USE OF BUFFALOES AS TRACTION ANIMALS

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INTRODUCTION

The domestic animals which have more affinity with man are the horse, the hound and the buffalo (*Bubalus bubalis*) (1).

The water buffalo is the classic work animal of Asia, an integral part of that continent's traditional village farming structure. The temperament and resistence to hot weather, disease, insects and parasites, plus the ability of the animal digestive systems to convert the poorest feed consisting of dry grass, weeds and rice straw into sufficient nourishment to maintain itself, makes the buffalo most suitable to those conditions. Probably the most adaptable and versatile of all work animals, it is widely used to plow; level land; plant crops; puddle rice fields; cultivate field crops; pump water; haul carts, logs, sleds and shallow-draft boats; carry people; press sugar cane; and much more. Even today, water buffaloes provide 20-30% of the farm power in South China, Thailand, Indonesia, Malaysia, Philippines and Indochina. In India, water buffaloes contribute much less to farm power, 6-12%; in Pakistan, 1-2% (2); in Brazil, there is too little information about its use as a traction animal. It is of common knowledge it's tradictional use in the Amazon region as a saddle animal and as a mean of transporting loads in wagons and canoes and to pull wood logs, but in a empiric and still not reckoned way. Only a few cases are known in other areas.

For many small farmers the buffalo represents capital. It is often the major investment they have. Buffalo energy increases their productivity and allows them to diversity. Even small farmers have work animals that, like the farmer himself, subsist off the farm. Tractors usually require at least four hectares for economical operation, which precludes their use on most peasant farms. Further, the structure to maintain machinery is often not readily available.

CAPACITY FOR WORK

The water buffalo is a sturdy draught animal. Its body structure, especially the distribution of body weight over the feet and legs, is an important advantage. It large boxy hooves allow it to move in the soft mud of rice fields. Moreover, the buffalo has very flexible pastern and fetlock joints in the lower leg so that it can bed back its hooves and step over obstacles more easily than cattle. This water-loving animal is particularly well adapted to paddy farming because its legs withstand continual wet conditions better than mules or oxen (2,3).

Water buffaloes do not work quickly. They plod along at about 3-4 Km per hour. They work about 5-6 hours a day and they may take 6-10 days to plow and harrow one hectare on the field (2,4,5).

In semi-hot and dry climatic condition the draught efficiency of buffaloes was compared with cross-bred bullocks. The results showed that buffalo sustained a draught force of 14,2% of body weight, compared with 11,6% of body weight of cattle bullocks. However, the working capacity of cattle bullocks was significantly higher than that of buffaloes, due a 7% greater generation of power. The cattle exerted a draught force of 473 N at a speed of 0,97 m/s and generated 460 W, whilet the buffalo exerted 449 N of draught force at 0,90 m/s and generated 410 W (6).

Table 1 shows comparative data over the estimated power of various species of traction animals, as well as the capacity for load on their loin, represented by the weight percentage of the animal.

Table 1 - Estimated power of the various species of traction animals.

Species of adult animal	Weight (Kg)	Power (HP)		Loin load (% of weight)	
		low velocity	medium velocity	minimum	maximum
Horses	500	0.58	0.74	12	15
Mules	200	0.29	0.29	13	18
Donkeys	200	0.29	0.36	27	40
Bullocks	450	0.59	0.67	12	26
Buffaloes	650	0.84	0.76	13	15

Low velocity: 2.5 Km/h
Medium velocity: 4.0 Km/h
Source:(7)

Males and females of other breeds can be used for draught power, except high milk yielding varieties. In countries where there is no milk culture, females are used for draught. In others countries, genetic characteristic is a combination of milk and draught. There is scope for improving such a combined characteristic, where importance of milk is not too high. In other countries, where milk is the main consern, females are not usually used for work (5).

The useful life of a traction buffalo is found between 20 to 30 years, as long as good sanitary, feeding and handlig conditions are considered , as well as the fact that the exploited power has to be within the physical limits, which have to be compatible to the structure of each animal (8).

TRAINING

The selection of the animal has a fundamental importance to obtain a load animal able to develop the desired power. Some criteria have to be observed at the moment of the choice of the animal, such as: docile temperament, weight approximate to 300 Kg or age between two and two and a half years, ample chest, strong, solid and well-developed bones and back loin line without an accentuated curvature (4).

