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☆ Draught Animal News continues to bring you the latest in research, techniques and information from around the world. We hear increasingly from Spanish and French speaking countries and are pleased to publish articles in both these languages as well as in English. As we hear more and more about world fuel price increases and worries about sustainability, draught animals continue to be important, especially in areas where use of mechanised machinery is not appropriate either because of cost or because of topography.

☆ This current issue has articles from Africa, Asia and South America covering a variety of subjects on both animals and the machinery they use. There is a request for help on the establishment of a database of literature and information on tillage and related matters in Africa. Also a request for information and contacts for improved animal-drawn implements. Our information on web sites may also be of value and we are grateful to anyone sending us information on any more useful addresses that we can pass on to our readers.

☆ Please continue to send in your news and articles to the editor: Dr R.A. Pearson, Editor, Draught Animal News, Centre for Tropical Veterinary Medicine, Easter Bush Veterinary Centre, Roslin, Midlothian EH25 9RG, Scotland, UK. (Fax: 44131 445 5099 or email: anne.pearson@ed.ac.uk).

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RESEARCH AND DEVELOPMENT PROJECTS

1. LATIN AMERICA

(a) Mexico

Instrumentos agrícolas tradicionales de tracción animal en México

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Summary: The paper looks at the various animal drawn implements used traditionally in agriculture in Mexico. One way of classifying these implements has been by the energy required to move or operate them. From ard through the symmetrical ploughs brought by the Spaniards to the asymmetric or mould board ploughs. The types of implements used for land preparation, sowing, cultivation and harvesting are explained.

En la transformación de la naturaleza con fines agrícolas se requiere un conjunto de actividades con las que el productor proporciona a plantas y animales de interés las condiciones óptimas para su crecimiento, desarrollo y producción. Para realizarlas el hombre utiliza diferentes instrumentos, considerados por Marx (1980) como el conjunto de objetos que el hombre interpone entre sí y el objeto de trabajo, éstos sirven como intermediarios de su acción, son una prolongación de sus órganos naturales, y se encuentran en contacto directo con objeto a transformar; al cual le imprimen características que lo convierten en un producto útil al satisfacer una necesidad concreta.

Una de las formas de clasificación de los instrumentos de trabajo es tomar en cuenta la fuente de energía que los pone en movimiento. Así, tenemos instrumentos manuales, de tracción animal y los movidos por el motor de combustión interna. Dicha clasificación corresponde al grado de desarrollo de los instrumentos; los de tracción animal se ubican en un desarrollo intermedio, los cuales han existido desde el inicio de la utilización de los animales como fuente de fuerza hace aproximadamente 6 000 años, y a pesar del avance tecnológico existen algunos lugares del mundo en donde se continúan utilizando, México es uno de esos lugares.

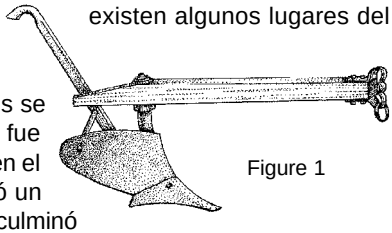

Figure 1

De los instrumentos usados con los animales se considera que debió ser el arado el que primero fue inventado; así, Steensberg (1977) establece que en el periodo entre 6,000 y 4,000 años a. C. comenzó un proceso de modificación de los instrumentos que culminó con la invención del arado. Por otro lado, Gordon Childe (1982) establece que el hombre aprendió a aprovechar la fuerza del toro e inventó el arado entre 6 000 y 3 000 años a. C.

Los instrumentos de tracción animal fueron introducidos a México por los españoles en el siglo XVI, se conoce que trajeron los arados simétricos dentro de los cuales se encontraban los radiales y dentales, se sabe que en la misma época se inicia el proceso de introducción de los vehículos. sin embargo, carecemos de información del proceso de introducción de otros instrumentos. Los arados asimétricos o de

vertedera fueron traídos hasta el siglo XIX y se incrementó su utilización a mediados del siglo XX.

Los instrumentos agrícolas en la agricultura de México

Las actividades necesarias para hacer agricultura son múltiples, razón por la cual los instrumentos que se requieren son variados, algunos se emplean para remover el suelo, otros para eliminar competidores o para el manejo de la planta. Con la finalidad de una presentación sistemática de los diferentes instrumentos de tracción animal usados en México, la enumeración se hace siguiendo la secuencia de las prácticas agrícolas y cuando sea posible se combinará el grado de desarrollo de los instrumentos. Es decir, primero se presentarán los instrumentos usados en la preparación del suelo, luego los correspondientes a la siembra, a las labores culturales y la cosecha.

Dentro de los primeros los arados son los de mayor importancia. De acuerdo a la forma como mueven el suelo, los podemos diferenciar en arados de palo o simétricos y en arados asimétricos o de vertedera (Haudricourt y Delamarre, 1955).

Cuadro 1: Prácticas, actividades agrícolas y los instrumentos de tracción animal.

Práctica	Actividad	Instrumentos más frecuentes
Preparación del terreno	Roturación	Arado Oliver, Apulco, Matador, Arado de palo, arado reversible,
Siembra		Arado de palo, sembradora, arado de vertedera, arado doble vertedera
Lab. Culturales	Deshierbe	Cultivadora, arado de palo
	Aporque	Arado de palo, arados de vertedera. Arado de doble vertedera.
Cosecha		Vehículos

Arados de palo o simétricos. Corresponden a los arados mas antiguos, a los que se les ha llamado egipcios, en México se les llama “de palo” por el material de construcción, ya que salvo la reja el resto es de maderas regionales. Por la forma como se une la cabeza y mancera, y por la disposición de telera y timón, los arados simétricos se clasifican en *radial, dental y cama.* En México se encuentran únicamente los dos primeros. En el periodo de 1940 a 1970 se registran aproximadamente un millón, cantidad que ha disminuido considerablemente en los últimos años. Dentro de los dentales se encuentran las variantes de *cuadrangular y triangular*

Arados radiales. Se caracterizan porque la cabeza (dental) y mancera (esteva) son de una sola pieza; razón por la que este arado es más fuerte comparado con los dentales, esta característica lo hace apto para ser empleado en suelos pesados.

Arados dentales. La parte de trabajo del arado se forma de tres piezas independientes: cabeza, telera y mancera; estas dos últimas van empotradas a la cabeza, además de sostener al timón por medio de las cuñas. A semejanza con los arados radiales, los dentales pueden tener timón largo o corto, y a diferencia del anterior su uso se prefiere en suelos ligeros.

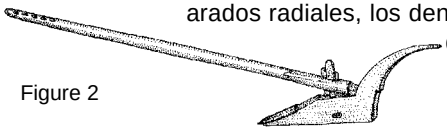

Figure 2

Arados triangulares y cuadrangulares. Corresponden a los arados dentales y en función de la colocación del timón, cabeza, telera y mancera, se les denomina *cuadrangulares* si la forma de unión de estas cuatro piezas delimitan una figura geométrica de cuatro ángulos; y *triangular* si la figura delimitada es un triángulo, en este caso el extremo del timón se apoya en la cabeza a la altura de la mancera. La utilización de los arados de palo puede explicarse porque abre el suelo en dos partes iguales, tienen ventajas para iniciar un surcado y, por último, debido al poco volteo del suelo, las primeras escardas de maíz o bien labores de plantas de bajo porte y especialmente hortalizas se realizan ventajosamente. Por lo anterior, presentan ventajas para la realización de prácticas agrícolas como es el caso de preparación del terreno, surcado siembra y primera escarda.

Arados asimétricos, de hierro o vertedera. Son los instrumentos usados con mayor frecuencia para labores de roturación del suelo, ya que su diseño logra mayor profundidad, aflojamiento y volteo del suelo en lo cual se parece al tractor. La parte de trabajo de estos arados es metálica y sus componentes son la vertedera, reja, talón y telera, en tanto que el timón y manceras pueden ser de madera. La combinación del diseño, casa constructora y tamaño arroja un número considerable de arados de vertedera que cubre las necesidades de determinada práctica, bajo características determinadas de suelo o de las costumbres de productores. Esto se manifiesta en la proliferación de un número considerable de tipos de arados que son fabricados por establecimientos industriales y en el nivel regional por herreros, y hay pequeños talleres que se encargan de la fabricación de ciertos tipos a pequeña escala y de las modificaciones y reparaciones pertinentes.

Plate 1: Use of draught animal power in crop production in Mexico (A. Cruz)

Fig. 3

Figures 1–3: Traditional animal drawn implements used in Mexico

Dentro de los principales arados de hierro tenemos el **Oliver**, mismo que se caracteriza porque la vertedera, reja y talón son intercambiables y van sujetos a un cuerpo central. Del Oliver existen cuando menos dos tamaños. El **arado Apulco, nacional o 19 y medio**, en el cual las formas son características y salvo la reja y el talón, que pueden ser intercambiables, todas las piezas se encuentran fundidas en un cuerpo. Este tipo de arado es el que presenta un número mayor de tamaños. El arado tipo **matador** es completamente metálico y su diseño le permite una mayor eficiencia en suelos arcillosos.

Los arados con una larga tradición de uso en México pero de menor frecuencia son el arado **reversible, el arado de doble vertedera, el arado mosco** y una serie de **arados locales** que son construidos y consumidos en el nivel regional en los estados de México, Guanajuato, Michoacán, San Luis Potosí. En el ámbito regional y para algunas prácticas y cultivos se realizan modificaciones en los arados que buscan eficiencia para realizar alguna actividad específica.

Como resultado de los escasos programas de apoyo para mejorar la tracción animal, existen arados de vertedera que funcionan con la barra de tiro, con el yunticultor o bien con algunos modelos de labranza de conservación.

Los arados son los instrumentos preferidos para casi todas las prácticas, su versatilidad lo permite, existen otros instrumentos de importancia menor, como son la sembradora y cultivadora que por su especificidad permiten mayor eficiencia. Dentro de otros instrumentos se tienen las rastras, escrepas y vehículos, algunos de estos últimos con la misma apariencia de cuando fueron introducidos hace 500 años tal es el caso de las carretas en Oaxaca.

La tradición de uso de instrumentos de tracción animal en México cuenta con una antigüedad de cinco siglos, algunos de ellos continúan siendo medios de trabajo de importancia actual para llevar a cabo la producción agrícola campesina.

BIBLIOGRAFIA

Anónimo. 1978. Manual de estadísticas básicas, sector agropecuario y forestal. Secretaría de Programación y Presupuesto. México, D.F. 1257 p.

Childe, G. 1974. Los orígenes de la civilización. Fondo de Cultura Económica. Breviarios (92). México. 290 p.

Haudricourt, A.G. y M. J. Brunhes D. 1955. L'Homme et la charrue: a travers le monde. Collection L'Homme et la nature. La Manufacture. Lyon, Francia. 410 p.

Marx, C. 1980. El capital (tres tomos, ocho volúmenes). Siglo XXI editores. México, D.F. 1328 p.

Steensberg, A. 1977. The husbandry of food production. _In_: Hutchinson, J.; J. G. Clark; E. M. Jope; R. Riley, Fr. S. (Eds.). The Early His History of Agriculture. The British Academy by Oxford University Press. Cambridge, Great Britain. pp. 43–53.

