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The Socio-Economic Study of the Draught Animal Power in the Dry Zone of Sri Lanka

A Case Study: Hureegama Village

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From the time of immemorial the buffalo has been the main source of power for the ploughing operation of paddy cultiviation in Sri Lanka. Since the introduction of mechanical power in 1950s, it has been gradually pushed away from paddy fields, mainly in the dry zone. But in some localities in the dry zone, buffalo power still retains the place it has held in paddy production. This paper is intended to identify the reasons for why buffalo power is still favoured in some localities in the dry zone of Sri Lanka. Hureegama, a small dry zone village of which the farmers heavily depend on buffalo power for ploughing has been selected and its socio-economic and physical conditions were observed with a view to identify their impacts on farmers' preference for buffalo power. In the light of the survey it has been found that the uncertainty involved in water supply, the relatively high buffalo work output, the flexibility in the implementation of water management regulations, the adequate availability of buffalo power and the difficulties in obtaining tractor/power tiller custom services collectively generate favourable circumstances for the continuous existence of the usage of buffalo power for puloughing.

INTRODUCTION

The history of the development of technologies is an intriguing story of the conflicts between old and new technologies. This phenomenon has always been there throughout the history of the development of agricultural technologies, and this process will continue into the future too. When a new technology comes, it has to struggle with the prevailing traditional technologies, but in the face of the advantages of the new, the old ceases to exist. The length of period taken by the new to replace the old may vary regionally due to various socio-economic and physical circumstances prevailing in various regions. These circumstances may retard or speed up the process of the adoption of a new technology.

Paddy cultivation in Sri Lanka has been under the traditional peasant sector of agriculture and the whole cultivation operation has been dominated by traditional technologies. Draught animal power, mainly the buffalo power has been the main source of farm power for ploughing and threshing operations. Since the invasion of tractors and power tillers in 1950s, buffaloes have gradually been displaced mainly from the dry zone[1] paddy fields where the socio-economic and physical conditions appear to be in favour of the adoption of mechanical farm power. At present approximately 60 % of the paddy extent in the dry zone is ploughed by the mechanical power. Despite the increasing popularity of mechanical power for ploughing in the dry zone, draught animal power still plays an important role in some localities. This paper is intended to identify the socio-economic and physical factors which still hold this traditional source of farm power in some particular localities in the dry zone.

For the purpose of this study, tractor is defined as 4-wheeled traction-engine of 35-45 HP fitted with tine tiller and cage wheels; and power tiller is defined as 2-wheeled traction-engine of 6-7 HP fitted with rotavator and mud wheels.

METHODOLOGY

It has been felt that perhaps the best way to achieve this objective is to observe the socio-economic and physical conditions prevailing in a locality in which buffalo power still plays a major role in ploughing operation, and to make attempts to identify the causal relationship between the observed variables and the farmers' decision-making in favour of buffalo power for ploughing. Hureegama was purposively selected for this study because,

a. its economy is exclusively based on paddy cultivation,
b. its ploughing operation is almost totally depenent upon buffalo power (see table 2),
c. its socio-economic and physical conditions do not seem to be peculiar,
d. it is so small that execution of such a survey is feasible under limited time and limited budget (see table 1).

Data required for the identification of socio-economic and physical factors were collected by open interviews (discussions guided by a set of pre-planned questions) and a simple questionnaire administered to all households; and by informal discussions with village leaders and a number of tractor/power tiller owners residing outside the village. This survey was executed in two visits made in January and February of 1982. In addition, data required for comparative considerations were gathered from various village level case studies. Although the emphasis of these studies has often been on different aspects, they have all involved the collection of some data and information relevant to this particular research problem.

It seems that the data collected from open interviews and informal discussions were less amenable to quantitative analysis. And also, the infor-

[1] The region with a rain fall of less than 20 inches for the south-west monsoon (May-September) period.

mation gathered from informal discussions with randomly selected farmers was in descriptive manner. Therefore, this paper is based on qualitative analyses rather than quantitative, and many conclusions are mostly untested hypotheses.

Background of the Study Area

Sri Lanka is an island of 25,000 squere miles which has a population of 14.8 million, currently increasing at 2 percent per year. Agriculture is the important sector in the economy which accounts for one third of the GDP; 75-80 percent of the exports and 50-60 percent of the total employment. While tea, rubber, and coconut are the main exports, total rice production is absorbed domestically for consumption. Rice is essentially a small holders crop because the major portion of (78. 92 percent) the national paddy extent is in holdings sized from 1 acre to less than 10 acres. Domestic rice production is still insufficient to meet the demand, therefore about 25-30 percent of the local demand is met by rice importation. It was estimated that 60 percent of paddy cultivating households do not produce adequate rice to meet their family needs, and there may be a further proportion who are just self-sufficient and have little or no surplus?. These deficit paddy producers are concentrated in the wet zone[3] coastal lowlands which are characterized by high population density and low average size of paddy holdings with low yields and low cropping intensity. The dry zone which covers almost three quaters of the island's land surface is characterized by its long dry season (see Figure 2) and high annual rainfall variability (see Figure 3). Dry zone has two well defined rainy seasons, the *MAHA* (major rainy season) extending from early October to late January and the *YALA* (minor rainy season) from late March to late May. The dry zone is particularly important regarding the rice production because it contributes 77 percent of the total production and 72 percent of the total paddy extent. Although this area is less-developed in terms of physical and institutional infrastructure, it was once in the history the region of a prosperous agrarian economy. "Extensive works of irrigation, secured with an immense amount of labour, skill and science had transformed arid plains to areas of plentiful prosperity at a period when agriculture in Europe was in the rudeust and most primitive state".[4] From about 1200 AD, due to various reasons, prosperity of the dry zone economy began to decline and there was a migration of population from the dry zone to the wet zone. Since then the dry zone remained sparsely populated and isolated. It was the beginning of this century when the state began to make efforts to restore the ancient tanks and to reestablish the agrarian prosperity. Now two types of settlements can be identified in the dry zone. These are the new settlements and the old settlements.