The training starts with a domesticating stage, which consists on the adaptation of the animal to the trainer, to the environmental conditions, ropes and to the hoop placed in the nasal cavity. The animal cannot be treated with harshness, it has to be trained in a way by wich it answers to the trainer's commands through his voice and the rope wich ties his horns and the hoop. The basic training consists in getting the animal used to the usage of the harness, wich begins with the pulling of small wood logs or a sled with and additional load. According to the fulfillment of the animal, the weight is increased until its complete training. For such activity, it is convenient to conduct the animal through roads or paths, since this way makes the trainer's command easier to be follwed. When the animal is used to the harnesses and to the simple traction activities, it will be trained to perform various operations. The animal starts pulling light equipaments, such as the small plough, cultivator and others (4).

HARNESS AND TOOLS

The inefficiency of the buffalo as a draught animal at present is due largely to the type harness used to attach it to the draft load. The yoke is made of wood or bamboo, in many shapes and sizes. The work position of the yoke is on top of the animals neck. A rope or strap tied to one side of the yoke , passing under the animals neck and back to the other side of the yoke where it is tied, is necessary to hold the yoke in position when under a

load. When the yoke is pulled back by the load, the rope under the throat pulls tight against the animals wind pipe, restricting the normal breathing function. Thus the air-oxygen intake is reduced and fatigue sets in a very short period of time after the animal begins pulling the load (3).

The wooden yoke used on the water buffalo contacts an area of the neck that is only about 200 cm^2. The entire load is pulled on this small area and causes the wood to dig into the flesh. The collar used in Thailand on water buffalo had a contact area of 650 cm^2, more than three times that of the yoke it replaced. The collar's padding is pressed against the animal's shoulders, not against its neck, and therefore do not choke it. In some trials a buffalo pulled loads 24 percent more with the collar than with the wood yoke, and the horsepower it developed increased by 48 percent (2,3,9).

In India, in pulling a cart using the three-point harness system (Figure 1), the thrust on the animal is concentrated on three points in three different directions. In the existing system of yoking, these three components are concentrated in one contact point between the

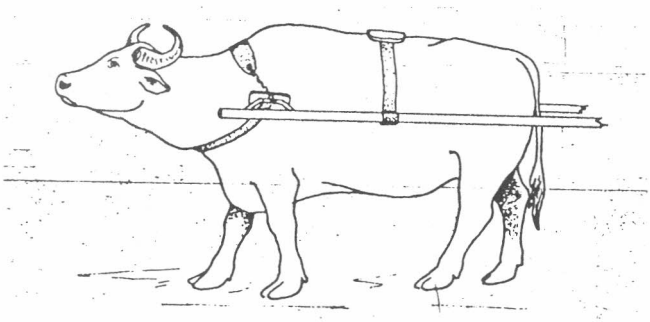

FIGURE 1 - The three-point harness system

neck and the yoke. The components of the three-point harness system effectively provide a hitching arrangement that distributes the thrust over three points in three directions: drag is taken on the hump, vertical weight on the back and the side thrust for turning on the side shoulders. Three straps are used for hitching the animal: neck, back and hold straps.

The neck strap is used for pulling. It can be made of leather, leather and chains or rope, and padding, and is hooked to the bracket (pad) or draw-pole (10).

In India, many cattle, buffaloes and equines involved in transport in the urban sector are shod. The condition and type of work surface, road, animal weight and weight pulled are some of the factors whith affect wear of claws in cattle and buffaloes, and for sustained work the hoof generally needs protection. Continuous work on hard paved surfaces or roads without shoes can make animals lame (11).

In Indonesia, the hooves of buffalos are protected by trompahs, large shoes made from old car tyres, which are fastened around the fetlocks and pastern. In Taiwan, tightly woven straw pads are tied on with cord to the feet of buffalo. In Eastern Turkey, Greece and Yugoslavia, working buffaloes are shoed with flat metallic plates (12).