2. ASIA

(a) Malaysia

Buffalo as draught animals with reference to oil palm plantations in Lahad Datu

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[This paper was presented at the Livestock-Plantation Crop Integration seminar, held on 12–13th October 1993 in Sandakan, Sabah and at the 1st Asian Buffalo Association Congress, Marc, 1994 in Khon Khen, Thailand.]

Summary: The use of buffalo as draught animals in oil palm plantations was studied in Lahad Datu. This paper reports on their performance and husbandry. Buffalo draught power (BDP) plays a complementary role to motorised power in the transport of harvested fresh fruit bunches in the plantations. The use of buffalo to provide opportunities for an integrated plantation based livestock production system is discussed.

Introduction

Palm oil industry

The Palm oil industry is a major player in the Malaysian economy. The total area planted with oil palms, and the production of palm oil were increased significantly from 1960 to 1990 (Table 2). In 1991, the area planted with oil palms was 2,068,008 ha with a corresponding palm oil production of 6,152,726 metric tones. This production is equivalent to 54% of the world's total palm oil production (Azmi, 1992, Anon, 1991a).

In 1991, oil palm plantations in Sabah covered an area of 342,476 ha with 70,584 ha (20.6%) all located in Lahad Datu (Anon, 1991b). The planted areas had increased to 103,960 ha in 1992 which is 73% of the total developed agricultural area in Lahad Datu, and this trend is expected to continue (Lim, 1993).

Table 2: Palm oil area and production development in Malaysia*

Year	Planted area (ha)	Production of CPO (metric ton)
1960	54,638	91,793
1970	261,199	431,069
1980	1,023,306	2,573,173
1990	2,029,464	6,094,622
1991	2,068,008	6,152,726

*Source: Statistic Department and PORLA as quoted by Azmi (1992)

Buffalo

Buffalo are not indigenous to Borneo (Cockrill, 1974). Ibrahim (1983) traced the first record of buffalo in Sabah to 1898. Cockrill (1974) and Jainudeen (1983) gave a detailed description of the animal.

The cultural and economic role of buffalo in Sabah has been significant in the past. However, their role has been gradually reduced due to advances in science and technology as well as developments in the manufacturing sector. On East Coast of the state especially there are many padi fields and buffalo still contribute to the livelihood of the farmers and peasants. The buffalo's enormous strength, docile temperament,

amenability to be trained and capacity for sustained work make it an excellent animal for haulage. It is tougher than any other draught animal (Kehoe & Chan, 1987).

Objectives

The objectives of this paper are to present the findings of a survey conducted on the use of buffalo for draught power of buffalo draught power (BDP) in several oil palm plantation in Lahad Datu. The exercise attempts to collect basic data on the standing population, management and logistics of BDP in oil palm plantations.

Survey findings

Population

Table 3 shows the number of buffaloes in the oil palm plantations included in the survey. The number of active working buffaloes was 367 males and 118 females which was 75.07% of the buffalo population in the plantations surveyed. The 161 'idle' animals were either too young or too old, suspected as being pregnant or were nursing cows. Some were being temporarily 'retrenched' as a result of farm mechanisation. The latter are waiting to be redeployed to other areas where machines are not suitable. The age of these draught buffaloes ranged between 4 to 10 years.

Management and husbandry

Ownership. In most plantations the draught buffaloes are owned by the harvesters/ handlers. However, some of the buffaloes are on loan to the workers (harvesters) who pay for them by monthly deductions from their income. In some estates, the management is planning to set up a *'Buffalo Fund'* to help their workers to own buffalo as a means of improving their income as well as to facilitate movement of harvested fresh fruit bunches (FFB) from the plantations.

Table 3: Buffalo population in oil palm plantations in Lahad Datu (August, 1993)

Plantation	Male		Female			
(ha)	Working	Idle	Working	Idle	Calf	Total
SLDB Mensuli (3,764)	76	12	50	18	26	182
SLDB Sandau (3,050)	91	19	19	10	18	157
SLDB Sebrang (1,855)	37	–	7	–	7	51
SLDB Matamba (3,579)	30	–	17	12	17	76
Felda Sahabat	104	9	23	5	8	149
UNICO-DESA (7,639)	11	–	2	–	–	13
Jeroco; Batangan (3,395)	12	–	–	–	–	12
Jeroco; Lutong (1,970)	6	–	–	–	–	6
Total	*367*	*40*	*118*	*45*	*76*	*646*

Feeds and feeding. Draught buffaloes depend on the natural vegetation. This is mainly grasses, legumes and various other types of cover crops under the palm. Occasionally the animals are supplemented with table salt or mineral licks as in the SLDB estates. The animals are allowed to graze *ad libitum* in between working hours, in the evening and during days off.

Housing. The draught buffaloes were either housed in a yard or tethered at nearby 'kongsi' or in the oil palm block at night depending on the working distance and security

situation. The yard is a small enclosure with roof erected close to the kongsi to prevent fighting and theft.

Working hours. Buffaloes in the oil palm plantations are mainly used to move the harvested fresh fruit bunch (FFB) from the plantation blocks to the main road. The FFB can then be collected by lorries or trailers and taken to the mill. A trained draught buffalo is ordered by the handler to move, turn (left or right) and stop. The usual working hours of these animals are as in Table 4:

Table 4: Draught buffaloes working hours

Working session	Working hours
Morning	7.00 – 11.00 am
Afternoon	3.00 – 5.00 pm

This working schedule, however, varies according to weather conditions, fruiting season and condition of the animal. During hot weather the working time is usually shorter as the animal is prone to heat stress. They are allowed to graze and wallow during resting hours. Table 5 shows the average working hours, area covered and output of draught buffaloes in some of the surveyed plantations.

Table 5: Operation and performance of draught buffalo in oil palm plantations

Parameter	Plantation				
	SLDB	FPSB	UNICO-DESA	Batangan	Lutong
Working period/ day/animal (hour)	6	7	6	7	6
Working area/ day/animal (ha)	1.3	7.7	2.0	4.0	6.0
Output/day /animal (ton)*	1.8	5.7	2.0	3.2	2.6

*Conversion of number of FFB evacuated.

Conveyances. Over 90% of the sleighs, yokes and harnesses used for BDP in the oil palm plantations are made of timber or are wood-based. Some are designed using other materials such as GI pipe; aluminium and iron bars. An empty sleigh is estimated to weigh up to 400 kg.

Healthcare. The working buffaloes in the survey were usually found to be in excellent body condition. Occasionally there were reported cases of traumatic injury due to fighting, lameness due to pricking by the awn of the palm frond, accident and weaknesses due to over working. Mortalities are minimum and mainly due to fertiliser poisoning and shock. The latter is due to a sudden change of body temperature when the animal wallows immediately after a heavy work session. Routine extension services such as deworming, HS vaccination and other veterinary care provided by local DVSAI personnel help to ensure the health status of these working ruminants.

Discussion

The major role of BDP in oil palm plantations is to carry FFB from the palms or blocks to the main road. In addition, the buffaloes are also used for other jobs such as refuse

collection, fertilising, weeding, watering and other estate haulage during the low production season (Kehoe & Chan, 1987; Dalzell, 1983). They also provide meat, skin, horn, blood and many other useful by-products for the owner (Ramasamy, 1985). The animals can also be sold for cash in times of need.

Both male and female buffaloes are used in the BDP system. They are trained and put to work at 3 to 4 years old but not earlier, and have long and useful working life span of 10 – 20 years (Fisher, 1983). Males are preferred as they are always available for work whereas females need to be rested when pregnant or when nursing a young calf. As far as strength is concerned there is, however, no evidence in the literature to suggest any superiority between male and female draught buffalo. Komanpatana (1984) reported both sexes of buffaloes are used for work in Thailand. Though slower than cattle, buffalo can haul more weight. Cattle are reportedly used for logging work in Thailand and Myanmar (Ramasamy, 1985). Konanta *et al* (1984) as cited by Bunyavejchewin *et al* (1985), reported that the work ability of swamp buffalo is superior to that of the crossbreed Murrah in Thailand in terms of area ploughed and walking speed.

Efficiency of BDP system

Kehoe & Chan (1987) discussed the various systems of FFB evacuation including BDP and concluded that the BDP system can be both efficient and economic but only if it is managed properly. The average productivity of BDP found in the survey is 3.06 tonnes per day per animal, which is similar to that reported by Kehoe & Chan (1987). The variability of performance of draught buffalo found in the survey was due to factors such as age and number of working animals, age of palm and terrain in the plantation. The level of productivity can be increased when the various factors involved in the system are improved. Kehoe & Chan (1987) suggested the use of two buffaloes, which allows maximum output per animal. Improved *animal draught implements* (ADI) i.e.harness and yokes, and *draught animal vehicles* (ADVS) i.e. sleighs, may significantly increase productivity. Lighter but durable sleighs, comfortable yoke and harness allow the BDP system to work more efficiently. The capacity of traditional large wooden wheel ADV with iron tires may haul up to one ton, while an improved ADV can haul 3.0 tonnes with reduced burden on the animal (Ramasamy, 1985). Better understanding of working physiology and engineering, feeding management, breeding and genetic upgrading, animal healthcare and other related factors are essential and the International Workshop on Draught Animal Power for Production has recommended various priority aspects of research on these (Copland, 1985b). Earlier the similar approaches were also suggested by the International Workshop on Evaluation of Large Ruminants for the Tropics (Copland, 1985a).

Advantages and limitations

Kehoe & Chan (1987) also described the advantages and limitations of a BDP system in oil palm plantations. Since mechanisation and automation are an integral part of development, the debate in favour of or against mechanisation has continued and will continue in the future because there is no clear-cut answer on the subject (Sasaki, 1985). Conventionally, BDP systems and technology are sometimes considered as backward and retrograde steps which is why most developing countries and plantation sectors show little interest. However, the recent fuel crisis that led to price escalation will require reconsideration of such an attitude. The present lower price of CPO will force

the planters to take any necessary steps to reduce production costs to improve their profit margins.

Another important aspect of a BDP systems under oil palm plantations which is sometimes overlooked is the contribution to the biological control of herbage or 'weeds' under the palms. Wan Mohammed *et al* (1987) classified the readily available feed sources under plantation crops into three categories: *the undergrowth, cultivated pastures and agro-industrial by-products and residues (ABR).* They have estimated that with almost 3.0 million ha of oil palm plantations, these feed resources are capable of supporting more than 1 million head of cattle and buffaloes. This environmentally friendly method of herbage control could reduce weeding costs by as much as RM200.00/ha/year (Liang & Rahman, 1985). This should be given due consideration in the current environmentally-conscious world.

The BDP system is economically competitive and helps to increase productivity on small estates and smallholdings (Kehoe & Chan, 1987). It can offer a solution to the current problem of labour shortage and provides an excellent alternative to the high capital and maintenance cost of mechanisation.

Local meat production cannot keep up with ever-increasing demand. This is another potential advantage that BDP systems in oil palm plantations can offer. The ample supply of feed resources and the number of animals that can be sustained have been mentioned by Wan Mohamed *et al* (1987). Dalzell (1983) highlighted the possible implication on meat production derived from the BDP system.

