Vidyodaya J., Arts. Sci., & Lett., Vol. 14, *No.* 1—*January*, 1986—*pp.* 91–101

BUFFALOES OR TRACTORS? IMPACT OF FARM SIZE ON FARM POWER SELECTION

By

ROHANA ULLUWISHEWA
Department of Geography, Sri Jayewardenepura University, Sri Lanka

Synopsis

In an effort to initiate measures to revive animal druaght power as a source of power for paddy land preparation, it is vital to understand the minimum size of paddy holdings below which such measures are acceptable to farmers. While animal tillage is labour and time consuming tractor tillage is labour and time saving. This paper points out that as the size of area to be tilled increa ses, the cash expenditure on labour per unit area also increases if the animal draught power is used whereas it remains unchanged if the hired mechanical power is used . However the length of time available per unit area decreases with increasing size of area to be tilled. Therefore small holders are in a position to spend more labour and time than large holders. For that reason animal tillage is feasible in small holdings and therefore small holders are likely to positively respond to the measures formulated to revive the animal draught power.

Introduction

A technology which works satisfactorily in the developed countries often fails to come up to expectations when it is transplanted without suitable modification into a less developed country which has its own distinctive socio-economic and industrial characteristics. For example in much of the less developed countries the main resource would appear to be the human resource; consequently most of the capital intensive machinery accepted in the developed countries, as a matter of course is likely to have a damaging effect in socio-economic terms when it is introduced without modification into a naturally labour-intensive less developed country. Tractorization in less developed countries also faces the same criticism. Its adverse socio-economic conseque nces are widely documented. In Sri Lanaka tractorization of the tillage operation of paddy fields has been found to have failed to fulfil its initial expectations ; and the significance of the revival of traditional labour-intensive animal draught power has been pointed out (Farrington and Abeyratne 1980 ; Ryan, Abeyratne and Farrington. 1981). At present efforts are being made by

authorities to revive this traditional source of farm power. Although the authorities make great efforts to revive it, if their suggestions are not accepted by farmers, their efforts become fruitless. Therefore care should be taken to make suggestions which are acceptable to farmers. In order to make acceptable suggestions it is necessary to understand the circumstances under which the draught animal power is acceptable. In this study an attempt was made to understand the minimum size of farm below which the animal draught power is acceptable to farmers. Such an understanding would assist the formulation and implementation of mesures aiming at the revival of animal draught power as a source of power for the tillage operation of paddy fields. Therefore the objective of this paper is to observe the effect of the size of paddy holdings in making decisions on alternative farm power sources : animal draught power and mechanical power.

Methodology

In order to achieve this objective it is necessary to ascertain the effect that the size of the paddy holdings have on the tendency of some farmers to continue with animal draught power and to establish a rational explanation for it. For the first purpose, the method adopted here is to observe the change in the application of animal draught power corresponding to the varying sizes of paddy holdings. Therefore district-wise average data on the percentage of paddy extent tilled by animal draught power in combination with manual labour* (Y) was regressed on the district-wise data on the average size of paddy holdings (X) (Table 1). The model is as follows :

$$Y = a + b \times + u$$

This method expects to measure the correlation coefficient between these two variables and to estimate the percentage increase in animal ploughed area correponding to the decrease in size of paddy holdings.

---

* Draught animal and animal operator

TABLE 1 : Farm Size and Animal Traction in Sri Lanka

Districts	*Average size of Paddy Holdings*	*% of Paddy Extent Tilled by Animal Power Manual Labour*
(1)	(2)	(3)
Colombo ..	.. 0.38	.. 93.70
Kalutara ..	.. 0.42	.. 58.59
Kandy ..	.. 0.37	.. 95.01
Matale ..	.. 0.50	.. 79.47
Nuwara Eliya	.. 0.38	.. 97.64
Galle ..	.. 0.47	.. 99.53
Matara ..	.. 0.47	.. 84.65
Hambantota	.. 0.82	.. 99.18
Jaffna ..	.. 1.37	.. 14.42
Mannar ..	.. 2.23	.. 10.35
Vavuniya ..	.. 2.27	.. 1.82
Batticaloa	.. 2.18	.. 26.37
Ampara ..	.. 1.85	.. 25.62
Trincomalee	.. 1.85	.. 16.51
Kurunegala	.. 0.46	.. 72.97
Puttalam	.. 0.66	.. 44.65
Anuradhapura	.. 0.60	.. 26.67
Polonnaruwa	.. 1.30	.. 72.89
Badulla ..	.. 0.45	.. 95.57
Moneragala	.. 0.59	.. 76.58
Ratnapura	.. 0.40	.. 87.27
Kegalle ..	.. 0.29	.. 99.84