The new settlements were established under renovated or newly constructed large and medium sized tanks. These settlements were provided

[2] For further details, refer Moore (1980).
[3] South-west quater of the island which receives rainfall almost throughout the year.
[4] Quoted from Brohier, R. L. (1934).

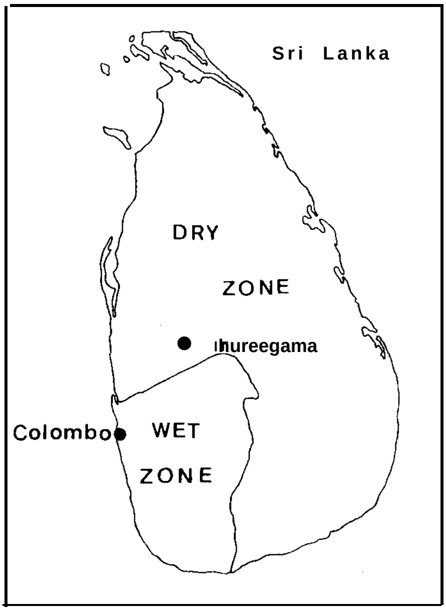

Fig. 1 Agroclimatic zones and the location of the study area.
Note: Dry zone is defined on the basis of the effective dry period.
Source: Mandfred Domros 1974 ***The Agroclimate of Ceylon.*** Wiesbaden.

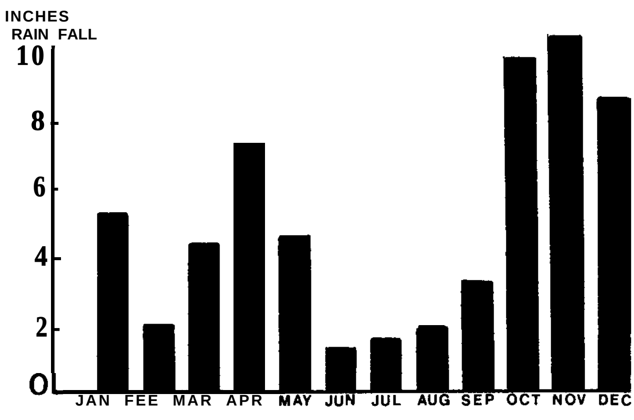

Fig. 2 The monthly distribution of rain fall in the dry zone of Sri Lanka; average over 52 years.
Source : Meteorology Department, Colombo.

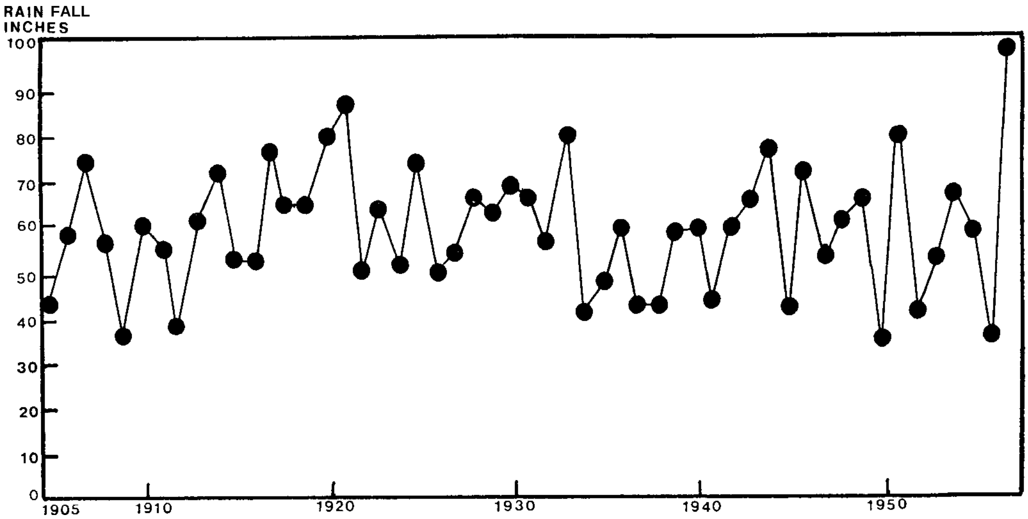

Fig. 3 The yearly total of rain fall over 53 successive years in the dry zone of Sri Lanka. Each dot represents the total for one year.
Source : Meteorology Department, Colombo.

with necessary physical and institutional infrastructure facilities. The settlers were given holdings of 5 acres of irrigated paddy land and 2 acres of high land.

The old settlements are generally associated with small tanks; and they are characterized by threefold landuse system: that of irrigated paddy, homestead and the chenas (the lands under shifting cultivation). While paddy is cultivated on the lands located immediately below the tanks, the homesteads are situated at one end of the tank bund. The chena cultivation is generally practised on adjacent jungles.

Hureegama, which falls into the second category is located in the rather neglected and less-developed north-central part of Sri Lanka. It is one of a village cluster which consists of five small tank villages; and it is about 90 miles away from the capital, Colombo and 20 miles away from Kurunegala, the local town which serves as the main service center to this less-developed area. It has 17 households of which the main source of income is paddy production. Hureegama experiences the typical dry zone weather conditions. The irrigation water for paddy cultivation is provided by the small village tank which is fed directly by rains. Paddy cultivation could be rarely done without irrigation even in the major rainy season, and during the minor rainy season, it is virtually impossible. Due to the unpredicatability associated with the mansoon rains, the irrigation water supply is also unpredictable. If the mansoon rains do not occur as usually or its intensity becomes low, it almost certainly leads to a total or partial crop failure. Therefore, the village economy which totally depends on agriculturel production is unstable. Average household income fluctuates yearly and monthly. Monthly average

Table 1 Demographic Characteristics in Hureegama

A Population			B	C
Male	Female	Total	No. of Households	Family Size
34	38	72	17	4.23

Unit: A & C = No. of Persons
Source: Field survey conducted by R. Ulluwishewa in 1982.