This integrated system of livestock production offers a two-tier farming concept in which ruminants could be profitably raised by integration with farming activities and thus maximise utilisation of natural resources and agricultural by-products for animal feeding (Chew & Ibrahim, 1990).

Conclusion

BDP under oil palm plantations represents a symbiotic and synergistic relationship between man, animals and plants under an integrated farming system. It is complementary to farm mechanisation. The system should be encouraged whenever it is technically feasible, inevitable or appropriate. The various factors affecting the system should be given due attention for research and development. This is important for the system to become more attractive and acceptable. The system may contribute toward the realisation of the Total Agriculture Development concept.

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References

Anon (1991a). Laporan Tahun (1991). PORIM, Kuala Lumpur, Malaysia

Anon (1991b). Laporan Tahunan (1991). Jabatan Pertanian Sabah, Malaysia

Azmi Kulop Ismail (1992). Prospek dan Saingan minyak sawit. Bahan kursus Kelapa Sawit Kategori A & B. PORLA. Kuala Lumpur, Malaysia.

Bunyavejchewin, P., Veerasit, P., Chaidiviek, P. & Chantalakana, C. (1985). Changes in body temperature and working efficiency on Thai swamp buffalo. Proc. International Workshop on Draught Animal Power for Production. James Cook University, Townsville, Qld. Australia. 10–16 July 1985, 46–50.

Chew, C.T. & Ibrahim B. Mokhtar (1990). Livestock production under coconut and oil palm. A paper presented as the SASS seminar on New Agricultural Venture of Economic Potential. 29–30 June 1990. Kota Kinabalu, Sabah, Malaysia.

Cockrill, W.R. (1974). The husbandry and health of the domestic buffalo. FAO. Rome.

Copland, J.W. (1985a). Evaluation of large ruminant for the tropics. ACIAR (Australian Center for International Agricultural Research) Proceeding Series No. 5. Canberra, Australia.

Copland, J.W. (1985b). Draught animal power for production. ACIAR (Australian Center for International Agriculture Research) Proceeding Series No. 10. Canberra, Australia.

Dalzell, R. (1983). Buffalo production on pamoil plantation. Proc. of 7th Annual Conference of MSAP. Kuala Lumpur, Malaysia.

Fisher, H. (1983). The water buffalo as working animal. Abstract in bibliography on swamp buffalo 1978–1985. International Buffalo Information Centre (IBIC). Bangkok, Thailand.

Ibrahim bin Mokhtar (1983). Towards a better deal and realisation of socioeconomic contribution of buffaloes in Sabah. *Bulletin of Society of Agricultural Scientist Sabah* (SASS). Vol. 6. 1–22.

Jainudeen, M.R. (1983). The Water Buffalo. *Pertanika* 6 (Rev. Suppl) 133–151.

Komanpatana, M. (1985). Recent research and development programs to improve buffalo productivity in Thailand. In: *Evaluation of Large Ruminants in the Tropics*. Ed J.W.Copland. ACIAR (Australian Center for International Agriculture Research) Proceeding series No: 5, Canberra, Australia.

Kehoe, M.M. & Chan., C.C. (1987). Buffalo draught power on oil palm estate. The Incorporated Society of Planters, Kuala Lumpur, Malaysia.

Liang, J.B. & Rahman, S.A. (1985). Integration of buffalo under oil palm estate: feasibility and problem. Proc. 9th Annual Conference of Malaysian Society Of Animal Production (MSAP), Kuala Lumpur, Malaysia.

Lim, Y. F. (1993). Personal communication.

Ramaswamy, N.S. (1985). Draught animal power – socioeconomic factors. *Draught Animal Power for Production.* Ed. J.W. Copland. ACIAR (Australian Center for International Agriculture Research) Series No.10, Canberra, Australia.

Sasaki, M. (1985). Buffalo production in Asia – past performance and future prospects. Proc. The Buffalo Seminar, April 29–May 2nd 1985. International Buffalo Information Centre (IBIC), Bangkok, Thailand.

Wan Mohamed, W.E. Hutagalung, R.I. & Chen, C.P. (1987). Feed availability, utilization and constraints in plantation-based production system. Proc. 10th Annual Conference Malaysian Society of Animal Production (MSAP), Kuala Lumpur, Malaysia.

(b) India

Fatigue score-card for working Asian elephants

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Elephants form an integral part of the timber industry in India and South East Asia. Very few systematic studies have been carried out to estimate the draught power of elephants. At present, there are no stipulations regarding the amount of work that can be assigned to working elephants and so often captive elephants are overworked. The present study assesses displacement of physiological functions and changes in speed of work. Using these, an attempt is made to formulate a fatigue score-card which may be useful in stipulating the amount of work for captive elephants.

Materials and methods

The experiment was carried out in three different districts of Kerala State in India. Two elephants each from Kodanadu, Ernakulam district and Muthanga, Wayanad district belonging to the Forest Department of Kerala and two elephants from Kozhikode district belonging to private owners were used for the study. All the elephants were trained and in the age group 20–35 years.

*Amount and duration of work***.** The elephants were made to haul a known weight of logs. Weight of the logs hauled was expressed as a percentage of the body weight of the elephant. The experiment was conducted at three draught levels, viz. 10%, 20% and 30% of their liveweight. The elephants were put to work for three hours from 7 am to 10 am and then for one hour from 11 am to 12 noon with one hour of interim rest period. *Observations on physiological changes.* Respiration and pulse rates and rectal temperature were recorded before the start of work, immediately after completion of each hour of work and after rest.

Speed of work. The walking speed of elephants with and without a load was estimated by measuring the time taken to traverse a particular distance and expressed in km/hour.

Fatigue score card. A score chart was prepared based on physiological changes and speed of work. A score of one was given to every unit increase in pulse and respiration rates and every 0.1 unit increase in rectal temperature from normal level, at the end of each hour of work. For every unit reduction of speed at the end of each hour of work from normal level, a score of one was allotted. Total scores were calculated after each hour of work at different levels of draught.

Plate 2: Elephant at work in Kerala Region, India (A. Nair)

Plate 3: Moving a log in the forest in Kerala Region, India (A. Nair)

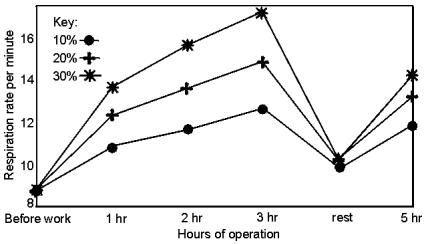

Fig. 4(a)

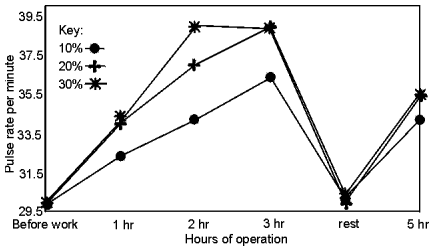

Fig. 4(b)

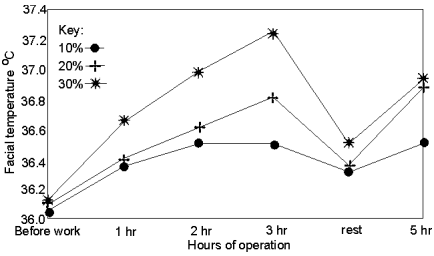

Fig. 4(c)

Figure 4: Variation in (a) respiration rate, (b) pulse rate and (c) rectal temperature of elephants at draught of 10%, 20% and 30% of their body weight at different hours of operation.

Signs of stress and fatigue during work at different draught levels as revealed by physical responses like reluctance to move, spraying of saliva, urination and appearance of tears from the eyes were noted and compared with the respective fatigue score. Based on this an index score was prepared to indicate the maximum limit to which an elephant can be put to work.

Results

When the elephants were put to work for three hours, respiration, pulse and temperature increased significantly at all levels of draught (Fig. 4). One hours rest after three hours of continuous work significantly reduced respiration, pulse and temperature, but pulse rate and rectal temperature after one hour's rest continued to be significantly higher than the initial values.

Average speed. The speed of operation decreased with duration of work at all draught levels (Fig. 5). After one hour of rest given after three hours of continuous work, the speed of work did not return to its original level. However, no significant difference in speed was observed between three hours of work and one hour work after rest.

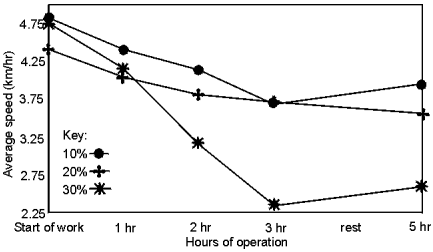

Figure 5: Comparison of variation in average speed of elephants at draught of 10%, 20% and 30% of their body weight at different hours of operation.

Table 6

Draught	Fatigue score 1 h	2 h	3 h
10%	5.20 ± 0.43	8.35 ± 0.45	11.98 ± 0.84
20%	8.26 ± 0.43	13.11 ± 0.30	17.16 ± 0.74
30%	10.00 ± 0.19	16.63 ± 0.71	20.65 ± 0.70

Table 7: Signs of stress and fatigue during work at different draught per cent

Draught % of body weight	Physical response
10%	Reluctance to move was shown only once during the third hour's work. Occasional spraying of saliva by trunk during second and third hour's work. Occasional urination at 2 hours and thereafter. Occasional appearance of tears.
20%	Reluctance to move was seen six to ten times during the work. Frequent spraying of saliva by trunk on its body. Frequent urination. Slow walking and occasional dragging of feet in third hour of work. Frequent appearance of tears.
30%	Frequency of spraying saliva by trunk onto body increases after second hour of operation. Reluctance and occasional refusal to walk during second and third hour of work. Slow walking. No co-ordination between legs. Continuous flow of urine. Continuous appearance of tears.

Fatigue score card. The total scores obtained when fatigue levels of elephants at work were quantified using a score card are given in Table 6.

The observation of fatigue signs given in Table 7 reveals that during one hour of work at any level of draught the elephants were not fatigued. At two hours of work, 10% and 20% draught levels were found to be non-fatiguing. The corresponding fatigue score after two hours of work at a 20% level was 13.11. At 30% draught the elephants showed signs of fatigue with a score of 16.64 $\pm$ 0.71 after two hours of continuous work.

Discussion

Physiological changes. Elephants showed a gradual rise in respiration rate, pulse rate and rectal temperature as the duration of work increased. This is in agreement with findings observed from cattle and buffaloes by several investigators (Singh *et al.*, 1968, 1970; Nangia *et al.*, 1980; Upadhyay & Madan, 1985; Thomas & Pearson, 1986; Sreekumar & Thomas, 1990a; Anil & Thomas, 1996).

One hour of rest after three hours of continuous work significantly ($P<0.01$) reduced the rectal temperature and pulse and respiration rates but was not enough to bring these down to pre-exercise values. This finding indicates that one hour of rest is not adequate for elephants working for three hours or more.

Average speed. The average speed of work was reduced significantly ($P<0.01$) at different levels of draught. This is in agreement with the earlier observations in cattle and buffaloes (Anil, 1994).

