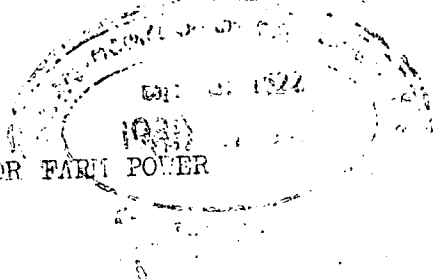


THE UTILISATION OF BUFFALOES FOR FARM POWER
IN SRI LANKA



by

Agrarian Research and Training Institute/
Reading University Study Team on Farm
Power and Water Use in Sri Lanka's Dry
Zone.

M. J. Ryan
F. Abeyratne
J. Farrington

Presented at the Workshop on

WATER BUFFALO RESEARCH IN SRI LANKA

24 - 28 November 1980, Peradeniya.

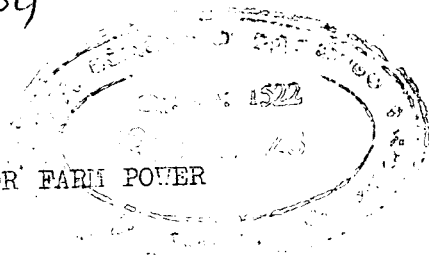
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SUMMARY

The traditional role of draught buffaloes in paddy cultivation has been eroded by tractor power in the last thirty years. Only about one third of ^{the} asweddumised acreage is currently ploughed by animals. With major land development programmes, the demands for draught power are increasing at a time when adverse terms of trade and balance of payments deficits make it difficult to support the present tractor-based strategy. It is against this background that the role of buffaloes in small scale farming is receiving renewed interest. This paper draws on data collected by ^{the} ongoing ARTI/Reading University Study on Farm Power and Water Use in the Dry Zone. Data were collected from a total sample of 447 farmers and power owners (including 91 buffalo owners) at three major colonisation schemes by twice-weekly visits over a 14 month period (August 1979 to October 1980). Preliminary analysis of part of the data has been completed and is examined in this paper.

A comparison of tractor and buffalo operating costs provides strong economic justification for the role of animal power. Attention is drawn also to the inadequacy of current statistical information on buffalo populations. Careful interpretation suggests only a slow decline since the mid - 1960s.

It is suggested that the role of buffaloes could be expanded even in the short/medium term by wider use of ploughs instead of trampling, and by transfer of adult and juvenile animals from areas of low (e.g. Hambantota) to areas of high use-intensity.

In the longer term, promotion of a stall feeding system such as that observed in parts of Polonnaruwa is essential. Even only with a diet of cut grass, the size and condition of animals is not inferior to that found under open grazing. The system has potential for intensification through higher quality feeds, and permits easy use of by-products. It also seems to reduce the incidence of disease and, by keeping average herd sizes small, reduces organisational problem in hiring out.

On the other hand, stall-feeding is a more costly system to the owner, and will only be spontaneously introduced where grazing land is unavailable. Policies to promote its adoption are essential. They include extension services, subsidised breeding, purchase and feeding schemes, the organisation of markets for working animals, and possibly the reduction of subsidies on tractor purchase and use.

2 BACKGROUND

From the earliest records of paddy cultivation in this country (approximately 500 B.C.) animal draught, usually in the form of water buffalo, has been used in land preparation. Only since the advent of imported tractors in the post-war period have significant reductions in the contribution of animal draught occurred. During this period tractor registrations have increased steadily: in 1960 some 3500 4-wheel tractors had been registered. By 1970 the figure exceeded 10000 and now approaches 20000, with the majority of registrations having appeared within the last two to three years. Similarly, over 12000 2-wheel tractors have been imported into the country since 1970. Along with this rising volume of tractor usage has been a corresponding growth in the proportion of land cultivated annually by mechanical means. Current estimates suggest that about 45% of paddy land in Sri Lanka is cultivated by tractor, with the balance falling to buffaloes and mamoty tillage (see Table 2 below). With major land development programmes such as the Mahaweli, the demands for draught power is increasing at a time when adverse terms of trade and deficits in the balance of trade make it difficult to support a tractor strategy on the scale hitherto pursued. The role of buffalo in small-scale farming is thus receiving renewed interest.

This paper will not dwell on the historical reasons which resulted in Sri Lanka possessing one of the most mechanised rural sectors in the developing world, a curious position given the island's per capita income, average size of farm holding, cultivation patterns, cropping systems and labour supply. The explanations for this particular choice of technology have been well documented elsewhere (for instance, see Burch 1979) - their origins lie largely in incorrectly perceived notions of shortages in farm power which were thought to be rectifiable only by tractor imports. Since the fifties policy makers have been easily persuaded by these arguments, and continue to be so today. However, cost considerations form the main reason for a fresh re-assessment of the role and usefulness of the national animal draught stock. This is evident from the data presented in Table 1 below.

Table 1 : Economic Costs¹ per Acre of Alternative Methods of Ploughing and Threshing

Power type	Land preparation (Rs.)	Threshing (Rs.)
Buffalo pair	162.88	80.74
2-wheel tractor	294.93	-
4-wheel tractor	318.34	234.20

Note : 1 At approximately calculated shadow prices.

Source: Farrington et al (1980a).

At the beginning of this year the economic cost to the national economy of ploughing an acre of land by buffalo was half the cost of the same operation performed by both types of tractor. The cost of threshing an acre of paddy by tractor is almost three times the buffalo cost. With recent increases in world market fuel prices these cost disparities can be expected to have worsened.

At real economic costs it has been estimated that the total fuel component of annual tractorised land preparation and threshing is in the order of Rs.200 millions, or approximately 5% of the 1979 fossil fuel import bill.

Thus, there exists an ample economic basis for broadening once more the scope of water buffalo in rural sector agriculture, allowing it to regain a proportion of the acreage currently ploughed by tractor. However, policies designed to achieve this switch need to proceed cautiously. Soil and agro-climatic parameters limit the area of substitutability between animals and tractors: for example, buffaloes are likely to show an advantage only where pre-wetting of the soil takes place and where tillage does not require a high horse power per power unit. Similarly, there is an opportunity cost, often unconsidered, in making stored tank water available for pre-wetting in terms of what the water could otherwise be producing (in a Yala season, for instance). Finally, and probably most importantly, policy encouraging buffalo use will be effective only if we can feel confident that farmers will be prepared to make the necessary effort after having become accustomed over two

decades to the ease of tractor tillage. In other words, if the farmer is to be expected to resume buffalo ploughing, policy has to be designed to make it worth his while.