Table 2 Farm Power Use Pattern in Hureegama

A Total Paddy extent	B Ploughed by animal power	C	D Ploughed by tractors	E
24	21.5	89.58	2.5	10.4

Unit: A, B, D=Acre, C & E=Percentage
Source: Field survey conducted by R. Ulluwishewa in 1982.

Table 3 Distribution of Paddy Land Ownership in Hureegama

Paddy extent owned (in acres)	Number of households	%	Cumulative frequency
Landless	3	17.6	17.6
Less than 1/4	0	0.0	17.6
1/4 - 1/2	3	17.6	35.2
1/2 - 3/4	1	5.8	41.0
3/4 - 1	3	17.6	58.6
1 - 2	2	11.7	70.3
2 - 3	0	0.0	70.3
3 - 4	1	5.8	76.1
4 - 5	1	5.8	81.9
5 - 6	1	5.8	87.7
Over 6	2	11.7	100.0

Source: Field survey conducted by R. Ulluwishewa in 1982.

Table 4 Distribution of Buffalo Ownership in Hureegama

No. of buffalo pairs	Number of households	%	Cumulative frequency
Buff alo less	6	35.3	35.3
1	7	41.2	76.5
1 - 2	0	0.0	76.5
2 - 3	3	17.6	94.1
3 - 4		5.9	100.0

Source: Field survey conducted by R. Ulluwishewa in 1982.

income fluctuates in a pattern with peaks at the harvesting time and with long troughs throughout the dry season. Village life is characterized by poverty and hardship. The agricultural production is done as a way of life rather than a profit-making business, because farmers' main objective is to produce food for family needs rather to produce a marketable surplus.

In addition to small paddy holdings, every household has a small homestead with a few coconut trees which provides a little supplementary income. Chena cultivation is now not practised due to the increasing pressure on the available arable land. Many households possess at least a pair of buffaloes. In this society, possession of buffaloes or cattle represents wealth, social status and influence. It also provides insuarance against crop failure. During the period of drought when crop failures are frequent many farmers are able to secure some income through the sale of buffaloes.

Some inhabitants who do not possess their own paddy lands, cultivate some cash crops mainly chillies and cowpea on state lands they encroached ill&ally. It has been observed that the encroached reservations along the main irrigation channel were planted with paddy by providing water from mechanical pumps. When the tank's water level becomes very low or when it completly dries out tank-bed is also occasionally cultivated. All thess show the increasing perssure upon the cultivable land.

DISCUSSION

Next part will be devoted to observe the causal relationship between the above briefly outlined socio-economic and physical conditions and the farmers' propensity to use buffalo power for ploughing. For the sake of brevity and simplisity discussion will be done under five categories as follows.

a. Uncertainty involved in irrigation water supply,
b. Higher buffalo work output,
c. Flexibility in the implementation of water management regulations,
d. Adequacy of the available buffalo population,
e. Difficulties involved in obtaining hired tractors.

Uncertainty involved in irrigation water supply

The sole source of water required for paddy cultivation in this village is the small village tank which is fed by rains. It is a well recognized fact that monsoon rains are characterized by their inter-year variation and by the unpredictability involved in the time of the outset of the rainy season. As it is shown in figure 3 the inter-year variation of the annual rainfall is remarakably high. Therefore, farmers can hardly pre-estimate what extent of the land they could successfully cultivate with forthcoming rains. On the other hand, due to the unpredictability of the time of the outset of the rainy season, farmers can hardly decide the best day on which cultivation operation should be commenced. If the village tank is fed by a reliable source of water other than unpredictable monsoon rains, the uncertainty involved in water supply could have been reduced, as it has been done in large scale irrigation reservours fed by rivers with rather stable volume of water throughout the year. However, due to the uncertainty involved in monsoon rains, in terms of the volume of rain water and of the timing, farmers reluctant to commence the cultivation operation until the water level of the tank becomes sufficiently high. Hence, rain water falls on paddy fields at the beginning of the season is not utilized, instead the water accumulated in the tank is excessively utilized for ploughing (Ranatunge et al., 1981). Then if the rains received afterwards become insufficient to raise the tank's water level, it consequently leads to water shortage in the growing period which results in total or partial crop failure. Therefore the inputs entered into the paddy production system do not yield the expected output. Therefore, it can be said that the situation, under which paddy cultivation is done, is highly uncertain and risky.

In order to minimize the risk and uncertainty, farmers here appear to practise many strategies. One of them is to make lower the levels of cash investments. The average cash outlay per acre of paddy cultivation in minor irrigation areas has been found to be significantly lower than that in major irrigation areas with reliable water supply. The low levels of cash investments in terms of purchased inputs and hired labour is understandable in view of the uncertainty faced by farmers due to lack of irrigation water. Since the mechanical ploughing is essentially associated with cash payments, farmers' tendency to use buffalo power instead of mechanical power may be described as farmers' adjustment mechanism against the risk and uncertainty. In Hureegama, the majority of farmers, if they have their own buffaloes, use the buffalo power in combination with family labour or exchange labour in order to keep cash investments in ploughing operation at the possible lowest level. Table 5 and figure 4 suggest a negative correlation between the quality of water supply and the usage of buffalo power for ploughing. The poor quality of water supply means lack of water in appropriate time in required quantity which certainly increases the level of risk and uncertainty. On this grounds, it can be assumed that the uncertainty involved in irrigation water supply encourages the usuge of buffalo power for ploughing.