Unit : (2) =Hectares (3)=Percentage

Note.=(2) Method of Estimation

A— No. of Operators

B— Area Cultivated. 1982/83 Maha

(2)—B/A

Source : (3) Estimated Area by Method of Preparation of Land by Districts, 1979/80—Maha—Department of Census and Statistics, Colombo

(2) A=Agricultural Statistics, Vol. 12, No. 1, 1985.

B=Paddy Statistics, Department of Census and Statistics, Colombo.

To be able to provide a rational explanation for the relationship between the size of paddy holdings and the degree of animal draught power usage, it was necessary to understand how the farmers make decisions on two alternative farm power sources : draught animals and tractors ; and ways in which the size of paddy holdings affect the farmers' decisions. It has already been pointed out that the cash expenditure on labour and the need to perform the tillage operation in time are crucial in the selection of farm power (Ulluwishewa and Tsuchiya 1985 (a) and 1985 (b). Therefore, in this study, attention has been focussed only on these two aspects. In order to identify the role of these two factors in farm power selection and to ascertain their relationship with the size of paddy holdings, a socio-economic survey was conducted in Nallamudawa village.* In this survey a questionnaire structured with a view to collect data pertaining to size of paddy holdings, labour application and cash cost for animal tillage was administered to 33 randomly selected paddy farmers. Supplementary information was also gathered from informal discussions with some local level officials and leading farmers.

Results and Discussion

The correlation coefficient between the size of paddy holdings and the percentage of paddy extent tilled by animal draught power in the whole country (Table 1) was found to be 0.8233. It points to the fact that smaller the size of paddy holdings the greater the farmers' tendency to use animal draught power based-labour intensive technology for tillage operations. Parameters of the regression line are as follows :

$$Y = 100.460 - 41.103x$$

As it can be observed from the above parameters one unit (one acre) decrease in the size of paddy holdings will increase the farmers' dependence on animal draught power based-labour intensive technology by 41.103 %

As a result of this, it can be concluded that relatively small size farms favour the existence of animal draught power based-labour intensive technology for tillage operation.

The conventional explanation for this correlation is two-fold:

(1) Scale economies : when the farm size is considerably large the fixed cost of machniery spreads over a large area so that the total cost per unit area becomes lower.

(2) Operation efficiency : large farms facilitate to enjoy greater operation efficiency from machines.

---

* A dry zonal traditional village in the Anuradhapura district in which paddy land preparation is totally performed by buffaloes in combination with family, exchange and hired labour. A survey in this village was executed in May 1983 in respect of 1982/83 Maha season.

However, it seems that these explanations are rather irrelevant to the situation in Sri Lanka. In Sri Lanka, the majority of tarctors are owned by non-farmers who provide custom services to farmers. Tractors, its attachments and the operator all are provided as a single package, and the fee is charged on the basis of the size of area tilled. Generally, fee (hire rate) is same to all hirers regardless of the size of holdings. Under such a situation, the cost advantages arising from scale economies and from the operation efficiency are enjoyed by the tractor owners, not by the farmers who decide what type of farm power they use. Therefore, these cost advantages do not have much influence on the farm power selection.

Furthermore, regarding the tillage operation of paddy fields, operation efficiency of machinery is mainly determined by the size and the shape of *liyaddas* (the small bunded units of paddy fields) within which machines are operated. The larger the size and the more rectangular the shape of *liyaddas* the higher the operation efficiency of machines. Size and shape of *liyaddas* are largely determined by the topography and water controlling factor rather than by the size of paddy holdings. Even though paddy holdings are relatively small, *liyaddas* may be relatively large on flat land with efficient water management. On the other hand, the size of *liyaddas* may be relatively small even in large holdings where the topography is rough and water management is problematic. Therefore, it can be concluded that the size of holdings does not determine the size of *liyaddas*, and therefore the operation efficiency of machines.