3 BUFFALOES AND TRACTORS IN AGRICULTURE

The relative importance of animal power in land preparation (Table 2) varies according to the differing distribution of resources (viz. labour, animals and tractors) amongst the three major agro-climatic zones on the island. As the figures in Table 2 indicate, tractorised land preparation at almost 70% of the cultivated acreage is a distinctly Dry Zone phenomenon which reflects in addition to the rainfall, land holding size and labour density characteristics of this area a lower buffalo: paddy land ratio (Table 3) compared to the rest of the island. While the Dry Zone accounts for 62.1% of the total asweddumised acreage it supports only 52.4% of the national herd. The power shortfall for paddy production under the present usage pattern of buffaloes is partly redressed by the greater number of tractors available for cultivation in this zone. It is therefore logical that, if tractors were to be widely used in small farm systems, the Dry Zone would be the first place where they would gain a foothold.

The smaller land holdings and higher buffalo and labour densities per unit of paddy land in the Wet Zone accounts for the low use of tractors in tillage in preference to mamoty and animal power. The abundant grazing found in the coconut growing areas of the Intermediate Zone (particularly in Kurunegala District) explains to some extent the 63.3% of paddy land ploughed by animal power: this area has the highest buffalo density (157.9 pairs per thousand acres of asweddumised land) on the island. However, it must be noted that Farm Power Survey data record for higher buffalo densities at the colonisation scheme level, which indicates the extent of variation concealed by national and regional aggregated figures (see Table 6).

Table 2 : Percentage of Annual Paddy Acreage Ploughed by Power Source

Zone	Mamoty %	Animals %	Tractors %
Wet	47.8	41.8	10.4
Intermediate	6.8	63.3	29.9
Dry	<u>3.7</u>	<u>26.4</u>	<u>69.9</u>
Sri Lanka	<u><u>17.9</u></u>	<u><u>37.3</u></u>	<u><u>44.8</u></u>

Source : Department of Agriculture, Peradeniya. Calculated as an average over four seasons, i.e. Maha and Yala in 1977/78 and 1978/79.

Table 3 : Availability of Farm Power

Zone	Wet	Inter- mediate	Dry	Sri Lanka
1 Asweddumised acreage (1978/79)	377975	261399	1046226	1685600
% distri- bution	22.4	15.5	62.1	100
2 Effective no. of power units available for cultivation:				
Buffalo pairs	39020(23.1%)	41280(24.5%)	88440(52.4%)	168740
2-wheel tractors	1800(23.3%)	1080(13.9%)	4860(62.8%)	7740
4-wheel tractors	950(13.9%)	1330(19.4%)	4560(66.7%)	6840
3 Density of draught pairs per 1000 acres asweddumised land	103.2	157.9	84.5	100.1

Source : Farrington et al (1980b).

However, the figures in Table 2 must be interpreted with caution since individual farmers frequently employ a combination of all three power types for successive stages of land preparation, and precise acreage estimates may be both inaccurate and inappropriate as a means of assessing the significance of individual power types.

Much of the following discussion of the potential for animal draught refers to the Dry Zone. It is from three major irrigation schemes there that our data are drawn, and, to some extent, if animal power can re-assert itself under ^{the} difficult soil and water supply conditions typical of this zone, then an expansion of animal draught in the Wet Zone, where topography, holding size, income levels and population densities are all less favourable to tractor use, should be relatively easy.

4 THE BUFFALO POPULATION

Any policy designed to encourage buffalo usage for draught purposes is immediately beset with the problem of a confused statistical base. Figures in Sri Lanka vary widely both on the current size of the national buffalo population and on its rate of growth: either deficiency renders estimation of the current draught buffalo supplies dependent on often questionable assumptions.

The Department of Census and Statistics provides an annual estimate of the buffalo population which indicates a slowly expanding herd numbering 844000 in 1979. These annual figures have traditionally been regarded as inaccurate. A second source of information on the national herd is the Agricultural Census conducted in 1962 and 1973 (Table 4).

Table 4 : Buffalo Population Projections('000)

	<u>1962</u>	<u>1973</u>	<u>1974</u>	<u>1975</u>	<u>1976</u>	<u>1977</u>	<u>1978</u>	<u>1979</u>	<u>1980</u>
1	596	381							286
2	596	381	378	376	373	370	368	365	363
3	667	711	736	818	854	796	814	844	

- Source : 1) Census base (1973) at 4% p.a. decline derived from 1962 and 1973 Census figure.
 2) Census base (1973) with 0.7% p.a. decline derived from N.L.D.B. published projections.
 3) Annual survey figures.

Between 1962 and 1973 the buffalo population has declined at an average of 4% per annum, giving a current 1980 projection of 286000 head of buffalo based on this rate. A more optimistic rate of herd decline is 0.7% per annum used by the National Livestock Development Board (NLDB 1979) which results in a current estimated buffalo population of 363000. However, the D'S Annual Livestock Survey figure is greatly in excess of Census - based projections. The evidence from a number of recent studies suggests that there are grounds for doubting the Census data and accepting the Annual Survey estimates, however unreliable and inaccurate the figures themselves are. For instance, in a house-to-house census conducted recently by the NLDB in the Kuliyaipitiya electorate of Kurunegala District, buffalo population figures were found to correspond closely with Annual Survey figures when extrapolated to a District basis. Similarly, a survey conducted by the Department of Animal Production and Health at Peradeniya within a number of Agrarian Service Centre areas suggests that for some districts the Annual Survey estimate is a more reliable measure of actual livestock populations (pers. comm., E.M. Richards, FAO/Dept. Animal Production and Health).

Even at the most optimistic estimates of the current buffalo population, some substantial reduction since the peak of the mid-sixties is indisputable. Much of this is accounted for by the growing demand for beef, which is the cheapest of meats available to consumers. Buffalo off-take rates are difficult to calculate since the slaughter of buffaloes under a certain age is prohibited, forcing the activity to continue concealed.

While the number of buffalo hides processed by the Ceylon Leather Products Corporation in 1978 and 1979 was 2580 and 4000 respectively, it is felt that the actual rate of slaughter is in excess of 20000 head per annum (Burch, 1979). The shrinking area of available grazing land and the spread of tractorisation in the rural sector as a substitute for, rather than a supplement to, buffalo draught power, particularly in the Dry Zone where over half the total herd is located, has also been a contributing factor to the overall reduction in the buffalo population in the last decade and a half. However, until the quality of the statistical base is improved many planning decisions taken with respect to buffalo promotion and tillage requirements will suffer.

Table 5 provides information on the national distribution of land holding sizes in relation to average number of buffaloes owned per holding. There exists a direct positive relationship between the amount of land a farmer operates and the size of herd under his control: this is not unexpected since ownership of land and animals are both indicators of wealth. A farmer cultivating a greater acreage under paddy naturally has a greater power requirement for land preparation. A total of 68% buffalo raising holdings fall within the five acres and less category. In the Dry Zone colonisation schemes the typical land holding allotment is three acres of lowland and two acres of highland. Thus, the 1 to 5 acre category may be considered the modal class for the Dry Zone, characterised by an average herd size of 3.2 buffalo. The implication of this for power requirements in paddy cultivation will be discussed later. At this stage the figures prove interesting when compared to average buffalo herd sizes controlled by owners in four major irrigation schemes in the Dry Zone (Table 6).

