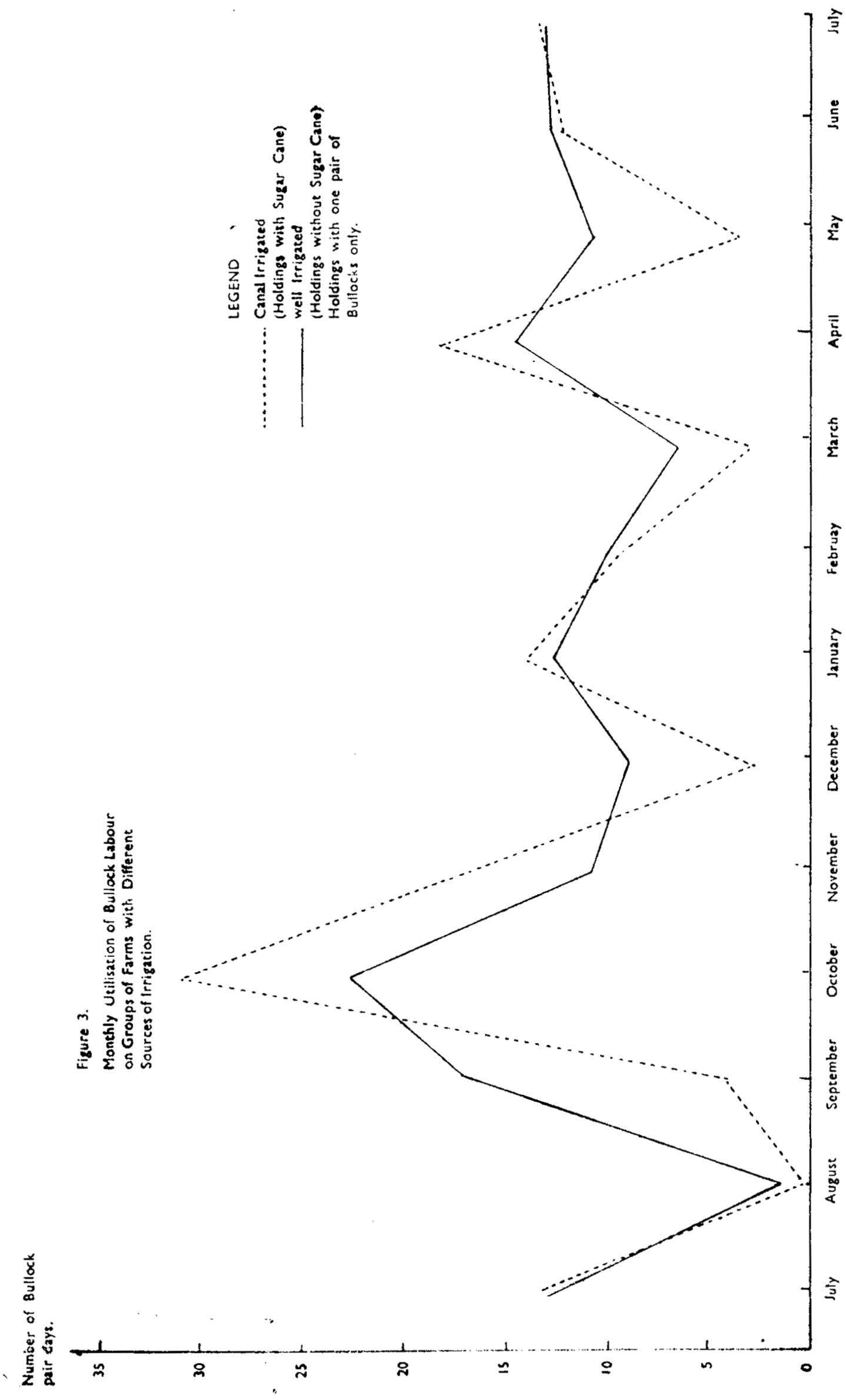


Figure 3.
Monthly Utilisation of Bullock Labour on Groups of Farms with Different Sources of Irrigation.