FOOD AND NUTRITION

In the Amazon region, the feeding of the buffalos is developed almost exclusively by supplies of voluminous food, specially by the usage of natives pastures or cultivated pastures, which might display a variation in the nutrition values because or weather conditions or inadequate handling, that can interfere in the profit of the animal in its production of meat, milk or its work. As far as working animals are concerned, in a cultivate pasture feeding system, in soils with a low level of fertility like the ones found in this region, its important try to understand the nourishing requirements, allowing them to display their full working power.

The data presente in Table 2 allow to remark that working adult animals with 600 Kg or living weight must consume a ration cointaing 7% of crude protein, 58.0% of total digestible nutrients, 0.23% of calcium, and 0.22% of phosforus (13).

If there are pasture conditions with low nourishing values, a suplement of food available in the region must be used. In Table 3, a few concentrated mixtures for working animals are shown, which must be furnished in the quantity of 3 Kg/animal/day. These formulas

are based in works of analysis over the nourishing values of the elements that compose them (14,15).

TABLE 2 - Nourishing values of working buffaloes.

Living Weight (Kg)	Daily Gain	Consumation MS (Kg)	Living Weight (%)	NDT (KG)	PB (g)	PD (g)	Ca (g)	P (g)
		Moderate work (4 hours/day)						
400	0.05	8.0	2.0	4.10	644	354	17	13
500	0.00	9.3	1.9	5.00	617	295	20	15
600	0.00	10.7	1.8	5.80	709	339	22	17
		Heavy work (8 hours/day)						
400	0.05	9.0	2.2	5.2	647	354	23	18
500	0.00	10.9	2.2	6.3	726	405	26	20
600	0.00	12.7	2.1	7.4	779	435	28	22

Source: (13)

TABLE 3 - Different concentrate formulas for buffalos in working activities.

Food	M.1	M.2	M.3	M.4	M.5
Corn (seeds)	13.000	11.600	25.500	44.700	43.700
Cassava flour	53.600	49.700	20.000	-	-
Wheat powder	32.400	-	24.200	30.000	30.000
African oil palm pie	-	37.400	30.000	25.000	25.000
Ureia	0.800	1.000	-	-	1.000
Salt	0.300	0.300	0.300	0.300	0.300

M = mixture

INCREASING UTILIZATION OF DRAUGHT BUFFALOES

Economics of draught buffalo system will improve, if the animals are used for a greater number of days per year. Studies show that draught buffalo are generally used only for ploughing in South East Asian countries. In South Asian, are used for carting also, though not to its full potential. In India, estimates show that draught buffaloes are used for ploughing only for 50 and for carting 50 days, a total of 100 days per year. This means that the potential for increased utilisation could be as much as an additional 100 or 200 days more. If draught buffaloes are used for about 200 to 300 days a year, they can bring in sufficient financial returns, which will enable farmers and owners of draught buffalo to keep animals in well fed conditions by giving them commercial feed. But, in most cases, draught buffaloes are used only for a few days in a year, and they have to be fed throughout the year. Since draught buffalo are non-productive for 200 or more days in a year, they are kept at maintenance diet levels, affecting their health and draught capability. Most animals thus become so weak at the end of the dry season that they do not have enough strengh to work when ploughing season starts (5).

ANIMAL TRACTION IN THE BRAZILIAN HUMIC TROPIC

The use of buffalos as traction animals in the Brazilian humid tropic is traditional, specially in the areas of flooding. The water buffalo is used for saddling in the traction of canoes when the river have low water levels and the soil is muddy, for the transportation of loads of wagons or sleds in dry lands. Also they are used for the transportation of wood logs from the interior of the woods to the patio of the stock of goods, located near by the river or the road.

The buffaloes have an essential importance for the rural men of the Amazon region, therefore they profit of their power in many different segments, substituting manpower by animals. In spite of that, the traction capacity is under-used because of the empiric form by wich the animals are profited from. The precautions with feeding and sanitary conditions are rare, and also the usage of the wood yoke as harness displays many problems. Studies have been made towards the improvement of the harnesses.
The leather harnesses, the strap and the collar, adapted by EMBRAPA-CPATU to be worn by the buffaloes are light and allow the distribution of the effort produced by the equipment when tractioned around the neck. Experiments have proved that the usage of leather harnesses in preparing the areas for planting makes the profit 25% superior in relation to the usage of the wood yoke (4).