Assessment of fatigue. At 30% draught, two hours of work made the animal fatigued with a score of 16.63 whereas the elephant remained unfatigued with a score of 13.11 after two hours of work at a 20% level. This indicated that the score at which the animal became fatigued was between 13.11 and 16.36. Thus a score of 15 may be taken as an index for limiting the work at any level of draught.

From the present investigation it can be concluded that the ideal duration of continuous work in elephants is 1, 2 and 3 hours at draught levels of 30%, 20% and 10% respectively.

References

Anil, K.S. (1994). Comparative draught capacity of cattle and buffaloes. Thesis submitted to Kerala Agricultural University.

Anil, K.S. & Thomas, C.K. (1996). Comparative draught performance of cattle and buffaloes. 1. Physiological reactions. *Indian Journal of Animal Science* **66**(4), 398–401.

Devadattam, D.S.K. & Maurya, N.L. (1978). Draftability of Hasiana bullocks. *Indian Journal of Dairy Science* **31**(2), 120–127.

Nangia, O.P., Singh, N. & Sukhija, S.S. (1980). Effect of exercise on thermal and acid base balance in buffaloes. *Tropical Animal Health Production* **12**(3), 185–188.

Singh, S.P., Soni, B.K. & Bhattacharya, N.K. (1968). Physiological responses in Hariana bullocks while performing different types of agricultural operation. *Indian Veterinary Journal* **45**, 30.

Singh, S.P., Soni, B.K. & Mehta, M.M. (1970). Studies on the performance of Sahiwal bullock during various agricultural operations. *Indian Veterinary Journal* **46**(4), 218–222.

Sreekumar, D. & Thomas, C.K. (1999a). Draught efficiency and thermal strain of Kangayam and Jersey – Red Sindhi bullocks in hot-humid tropics. *Indian Journal of Animal Science* **60**(5), 582–586.

Thomas, C.K. & Pearson, R.A. (1986). Effects of ambient temperature and head cooling on energy expenditure, food intake and heat tolerance of Brahman and Brahman × Friesian cattle working on treadmills. *Animal Production* **43**(1), 83–90.

Upadhayay, R.C. & Madan, M.L. (1985). Draught performance of Hariana and crossbred bullocks in different seasons. *Indian Journal of Animal Science* **55**(1), 50–54.

(c) India

Study on draught capacity of bullocks in Bastar Region, India

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Abstract

Draught animals, particularly bullocks and buffaloes, hold an important place in our agricultural farming and will continue to do so for many more years to come, especially in the regions like Bastar. A pair of local bullocks (543 kg/pair) of non-descript breed were studied for their performance in four-hour continuous working under different conditions of load. The performance was assessed on the basis of variation in pulse rate, respiration rate, body temperature, forward speed, power output and fatigue score. It was observed that the local bullocks could pull a draught load of 14% (76 kg draught) without excessive fatigue on a dirt road. The average power output per pair during four hours of operation in the winter season was maximum at 16% draught load. The overall average increase in respiration rate from the initial value for 8–16% draught loads of body weight and four hours of working was 73% whereas the pulse rate increase was 15.6%. The maximum variation in rectal temperature from initial value was 0.9ºC. The forward speed reduced with increase in operating time and draught load. The fatigue score was well below 20 points in the winter season up to 16% loading condition.

Introduction

During the last two decades or so the growth of mechanisation of Indian agriculture has been comparatively rapid draught animals, particularly bullocks, still continue to be a predominant source of renewable energy for traction and rural transport in India. Today, draught cattle provide about 50 million hp or about 35 million kW of energy in a year. More than 65% of this energy is used for agriculture and the rest for transport. Over 150 million ha of land, farming about 65% of the area sown, is cultivated through the use of draught animals every year. Tractorisation is increasing every year, but is confined to large farms in the country, each having an area more than 5 ha. The average size of an operational land holding in India has declined from 2.7 ha in 1960–61 to 1.7 ha in 1985–86. Most of the farmers have small holdings and can hardly opt for complete mechanisation. Therefore the use of draught animal power is going to stay in India for many more years, especially in a region like Bastar.

Materials and methods

A pair of bullocks (543 kg/pair) of non-descript breed were studied to find their draught capacity on a dirt road. The CIAE loading car was used for varying the quantity of load. Adequate training of bullocks and operators was given for pulling the loading car at various draught loads. The pull at different pressure settings of the loading car was measured by using a load cell and load cell indicator. The angle of pull was measured using an abney level and thus draught was calculated.

Observations of physiological parameters, ie. pulse rate, respiration rate, body temperature, distress symptoms, speed, angle of pull etc., were recorded for different loads applied as per cent of body weight by loading the car while working on a dirt road. It was planned to work in the morning for about four hours duration or until the animals became fatigued which ever came first. The following measuring equipment/techniques were used for measuring various physiological and other parameters: pull (load cell and load cell indicator); speed (stopwatch and measuring tape); rectal temperature (thermometer); respiration and pulse rate (hand sensing); stepping rate (counting manually); angle of pull (Abney level); distress symptoms – frothing, leg UN coordination, etc. (manually through subjective assessment).

Results and discussion

A pair of local non-descript breed of bullocks was put to pull the loading car on the kaccha (dirt) road at different loads. The average variations in physiological parameters at different times and loads, corresponding fatigue score and power developed by the bullocks in the winter season are given in Table 8(a–f) and Figures 6(a–e) and 7(a–b).

Variation in respiration rate

The average variation in respiration rate of local bullocks with respect to time of working and draught loads in the winter season while pulling the animal loading car is given in Table 8(a). The data reveal that in general there was an increase in respiration rate with increase in operating time and draft load with the bullocks. The occasional decrease in respiration rate with increase in draught load and operation time may be due to deep breathing of the bullocks and reduction in their speed. The overall average respiration rate of local bullocks was 13.4 blows/min at rest and 17.8, 21.8, 27.0 and 26.4 blows/min after the first, second, third and fourth hour of operation, respectively. This indicates that respiration rate had increased up to the third hour of operation, but it had slightly decreased from the fourth hour to the third hour. This was due to reduction in the speed of the bullocks as well as deep breathing during the fourth hour of work. The average respiration rate (blows/min) during four hours sustained working of these bullocks at 8, 10, 12, 14 and 16% draught loads of their body weight (543 kg) was 18.8, 19.8, 22.8, 27.0 and 28, respectively. This shows that maximum respiration rate was at maximum draught load of 14 and 16% and rate of increase was more beyond 12% draught load. The data also reveals that overall average increase in respiration rate for 8–16% draught loads and four hours of operation from initial respiration rate of the non-descript local breed was 73.5%.

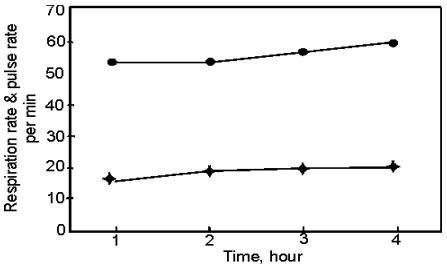
Variation of pulse rate

The average variation in pulse rate of local bullocks with respect to time of working and draught load in the winter season is given in Table 8(b). The overall average pulse rate of local bullocks was 51 beats/min at start of work and 55, 58, 60 and 63 after the first, second, third and fourth hours of work, respectively, an increase of 8, 13, 18 and 24% from resting levels. The overall average pulse rate during four hours sustained work was 55, 57, 60 and 64 beats/min at average draught forces equivalent to 8, 10, 12, 14 and 16 kg draught force/100 kg liveweight (Table 8(b)). Rate of increase in pulse rate was approximately proportional to the increase in draught load up to 14 kg draught force/100 kg liveweight but beyond this the increase was high.

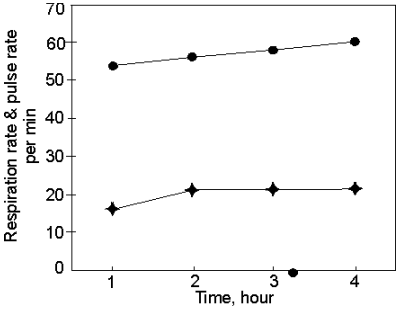
Table 8: Average variations in (a) respiration rate, (b) pulse rate, (c) rectal temperature, (d) speed, (e) power output and (f) fatigue score of experimental bullocks at different times of work and loads with traditional yoke in winter season.

Ambient temp (°C)	Draught load % of body weight	At rest	1	2	3	4	Average (%)
(a) Respiration rate (blows/min)							
15.4–27.1	8	14	16	19	20	20	18.8 (33.9)
15.6–27.8	10	14	16	21	21	21	19.8 (41.1)
16.9–26.3	12	13	16	19	28	28	22.8 (75.0)
16.0–27.6	14	13	21	24	33	30	27.0 (107.0)
14.9–28.1	16	13	20	26	33	334	28.0 (115.4)
Average (%)		13.4	17.8	21.8 (24.7)	27.0 (62.7)	26.4 (101.5)	23.3 (97.0)
(b) Pulse rate (beats/min)							
15.4–27.1	8	51	53	53	56	59	57 (11)
15.6–27.8	10	51	54	56	58	60	57 (12)
16.9–26.3	12	51	55	57	61	63	59 (16)
16.0–27.6	14	51	54	59	61	65	60 (17)
14.9–28.1	16	51	59	63	65	69	64 (25)
Average increase from resting (%)		51 (8)	55 (13)	58 (18)	60 (24)	63	59 (16)
(c) Rectal temperature (°C)							
15.4–27.1	8	38.1	38.2	38.4	38.5	38.6	38.4
15.6–27.8	10	38.1	38.3	38.5	38.6	38.7	38.5
16.9–26.3	12	38.1	38.4	38.5	38.7	38.8	38.6
16.0–27.6	14	38.1	38.4	38.6	38.8	39.0	38.7
14.9–28.1	16	38.1	38.4	38.6	38.8	39.0	38.7
(d) Speed (km/hr)							
15.4–27.1	8		2.3	2.2	2.1	2.0	2.2
15.6–27.8	10		2.1	2.0	1.9	1.7	2.0 (–12.4)
16.9–26.3	12		1.9	1.7	1.6	1.5	1.7 (–23.5)
16.0–27.6	14		1.6	1.6	1.6	1.5	1.6 (–26.7)
14.9–28.1	16		1.6	1.5	1.3	1.3	1.4 (–34.6)
Average decrease (%)			1.9	1.8 (–6.3)	1.7 (–11.6)	1.6 (–14.7)	1.8
(e) Power output (kW/pair)							
15.4–27.1	8		0.279	0.266	0.252	0.242	0.260
15.6–27.8	10		0.316	0.292	0.280	0.256	0.285
16.9–26.3	12		0.336	0.298	0.284	0.273	0.298
16.0–27.6	14		0.344	0.338	0.329	0.321	0.333
14.9–28.1	16		0.374	0.352	0.319	0.314	0.340
Average			0.329	0.309	0.292	0.281	0.303
(f) Fatigue score							
15.4–27.1	8			1.0	2.0	4.0	6.5
15.6–27.8	10			0.0	1.5	3.5	5.5
16.9–26.3	12			1.0	3.0	6.5	8.5
16.0–27.6	14			3.0	5.0	9.5	11.0
14.9–28.1	16			5.5	9.5	12.0	15.5