Table 5 : Distribution of Buffalo Ownership by Size of Land Holding

Size of Land Holding(acres)	% of buffaloes	% of buffalo raising holdings	Ave. herd size per holding
No land	-	-	3.6
0 - 1	7	11	2.4
1 - 5	48	57	3.2
5 - 10	32	23	5.1
10 +	13	9	7.0
All sizes	100	100	3.8

Source : Dr. H.E. Perera (pers. comm.)

5 ANALYSIS OF FARM POWER SURVEY FINDINGS

5.1 BUFFALO DENSITY AND OWNERSHIP CHARACTERISTICS

The ARTI/Reading University Study Team is, amongst other things, closely scrutinising the relationships and degree of substitutability between a range of farm power technologies and water use regimes in the Dry Zone. We present below some preliminary results of research which are relevant to buffalo usage - these are drawn from field research conducted at four major irrigation schemes: Padaviya, Kaudulla, Minneriya and Uda Walawe. It is felt that there is sufficient variation in agricultural characteristics displayed by this group of schemes to permit relevant and applicable conclusions to be drawn for major colonisation in the Dry Zone.

Table 6 shows some interesting differences in buffalo densities per thousand acres of paddy land both between the four colonisation schemes, and between tracts within each scheme. Padaviya has the highest density of buffaloes, which is probably attributable to the continued availability of abundant grazing in surrounding jungle areas. Both Kaudulla and Minneriya have very much lower buffalo population densities, which partly reflects the limited availability of free range grazing land

Table 6 : Buffalo Densities and Ownership Concentration in Four Selected Colonisation Schemes.

Scheme	Total No. of buffaloes	Buffalo density per '000 acres paddy land	No. of adults per owner
1 PADAVIYA *			
Tracts: 1-5	1922	811.7	16.2
A-D	923	424.6	15.9
6-10	3410	782.2	17.7
E	1499	743.6	7.2
11-13	<u>475</u>	<u>345.7</u>	<u>12.8</u>
All tracts	8229	668.0	13.2
2 KAUDULLA **			
Stage I: Tracts 1-4	723	283.5	3.1
5-9	862	418.6	3.3
Tracts 1-6	654	226.6	2.5
7-12	<u>923</u>	<u>302.7</u>	<u>2.9</u>
Stage I and II	3162	299.9	2.9
3 MINNERIYA **			
Stage I	440	70.9	6.3
II	100	367.6	5.9
III	1129	407.9	3.8
IV	890	347.4	3.4
V	<u>764</u>	<u>224.4</u>	<u>4.7</u>
All stages	3323	218.9	4.2
4 UDA WALAVE *			
Tracts: 2-7	1218	345.1	58.0
Chandrikawewa	1008	219.5	42.0
9-11	1498	633.1	45.4
12-14	1773	384.8	28.6
15-19	<u>911</u>	<u>307.6</u>	<u>26.0</u>
All tracts	6408	364.2	36.6

* Allottees and non-allottees

** Allottees only

Source : Farrington et al (1980b)

in this well-established paddy growing area of Polonnaruwa District. What is significant in these two schemes is that it has been possible to sustain substantial buffalo numbers under a management system very different from that practised in most of the Dry Zone. Grass and forage is generally cut and brought to the animals tethered at the homestead, a system which is compatible with the large contiguous areas of paddy (approximately 60000 acres) found in this area, with grazing land available only at the peripheries. Contrasts between differing management systems for buffalo will be discussed later when the authors examine some of the implication of their recommendation for herd expansion. Uda Walawe, in the Southern part of the island, is an area which to a limited extent has on its boundaries forest areas suitable for supporting large herds of buffaloes at certain times of the year. Buffalo rearing is a long-practised traditional activity in this area, which partly explains the larger herd sizes found there, whereas at Padaviya the stock of domesticated buffaloes started to increase only since the commencement of colonisation in the late 1950's. It is interesting to note that at Uda Walawe, tillage techniques are limited frequently to rudimentary trampling of the flooded liyaddes by teams of buffaloes, a practice which is partly the result of soil conditions there.

Whilst variations in the density of tractors could be expected according to the distribution of income and wealth within irrigation schemes (and wealth is likely to be strongly influenced by water availability, so that distance from the scheme headworks might serve as a good proxy for wealth distribution), the same cannot be anticipated for buffaloes. This is partly because a reduction in their density might be expected in wealthy areas with the advent of tractors; partly also because they are a relatively less expensive form of power with a much longer history in small farming.

Our data confirm a declining density of tractors with increasing distance from the head works (Farrington et al, 1980b), but variations in buffalo density do not follow a clear pattern, with the exception of some decline at the tail end of Uda Walawe. (Table 6).

The striking differences in buffalo ownership concentration, between Uda Walawe/Padaviya on the one hand and Kaudulla/Minne iya on the other correspond with the differences in husbandry practices mentioned above. Where free range grazing land is available herd sizes tend to be larger (in some instances individual herds have been known to number several hundred), whereas with tethering and stall-feeding typical herds number some three or four adults. With the growing pressure on Dry Zone land by people and animals it is clear that any future solution to encouraging larger buffalo population lies in more intensive integrated cropping/husbandry systems. Such systems, already evident in the Polonnaruwa District, offer the advantages of spreading more evenly the distribution of buffalo wealth and improving potential use-efficiencies of draught animals as a result of more closely supervised smaller herds.

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5.2 ANALYSIS OF SAMPLE BUFFALO CHARACTERISTICS

5.2.1 AGE/SEX ANALYSIS

Analysis of the age/sex structure of the buffalo population is important for a number of reasons. Firstly in areas like Uda Walawe the sex is important since predominantly male buffaloes are used for field operations. The greater the number of males in the stock the greater is the draught potential of the herd. Also, the male/female sex ratio is important for growth of the stock. The age of the buffalo population is important since it determines the number of buffaloes available at a given point of time for work. The juvenile population (less than 2 years of age) provides an indicator of the growth rate of the stock and the future power availability in the area.

Examining the sex content of the overall adult stock (Table 7) shows that the male to female ratio of adults (more than 2 years old) is 1:1.06. The Uda Walawe sample conforms to this, but in Kaudulla the ratio is 1:0.6 and in Padaviya 1:1.3. In Kaudulla the picture is potentially serious since, given the fact that the herd size is small in this area, the growth of the buffalo stock could be very small and this could lead to greater dependence on tractor power. With the juvenile

stock (less than 2 years) the sex ratio for Padaviya is quite different (1:0.75). This raises concern that the growth of stock would be ^{more} on the decline than before, but since the land will become increasingly scarce in the future for open grazing, this could be a good sign if a more ^{even} distribution is possible. When the entire population (adult and juvenile) is analysed according to sex in Uda Walawe and Padaviya a balance (1:1.1) is maintained while at Kaudulla it is 1:0.69, giving cause for concern.