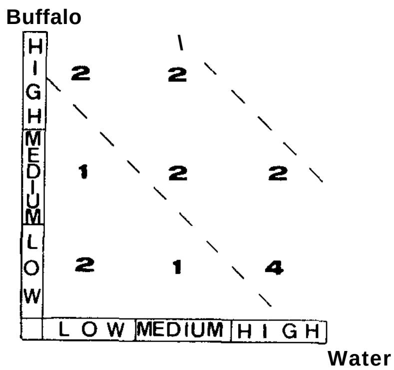

Fig. 4 Degree of the usage of buffalo power for ploughing and quality of water supply of *16* locations in the dry zone of Sri Lanka.
Source: See table 5.

Table 5 Degree of Animal Ploughing & Quality of Water Supply of 16 Locations in Sri Lanka

A Locality	B Degree of Animal Ploughing	C Quality of Water Supply
a. Mahawilachiya	high	low
b. Mahakanadarawa	medium	low
c. Pavatkulam	low	low
d. Usgala Siyabalangamuwa	high	medium
e. Kandalama	low	low
f. Kaudulla	medium	medium
g. Minipe	medium	high
h. Polonnaruwa	medium	high
i. Hambantota	low	high
j. Elahera	high	medium
k. Walagambahuwa	low	high
1. Kalaoya	medium	medium
m. Mahaweli	low	high
n. Mahabolana	low	high
o. Hureegama	high	low
p. Unagaswewa	low	medium

Source: a-m; Fieldson, R. S. 1981 *Farm Labour Input* in *the dry zone.* ART1 (Agraian Research and Training Institute),
n ;Charlet, P. 1980 *Paddy Land Mechanization in Sri Lanka: Unpublished graduation dissertation.* Sri Jayawardenapura University, Sri Lanka.
o & p ; Field survey conducted by R. Ulluwishewa in 1982.

Note :

B: The classification into groups is based on percentage of the paddy extent (first and second ploughing, and levelling) at each location which was cultivated by mechanical power and animal power. If the proportion cultivated by animal power exceeds 2/3, the location is classed as high animal use; if it is less than 1/3, the location is classed as low animal power use; and between 1/3 and 2/3 is classed as medium animal use.

c : The classification is based on the cropping intensity of each location, because it is a well observed fact that the cropping intensity is positively related to the quality of water supply. Although comparable quantitative data on cropping intensity of each location are not available, it was possible to get a reasonable impression of the conditions which existed from figures or comments in the reports, thus allowing the locations to be divided into categories according to quality of water supply.

Higher Buffalo Work Output[5)]

The power required per unit area of ploughing varies from region to region depending on hardness of soil on paddy fields, density of weeds and the availability of water for pre-softening the soils. At the time of the commencement of the ploughing operation if soils on paddy fields are very dry and hard, and paddy fields are densely covered with weeds, and water

[5)] Extent of paddy land that can be ploughed by a pair of buffalo per day.

Table 6 Rain Fall, Buffalo Work Output, Average Cost of Buffalo Ploughing and the Degree of Buffalo Usage of Five Locations in the dry zone of Sri Lanka

Location	A Rain Fall	B Buffalo Work output	C Average Cost per Acre	D Farm Households Used Buffaloes
a. Mahabolana	43.24	0.07	365.00	0.00
b. Unagaswewa	56.40	0.08	350.00	0.00
c. Kala-oya	58.40	0.14-O. 2		50.00
d. Padaviya	61.90	0.16	240.00-300.00	75.00
e. Hureegama	84.67	0.20	225.00	94.00

Unit: A=inches, B=acres, C=rupees, D=percentage.

Source : a ; Charlet. P. ***1980 Paddy Land Mechanization in*** Sri ***Lanka: Unpublished graduation dissertation, Sri*** Jayewardenapura University, Sri Lanka.

c ; Ranatunga, A. S. and Others 1979 ***An*** Analysis *of* ***the*** *Pre-Mahaweli Situation* ***in*** $H_4 H_5$ Areas in ***Kala-oya Basin.*** ARTI, Colombo.

d ; ARTI ***1980 A Study of Five Stttlement Schemes Prior to Irrigation*** *Modernization*: ***Vol.*** *V.* ARTI, Colombo.

b, e ; Field survey conducted by R. Ulluwishewa in 1982.

A ; Meteorology Department, Colombo, Sri Lanka. (recorded in the nearest station to the each locality 1911-1940)

Note: B; ***l/No.*** of buffalo (pair) days required per acre=Work output per buffalo (pair) day.

C ; Estimated on the basis of buffalo hire rates and labour wage rates in the each locality.

for pre-softening is not sufficiently available, the number of buffalo (pair) days that should be applied per unit area, has to be increased. In other words, all these three factors reduce the buffalo work output which results in higher cost. Data collected from various locations suggest that drier and harder the solis, lower the buffalo work output and higher the average cost of buffalo ploughing. As it is indicated in table 6 coloum A & B and in figure 5 the linear association between the mean annual rainfall of five locations and the buffalo work output suggest that the dry and hard soil conditions may have a decisive impact on the buffalo work output. Where the mean annual rainfall is high, soils on paddy fields may be rather soft and wet so that ploughing operation is possible with relatively low number of buffalo (pairs) days, because rainfall has a positive impact on buffalo work output. Thus, the number of buffalo (pairs) days per unit area of ploughing which is a function of the buffalo work output, has implications with cost in two different ways.