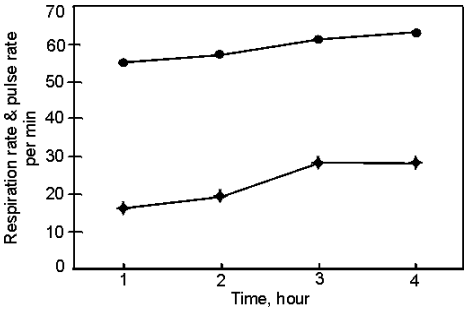
(a) 8% draught load



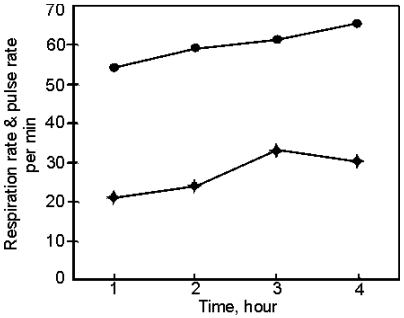
(b) 10% draught load



(c) 12% draught load



(d) 14% draught load



(e) 16% draught load

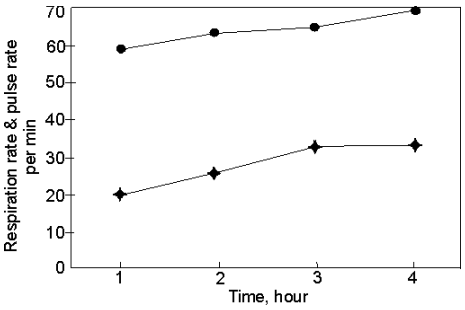


Figure 6(a–e):

Pulse and respiration rate of Bullocks vs time at different draught loads: (a) 8%; (b) 10%; (c) 12%; (d) 14%; (e) 16%.

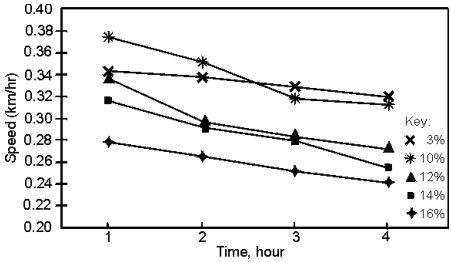
Variation in body temperature

The average variation in rectal temperature of local bullocks at different loads and times during the winter season while pulling the animal-loading car are given in Table 8(c). The data reveal that for local bullocks rectal temperature increased with advancing of working time and increase in draught load. The maximum increase in rectal temperature from initial value was 0.9°C. The maximum variation in rectal temperature was observed always at highest draught load and at the end of the longest duration of work in the working bullocks. This indicates that the increase in body temperature was within permissible limits in the case of working bullocks.

Variation in forward speed

The average variation in forward speed of local bullocks with respect to operating time and draught load for pulling an animal-loading car on Kaccha road during the winter season is given in Table 8(d). The overall average speed of local bullocks was 1.9, 1.8, 1.7 and 1.6 km/hr during first, second, third and fourth hour of operation, respectively, and thus there was a reduction of 6.1, 11.6 and 14.7% in speed during the second, third and fourth hour with that of the first hour speed, respectively. The overall average speed of four hours sustained working was 2.2, 1.9, 1.7, 1.6 and 1.4 km/hr at 8, 10, 12, 14 and 16% draught loads of their body weight, respectively. The reduction in speed with that of 8% draught load was 12.4, 23.5, 26.7 and 34.6% at 10, 12, 14 and 16% draught loads. This indicates that reduction in speed was beyond 14% draught load.

(a) power output



(b) speed

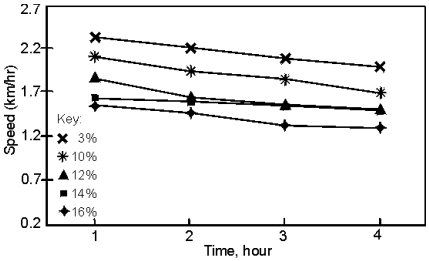


Figure 7(a–b): Variation in (a) power output and (b) speed of experimental bullocks.

Variation in power output

Power output being directly proportional to forward speed of bullocks, the power output was also reduced with passes of working time at all draught loads (Table 8(e)). The average power output of local bullocks was 0.260, 0.285, 0.298, 0.333 and 0.340 kW/pair at 8, 10, 12, 14 and 16% draught loads of their body weight, respectively. This indicates that there was a continuous increase in power output of local bullocks from 8–16% draught loads, the increase beyond 14% draught load was marginal.

Fatigue score

During winter season testing, the variations in fatigue score of experimental bullocks at different times of work and loads with traditional yoke was well within 20 points up to 16% draught load after four hours of continuous pulling of animal loading car on dirt road.

Conclusions

1. The overall average increase in respiration rate from initial value of local bullocks for 8–16% draught loads of their body weight and four hours continuous operation was 73.5%. The rate of increase in respiration rate was almost in the same proportion up to the third hour of operation.
2. The pulse rate of local bullocks increased with duration of work as well as increase in draught loads. The overall average increase in pulse rate from its initial pre work value during four hours of operation was 15.6 in local bullocks.
3. The maximum increase in rectal temperature value from its initial value was 0.9^{o}C in local bullocks.

4. The forward speed reduced with increase in operating time and draught load.
5. The fatigue score was well below 20 points in the winter season up to 16% loading condition.
6. It was observed that local bullocks could pull the draught load of 14% (76 kg draught) without excessive fatigue on kaccha road.
7. The average power output per pair during four hours of operation in the winter season was 0.260, 0.285, 0.298, 0.333 and 0.340 kW with local bullocks at 8, 10, 12, 14 and 16% draught loads.

References

Devdattam, D.S.K. & Maurya, N.L. (1978). Draftability of Haryana bullocks. *Indian Journal of Dairy Science* **31**(2), 120.

Maurya, N.L. (1982). Draftability of crossbred bullocks. In: Proc. of National Seminar on Draught Animal Power System in India. IIM, Bangalore, India. Vol. 2:1–21.

Upadhyay, R.C. & Madan, M.L. (1982). Work performance of Haryana and crossbred bullocks during summer. Paper presented at National Seminar on Animal Energy Utilization. TNAU, Coimbtore, India.

Premi, S.C.L. & Singh, Gajendra (1987). Performance of bullocks under varying conditions of load and climate. Paper presented at National Seminar on Utilization of Animal Power. CIAE, Bhopal, India.

Dave, A.K. (1995). Final ICAR ad-hoc projects report on 'Utilization of animal energy through effective animal machine system in Bastar region'.

3. AFRICA

(a) Uganda

The use of music from FM radio/cassette in draught animal power (DAP) training.

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Introduction

For a long time draught animals (oxen) have been trained by the use of the driving whip and commands such as: Go, Straight line, Stop, Right corner, Left corner etc. Fences and logs of different sizes have also been used.

Playing music from FM Radio and radio cassettes has been mostly excluded from DAP training programmes. This has been an oversight in DAP training has encouraged me to research the use of music from radio/cassettes in DAP or animal traction training. As a result it has been proved that the use of music improves the efficiency and output of working oxen and has several other advantages in the training programme. On one occasion when I was listening to music from FM radio placed near my trained oxen I realised that the oxen's behaviour started changing from fairly wild to mild. On hearing the music they started twisting their ears and tails. When the radio was switched off this behaviour ceased. When the radio was turned on for the second time the oxen became alert but this time without shaking parts of their bodies. This time I became more aware of the behaviour of these oxen and started planning to train them intensively using music from FM radio or a cassette. With this system they are trained in two main phases as follows:

Phase 1. The pair of oxen trained without music was introduced to music provided by radio. FM radio/cassettes of small or medium sizes are preferred so that when attached to the yoke, the weight of the yoke does not become too heavy. First the music is played near the pair undergoing training for at least 2 days so that the oxen become used to the sound of the music provided by the radio.

Phase 2. The radio is attached near the centre of the yoke for equal distribution of sound from the radio to the oxen in the pair. The yoke with the radio on it was placed on the necks of the oxen (harnessing) for training (Plate 4). The oxen were then driven for work with the radio switched on for at least 4–7 days. After 7 days training the oxen became used to the sound of the radio and a great improvement in efficiency was established.

During training a radio system can, however, be introduced during phase 4 of the usual training of oxen when the implement is being introduced. This is the phase when oxen are trained and can now pull logs of different sizes and because they are calm they thus cause no damage to the radio.

The following advantages have been noted when a music system was included in our DAP training programme.

1. Our Ox-attendants feel very comfortable while steering and controlling implements together with the music coming from the radio attached onto the yoke of the working oxen.
2. The behaviour of the working pair remains quite good.
3. Some neighbouring farmers come to the training field to see animals at work using a radio and eventually end up by adopting DAP practices.

Plate 4: Farmers using music to help train young oxen in Uganda (A. Ocan-Owachigiu)

Negative attitudes of some farmers on the training of oxen are therefore to some extent eliminated.

4. Efficiency and output of the working pair is improved because the music is a distraction from the load they are pulling.
5. Groups of farmers are already adopting the practice of training oxen using music. Since 1999 52 pairs of oxen have been trained using this system. The type of radios used are cheap and affordable.

In conclusion I am appealing to any interested funding organisation to help me in the research work on the use of music in draught animal power training.

Although only used with oxen to date I feel that this system will work well on other draught animals such as donkeys, goats etc.

(b) Kenya

Making ploughs that donkeys can use

Barney Muckle*, *Triple W Engineering Ltd

The idea of making equipment for donkeys arose from a workshop held in Nanyuki Kenya in 1998 and organised by KENDAT. The farmers present were encouraged to express their views in their maternal language on the state of animal drawn equipment generally.

Apart from being very critical of ox drawn equipment, too heavy, weak, unable to penetrate hard ground, lack of spares and other complaints they pointed out the lack of equipment specially made for donkeys. Many farmers had lost their cattle to thieves and were struggling to use ox drawn ploughs with their donkeys so asked for something more suitable.

This company recognised the possibility of a new product and was well aware of Professor Frank Inn's work on the lightweight plough but finance was needed. Fortunately the Ministry of Trade Tourism and Industry had just set up a Micro Enterprise Support Programme funded by the EU which, amongst other things, sought out innovative ideas for development and marketing as a means of job creation.

A 75% grant was provided after some negotiations and work started in November 2000 after one of the worst droughts in the countries' history. This had a disastrous effect on the cattle population in dry areas but donkeys survived in remarkable condition and having seen them feed avidly on Mexican Marigold (*Tagetes minuta L.*) which has a very pungent smell this can be understood.

The objective was to make a small batch, loan them to farmers for a season's use then contact local artisans to see the results and if acceptable to train the artisans to manufacture them for direct sale to farmers. All raw materials were sourced locally at a small trading centre and the work carried out in a farm workshop with generator power.

The basis design was used with modifications to suit the availability of raw materials and to allow the standard mould board plough to be changed for other tools of which weeder, winged chisel and ridger have been developed. Jigs were made and used wherever possible to obtain and maintain quality production. Hammering the precise curvature of the mouldboard proved relatively easy given the information from Frank Inns.