5.2.2 STOCK CHANGES

Analysing the change of stock is important for two reasons. Various estimates exist of the buffalo population and its growth rate which, as we noted above, are inconsistent. The information from 12 months of observation in our sample, whilst constituting a relatively small data base, is more accurate and warrants some analysis here.

Firstly, we consider changes in buffalo herds due to natural causes, viz. births and deaths over the one year period.

Apart from slaughter, the remaining reason for stock changes (i.e. purchases, sales, gifts, and theft), although they have affected our sample sizes, do not influence the size of the national herd.

Table 8 illustrates the **inverse** relationship between the size of **herd** in a given area and the change resulting from natural causes. For example, in Uda Walawe, where the sample population is highest (811), there is a net reduction in the stock by 8.75% over the survey period, whereas in Kaudulla, characterised by a wide distribution of small herds, there has been a net increase of 12.2%.

At Padaviya, with an intermediate stock size, an increase of 3.5% has been achieved. Over the three samples combined there has been an overall reduction in buffalo numbers of 2.1%, which is half of the rate of decline calculated from the DCS Census

SUMMARY

The traditional role of draught buffaloes in paddy cultivation has been eroded by tractor power in the last thirty years. Only about one third of ^{the} asweddumised acreage is currently ploughed by animals. With major land development programmes, the demands for draught power are increasing at a time when adverse terms of trade and balance of payments deficits make it difficult to support the present tractor-based strategy. It is against this background that the role of buffaloes in small scale farming is receiving renewed interest. This paper draws on data collected by ^{the} ongoing ARTI/Reading University Study on Farm Power and Water Use in the Dry Zone. Data were collected from a total sample of 447 farmers and power owners (including 91 buffalo owners) at three major colonisation schemes by twice-weekly visits over a 14 month period (August 1979 to October 1980). Preliminary analysis of part of the data has been completed and is examined in this paper.

A comparison of tractor and buffalo operating costs provides strong economic justification for the role of animal power. Attention is drawn also to the inadequacy of current statistical information on buffalo populations. Careful interpretation suggests only a slow decline since the mid - 1960s.

It is suggested that the role of buffaloes could be expanded even in the short/medium term by wider use of ploughs instead of trampling, and by transfer of adult and juvenile animals from areas of low (e.g. Hambantota) to areas of high use-intensity.

In the longer term, promotion of a stall feeding system such as that observed in parts of Polonnaruwa is essential. Even only with a diet of cut grass, the size and condition of animals is not inferior to that found under open grazing. The system has potential for intensification through higher quality feeds, and permits easy use of by-products. It also seems to reduce the incidence of disease and, by keeping average herd sizes small, reduces organisational problem in hiring out.

On the other hand, stall-feeding is a more costly system to the owner, and will only be spontaneously introduced where grazing land is unavailable. Policies to promote its adoption are essential. They include extension services, subsidised breeding, purchase and feeding schemes, the organisation of markets for working animals, and possibly the reduction of subsidies on tractor purchase and use.

figures. It is of interest to relate the stock changes to herd size and management practices. At Kaudulla, with smaller average herd sizes per family household, the mortality rate is recorded as only 1 out of every 25, or 4% p.a. This low rate is probably attributable to the stall feeding management system practised there. However, at Uda Walawe the picture is quite different, with a juvenile mortality rate of 81.5% recorded (62 deaths from 76 births). To some extent this may be a reflection of the management system under which buffalo herds are removed in the dry season to distant areas in search of grazing land. Under these circumstances the animals become more prone to neglect and disease, and veterinary facilities are hard to come by. We have also noted instances where herdsmen in charge of stock report deaths of animals to the owner who, due to factors of distance and large size of herd, is poorly placed to verify whether the animal has in fact died or been sold for slaughter. Thus, the high adult mortality rate recorded for the Uda Walawe sample (57% of the total number of deaths) might be an over-estimate.

Padaviya too has a fairly high juvenile mortality rate of 38% of births, which is probably due to the same reasons as mentioned above for Uda Walawe, despite the smaller herd sizes.

Unique to Padaviya are sporadic livestock sales for slaughter, due mainly to cash difficulties faced by farmers who lack other employment opportunities and who were unable to cultivate during the Yala 1980 season for want of irrigation water.

A number of other reasons for stock changes are worth mentioning for particular areas, though these are not ^{always} related to management systems. At Uda Walawe a substantial proportion of buffaloes (27.6% of total stock addition) were received as gifts. The main reason for this is the rudimentary "Gambaraya" system that prevails in this area, i.e. those who owned large herds were regarded as community leaders, and would often make livestock gifts to their children as dowries and so on. At Uda Walawe, also, there is a remarkably high rate of stock theft recorded in our sample amounting to 47.6% of total outgoing stock. This may be a reflection of the management system practised.

At Kaudulla 20% of total stock additions were attributable to purchases, and 44% of outgo was the sales of buffaloes as working animals. This perhaps reflects a keen commercial awareness of the value of buffaloes in this paddy - surplus area.

5(2) IMPLEMENT OWNERSHIP

Implement ownership is closely related to a number of variables, viz. number of working animals, different managerial aspects, sex of the animal and different field operations performed. In Uda Walawe, as mentioned earlier, ploughing of fields is rarely done, therefore the number of implements recorded was very low. Also females are hardly used for farming operations. With a sex ratio of 1:1.06 the number of available animals for field work is almost half of the total i.e. 50. Yet, an average of only 1 plough per 40 buffaloes was recorded, and all the ploughs (21) were owned by only 4 owners. In Kaudulla the availability is quite different, with both seasons being cultivated by ploughing of fields and almost all the farmers owning small stocks of buffaloes. The availability of implements was high, for example, almost 2 ploughs for each adult buffalo and each farmer. There were also 1.5 levelling boards for each buffalo and farmer. In Padaviya, with fairly large herds, the picture is very similar to Uda Walawe. One difference is that here even the female animals are used for field operations, thus there was a plough for 7 buffaloes; each buffalo owner had 2 ploughs and 1.5 levelling boards on average. One striking point is that there is no dearth of implements except in Padaviya where there is only one plough for 3 pairs of buffaloes, and arguably at Uda Walawe, where a different land preparation system is used.