1. Low work output requires a greater number of buffalo (pair) days and man days per unit area. In the case of farmers who do not possess their own buffaloes, much money should be spent on hired buffaloes and probably on hired labourers, if family labour is insufficient.

ii. In general, once the ploughing operation started, the time can be taken per unit area is fixed, and it varies from l-2 days per acre for

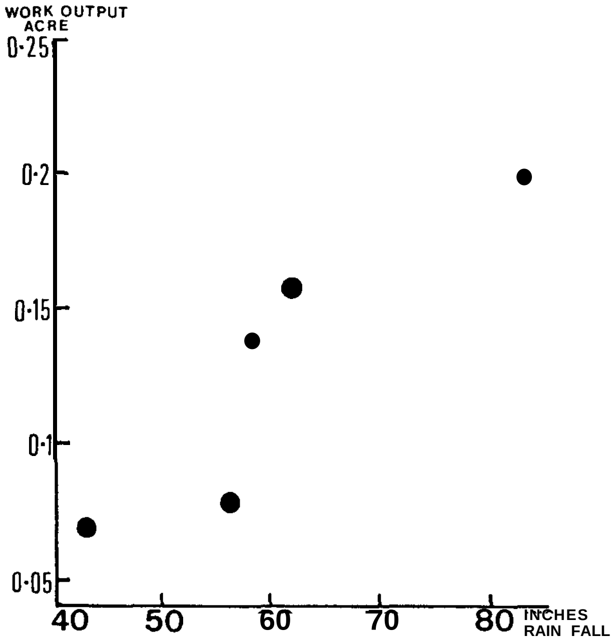

Fig. 5a Rain fall and buffalo work ouput of five locations in the dry zone of Sri Lanka.

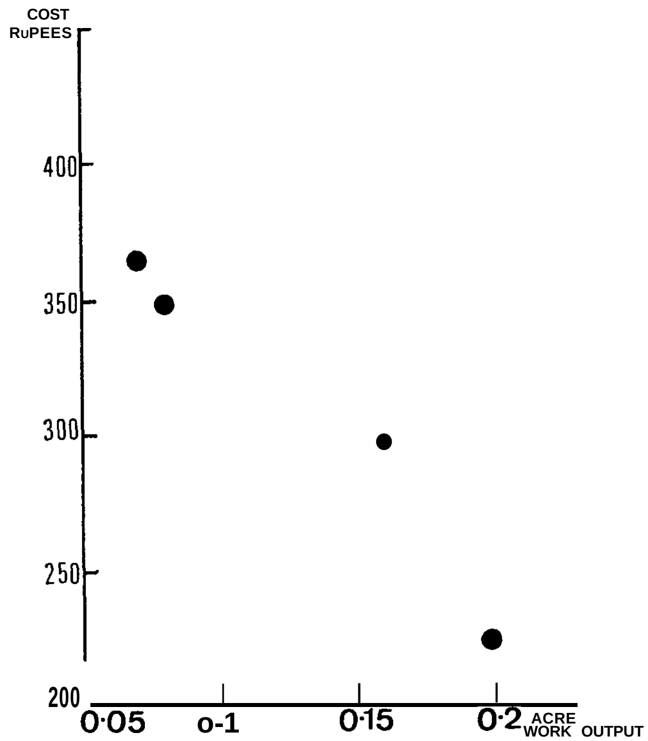

Fig. 5b Buffalo work output and average cost of buffalo ploughing of four locations in the dry zone of Sri Lanka.

Source: See table 6.

first ploughing and 0.5-l. 0 day per acre for second ploughing. For that reason, if the buffalo work output is rather low, farmers have to employ a greater number of buffalo pairs per unit area per day. At this point, it is necessary to understand the cost difference between the employment of a few buffalo pairs for many days and the employment of many buffalo pairs for a few days. In the former case the farmer who has a few buffalo pairs may be able to complete his ploughing operation without any cash expenditure on hired labour and hired buffaloes but in the latter case the farmer has to employ many hired buffaloes and hired labourers because the power requirment per day exceeds his own power resources. Since the time can be taken for ploughing is more or less fixed, the second case is in practice. Therefore, low buffalo work out involves higher cash costs.

Thus, it can be assumed that lower the buffalo work output higher the cost. Data appeared in table 6, coloum B & C and figure 5b provide empirical evidence for such a correlation.

In Hureegama, number of buffalo (pair) days required per acre is relatively low (see table 7) and therefore buffalo work output is relatively high (see table 6). This fact can be considered as a reason for Hureegama farmers' propensity to use buffalo power for ploughing.

Flexibility in the implementation of water management regulations.

In contrast to major irrigation schemes, in every tank village, decisions concerning water management are taken by a meeting attended by all farmers in that particular village, and decisions are implemented by the secretary of the cultivation committee who is elected by farmers. His activities are mostly free from the interference of the bureaucracy, but since he is one of the same village community in which he lives he is not free from the ties of kinship, friendship and neighbourhood which are very effective in traditional villages. Therefore, when he implements the water management regulations, most probably, he is bound to be considerate with individuals' problems and situations. It has been evident that the pre-setup dead lines for water issues are adjustable in order to cope with individuals' delays in the performence of ploughing. In addition, incidents of illegal water tappings are not unusual. Since the sluice of the tank and the outlets of the main channel are not properly maintained, as long as water is available in the tank, farmers appear to be able to get water much as they need. This is particularly true at the beginning of the season when the tank is filled,

Table 7 Number of Buffalo (pair) days Required per acre for Ploughing Operation in Hureegama

	Number of buffalo pairs	Number of days
First Ploughing	2	2
Second Ploughing	2	1/2

Source: Field survey conducted by R. Ulluwishewa in 1982.

but this habit of the excessive utilization of water for ploughing leads to water scarcity in the late season. However, this situation encourages the usage of buffalo power for ploughing in many ways.

Since the pre-setup dead lines for water issues are not strictly implemented the real period during which farmers are permited to complete the ploughing operation is longer than it otherwise would be. Therefore, those who do not possess their own buffalo resources enough to meet the total power requirements are able to wait until their neighbouring farmers release their buffaloes from works on their own farms. In the same way, farmers whose family labour force is insufficient to meet the greater labour requirement are able to wait until their neighbouring farmers release themselves from works on their own farms. Therefore, where the dead lines set-up for water issues are adjustable through personal negotiations with the authority, almost all farmers are in a position to use buffalo power for ploughing; otherwise those who do not possess sufficient buffalo and family labour resources have to depend on hired tractors for ploughing.