As the plough and harnessing system are a single unit a harness was developed

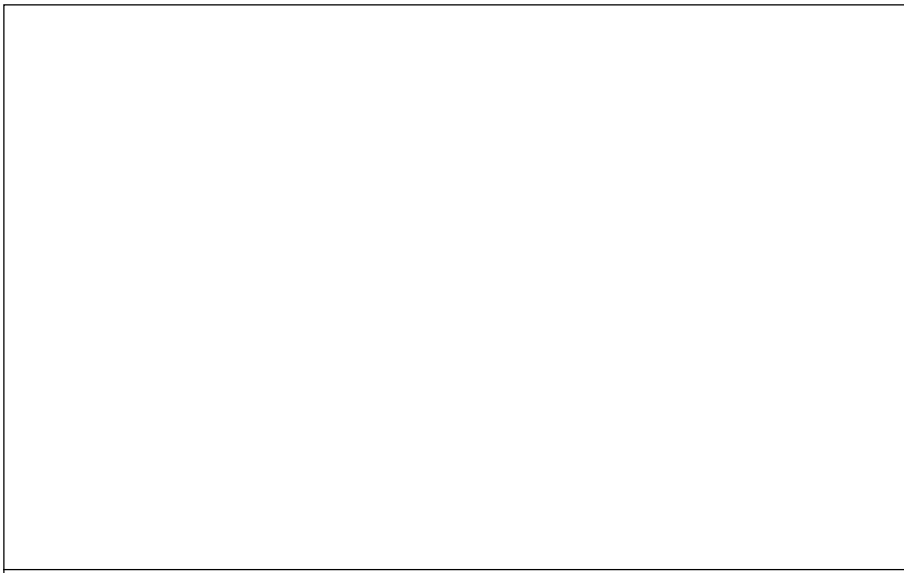

Plate 5: Frank Inns testing his donkey plough in the early stages of development in UK (A. Pearson)

to be provided with the plough. The material chosen was webbing from holding down containers in aircraft which is changed frequently and was available cheaply on the market. It is 50 mm wide so for the breast band and back strap three strips were used overlapping to give a width of 100 mm which appears adequate to distribute the load evenly.

Making the harness took time due to the variability of donkey size and the change in weight of each donkey. A test harness is first fitted then measurements taken and a second harness made to fit. It has been found that some adjustment is needed of the length of the side straps as when they put on weight it is round the chest area and this pulls the side straps and the plough becomes too close to the back legs.

In use the plough performs exactly as intended and once the correct hole in the hake has been found it operates with minimal effort and women and young persons can use it without fatigue. Minor modifications have been found necessary to suit the different conditions and heights of users especially female. Frank Inns has made several suggestions which have been incorporated into the design. Most donkeys needed some training but after three days there were able to walk straight and in the furrow bottom.

At the present time they are ploughing and weeding and there is great interest from neighbouring farmers.

A detailed manual is in preparation to be used for the training courses.

The range of instruments is plough, rider, chisel and weeder but longer term testing is still underway before it is offered to artisans (with training) to make it.

(c) Cameroon

Animal traction in Cameroon – A case study of the MIDENO / PAFSAT Project, North West Province

Dr Mutan A.V.

Introduction

Cameroon is located in the central African sub-region, with an area of 475.444 km² and a population of about 15 million. It is a major exporter of livestock and its by-products as well as cereals and other food items to neighbouring countries within the sub-region.

The North West Province of Cameroon, located between latitude 5°40' and 7°15' N and longitude 9°30' and 11°E, has an area of 17.910 km² and a population of about 1.2 million with a population density of 67.00 persons/km² – twice the national average of 31.5 persons/km². About 15% of the population live in urban or semi-urban areas and 85% live in the rural areas. Due to tectonics the landscape of the province which would otherwise have been a plain is now saw-toothed and dissected by deep valleys filled with rivers. The abundance of crater lakes in this region testifies to past volcanic activity.

The high population density imposes pressure on the available land. On average less than one hectare of land is used for food, fuel and fibre production per person per year. It is out of the need to solve these problems that the government of Cameroon created the North West Development Authority “Mission de Développement du Nord Ouest” (MIDENO). Its objectives are to alleviate poverty in resource limited communities that are dependent on agriculture by providing improved crop seeds/livestock breeds, credit, self-help facilities, rural infrastructure and other farm inputs such as fertilisers and phytochemicals and by reducing post harvest food loss.

PAFSAT (Promotion of Adapted Farming System based on Animal Traction), a sub-project funded by MIDENO, is involved in propagating of the use of Animal traction (AT) and the Permanent Farming System (PFS), a sustainable farming system involving soil fertility conservation and improvement.

Historical background of draught animal use in the North West Province

Animal Traction (AT) was introduced in the North West Province in Wum by a project called the Wum Area Development Authority (WADA) in 1975. This followed the failure of a previous tractor or mechanical programme introduced into the area in 1966. Lack of road infrastructure, inaccessibility of heavy machinery to farms, high external inputs and subsidy impaired the success of the tractor or mechanical programme.

In 1978 it was discovered that the use of animal traction was popular amongst farmers in the project zone and was rapidly extending to those outside the area. As a consequence a new oxen programme, Introduction and Promotion of Draught Animal Utilization (IPDAU), was created in 1980 to cover the entire province. The use of Draught Animal power (DAP) in the province led to the mechanisation of large areas of farm land, causing soil erosion, lower soil fertility, deforestation and migration. Cognizant of these adverse environmental effects, a new project was created in 1985 called the Promotion of Adapted Farming Systems based on Animal Traction (PAFSAT). It had to resolve these problems and foster agricultural activities out of a traditional system. PAFSAT adopted the Permanent Farming System (PFS) to achieve these objectives: This is a

sustainable farming system that emphasises permanent farm lands and abandoning shifting cultivation, mixed cropping, use of fertiliser, phytochemicals, and Agroforestry. The PFS was disseminated to farmers in the Province even if they did not use DAP.

However, 1021 farmer families, 72 women groups from 150 villages of all the divisions of the North West Province, were trained in draught animal use and Permanent Farming Systems before the 1991/1992 session, with their oxen given on credit. PAFSAT then moved to the supervision of an enlarged Provincial Development Authority (MIDENO). It has further been integrated into the structures of the Ministry of Agriculture to ensure it's continuity perhaps when MIDENO's mandate expires in the future.

In 1999 the Government of Cameroon and the African Development Bank (ADB), aware of the pivotal role of MIDENO in improving the living standards of the rural population in the Province reformulated the project to MIDENO phase II. The reformulated project is placed under the aegis of a dedicated, experienced and assiduous management/technical staff. Today the project places more emphasis on the participation of women in agriculture and development with a new impetus namely: a small livestock production scheme, training of donkeys for transport, establishment of feeding plots for draught animal during drought periods.

Discussion

DAP has played a vital role in the evolution of an agricultural system for the province and has been responsible for increasing agricultural activities. This is indicated by the increase in farm sizes averaging 2 hectares per oxen farmer, larger than those of hardworking hand-hoe farmers, 0.25 ha.

A recent release by MIDENO indicates that there is greater enthusiasm by farmers all over the Province for oxen farming. PAFSAT has trained 50 farmers and oxen in Wum during the month of March 2000 and 46 farmers and oxen in the month of June in Ntabah. More farmers than planned have been trained during this period and they also come with their oxen, no longer waiting to get them on credit. Nomadic Fulani (cattle owners) have also settled to carry out serious food crop cultivation using Animal Traction (AT). More of them are indicating their interest in receiving training, 14 Fulanis trained out of a total of 20, representing 75% participation in Misaje training; 23 Fulanis out of a total of 50, representing 46% training in Wum and in Ntabah 14 Fulanis out of 46, representing 30.4% participation. Many cultivated hill areas in the world are inaccessible to tractors and other forms of mechanical power. Increasing fuel prices and the difficulties in repairing machinery in these and other areas suggest that animal power will continue to be important in developing countries in the future. Presently a litre of fuel in Cameroon costs between 430–450 F CFA (equivalent to 0.60–0.75 US$/l). With the prevailing economic structural adjustment, hard currency for importing and maintaining tractors might be scarce and not a government priority. These only accentuate the dependence on healthy animals, for work, fuel and manure by the rural masses where poverty is rife and human morbidity and mortality relatively high.

There is no doubt that the use of DAP has tremendously improved agricultural production in the North West Province of Cameroon. According to the Provincial Service of Statistics, Provincial Delegation of Agriculture, North West Province, out of 750 000 tons of maize produced in Cameroon, the North West Province accounts for 188 500

tons, about 25.1% of the national production, enabling it to be the leading smallscale or peasant national maize producer . It is also the leading national producer of rice, 138.884 tons out of 512.478 tons, 27.1% of the national production. With more people acquiring cattle, it has also become the leading producer of milk 11.000 tons out of 50.000 tons , about 22% of the national production.

It appears that plenty of caution is being shown by PAFSAT in order to ensure that farmers using DAP do not indiscriminately and recklessly exploit large areas of farmland. No incidence of migration as a result of depletion of soil fertility due to the use of Animal traction (AT) has been reported to date, as is the case with oxen cotton farmers in Northern Cameroon. These might be ascribed to the hard work of the project evaluation and monitoring departments enabling them to sensitise these farmers. In our subsequent articles, we will attempt to answer pertinent questions that may arise following the widespread use of DAP in the North West Province of Cameroon. These will be as a scientific investigation in the areas of welfare, nutrition, management and health status of some draught animals (cattle and donkeys) used by this project in the province .

Acknowledgements

I am very grateful to the General manager of MIDENO Mr. J.B Ndeh for funding and permitting this work . And also Mr. Nuza Syxtus the Provincial Delegate of Agriculture, North West Province, and Mr. Mubang Amos the Provincial Co-coordinator of PAFSAT for allowing me to use their facilities and for providing useful information. Thanks also go to Ndang Gladys for typing and printing this work.

(d) Botswana

Effect of the Arable Lands Development Project (ALDEP) on animal draught power and equipment use in Botswana

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Introduction

The people of Botswana have subsisted from agro-pastoral farming over many years and extensive cattle raising appears to have consistently had a comparative advantage over arable agriculture amongst farming enterprises in terms of returns to capital and to labour, the traditionally scarce resources.

Prior to the discovery of the mineral resources, especially diamonds in the early seventies, the livestock sector contributed 35–40% in terms of the gross domestic product and 50–55% in terms of exports (Purcell, 1982). A study conducted by the Rural Income Distribution Survey in 1974/75 overturned the conventional belief then that every Botswana family owned cattle and was therefore benefiting directly from the development of the livestock industry. On the contrary though, the survey found that 45% of the rural households did not own cattle and of those who did 5% of the households owned 40% of the national herd (Purcell, 1982). Furthermore, the machinery manufacturing sector of Botswana was at its infancy stage. Therefore, scarcity of implements or equipment used in crop production was a common problem which largely limited productivity of rural households. Farmers depended much on borrowed

equipment and on imported implements from South Africa. Availability of spare parts and servicing was always a problem, which hindered crop production.