Table 7 : Comparing stock at the end of season and at the beginning of the season (August 1979 to October 1980)

Location - 1 :UDA WALAVE

Type of buffalo	Total in	Total out	Net loss or gain	Beginning stock Aug.'79	Final stock Oct.'80
Male over 2 yrs.	12	114	-102	275	173
Female over 2 yrs.	06	46	- 40	291	251
Male under 2 yrs	50	40	+ 10	95	105
Female under 2 yrs.	37	22	+ 15	110	125
Senile/sick/ injured	<u>00</u>	<u>01</u>	<u>- 01</u>	<u>40</u>	<u>39</u>
	105	223	-118	811	693

Location - 2 :KAUDULLA

Type of buffalo	Total in	Total out	Net loss or gain	Beginning stock	Final stock
Male over 2 yrs.	03	02	+ 01	95	96
Female over 2 yrs.	01	07	- 06	65	59
Male under 2 yrs.	14	00	+ 14	19	33
Female under 2 yrs.	11	00	+ 11	13	24
Senile/sick/ injured	<u>01</u>	<u>01</u>	<u>00</u>	<u>04</u>	<u>04</u>
	30	10	+ 20	196	216

Location - 3 :PADAVIYA

Type of buffalo	Total in	Total out	Net loss or gain	Beginning stock	Final Stock
Male over 2 yrs.	03	46	- 43	139	96
Female over 2 yrs.	09	26	- 17	183	166
Male under 2 yrs.	64	25	+ 39	55	94
Female under 2 yrs.	49	23	+ 26	41	67
Senile/sick/injured	<u>00</u>	<u>03</u>	<u>- 03</u>	<u>29</u>	<u>26</u>
	125	123	+ 02	447	449

Source : ARTI/Reading University Farm Power Study

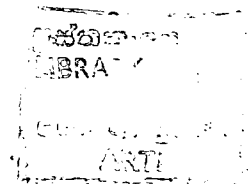


Table 8 : Reasons for the Changes in the Buffalo Herds

Location 1 - UDA WALAVE

Reason	Adult		Juve-		Sen-	Total	% of total	
	M	F	nile M	nile F	ile		In coming	Out going
Birth	00	00	43	33	00	76	72.4	-
Purchase	00	00	00	00	00	00	0.0	-
Received as a gift	12	06	07	04	00	29	27.6	-
Died	51	33	40	22	01	147	-	65.9
Sold as a working animal	03	03	00	00	00	6	-	2.6
Sold for slaughter.....	00	00	00	00	00	00	-	0.0
Given away....	00	00	00	00	00	00	-	0.0
Stolen	60	10	00	00	00	70	-	31.5

Location 2 - KAUDULLA

Reason	Adult		Juve-		Sen-	Total	% of total	
	M	F	nile M	nile F	ile		In coming	Out going
Birth	00	00	14	10	01	25	83.4	-
Purchase	03	01	00	01	00	04	16.6	-
Received as a gift	00	00	00	00	00	00	0.0	-
Died	00	01	00	00	01	02	-	-
Sold as a working animal	00	04	00	00	00	04	-	50.0
Sold for slaughter.....	00	00	00	00	00	00	-	0.0
Given away....	00	00	00	00	00	00	-	0.0
Stolen	02	02	00	00	00	04	-	50.0

Location 3 - PADAVIYA

Reason	Adult		Juve-		Sen-	Total	% of total	
	M	F	nile M	nile F	ile		In coming	Out going
Birth	00	00	64	49	00	113	90.4	-
Purchase	01	04	00	00	00	05	4.0	-
Received as a gift.....	02	05	00	00	00	07	5.6	-
Died	26	20	20	23	03	92	-	74.8
Sold as a working animal	13	02	01	00	00	16	-	13.0
Sold for slaughter.....	01	04	00	00	00	05	-	4.0
Given away....	00	00	00	00	00	00	-	0.0
Stolen	06	00	04	00	00	10	-	8.2

Table 9 : Implement Ownership

Location	No. of ploughs	No. of leveling boards	No. of adult buffaloes	No. of farmers who own implements	
				Ploughs	Leveling Boards
1 Uda Walawe	21	01	426	04	01
2 Kaudulla	771	48	34	32	03
3 Padaviya	36	14	256	17	09

Source : ARTI/Reading University Farm Power Study

5.04 INTER-LOCATIONAL COMPARISONS OF PHYSIOLOGICAL CHARACTERISTICS

As far as draught purposes are concerned, the weight and condition of animals are of prime importance. The study team, comprising mainly economists, were not qualified to make anything more than casual observations on the animals' condition. However, it was thought worthwhile to make more systematic observations of their size, particularly since differences between the management systems at Kaudulla, on the one hand and Padaviya and Uda Walawe on the other, might be significant in terms of size.

Girth measurements were therefore taken for a sub-sample of adult male buffaloes at each location. The mean girths and numbers of observations were as follows: Uda Walawe - 68.52 inches (n = 130); Padaviya - 66.94 inches (n = 176); Kaudulla - 69.18 inches (n = 88).

Although the average buffalo at Kaudulla appears to be slightly larger, the difference is small and is unlikely to reflect any impact of management systems on size of animal. Significance tests suggested that the Kaudulla figure is not significantly different from that at Uda Walawe at the 5% level. On the other hand, the differences between Kaudulla and Padaviya, Padaviya and Uda Walawe are significant at the 5% level.

These significance tests notwithstanding, perhaps the only safe conclusion is that stallfeeding certainly does not produce animals of inferior size compared with open grazing. We would argue that it has the potential (given better quality feeds) to produce much larger animals. Whether this potential can be exploited remains to be seen.

BUFFALO OWNERS' EXPENDITURE ON LABOUR AND EQUIPMENT

The data presented in Table 10 below record the average annual costs incurred by buffalo owners in paying wages to herders and drivers and purchasing and maintaining equipment, feed and medicines for their animals. The figures are preliminary and therefore require cautious interpretation: they conceal, for instance, the frequently seasonal nature of expenditure and the important uncosted role of family labour in herd management. Furthermore, herding and payment practices vary significantly between study locations. At Kaudulla the large number of small herds are often pooled under the care of a single herder during the off-peak months when land preparation and threshing are completed, and for this a monthly payment per animal is made by the owner; at Uda Walawe and Padaviya the larger herd owners are able to employ full-time herders (adults or children) to take care of the herds in the "villus".

Despite the level of data aggregation in Table 10 the figures do provide some indication of the costs of maintaining buffaloes for the average owner at each location, as well as the income derived from the sale of curd and milk (although only Uda Walawe owners appear to exploit this extra form of earnings to any significant extent).

There is a distinct variation in the amounts spent on labour wages per animal between each location which seems to be related to both herd size and to management system. Thus, Kaudulla owners, possessing an average of five animals each in the survey sample, spend Rs.356.10 on labour costs per animal,

while the larger herd owners at Uda Walawe (32.7 animals per owner) incur only Rs.94.25 per animal. Padaviya owners occupy the intermediate position. The data suggest that significant economies of scale are enjoyed by larger herd owners with regard to labour costs. The management system at Uda Walawe is also less labour intensive, and therefore less costly.