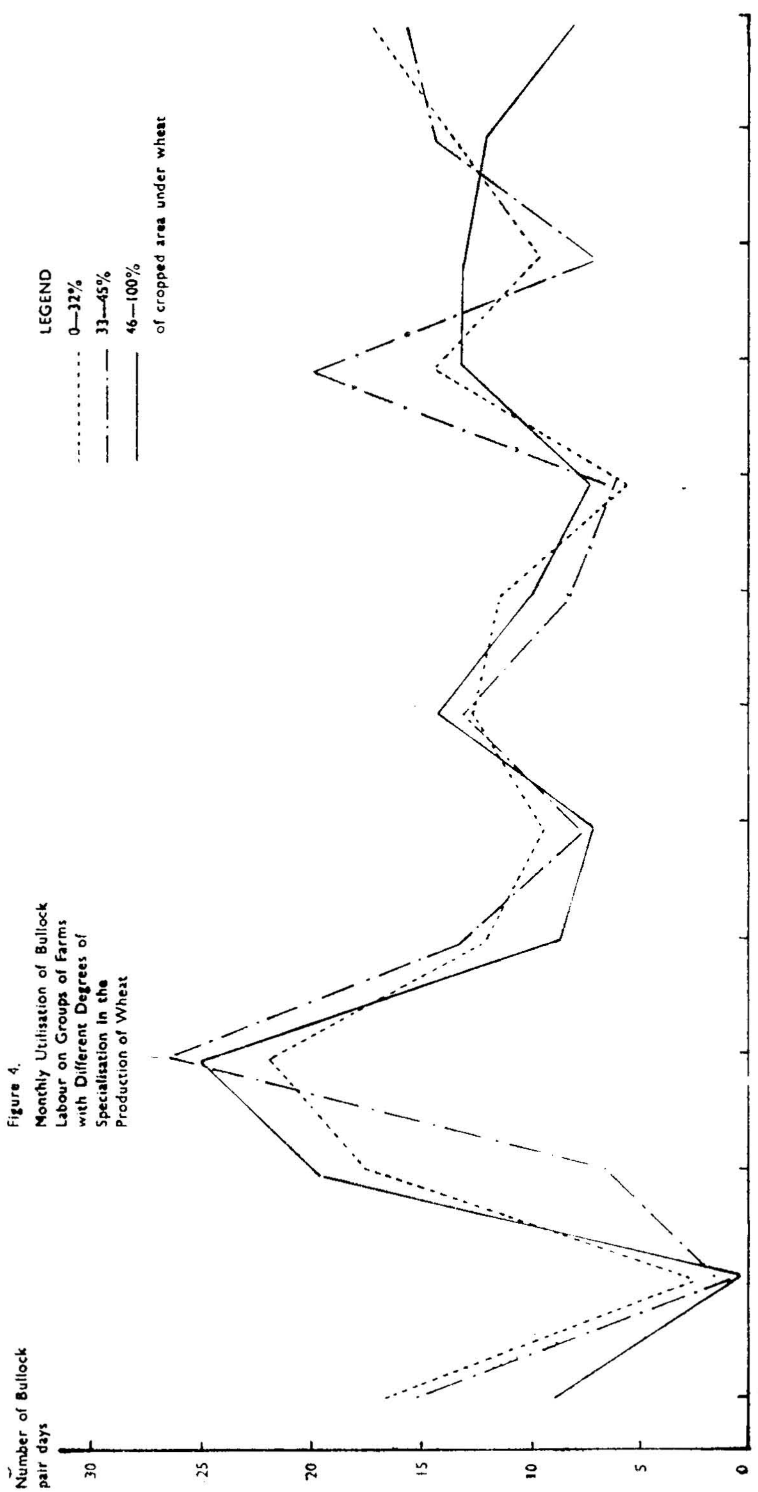


Figure 4. Monthly Utilisation of Bullock Labour on Groups of Farms with Different Degrees of Specialisation in the Production of Wheat

To analyse the 'bunching' effects of too much specialisation in one crop, three groups were formed according to the percentage of their total cropped area under wheat. The percentage of wheat for the groups were : 0—32, 33—45 and 46—100. The seasonal bullock utilisation pattern for these groups is shown in Figure 4. It may be noticed that in the case of the middle group, utilisation tends to fall perceptibly during September and rise during April, as compared to the other two groups. Seasonal bullock utilisation tends to fall relatively to the other groups in November and July for the most specialised wheat growing group. Both of these phenomena may be explained by the relatively small portion of *kharif* crops in the cropping pattern of these farmers.

Thus the common features of the seasonal fluctuations in bullock labour use, irrespective of the postulated factors influencing it, are as follows : Firstly, there is maximum utilisation for all groups during October and minimum in August. Secondly, October, January and April almost always record a peak, while August, December, March and May fall mostly on troughs in a monthly utilisation graph.

CONCLUSIONS

On the basis of the findings of the various analyses carried out in the study, it could be said that the fixity of a large part of the maintenance costs of bullocks results in a heavy burden of cost of smaller sized farms. On these farms there is usually little scope for increasing the use of bullock power within the present farm organisation, because the marginal productivity of bullock labour appears to be already low. However, if the preliminary estimates of marginal productivity are accepted as an approximate indication of actual productivity, and if the variable cost involved in additional bullock labour days is as low as the roughly estimated variable feed cost component, together with the ploughman's wages, then it seems that bullock power could be used more intensively even on small farms.

The analysis showed that farmers do attempt to reduce their fixed costs per unit of bullock labour day by higher level use and lower level of feeding on smaller sized holdings.

The monthly utilisation pattern for groups of farms formed according to various criteria showed that in the peak month of October, bullock power was fully utilised on all groups of farms, but definite idle periods existed in other parts of the year for all size-groups. These may be reduced somewhat by a diversification in the cropping pattern leading to an increase in crop intensity and the use of wells to supplement water available from canals.