The climate of Botswana is characterised by low and erratic rainfall with recurring drought spells. This adversely affects crop production but is less damaging towards pastoral farming. The erratic rainfall and recurrent droughts do not only affect crop performance but also affect the main source of draught power to the farmers, animals. These droughts usually result in loss and/or weakened draught animals leading to delayed ploughing. This is a hindrance to timeliness of operations, usually a requirement in semi arid areas for the utilisation of the first rains.

The Government of Botswana therefore started the Arable Lands Development (ALDEP) in 1982. This was a US$10 million project funded by loans from the African Development Bank (ADB), the African Development Fund (ADF) and the International Fund for Agricultural Development (IFAD). The programme received technical assistance from the Food and Agriculture Organisation (FAO) of the United Nations from 1983 to 1990 and from John Bingle Ltd of Australia since 1988 (eight years of ALDEP 1982–90). ALDEP commenced in 1982 and was to operate in two phases. The first phase was from 1982 to 1993, with the second phase following from 1993 and still ongoing. ALDEP has a working target population of resource poor farmers herein referred to as smallholder farmers who own less than 40 cattle. The farmers constitute the majority (70–75% of the traditional arable farmers with land) of the farming community in Botswana. The main objective was to assist farmers with on-farm packages such as draught power animals (cattle and donkeys), animal-drawn implements (ploughs, planters, cultivators, harrows), scotch carts, fencing material and water catchment tanks. For implementation purposes ALDEP was initially spread through five agricultural regions in Botswana, which were: Gaborone, Central, Maun, Southern and Francistown regions. The Western region was introduced later. The first phase of ALDEP focused at assisting farmers to grow enough food for subsistence consumption. The second phase was targeted at assisting eligible farmers with agricultural implements and strengthening agricultural extension services.

Draught power package

Over the years during ALDEP phase one, from 1980–1990, animal draught power usage declined (Table 9), although there was a cumulative distribution of draught power animals. The decline is contrary to the objective of ALDEP, which is to provide timely access to draught power to improve crop production.

The decline in draught power use could be due to many factors. ALDEP phase one was implemented during a

Table 9: Draught power usage (household numbers).

Year	Animal draught power	Tractor power
1973	24,800	500
1980	53,550	11,350
1981	56,700	11,200
1982	44,650	12,100
1983	38,600	9,400
1984	38,000	13,000
1985	36,250	19,000
1986	33,850	22,350
1987	34,750	22,600
1988	35,650	22,850
1989	39,050	23,800
1990	37,650	24,850

Source: Botswana Agricultural Statistical reports (1973–1990).

drought spell, which dominated most of the period during which the programme was implemented. The droughts affected the condition of the animals and most either died or were too weak to provide draught power. The timing of the first phase of ALDEP was therefore detrimental to the performance of the scheme (Kerapeletswe, 1992).

Furthermore, the smallholder farmer who owns cattle usually earns income from sales of their livestock to pay for their family's subsistence needs. The increase in economic value of cattle has also led to reductions of draught power sources.

Another point worth noting, which has also constrained the performance of the draught power package was the introduction of drought relief schemes. Schemes such as the Accelerated Rain-fed Arable Program (ARAP) and the Drought Relief Programs (DRP) introduced during the same period to alleviate the effects of drought on farmers, constrained ALDEP in two ways.

First the schemes offered 100% subsidies for ploughing, planting and other farm activities such as weeding and destumping and therefore farmers were attracted to these schemes. Due to ARAP and the drought relief programmes people who had financial resources got loans from banks to buy tractors, which they hired out to farmers at government expense. Therefore, tractor owners captured all the ploughing subsidies provided to farmers and this also led to increases in tractor hire prices. Thus it can be noted that ARAP and the DRP created dependency on the government for the smallholder farmers. Realising the benefits of tractor use in farming operations such as labour substitution and timeliness, the smallholder farmer's enthusiasm for use of animal draught power declined, even though schemes, which wholly depend on government funding, like ARAP, are prone to failure as noted in Swaziland for the tractor hire scheme (Agrippa & Lukhele, 1991). The fact that ARAP negatively affected the draught power package on ALDEP was evident from the fact that with the withdrawal of ARAP in 1989–90, the demand for animal power has gradually increased (Kerapeletswe, 1992). Secondly, the schemes deprived ALDEP of the extension agents who were expected to implement concurrently the schemes and ALDEP. These led to implementation conflicts, there was heavy involvement of village level extension workers on administering these programmes to the exclusion of executing other extension services such as disseminating information on improved technologies (Seleka & Mmofswa, 1996).

The other point worth noting is that the farmsteads in Botswana are dominated by old people due to the migration of able-bodied people from rural areas to towns (Atlhopeng, 1999). This rural-urban drift left farmsteads with no source of labour to train, let alone work the animals. From the above submissions it becomes rather difficult to conclude that the decline observed for the number of households using draught power was due to the inefficiency of ALDEP. However, it is surprising that even so there was a decline in animal draught power use. There was continued distribution. There, however, seems to have been improper monitoring which could have highlighted that draught use was declining. Therefore, ALDEP implementors should have closely assessed the running of the programme to solicit such mishaps within the programme. A study carried out by Kerapeletswe (1992) in the Tlokweng extension area concerning the uptake of ALDEP packages, revealed that farmers did not find draught power suitable to their area due to lack of grazing land. Farmers therefore showed preference for tractors.

Equipment (machinery) package

The number of farm implements used increased with distribution over the years. The use of planters, cultivators and harrows also increased during ALDEP phase one, this shows a positive response to ALDEP (Table 10). The increase in planter use was because farmers had begun to see the benefits of row planting as opposed to broadcasting. This realization led to a high demand for planters. The increase in use of cultivators/harrows was enhanced by a condition introduced during ALDEP phase one, which required a farmer to take a planter and a cultivator/harrow in one package. This led to an improvement on the uptake of the cultivator/harrow which was originally low (Kerapeletswe, 1992). The number of ploughs increased sharply whilst that for planters, cultivators and harrows increased gradually. This also shows a positive response to ALDEP. A positive correlation is noted between implement ownership and distribution for ploughs, planters and cultivators and harrows.

Table 10: Equipment type and usage (household numbers).

Years	Cultivators/harrows	Planters
1968	317	300
1969	468	536
1977	1,858	1,095
1981	2,450	1,800
1983	4,300	3,050
1984	3,850	5,500
1985	6,600	4,800
1987	7,350	10,850
1988	9,050	13,600
1990	10,400	15,500

Source: Botswana Agricultural Statistical reports (1968–1990).

Table 11: Number and types of farm packages distributed during ten years of ALDEP (phase one).

	Draught power	Ploughs	Planters	Cultivator/ harrows
1983	198	250	65	53
1984	54	70	35	12
1985	709	663	313	175
1986	1,078	211	19	14
1987	467	3,154	285	153
1988	572	3,285	288	135
1989	350	4,141	386	170
1990	479	425	278	217
1991	649	2,361	627	251

Source: Ten years of ALDEP (1982–1992)

The distribution of planters and cultivator/harrows was low compared with usage. A comparison of draught power use and plough ownership shows that the ownership of ploughs has far surpassed the use of draught power. This could suggest that ploughs were oversupplied and beneficiaries of the ploughs had not been using the ploughs. It

is expected that the number of households using draught power should be consistent with the number of ploughs owned or higher since ploughs can only be used when there is power to pull the ploughs. The number of households using draught power fell to 35,650 whilst that for the ploughs owned was reported at 94,200 for the same year. Therefore, it can be seen that ALDEP was distributing ploughs although their use was declining (Table 11).

Conclusions

The level of mechanisation with respect to the use of draught power did not improve during phase one of ALDEP. The distribution of planters, cultivators and harrows during ALDEP phase one was low compared with usage. ALDEP should be credited for enhancing the level of farm implement availability, particularly planters and cultivators, which was originally low but has gradually increased during ALDEP, phase one.

References

Agrippa, D. & Lukhele, P.K. (1991). A review of agricultural mechanization strategies for small-scale farmers in Swaziland. In: Mrema, G.C. (ed.), *Agricultural Mechanization Policies and Strategies in Africa*. Food Production and Rural Development Division, London.

Anon. (1968–1990). Agricultural Statistics Reports, Ministry of Agriculture, Gaborone, Botswana.

Anon. (1992). Ten years of ALDEP (1982–1992). Ministry of Agriculture, Gaborone, Botswana.

Atlhopeng, M. (1999). Problems associated with draught power package acquisition (ALDEP). Monitoring and Evaluation Section, Division of Agricultural Planning and Statistics, Ministry of Agriculture, Gaborone.

Kerapeletswe, C.K. (1992). Tlokweng extension area ALDEP uptake study. Socioeconomic Monitoring and Evaluation Unit, Division of Planning and Statistics Report.

Purcell, R.A. (1982). A note on the evaluation and of the Botswana Arable Land Development Program. Ministry of Agriculture, Gaborone.

Seleka, T.B. & Mmofswa, D. (1996). Promotion of smallholder farmer development in Botswana: the case of arable and livestock farming. In: *Promotion of Smallholder Farmer Development in the SADC Region.* Proc. of a SADC Smallholder Farmer Development Workshop, 11–13 November 1996, Troutbeck Inn, Zimbabwe.

(e) Botswana

Some clinical chemistry values for donkeys *(equns asinus)* in Oodi, Kgatleng District, Botswana

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Summary. Baseline clinical chemistry data were obtained from blood samples collected from 100 adult donkeys. These values could be regarded as reference values to be used in disease diagnosis.

Introduction

In Botswana, rural communities rely on the donkey as the beast of burden for pulling ploughs, transporting goods, especially in inaccessible areas such as hilly and rocky terrain. The Tswana donkey is virtually never supplemented even in the dry winter months. When grazing is scanty, the donkeys roam about in search of grazing and water. Questionnaires performed by some authors indicated that very few donkey owners gave anthelmintic, some claiming that their donkeys 'never got sick at all' (Mushi *et al*., 2000). To date there are no published blood biochemical parameters of the

Tswana donkey found in Botswana. The aim of the present paper was to establish the reference serum biochemistry values of the Tswana donkey and the possible management influences on these analyses is discussed briefly.

Materials and methods

Blood samples were obtained from 100 clinically normal adult local breed (Tswana) donkeys of either sex, aged between 3 and 10 years. The donkeys belonged to several smallholder farmers in Oodi village, Kgatleng district. No supplementary feeding was available for the donkeys, since it was out of ploughing season, the donkeys were allowed to graze freely in search of feed and water. The donkeys were not routinely dewormed. Minimum handling was done to reduce stress and its effects on the blood constituents.