Average expenditure on equipment and repairs, etc. display a similar inverse relationship to average herd size, suggesting that the economics of management systems are not merely confined to labour costs. Total annual average costs incurred by owners on a per herd basis are (obviously) determined by herd size. Thus, Kaudulla owners have the lowest costs per annum and Uda Walawe owners the highest, with Padaviya again falling in between. Only when income data deriving from buffalo usage are analysed in detail can any estimates of net profitability of buffalo ownership be made and implications for buffalo promotion be examined.

It is interesting to note that at Uda Walawe many buffaloes are maintained for milk and curd production: in fact, the income derived from sales of these products comfortably exceeds labour and equipment costs per animal.

5.3 AGE PATTERNS OF BUFFALO OWNERS

We can, to some extent, attempt a reply to a query raised in the introduction concerning the willingness of farmers to respond positively to any moves directed towards encouraging buffalo use in farming... Critics may argue that the old traditional means of animal - powered land preparation has little appeal to modern farming men today. If the young are committed to tractors then the prospects may not be as optimistic as considerations of cost and high quality of tillage would suggest. We have examined the issue of the age structure of both buffalo owners and buffalo hirers in order to detect whether any patterns emerge.

Table 10 : Annual Average Buffalo Expenditure on Labour and Equipment (juveniles and adults)

	Padaviya (N=27)	Kaudulla (N=41)	Uda Walawe (N=23)
1 Average No. of buffalo per sample owner	16.6	5.0	32.7
2 Average herders' and drivers' wages (Rs./animal) [†]	Rs. 157.95	Rs. 356.10	Rs. 94.25
3 Equipment, repairs, medicine and feed (Rs./an.)	Rs. 35.73	Rs. 54.69	Rs. 23.53
Total 2 + 3	Rs. 193.68	Rs. 419.79	Rs. 117.78
4 Total average herd expenditure per owner p.a.	Rs. 3215.09	Rs. 2053.95	Rs. 3851.41
5 Income from curd and milk sales (per animal)	Rs. 28.20 ²	Rs. 87.17 ²	Rs. 158.77

Note : 1 Includes payments in kind, such as food and lodging
 2 Less than five owners reporting

Source : ARTI/Reading University Farm Power Survey

Using a criterion of 40 years of age to distinguish between young and old farmers, it emerged from our survey that at all locations a higher percentage of buffalo owners were 40 or over than were tractor owners. Thus, while buffalo owners do tend to appear to be predominantly older men than tractor owners, the difference is small and may prove to be statistically insignificant.

An analysis of buffalo and tractor users indicated no clear age bias. However, since the use of more than one power type in land preparation is common it is impossible to satisfactorily classify farmers as using exclusively one or another power type. When both owners and hirers of power were considered together the trend of a relatively high age structure for buffalo users recurred (Table 11), but even more weakly than for owners alone.

Table 11 : Percentage and Numbers of Power Users and Owners Over 40 years by Power Type and Location (Land Preparation)

	Buffalo		4-w.t.		2-w.t.	
	%	(No.)	%	(No.)	%	(No.)
Padaviya	80	(72)	75	(58)	57	(13)
Kaudulla	75	(76)	53	(9)	68	(17)
Uda Walawe	81	(46)	50	(3)	79	(26)

Source : ARTI/Reading University Farm Power Study.

We conclude that the evidence that the ownership and use of buffaloes is more widespread amongst older farmers than younger farmers is weak and inconclusive. As far as policies to promote animal draught are concerned it seems unlikely that the observed age profiles of owners indicate irreversible increases in preferences among young farmers for the ownership of tractors.

PATTERNS OF DR. UCHH BUFFALO

Crucial to any policy of encouraging buffalo use in agriculture is the question to what extent are animals already used in farming? Is it a residual activity encountered among only a small proportion of farmers, or does it remain widespread?

The data presented in Table 12 suggest that buffaloes are commonly used for at least part of land preparation sequence than any other power type, whilst in threshing it is overshadowed by the 4-wheel tractor.

Table 12 : Percentage of Farmers Using Individual Power Types By Location and Operation.

	Kaudulla (N=145)		Padaviya (N=144)		Uda Walawa (N=145)	
	%	(No.)	%	(No.)	%	(No.)
(a) <u>Land preparation</u>						
Buffalo	70	(102)	63	(90)	39	(57)
4 w.t.	12	(17)	53	(77)	5	(6)
2 w.t.	17	(25)	16	(23)	23	(33)
(b) <u>Threshing</u>						
Buffalo	17	(25)	15	(21)	0	(0)
4 w.t.	49	(71)	54	(78)	63	(92)
2 w.t.	0	(0)	0	(0)	0	(0)

N.B. A certain number of farmers practised hand cultivation.
Source : ARTI/Reading University Farm Power Study.

The use of buffaloes for at least part of land preparation remains very widespread. This is probably explained by farmers' apparent preference for buffaloes in finishing off and levelling, frequently after an initial rough tilling by tractor. It is particularly noticeable that many more farmers were able to use buffaloes at Kaudulla (70%) than elsewhere in spite of a lower overall buffalo density (Table 6). This may be accounted for by the observed widespread ownership of small numbers of animals per owner.

In conclusion, the figures are encouraging. Any programme designed to increase the proportion of land preparation performed by animals would not be faced by insurmountably strong preferences for the ownership and use of tractors.

We consider next the information gathered in our survey concerning the intensity with which draught buffaloes are utilised amongst our sample owners.

The data on average number of hours worked by buffaloes per week presented in Table 13 below are drawn from research observations of buffalo use-patterns covering the first twenty weeks of the Farm Power Survey: included in this is the entire Maha 1979-80 land preparation season at all locations, and thus includes the busiest period in the agricultural calendar. The data are presented by spatial location within schemes in order to reflect the effects of water availability on use-patterns. The attempt was also made to determine whether the owner's main occupation (whether farming or some other business) influenced use-levels.

6.1. HOURS WORKED BY STUDY LOCATION

The overwhelming impression of the figures presented in Table 13 is one of very low use-intensity of buffaloes. While the figures vary markedly within schemes the total number of hours worked is remarkably consistent amongst the three study locations, averaging between 6½ and 7 hours per pair per week. These figures include work performed at the busiest time of the year (i.e. Maha land preparation) and thus the average over a 12-month period would be much lower. The peak period average was found to be 17-22 hours per pair per week, though this was seldom sustained over a protracted period of time. Even if one were to assume that the land preparation season numbered ten weeks, during which time all the work recorded in Table 13 was performed, the resultant average of roughly 14 hours per pair per week at the peak land preparation season can still be considered far below the optimum potential of draught buffalo capacity, which might lie in the region of about 20 hours per week.