It is a well observed phenomenon in traditional tank villages in Sri Lanka that almost all farmers possess several small paddy plots which are dispersely located within the *YAYA*[6]. In the cultivating operation, priority is given in accordence with the access to water and with the productivity of the each paddy plot. It has been observed in Hureegama that since the dead lines set-up for water issues are not strictly implemented, farmers are able to plough their dispersely located small paddy plots one after other over a rather long period observing the changing tank's water level and weather conditions. First they plough their most productive paddy plots and then having observed the situation of water supply they decide whether they should proceed to the next. If the farmer can guess from his knowledge and experience that tank's water level and weather conditions are likely to be favourable, he may proceed to the next paddy plot. This behaviour may be described as a kind of strategy devised by farmers against the risk and uncertainty. Whatever it is, this phenomenon seems to facilitate the usage of buffalo power for ploughing, because since even large farmers plough one small paddy plot and after another, they are likely to be able to manage with a rather small number of buffalo pairs. In other words, if the farmer ploughs his total paddy extent at once, it would require a greater number of labourers and buffaloes which may exceed the capacity of his own power resources. Therefore, this prevailing tradition assists to keep the cost of hired labour and hired buffalo at a low level than it otherwise would be.

Futher more as it was mentioned already, it has been observed that due to the poor maintenance the sluice of the tank and the outlets of the main channel are not properly functioned and illegal water tappings are also not severely punished. Therefore, farmers in Hureegama are in a position to utilize an excessive volume of water for pre-softening soils so that ploughing operation could be performed with a relatively small buffalo team.

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[6] Paddy tract fed by the tank.

Table 8 Buffalo Population in Hureegama

Adult buffaloes	Calves	Total
39	21	60

Unit: Buffalo head
Source: Field survey conducted by R. Ulluwishewa in 1982.

Table 9 Density of Buffalo Power in Hureegama

A Number of Buffaloes	B Paddy Extent	C Buffalo Density
19.5	41.55	0.46

Unit: A=Buffalo pairs, B=Acres, C=A/B
Source: Field survey conducted by R. Ulluwishewa in 1982.
Note: National average of the density of buffalo power is estimated to be as 0.1/acre.

Adequate buffalo population

Buffalo shortage was the fact which has often been emphasized by many writers as the most important single factor which made the mechanization inevitable and it, of course, generates circumstances under which buffalo power based strategy is quite impossible. Although farmers are convinced with low cost and high quality associated with buffalo ploughing, the acute shortage of buffaloes generates compelling grounds to discard this domestic source of power resource in favour of alien and expensive mechanical power. Though this is the common situation in almost every where in the dry zone, in some particular localities, buffalo power still remains sufficient. In Hureegama too, the available buffalo population seems to be sufficient in follwing terms.

i. The value of the buffalo density is approximately four and half times higher than the national average value (see table 9)
ii. The operational capacity of a buffalo pair (buffalo work output) has been observed to be as five buffalo (pair) days per acre (see table 7). On account of this operational capacity, if the total number of buffaloes are utilized in their full capacity, total paddy extent in the village could be ploughed within 10.65[7] days.
iii. If the length of the ploughing period is assumed to be 40 days, 18.77[8]

7) $\dfrac{\text{Total no. of buffalo pairs (19.5)}}{\text{Operational capacity of the buffalo power (5 buffalo (pair) days per acre)}}$ = Operational capacity of the total buffalo force per day (3.9 acres)

$\dfrac{\text{Total paddy extnet held by villegers 41.55*}}{\text{3.9 acres}}$ = No. of days required for the total paddy extent (10.65 days)

8) $\dfrac{\text{Total no. of buffalo pairs (19.5)} \times \text{Length of the ploughing period (40 days)}}{\text{Total paddy acreage (41.55)*}}$ = 18.77 buffalo (pair) days

Note: *This includes *some* paddy holdings located out of this village.

buffalo (pair) days could be taken per acre. But according to the operational capacity of a buffalo pair, 5 buffalo (pair) days are sufficient.

These figures suggest that the total buffalo power available within this village may be in excess of the requirement.

However, though the available buffalo force is sufficient in terms of the total power supply and total power requirement, probably the buffalo ownership pattern may keep some farmers away from the access to buffaloes as it is evident in villages where buffalo ownership is not properly distributed (Farrington and Abeyrathne, 1982). But in Hureegama since the majority of farmers (64.7 %) have at least one pair of their own buffialoes, farmers' access to buffalo power is not very unfavourable (see table 4). Furthermore, average herd size was observed to be rather small (2-8 abult buffaloes). Therefore some organizational problems which make it difficult to utilize the available total buffalo power resources intensively, are unlikely to occur here. For example, it has been observed in areas with large buffalo herds (average herd size 31.1) that the organizational problems cause difficulties in arranging full work programmes for large herds[9]. As it is shown in figure 6, there is a positive correlation between the size of buffalo holdings and the size of paddy holdings ($r=0.465$). Although the cor-