The collar (Figure 2) is more technically appropriate than the strap, being more durable and resistant to bigger efforts, although displaying the inconvenience of being manufactured by people specialized in the making of the leather artifats, which brings about a more expensive product. That does not happen to the strap (Figure 3), since its making is simple, sometimes being made by the rural man himself (4).

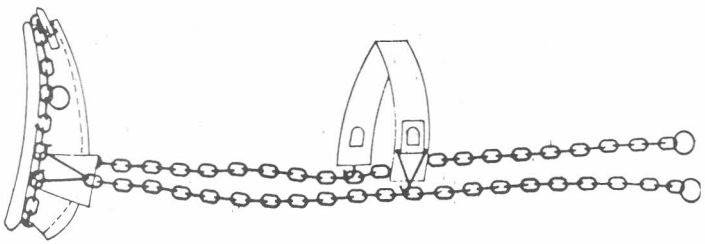

FIGURE 2 - Leather collar

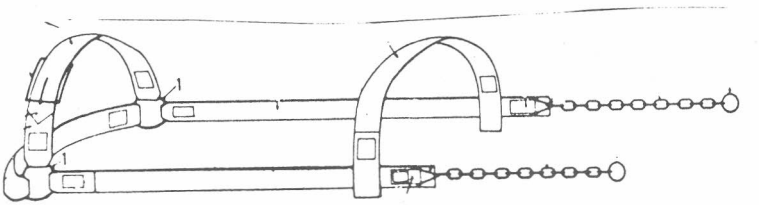

FIGURE 3 - Leather strap

Table 4 displays the comparative results of the weeding of the interlineation and subsistence culture, showing that the animal traction is more efficient and economic than the manual system with the hoe (4).

TABLE 4 - Comparative profit of the operation of the weeding.

Type of the weeding	Number of men	Worked days/Ha
Animal traction	2	2
Manual with the hoe	2	7

In the preparation of stonemasons, Table 5, data of the construction of stonemasons using the plowgh, tractioned by a buffalo compared with a manual system were collected. With the same number of men used in the manual labour, the use of animals has increased the number of stonemasons in one day (4).

TABLE 5 - Preparation of stonemasons for vegetable gardening.

Quantity	Dimension (m)	Number		Time spent (Hours)
		Animal	Man	
09	1.4 X 50.0	1	1	5.0
04	1.4 X 50.0	-	1	5.0

Table 6 displays the results of time spent per hectare in some activities for the preparation of the soil and its cultivation with beans (4).

TABLE 6 - Time spent per hectare of some agricultural activities.

Operation	Number		Time spent (Hours)
	Animal	Man	
Ploughing	1	1	25.0
Harrowing	1	1	15.0
Seeding/manuring	1	2	10.5
Weeding	1	2	11.0

Another section in which the animals are used in substition to the manual labour is in small brickyards, which increases the productivity with the goal or supplying the market of their micro-region. Two activities can be done by animals, the transportation of clay from the mine to the brickyards and the uniformizing of the clay.

Table 7 displays the quantity of raw material transported in two days of work and the average power developed (12). The distance of each journey is approximately 100 meters.

TABLE 7 - Power developed by the animal in the transportation of the clay from it's origin to the brickyards.

Day	Effectuated Journey	Mass Tractioned (Kg)	Velocity (Km/H)	Power (HP)
First	1º	490.00	2.2	2.61
	2º	379.75	3.3	3.01
	3º	367.50	2.2	1.81
	4º	367.50	3.0	2.74
	5º	428.75	3.0	3.29
	6º	428.75	3.0	3.29
sub-total		2,462.25		2.79
Second	1º	420.00	3.0	1.64
	2º	420.00	3.0	2.36
	3º	420.00	3.0	2.47
	4º	420.00	2.4	2.10
	5º	567.00	2.4	2.28
Sub-total		2,247.00		2.17

In the mixer clay, the animal develops a power of 0.29 to 0.43 HP in and average velocity of 4 Km/h.