Thus, in the failure of these conventional explanations, it is necessary to establish a rational explanation for the observed negative correlation between the size of paddy holdings and farmers' dependence on animal draught power. Therefore, attempts were made to explain this correlation in terms of cash expenditure on labour and timeliness of the tillage operation which were found to be crucial in determining the farmers' decision-making over alternative farm power sources. Peasant farmers' main production objective is to produce food for their family needs at the possible minimum cash cost. Therefore they make full effort to minimize the cash expenditure on all inputs instead. The low level of the application of purchased inputs is a well observed phenomenon among peasant farmers. Their preference to capital saving-labour intensive technology has always been noticeable. The greater labour force required for this labour intensive methods has been supplied by unpaid family labour and exchange labour. Peasant farmers do not much evaluate their own family labour of which opportunity cost is almost zero. While they make full effort to manage with their unpaid family labour, they are quite reluctant to employ hired labour due to its cash involvements. On the other hand, while relatively small paddy holders could manage to perform their farm operations with the limited unpaid family labour available to them, in the case of large holders, extra labour requirement has been met by the exchange labour which is also unpaid. At present, the system of exchange labour is subject to rapid disintegration and hired labour is emerging in place of the

exchange labour. Therefore, the paddy holders whose family laour is insufficient to meet the labour requirement, can hardly get sufficient support from the exchange labour. Consequently, they have to employ hired labour to meet the greater labour demand which is associated with the labour intensive technology. As a result, size of paddy holdings has become a crucial factor which determines one's capacity to manage with unpaid labour. When the size of one's paddy holdings exceeds the capacity of the unpaid family labour then one has to employ paid labour. In this way cash expenditure on labour has come to be related with the size of paddy holdings.

In order to observe the relationship between the employment of paid and unpaid labour and the varying size of paddy holdings the number of family, exchange and hired labour days utilized for animal tillage operation in paddy fields in Nallamudawa village has been categorized into size-classes of paddy holdings (Table 2). The findings are as follows :

(1) The paddy holders whose holdings are less than one acre manage to perform their tillage operation only with the unpaid family labour.

(2) As the size of paddy holdings increases, at the first instance, farmers make efforts to get the support of exchange labour which is also unpaid. In their failure to find sufficient labour on exchange basis, as a last resort, the large holders tend to employ hired labour.

TABLE 2 : Labour Composition in Relation to the Size-class of Paddy Holdings in Nallamudawa

Number of Sample Farms	*Size-Class*	*Family Labour*	*Exchange Labour*	*Hired Labour*
(1)	(2)	(3)	(4)	(5)
13	.. 0—1.0	.. 100.00	.. 0.00	.. 0.00
8	.. 1.0—2.0	.. 82.41	.. 7.24	.. 10.34
12	.. 2.0—4.0	.. 70.36	.. 6.67	.. 22.92

Unit : (2) Acre

(3) (4) and (5) percentage

Source : Field Survey, 1983

In this way, employment of paid labour (hired labour) becomes inevitable as the size of paddy holdings increases. As a result, cash expenditure on labour rises as the size of paddy holdings increases. As it is shown in Table 3 cash expenditure on labour per farm and per unit area both rise with increasing size of paddy holdings. This positive correlation between the size of paddy holdings

and the cash expenditure on labour is very crucial because, as it has been pointed out already, the peasant farmers exercise greater concern over the cash costs. As long as the cash costs involved in the animal draught power based-labour intensive technology is comparatively little, that technology can compete with the mechanical power based capital intensive technology. Therefore, this type of labour intensive method is still preserved among small peasant farmers who can manage with a little amount of cash cost on labour.