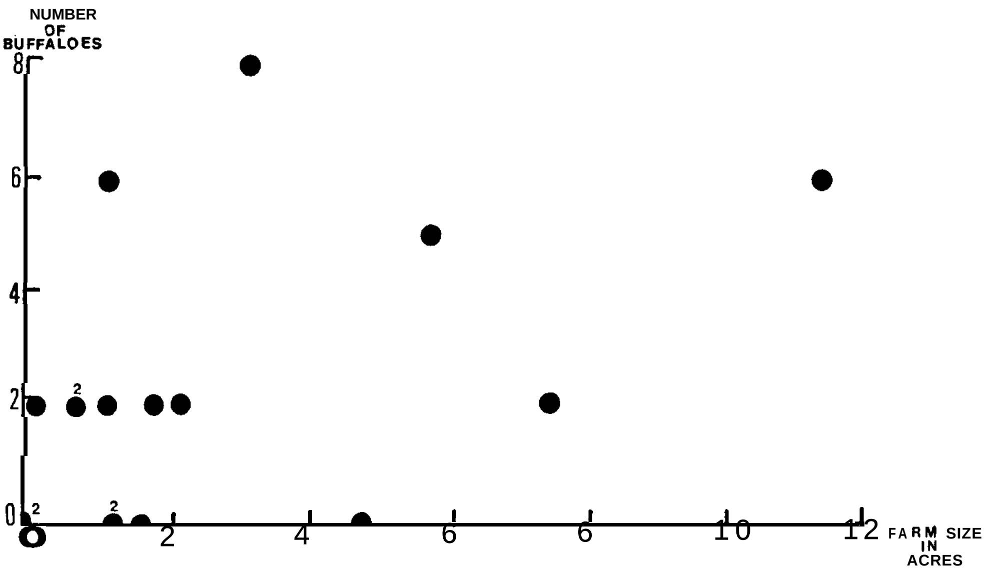

Fig. 6 Size of buffalo herd* and farm size (size of paddy holdings) in Hureegama.

Source: Field survey conducted by R. Ulluwishewa in 1982.

Note: *Number of adult buffaloes held by individual households.

9) For further details refer Ryan *et al. (1981).*

relation is rather poor it suggests that larger the size of paddy holdings, greater the likelihood of keeping large buffalo herds. This kind of relationship partly solves the farm power shortage that could otherwise be arisen. The farm power shortage that could be arisen from the imbalance between the size of paddy holdings and the number of buffaloes held by individual households may be remedied by the prevailing tradition of buffalo exchange which is favoured by the existing cordial relationship and strong kinship ties among inhabitants. Some buffalo owned farmers offer their animals to their close relatives and neighbourers free of charge. Those who possess large paddy extent are socially powerful and influencial, and also they are well respected. Therefore, they can easily assemble buffaloes from others in case they are in short of farm power. In the same way, they can assemble enough labour force without much trouble.

Further more, increasing costs and troubles associated with buffalo keeping which have been emphasized by many writers as major constraining factors for the usage of buffalo power do not seem to provide strong disincentives for buffalo keepers in Hureegama due to following reasons.

i . Average size of buffalo herd is so small that their management can be performed by the limited family labour of which opportunity cost is relatively very low. It seems that many farmers limit the size of their buffalo herds to the extent that can be managed by their own family babour. The observed positive correlation (r=O. 500) between the number of adult male family members whose labour is used for

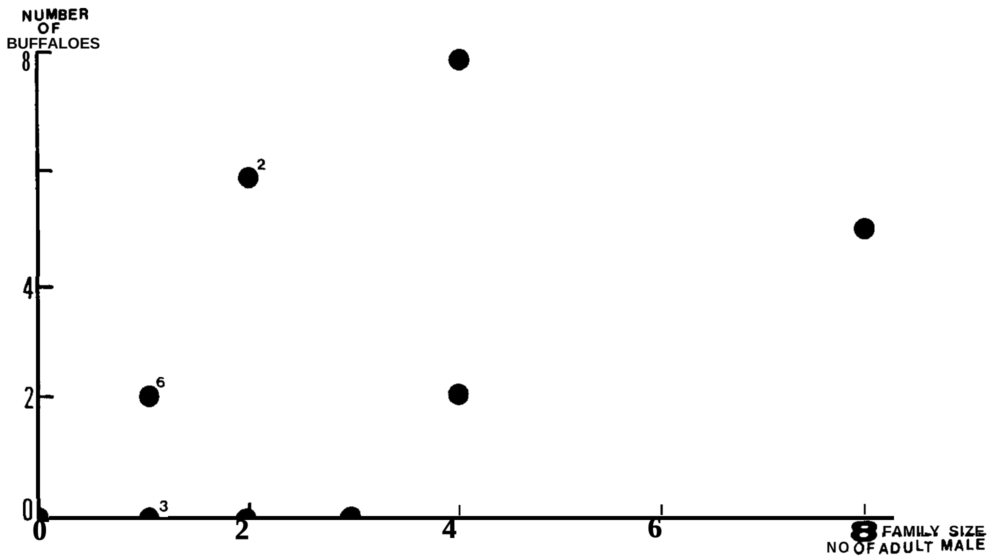

Fig. 7 Family size and size of buffalo herd* in Hureegama.

Source: Field survey conducted by R. Ulluwishewa in 1982.
Note: *Number of adult buffaloes held by individual households.

buffalo keeping and the number of adult buffaloes (see figure 7) kept by individual households provides evidence for such a behaviour. In some cases it appears that when the herd size exceeds the management capacity of the available family labour, animals are pooled into the supervision of herders during the off-season. Normally herders are not paid in cash, instead a number of calves born during that period are given to the herder. This provides employment opportunities in the off-season for labour which would otherwise be unemployed.

ii. The method of buffalo keeping practised in this village is tethering. Under this management system, buffaloes are tethered within the homesteads or on uncultivated lands. It appears that in many cases those who possess one or two buffalo pairs, keep the probability of causing crop damages by trespassing animals at a low level. If the trespassing buffaloes cause any damage to the crops, the owner of the animal is liable to pay compensation. Although the compensation money accounts for a sizeable share of the buffalo maintenance cost in areas where the open-grazing method is in practice, it appeared to be negligible in Hureegama.

Almost all farmers are well aquainted with the buffalo ploughing operation and buffaloes are also well trained. Long standing methods and traditions associated with buffalo ploughing and buffalo keeping which have already been disappeared in developed areas are still preserved in this rather backward area. The inherited knowledge and skill possessed by farmers which are required for buffalo keeping and ploughing undoubtedly enhance the buffalo work output too.