6.2. HOURS WORKED BY SPATIAL DISTRIBUTION OF OWNERSHIP

Of all the study locations, Uda Walawe owners record simultaneously both the highest and the lowest extremes of buffalo use-intensity at the top and bottom ends of the scheme

(10.7 and 4.04 hours respectively). The variation in hours worked is fairly strongly related to differences in water availability between upper and lower tracts. Padaviya displays the opposite relationship between the number of hours worked and distance from the tank headworks, making any general statement about buffalo use impossible. The low concentration of tractors at the bottom end of Padaviya might explain the higher use-intensity of buffaloes there, given the seasonal demand for tillage power requirements.

Differences in access to irrigation water are low at Kaudulla for reasons already mentioned and this tends to correspond with the lack of variation in work rates recorded at top and bottom tracts there.

6.3. HOURS WORKED BY CATEGORY OF OWNER

Owners who derive a major part of their income from business activities record higher use-intensities for their buffaloes at Kaudulla and Uda Walawe, achieving a maximum of 14.42 hours per week at the latter scheme. This difference corresponds with a general notion that owners who are business - oriented have greater incentives and opportunities to employ their income-generating assets productively. The absence of business-men owners at Padaviya is probably a reflection of the relatively underdeveloped commercial non-farm sector there.

6.4. HOURS WORKED FOR "SELF" AND ON "LOAN/HIRE"

Data on the division of work between owners' own personal farming requirements and contract work are presented in Tables 13 and 14. No consistent pattern emerges for all three locations. While contract work at Uda Walawe absorbs nearly all of buffalo working time for both owner categories, the reverse is true at Kaudulla. This may be partly explained by the large herds found at the former location in contrast with the smaller herds found at Kaudulla (resulting in a high proportion of "self" work). At Padaviya, farmers hire or loan out their animals for 43% of the recorded working time. From the data displayed

Table 13 : Average Weekly Number of Hours Worked by Buffalo Pairs*

	<u>Location in Scheme</u>			<u>Owner category</u>		
	Top	Botton	All	Business-men	Farm-ers	
1	PADAVIYA			(N=0)	(N=174)	
	Self	3.43	4.84	3.75	0	3.75
	Loan/hire	2.14	5.16	2.83	0	2.83
	Total	5.57	10.00	6.58	0	6.58
2	KAUDULLA			(N=13.5)	(N=75.5)	
	Self	6.57	6.54	6.55	6.65	6.52
	Loan/hire	0.68	0.24	0.37	0.87	0.25
	Total	5.75	6.78	6.92	7.52	6.77
3	UDA WALAME			(N=20.5)	(N=230.5)	
	Self	0.64	0.04	0.31	0.55	0.33
	Loan/hire	9.43	4.00	6.49	13.87	5.83
	Total	10.07	4.04	6.80	14.42	6.16

* Based on a 20 week period from 26/8/79 to 19/1/80 covering the Maha season
N refers to the number of buffalo pairs

Source : ARTI/Reading University Farm Power Study

Table 14 : Percentage of Use-hours per Buffalo Pair spent on contract work by owner type

	<u>Owner category</u>	
	Business %	Farmers %
Padaviya	0	43
Kaudulla	12	4
Uda Walawe	96	95

Source .: ARTI/Reading University Farm Power Study

in Tables 6, 13, ¹⁴ it may be deduced that the extent to which a team of draught buffaloes perform contract work is dependent on the size of the herd, i.e. the larger the herd size owned the greater the likelihood animals will be made available on the power hire market.

However, any future policy decisions on the size of the national buffalo population in relation to power requirements for seasonal land preparation will have to take cognisance of the fact that buffaloes in Sri Lanka are being utilized at extremely low intensities. (It may be of interest to note that the level of use-efficiency for tractors is little better).

7. ESTIMATING FUTURE DRAUGHT BUFFALO REQUIREMENTS

Having argued the need to encourage a greater buffalo population to meet annually rising land preparation requirements we discuss here some of the problems encountered in planning exercises designed to estimate the numbers of draught animals that will be needed for tillage purposes. Although this type of farm power planning is essential, its effectiveness is highly sensitive to a number of crucial assumptions (for a critique of draught power planning methodologies see Farrington et al, 1980c) on which often vast amounts of aid/loan funds are based. Hitherto, farm power shortages have been claimed on the basis of observed delayed and staggered land preparation, or on the basis of estimating total tractor and buffalo stocks, deducting estimates for break-downs and non-agricultural work, and thus arriving at the number available for farm work. The use of selected performance rates then permits the potential work output of this stock to be compared with the cultivated acreage: the potential to plough more than the available acreage indicates a surplus of farm power, and vice versa. The lack of precision in buffalo population data has already been discussed in an earlier section. Assumptions about buffalo field performance rates are dependent on the type of implement used (if any) and its condition, soil condition, water use, and size and condition of the buffalo. Experimental rates are generally higher than those achieved on farmers' fields, since most of these factors are more favourable under experimental conditions.

land preparation season are Assumptions concerning the length of the/difficult to quantify, yet the estimation of the tillage capacity of a given herd over time is extremely sensitive to this factor. It is dependent on soil, water and weed conditions, the farmers' access to credit and inputs, and on the structure and efficiency of the power hire market.

We mention briefly here the assumption used by the recent FAO Report on Farm Power Availability (1980) in order to illustrate the shortcomings of this type of planning methodology and consider its relevance to draught buffalo in particular.

Table 15 : Buffalo Tillage Capabilities

Total number of buffalo pairs available for cultivation	73,000
Length of ploughing season (days)	32
Performance rates (acres/day) (full land preparation)	0.154
Calculated acreage capacity	360,000
Actual aswedumised acreage	1,685,600
Acreage capacity of tractor population and mammoties	837,144
Estimated farm power deficit (acres)	<u>488,456</u>

Source : FAO Farm Power Availability Study.

We present our own estimates of the national buffalo population in Table 6 along with the reasons for accepting them. On the basis that the number of draught buffalo pairs should be 168,740 rather than 73,000 and accepting for the moment the FAO assumption on length of ploughing season and performance rates, the tillage capability of the national herd increases by 471,551 acres, sufficient to almost fill the farm power "gap" on an aggregate national basis, but with possible regional imbalances.

It is felt also that the assumed buffalo performance rate of 0.154 acres/day is an under-estimate, though is probably more appropriate to the trampling or mudding systems of tillage practised in the Wet and Intermediate Zones. A more realistic estimate for their use with ploughs, as is common in the Dry Zone, might be the 0.3 acres/day suggested by Parker

(1978). This would add another 340,888 acres to buffalo tillage capability. With these two revisions alone a claimed farm power deficit of 488,456 equivalent acres is transformed into an apparent surplus equivalent to 1,259,904 acres: a 29% farm power deficit at one extreme is, at a stroke, changed to a 46% surplus.