Timeliness which is often mentioned by tractor users as a principal motive for tractorization also seems to have implications with the size of paddy holdings. In traditional villages as well as in settlement schemes, farmers have to complete their farm operations in accordance with the pre-decided cultivation calendars which are prepared at meetings attended by all farmers who cultivate in each paddy tract. Dead lines for tillage operation, sowing or transplanting, fencing and harvesting are given by the cultivation calendar. Those who fail to complete the operation in time were punished in ancient time. At present, although they are not punished, any delay would cause heavy losses in harvest due to either water shortage or excess and natural causes such as insects and pests. Irrigation water issues are regulated in compliance with the calendar. Therefore, late starters most probably have to suffer from water scarcity when they do land preparation and sowing. Even if the late starters want to use machines to break the time bottleneck they would not be able to bring the tractor-like heavy machines to their paddy plots since their plots are already surrounded by the planted paddy fields. In such a situation they have to leave their paddy plots uncultivated. Even if they somehow manage to cultivate, due to the water scarcity, weed control becomes problamatic, Therefore, all the farmers have to complete the tillage operation before the date given by the cultivation calendar. These dates are fixed regardless of the size of paddy holdings. Therefore the time available per unit area for all operations diminishes as the size of paddy holdings increases. Consequently. relatively large farmers find difficulties in completing their farm operations in time. Nevertheless, those who hold relatively small farms are able to complete the farm operations in time despite they use more time consuming methods.

As illustrated in Table 4 animal tillage consumes much longer time than tractor tillage . Threfore it is quite understandable that those who cultivate under the heavy pressure of time are higly unlikely to use animal draught power for tillage operation. Table 5 shows that the relatively large paddy holders have to work under heavier pressure of time than small holders because the time available per unit area is little less for large holders than for small holders. However, those who hold rather small farms are subject to less pressure of time so that they could complete their tillage opertions with the time consuming method which means animal draught power based method.

TABLE 3 : Estimated Cash Expenditure on Labour by Size-Class of Paddy Holdings in Nallamudawa

Size Class	*Labour days provided by family for land preparation per farm per season*	*Total Labour Required*	*Outside Labour Required*	*Cash Expenditure on Labour*	
				Per Farm	*Per Acre*
(1)	(2)	(3)	(4)	(5)	(6)
0.5	4.5	3.1	0.0	0.0	0.0
1.0	6.2	6.3	0.1	3.7	3.7
1.5	7.8	9.5	1.7	42.6	28.4
2.0	9.4	12.7	3.2	81.7	40.8
3.0	12.7	19.1	6.3	159.8	53.2
4.0	15.9	25.4	9.5	237.0	59.4

Units : (1) Acres ; (2) (3) and (4) Man days ; (5) and (6) Rupees

Notes : Method of estimation

Column (2)X = Size of Paddy holdings.

Y = Family labour days applied per paddy holding.

Y was regressed on X, and parameter estimate of the regression line are as follows :

$$Y = 2.975 + 3.247\ X$$

$$(2.465)\ (5.692)\ r^2 = 0.715$$

Then, figures under column (2) have been estimated according to the above equation.

Column (3) According to the survey data, average labour requirement for land preparation was 6.37 man days per acre. Therefore (3)=6.37 X (1)

Column (4), (4) = (3)—(2)

Column (5), Prevailing labour wage rate of buffalo operators, according to the survey, is Rs. 25.00 per day. Therefore (5) = (4) X Rs. 25.00.

Column (6), (6) = (5)/(1)

Source : Estimation is based on field data, field survey, 1983.

TABLE 4 — Time Requirement for Tractor Tillage and Animal Tillage

Operation	*Tractor Tillage Hrs./Acre*	*Animal Tillage Days/Acre*
(1)	(2)	(3)
First Ploughing ..	2.00 ..	2.00
Second Ploughing ..	2.00 ..	0.50
Levelling ..	1.30 ..	0.50
Total ..	5.30 ..	3.00

Source : (2) Field Survey, Unagaswewa, 1982
(3) Field Survey, Hureegama, 1982

TABLE 5 : Estimated Time Availability per Acre for Animal Tillage in Relation to Farm Size

Farm Size Acres	*Time Available Days*
(1)	(2)
1.0 ..	9.00*
1.5 ..	6.00
2.0 ..	4.50
2.5 ..	3.60
3.0 ..	3.00
3.5 ..	2.57
4.0 ..	2.25

Note : *Method of Estimation

Time required for fixed intervals between first ploughing, second ploughing and levelling = 21 days

Land preparation period = 30 days

Therefore, time available for all operations involved in land preparation = 30—21 = 9 days

(2) = 9.00 days / (1)

Source : Field Survey, 1984.