From farmers' point of view the quality of land ploughed by buffaloes is higher than that of land ploughed by tractors. According *to* them, buffaloes' feet are just the right shape for pressing down the soil in the paddy field, which as a result forms gley or crust which holds the water in. They also stir up the soil above gley and loosen it. In addition, a buffalo also produces about 1500 pounds of dung every year and a vast amount of urine both of which contribute very significantly to the fertility of the soil.

Difficulties involved in obtaining and using hired tractors

It is important to mention here the fact that neither tractors nor power tillers are available within Hureegama. Therefore, it seems rather difficult for farmers to obtain them during the ploughing period. Since almost all tractor owners are involved in the preparation of their own lands, farmers are unable to obtain custom services at the exact time when they are needed. Therefore, although the mechanical ploughing is superior in the speediness of operation, the waiting time for the arrival of tractors is long. If this long waiting time is also taken into consideration, ploughing with buffaloes may enable farmers to get their paddy lands ploughed in time if buffaloes are readily available.

As it has been observed elsewhere"", some tractor owners maintain

[10)] Unagaswewa Village, Sri Lanka, Field survey conducted by R. Ulluwishewa in ***1982.***

Table 10 Hire Rates of Mechanical Farm Power

A Hire rate in Hureegama	B National average hire rate
500.00	330.00

Unit: Rupees/Acre
Source: A ; Field survey conducted by R. Ulluwishewa in 1982.
B ; Central Bank of Ceylon 1980 Price & Wage Statistics. Colombo.

agreements with farmers under which tractor custom service is provided on share-cropping basis. In this case, the tractor owner provides not only the power for ploughing, threshing and winnowing but also the necessary variable inputs such as seeds, fertilizers and other agro-chemicals; and in return for the provided power and inputs the tractor owner is entitled to get a half of the harvest. Under such an agreement, the tractor owner shares not only the output but also the risk and uncertainty associated with it. In Hureegama, due to the observed uncertain water supply which results in high degree of risk and uncertainty involved in the returns on input, the tractor owners are reluctant to enter into this type of share-cropping agreements. For the same reason they hesitate to offer custom service on loan. Tractor owners expect farmers to settle their charges in advance or immediately after the operation, whereas the farmers who hire buffaloes are able to come to an agreement with the buffalo owners to settle their payments after the harvest. The later is convenient for farmers especially because they are in short of capital at the beginning of the season. It seems that some buffalo owners write-off their charges in the case of crop failure.

In addition, it has been observed that tractor hire rate in this area was much higher than the national average (table 10). Under this level of hire rate, even if hired buffaloes and hired buffalo operators were employed, the possible maximum average cost remains lower than the tractor hire rate.

Cost on buffaloes

Hire charge for a buffalo pair/day=Rs.[11] 25.00

Since 5 buffalo (pair) days are required per acre, the total cost on buffaloes is Rs. 25.00×5=Rs. 125.00

Cost on hired labour (buffalo operators)

Labour wage rate/day=Rs. 20.00

Since 5 labour days are required per acre, total cost on labour is Rs. 20.00 ×5=Rs. 100.00

Therefore, the total cost per acre

Cost on hired buffaloes	Rs. 125.00
Cost on hired labour	Rs. 100.00
Total cost per acre	Rs. 225.00

[11] 1 Rupee=approximately 9 ¥ in 1983.

Thus, the apperant cost difference between mechanical ploughing and animal ploughing obviously provides incentives for animal ploughing. In addition to the tractor hire charge, tractor ploughing also involves the additional use of man power around two man days to complete the operation by way of the repairing broken bunds and unploughed strips and corners near the bunds. Apart from this cost disadvantages, from farmers' point of view, mechanical ploughing has yield-decreasing effects. At this point, it is worthwhile to quote a well-known leading farmer in this area. "The tractor is much too heavy for the paddy field. Wherever it passes it breaks through the gley and water penetrates into the sub-soil. So if one uses tractor one requires very much water (in the growing period) and this especially today is unlikely to be available. Also it stirs up the soil. The light organic matter comes to the surface and is lost to the flood water. So its use leads to reduced fertility".[12] Thus farmers here strongly claim the superiority of the quality of land prepared by the buffalo in relation to that undertaken by the tractor. This view does not seem to be proved by any research evidence. Perhaps in situation where hired tractors are employed the farmers cannot exert much control over quality of work and chances of finishing with a low quality are greater. In the case of buffalo power the situation is different since the family members too generally participate in the ploughing operation, allowing the farmer to obtain the work to his level of satisfaction. Thus, the increase in tractor hire charges, the long waiting time for tractors and the poor quality of land preparation would all at first appear to generate compelling grounds for farmers to turn to animal traction if it were easily available.

CONCLUSION

Since the data on which this paper was based on were less amenable to quantitative analysis, the extent to which these observed socio-economic and physical factors affect the farmers decision making on the adoption of buffalo power for ploughing cannot be expressed in quantitative terms. Therefore the conclusion can only be briefly outlined as a untested hypothesis. The uncertainty involved in water supply, the relatively high buffalo work output, the flexibility in the implementation of water management regulations, the adequate availibility of buffalo power and the difficulties in obtaining tractor/power tiller custom services all together generate favourable circumstances for the continuous usage of buffalo power for ploughing.

At present, these favourable circumstances appear to be gradually vanishing with the coming up large scale irrigation projects and the restoration of small scale village tanks. All these bring the modernization which certainly disfavours this traditional source of farm power. But the rising energy bill and the shortage of foreign exchange may generate compelling grounds to rely on domestic power resources. This study suggests that the

[12] Quoted from Goldsmith and Tenakoon (1982).

provision of water for pre-softening solis and the improvement of buffalo power on a broader-based ownership with small of power units (specifically one or two buffalo pairs per household) would enable small farmers to depend on domestic less expensive buffalo power resources.

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