The fulfillment of a small brickyards depends basically on the quality of the employed human labor. Usually, in the country side of the state, there is no qualified human labor

available to non-agricultural or cattle-raisin activities. Therefore, the income of the small brickyards is low, a it is shown in Table 8. The income increases when one or two animals are used (lines B and C of Table 8) in the heavier jobs, leaving the lighter jobs for man power (12).

Another factor influenced enormously the productive sector of the small brickyards is the syncronism of the various operations, so that one unity of this whole did not present neither idleness, nor excess of activities.

TABLE 8 - Income, cost and profit of a small rural brickyard in the production of tiles under different systems.

Labour System	Marckes Valve/tile US$ 1.00	Production and sell (tile)	Total income US$1.00	Fixed Cost US$1.00	Variable Cost US$1.00	Total Cost US$1.00
A-Manual	0.12	2,000	260.00	338.00	9.90	348.00
B-Use one of Animal	0.13	8,000	1,040.00	953.00	15.00	968.00
C-Use of two Animals	0.13	12,000	1,560.00	1,028.00	19.65	1,048.40

A research project carried out the Brazilian Agricultural Research Organizations (EMBRAPA) and a timber Commercial interprise (AMACOL S/A), aiming study methods of timber extraction in floodable low land areas using buffaloes for wood transportation has already presented some promising results. In table 9 the volume of wood transported by two animals, working together or separately is presented.
The timber are of different densities and the lenght varied from 3.0 to 4.5 meters.
The aim of this work is to reach at least 15m^3/day to improve profitability. This may occur with the acquisition of other buffaloes.

TABLE 9 - Volume of timber transported by buffaloes

Month	Volume of timber (m^3/day)
January	2.67
February	4.68
March	4.37
April	5.49
May	5.53
June	5.94

Source: (16)

REFERENCES

(1) Cockrill, W. R. 1974. The working buffalo. In: The husbandry health of the domestic buffalo. Food and Agriculture Organization of the United Nations, Rome, Italy.

(2) National Research Council.1981. The water buffalo: new prospects for an underutilized animal. Washington, D.C. National Academic Press.116p.

(3) Garner, J.K. 1979. The buffalo as a draft animal in Thailand. Agency for International Development.

(4) Martínez, G.B., Moura Carvalho, L.O.D. de,Garner,J.K., Nascimento, C.N.B. do and Monteiro, J.de S.1985. Traçæo animal com bubalinos. EMBRAPA-CPATU, Boletim de Pesquisa, 51.

(5) Ramaswamy, N.S. Management of the draught buffalo system. (mimeografado).

(6) Gattewar, A.B., Deshmukh, A.M.,Pingle, S.S. and Chhanwal, S.R. 1992. Draught Animal News, 17:13.

(7) Goe, M.R. 1983. Situación actual de las investigaciones sobre traccion animal. Revista Mundial de Zootecnia 45:2-17.

(8) Petheram, R.J. and Liem, C. 1990. Farming in west Timor: a greater role for animal traction. DAP Project Bulletin 10:1.

(9) FAO. 1981. Draught animal power. Inter-regional Conference, India.

(10) Pragasam, A.R.A. 1987. A three-point harness system for simgle animal drawn carts and implements. World Animal Review 63: 20-22.

(11) Upadhyay, R.C. 1991. Shoes for draught animals. Cartman, 4(5): 34.

(12) Pimentel, G.B.M. and Reis, A.F.S.1992. Uso da tração animal em pequenas olarias. EMBRAPA-CPATU, Circular Técnica,64.

(13) Keal,L.C. 1982. Nutrients requirements of ruminants in developing countries. 150p.

(14) Rodrigues Filho, J.A., Lourenço Júnior, J. de B. and Batista, H.A.M. 1992. Métodos práticos para cálculos de dietas para suplementação animal. EMBRAPA-CPATU, Documentos, 63.

(15) Rodrigues Filho, J.A., Camarão, A.P., Lourenço Júnior, J. de B. 1993. Avaliação de subprodutos agroindustriais para a alimentação de ruminantes. EMBRAPA-CPATU, Documentos, 71.

(16) Dias, A.T.G.1994. Produtividade da exploração florestal com bubalinos: resultados preliminares. AMACOL SA (mimeografado).