In this way, the inclination of small paddy holders towards the animal draught power based-labour intensive technology can be explained in terms of cash expenditure on labour, and time available for the field operation. Table 3 column (6) and Table 5 column (2) show the relationship between cash expenditure on labour, time available for tillage operation and the size of paddy holdings. It can be noticed from these tables that as the size of paddy holdings increase the cash expenditure on labour per unit area rises whereas the length of time available per unit area becomes shorter. Therefore, small holders can easily depend on animal draught power which is more labour and time consuming but large holders can hardly do so due to the increased cash expenditure on labour and the time limitation. Since the tractor hire rate per acre is fixed regardless of the area to be tilled, cost of tractor tillage per unit area is the same for small holders as well as for large holders. Therefore, due to the cost and time advantages, and the inconvenience associated with animal tillage, large holders are tempted to adopt tractor tillage.

Conclusion

In conclusion, it can be stated that the size of paddy holdings plays a vital role in making decisions on alternative farm power sources. The smaller the size of paddy holdings the greater the farmes' tendency to depend on animal draught power based-labour intensive technology. Larger the size of paddy holdings the greater the farmers' tendency to substitute the animal-power technology for the mechanical power based capital intensive-labour saving technology for the tillage operation on paddy fields. This correlation can be attributed to the fact that the smallness of the size of paddy holdings permit the farmers to cope with the limited time and limited unpaid family labour available for tillage operations despite the greater time-consuming and labour-consuming nature of the animal draught power based technology.

However, in this study, attention was not paid to the determination of the optimum size of holdings in relation to various types of farm power. It may vary according to the unpaid family labour force available to each farm house holder and the length of the land preparation period. However, in the light of the findings it can be stated that the relatively small farmers are likely to show a positive response to the measures taken by the authorities to promote the animal draught power but large farmers are highly unlikely to do so. Steps have to be taken to improve the work output of animal draught power, especially in the Wet Zone and in traditional villages of the Dry Zone where the size of paddy holdings is relatively small. In new settlement schemes in the Dry Zone where the size of allotments is relatively large the farmers can hardly manage with animal draught power. If the animal draught power is to be popularized in future settlement schemes, care should be taken to keep the size of paddy allotments so small that the allotees could manage only with their unpaid family labour. At the same time, measures have to be adopted to improve the work out put of draught animals. Such an approach would make it possible to reduce the cash expenditure on tillage operation which accounts for a greater portion of the cost of paddy production.

Acknowledgments

The author wishes to express his gratitude to Professor Keizo Tsuchiya, Professor of Agricultural Economics, Kyushu University, Japan, and Dr. (Mrs.) Dammika Wanasinghe, Senior Lecturer, Department of Geography, Sri Jayewardenepura University, Sri Lanka, for their constructive comments on the first draft of this paper.

References

Farrington, J and F. Abeyratne, 1982, *Farm Power in Sri Lanka.* Reading U.K., University of Reading, (Department of Agricultural Economics and Management.)

Ryan, M. Abeyratne, F. and J. Farrington, 1981. *Animal Draught Power, The Economics of Revival* (Occasional Publication No. 23, Colombo,) Agrarian Research and Training Institute.

Ulluwishewa, R. and K. Tsuchiya 1984. A Study of the Motivating Factors for Farm Mechanization in the Dry Zone of Sri Lanka; A Case Study : Unagaswewa vlilage. *Bulletin of the Institute of Tropical Agriculture, Kyushu University,* 7 : 91—117.

Ulluwishewa, R. and K. Tsuchiya, 1984. The Disintegration of a Traditional System of Exchange Labour and Mechanization of Paddy Land Preparation in Sri Lanka. *Journal of the Faculty of Agriculture, Kyushu University,* 29 (2—3) 117—138.