Cultivated acreages are planned to expand rapidly in the next few years: an anticipated 500,000 acres of irrigated land under the Mahaweli Scheme alone will be added to the existing 1,685,600 acres of asweddumised land. If we postulate a stable or declining share of ploughing^{to} be done by tractors, buffalo populations and use-intensities will, within the next 5-10 years, have to expand at a rate sufficient to plough a higher proportion of the anticipated 2.1 million acres than the present 37.3%.

The policies and problems contingent upon such an intensification are discussed below.

8. CONCLUSIONS AND RECOMMENDATIONS

1. When the observed market prices of tillage by animal and by tractor power are converted into shadow prices to give an estimate of the real costs to the national economy (as has been done in Table 1) there seems to be an overwhelming case for expanding the proportion of paddy land tilled by buffalo and for reducing investment in tractors. To plough an acre of land by draught animals is only half as expensive to the national economy as tractorised ploughing.

Yet, to present a complete picture of the potential costs and benefits to the national economy of the alternative systems requires a more comprehensive analysis: Animal draught (buffalo power in particular) is not practicable in hard soil conditions. The area of potential substitution between buffalo and tractors is therefore limited to areas where the soil can be softened by rainfall prior to ploughing (as in the Wet Zone) or by a combination of rain and irrigation water (Dry Zone). For the Dry Zone, however, it has been claimed that continued reliance on animal draught would cause high ^{consumption} and low productivity by use of stored water, and loss of the potential productivity of early rains. Given sufficiently large animal population, there seems no reason why inter-farm staggering of cultivation should be more severe than with tractors. On the other hand, the fact that animal tillage relies on pre-wetting will make animal draught system overall, later to start than tractor power (potentially at least) could start.

This is a complex issue which can only be touched upon here (but for a fuller discussion see Ranatunga et al, forthcoming). The central issue, though, is whether the potential that tractors have for dry tilling can be realised in practice, and how high the associated costs of additional weed control, poorer levelling and reduced yields might be. Experiments along these lines at the 5 Marks have so far not been encouraging

the necessary mechanical technologies for efficient weed control being costly to purchase and maintain and requiring a high degree of skill in use and maintenance.

Additional arguments, impinging on welfare and political issues ^{in the} "animal versus tractor" debate, need to be considered: what is the impact on employment and the distribution of income and wealth of tractor vis-a-vis animal systems? Recent evidence from the Farm Power Study is still being processed, but preliminary results place the advantage with animal draught. At a much broader level: what are the implications for national morale and food self-sufficiency of tractor and animal systems? Does the Administration feel that it is worth relying on imported technologies primarily to achieve quick returns, but also because the organisational capacity, initiative and will for self-sufficiency simply no longer exist in adequate quantities to enable animal draught to work on the necessary scale ("no longer exist" because they clearly did exist in earlier Dry Zone civilisations)?

These issues must remain outside the scope of the present discussions: some encroach on the broader areas of political and economic development philosophy and defy empirical analysis; for others, quantitative data are still being assembled under the Farm Power Study. Preliminary indications, though, suggest that an active reconsideration of animals draught is long overdue, and we suggest below some issues and policies which require attention.

2. In the short term higher use - levels can be obtained from the existing buffalo population in the following ways:

- by transfer of animals from areas of low use - intensity to areas of high demand
- by improved feedstuffs for stall-fed animals
- by purchasing, feeding and veterinary care schemes for juveniles
- by more widespread use of steel-tipped ploughs.

Policies necessary to achieve these objectives hardly need elaboration, though it should be stressed that the current division of Ministerial responsibility between crop production and animal husbandry cannot be conducive to the development of integrated livestock/crop production systems.

3. In the medium term, it is clear that the only future for animal draught lies in systems relying predominantly on stall-feeding. Much can be done to establish these in the design of new settlement schemes or in the rehabilitation of old ones (and it is worth noting that a switch back to animals on a large scale is particularly difficult to achieve where experience with tractors has been widespread). The focus of new stall-feeding efforts might therefore best be directed towards new settlement areas under the Mahaweli and other projects.

Current stall-feeding systems at Kaudulla rely on cut - grass feeding, and achieve use - levels per animal and animal sizes comparable with open grazing. The introduction of improved feeds would increase both the power output per animal and the length of time over which heavy work can be sustained. The potential for growing improved feed crops clearly exists on highland allotments, most of which are grossly underutilised. Similarly, we have observed in Polonnaruwa that potentially valuable rice bran is frequently sold for as little as Rs. 5/hundred weight or put to low productivity use as a fuel in parboiling.

Additionally, with stall-feeding the potential for use of by-products such as manure and milk is raised. Veterinary services are more easily administered, the risk of disease appears to be reduced, and productive assets (in the form of draught animals) are more evenly spread among the community. Organizational problems in hiring out small numbers of animals are fewer than with the large herds found under open grazing, and so the potential for raising overall use - levels is higher under small-herd stall-feeding systems.

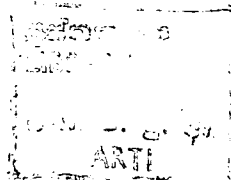
- .4. For the longer term, but requiring an early start, are policies designed to upgrade the genetic potential of the stock, and to raise overall populations. The selection of target characteristics in breeding programmes lies outside our field, but it is worth stressing that the introduction of larger animals will only succeed if adequate feeding systems can first be developed. The feeding issue must therefore be a prime focus of attention.

5. Finally, we must stress that buffalo development strategies should not be formulated in isolation from the potential offered by other types of animal draught. Bullocks, for example, are a dual-purpose draught animal (transport and ploughing) and can achieve higher work output over longer periods than buffalo. They also require more careful husbandry and feeding. Whilst their potential has been widely exploited in the Jaffna area, their agricultural use in other parts of the country is not common. Would the potential for wider use either alongside or instead of buffalo development merit consideration? Or are the barriers (possibly cultural in origin) to such a strategy too great? We feel that they should at least be considered as an option before buffalo development strategies are defined.

In conclusion, tractors have gained ground through a wide network of subsidies, many of which still exist. A successful re-assertion of animal draught will depend to a large degree on a widening of the gap between current market costs of ploughing under the two systems. Our evidence suggests that animal hire charges tend to follow the upward trend in tractor hire prices, and so escalating fuel costs alone are unlikely to widen this gap for the farmer who has to hire in either power type. The widening cost advantage would seem to lie primarily with those who own animals, and this suggests that the thrust of policy should be towards more widespread ownership.

A greater cost advantage for the hirer of animal power may emerge from the reduction of subsidies on diesel and from their introduction into animal purchase and feeding.

Whatever the buffalo development strategy eventually adopted, some shift in the present tractor bias of subsidies will be essential.



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