Blood samples were obtained from the jugular vein in serum vacutainer tubes without anticoagulant. Prior to bleeding the jugular vein was exposed, cleansed with a cotton swab moistened with an aqueous solution of Savlon, a disinfectant containing Chlorohexidine gluconate (Johnson & Johnson, East London, South Africa), followed by another swab moistened with 70% alcohol. Blood was collected into vacutainer tubes without anticoagulant at the same hour (10.00–11.00). Some blood was collected in fluoride-citrate as anticoagulant for the determination of glucose. In order to reduce possible variations associated with diurnal changes, the blood without anticoagulant was allowed to clot for one hour at room temperature and then was immediately harvested to prevent the diffusion of potassium from the clot into the serum. Serum samples from each donkey were kept in 1 ml aliquots at 4°C for a maximum of 4 hours before being analysed. The fluoride-citrate blood samples were centrifuged within 20 minutes of collection to minimise erythrocyte consumption of glucose. The plasma thus collected was dispensed into l ml aliquots and stored at +4°C until ready for use. The sampling exercise was done during the course of one month (July 1999) in order to avoid introducing seasonal effects which usually influence the diet and the physiology of the donkeys.

Serum samples were analysed for copper and zinc colorimetrically on a UV spectrophotometer (Shimadzu 1601) using commercial kits (Boehringer Mannheim Diagnostics, Germany) for copper and (Wako Chemicals, GmH, Germany) for zinc respectively. Serum zinc levels were quantitated using *in vitro* colorimetric method involving deproteinisation with trichloroacetic acid. Thereafter, the zinc that is released binds to a chromagenic component forming a reddish violet chelate whose absorbance when measured at a wavelength of 560 nm is directly proportional to the amount of zinc in the serum. Serum copper was determined using diethydithiocarbamate as the chromogen with the resulting golden yellow complex which is read at a transmission wavelength of 440 nm. The detailed protocols for the methodologies for both copper and zinc were as stipulated by the manufacturers of the kits was also provided the control serum for the tests.

Serum phosphorous, calcium, magnesium, cholesterol, triglyceride, urea, creatinine, total bilirubin including enzyme activities were determined from serum using a chemical analyser (Vitalab Selectra, Merck Instruments) fitted with an Isoselective electrode (ISE) for the determination of the electrolytes, sodium, potassium and chloride. The chemical analyzer has a built-in automatic calibration system using commercial

calibrators (SMT calibrator, Merck) supplied with reagent kits. Glucose was determined from plasma using the same kits.

Results

Reference ranges of chemical constituents of the blood of the indigenous donkey in Botswana, commonly referred to as the 'Tswana' breed in the present study are depicted in Table 12.

There was a wide variation in the range of activity of the enzymes alkaline phosphate (AP), aspartate aminotransferase (AST), alanine aminotransferase (ALT) and creatine kinase (CK). The other analyses namely total bilirubin, calcium, creatine, magnesium, phosphorous, potassium, total protein, albumin, globulin, urea, sodium, chloride and triglyceride seemed to have normal distribution. The rest of the analytes, total cholesterol and glucose did not seem to have a normal distribution. Variation in the concentration of analytes caused by differences in age and sex were not evaluated in the present study.

The Tswana donkey had a mean serum triglyceride value of 157.5±35.0 mg/dl which was twice the value given obtained for the Catalonian donkeys, 74.8±32.5 mg/dl (Jordana and Folch, 1998). Comparison of clinical biochemical ranges of donkey breeds and populations from various countries is shown in Table 12.

Discussion

In the present study, an attempt was made to establish reference ranges for the indigenous donkey, commonly referred to as the Tswana donkey. The results obtained in this study were compared to other donkey populations from other countries (French & Patrick, 1995). The activity of the serum, AP in the Tswana donkeys was comparable to that obtained from the Zimbabwe donkeys (Hill, 1989). In the equine, this enzyme is involved in bone metabolism where it is higher in the young than in the adult animals (Kaneko, 1989). The Tswana donkeys showed higher (AST) and (CK) than the Catalonian donkey (Jordana & Folch, 1998). However, both donkey populations had lower serum AST activities than values obtained for donkeys from the USA (Zinkl *et al*., 1990). Donkeys from Zimbabwe showed serum AST activity ranges comparable to the Tswana donkey. Handling and restraint prior to bleeding coupled with management practices peculiar to each household, could in part account for comparatively elevated levels of CK seen in Tswana breed of donkey. The donkeys were sampled during the non-ploughing season during which time they resent handling by strangers.

While the mean for total bilirubin was comparable to that obtained for Zimbabwe donkeys, the values were lower than for the Catalonian and American donkeys. Total bilirubin levels are a reflection of hepatic integrity (Kaneko, 1989) which in this study indicated normality.

The mean and range for serum calcium were comparable to the levels reported for Zimbabwe donkeys. Ionised calcium which is approximately 50% of the total serum calcium is biologically involved in bone formation, neuromuscular activity, cellular biochemical processes and blood coagulation. According to Ferlazzo *et al*. (1986), serum calcium represents a balance between bone formation and bone resorption and is independent of dietary intake, unlike phosphorus whose levels are influenced by the diet. In this study, the levels were a reflection of uncompromised absorption, synthesis, assimilation and excretion of calcium in the Tswana donkey.

Table 12: Means, standard deviation and ranges for clinical chemistry analytes.

			Donkeys:			
Analyte	**Range**	**Tswana**	**Catalonian**[1]	**USA**[2]	**Zimbabwe**[3]	**Indian**[4]
Alkaline phosphatase (U/l)	300–900	600±150	–	–	604±207	–
Total bilirubin (mg/l)	0.12–1.17	0.41±0.29	0.05±0.03	0.10±0.20	0.43±0.37	–
Calcium (mg/dl)	7.6–14.4	12.08±1.16	–	–	11.04±2.04	–
Total cholesterol (mg/dl)	50–75	53.67±1.16	71±26.3	108±30	91.89±29.73	56.8±0.7
Creatine kinase (IU/l)	156–1000	300±120	195±104	64±43	343±200	–
Creatinine (mg/dl)	0.50–1.08	0.77±0.14	1.06±0.22	1.1±0.3	0.70±0.16	1.2±0.1
Glucose (mg/dl)	0.43–2.36	63.0±13.3	–	–	71.0±16.04	–
Magnesium (mg/dl)	2.48–4.80	1.56±0.41	–	–	2.09±0.78	–
Phosphorus (mg/dl)	3.5–4.5	4.45±1.51	3.80±0.86	4.3±1.3	5.02±1.30	2.9±0.1
Potassium (mEq/l)	7.01–11.61	3.50±0.45	–	–	4.30±0.45	–
Total protein (g/dl)	2.00–5.10	8.76±1.05	–	–	6.40±0.59	–
Albumin (g/dl)	3.07–8.71	3.30±8.37	2.68±0.36	–	2.30±0.39	–
Globulin (g/dl)	100–700	5.48±1.46	–	–	4.00±0.54	–
Aspartate aminotransferase (U/l)	10–30	300±120	254±57	487±119	338±150	–
Alanine aminotransferase (U/l)	14–25	15.0±6.0	–	–	20.0±8.5	–
Urea (mEq/l)	130–154	40.86±1.95	36.1±7.7	18.5±5.0	36.45±7.95	25.0±0.7
Sodium (mEq/l)	90–115	149±10	–	–	128±8.2	–
Chloride (mEq/l)	0.64–2.86	109±5	–	–	–	–
Triglyceride (mg/dl)	100.3–180.0	157.5±35.0	74.8±32.5	–	–	–
Albumin : globulin ratio	0.28–1.43	0.67±0.35	–	–	0.60±0.16	–

It was also noted that Tswana donkeys had lower mean cholesterol levels than Catalonian or USA donkey populations but was closer to the mean value obtained for the Zimbabwe donkeys.

A relative hypertriglyceraemia compared to the Catalonian donkeys, was evident, the cause of which could not be explained since the Tswana donkeys in this study were given no supplementation. Hyperlipaemia syndrome in donkeys has previously been associated with a 65% mortality rate in pony breeds (Tarrant *et al*., 1998). However, there has been no reported cases in the Tswana donkey in this country.

The mean level of cholesterol was lower than that cited for Zimbabwe donkeys. The lower concentrations could probably have been due to a lower nutritional status, since these donkeys were not given any supplementary feeding. The donkeys were sampled during the non-ploughing season when they were mostly dependent on pastures which were scanty since there had been a drought.

Creatinine concentration is dependent upon the total body content of creatinine and hence this in turn depends on the dietary intake and muscle mass (Kaneko, 1989). It would appear the Tswana donkey could only compare with the Zimbabwe donkeys in this regard. In appearance and physique, these two donkey populations seem to be similar and hence the muscle mass. Most creatinine originates endogenously from the conversion of creatine that stores energy in the muscle as phosphocreatine. Creatine is converted to creatinine daily and the creatine is influenced by muscle mass. It would appear that conditioning resulting from the use of the donkey as a draught animal in Botswana may have influenced the concentration of this analyse. It was, however, noted that the mean creatinine level was comparable to those obtained for the other donkey populations. The mean glucose levels were comparable to that reported by Hill (1989). In the present study it was considered to be post-prandial since there was no fasting prior to collection of the blood sample.

The Tswana donkey had lower serum magnesium levels compared to Zimbabwean donkeys. However, the serum levels of phosphorus, urea and albumin were comparable to Zimbabwean and Catalonian, America. In contrast, sodium levels were higher In the Tswana donkeys than Zimbabwe donkeys. This could be attributed to the higher level of tolerance to salinity by the donkeys in this study since this geographical location is notorious for high salinity in the water.

Total protein is often a reflection of the nutritional status of an animal. Surprisingly, the mean serum total protein and albumin values were higher in the Tswana donkeys than the Zimbabwe donkeys although there was no supplementation for the latter.

In conclusion, it is imperative to find baseline levels for donkeys in developing countries especially where the donkey contributes immensely to the survival of rural populations by providing transport, draught power and meat. Ultimately, the nutrition and health status of the previously uncared for donkey will be improved. The findings in this study suggest that since the Tswana donkey is comparable to other donkey populations on the African continent (Nayeri, 1978), the above mentioned objectives could be achieved by standardising management practices to better the life of the donkey.

References

Hill, F.W.G. (1989). Haematological and clinical chemistry values for donkeys in Zimbabwe. *Zimbabwe Veterinary Journal* **20**, 113-120.

Ferlazzo, A., Panzera, M; Balbo, S.M. & Caola, G. (1986). Some blood chemistry values in *Equus asinus*. Influence of transport stress. *Clinca Veterinaria* **106**, 238-242.

French, J.M. & Patrick, V.V. (1995). Reference values for physiological, haematological and biochemical parameters in domestic donkeys (*Equus asinus*). *Equine Veterinary* Education 7, 133-35.

Gupta, A.K., Varshney, J.P. & Uppal, P.K. (1994). Comparative studies on biochemical indices in different breeds of equines. *Indian Veterinary Journal* **71**, 26-30.

Jordana, J. & Folch, P. (1998). Clinical biochemical parameters of the endangered Catalonian donkey breed. Normal values and the influence of sex, age and management practices effect. *Research in Veterinary Science* **64**: 7-10.

Kaneko, J.J (1989). *Clinical Biochemistry of Domestic Animals* (4th edit.). San Diego, Academic Press, Inc. Chs 6 and 18, Appendix VII.

Mushi, E.Z., Binta, M.G., Chabo, R.G., Ndebele, R., Machete, J.B. & Giddie, B. (2000). Parasites of donkeys *(Equus asinus)* in Oodi, Kgatleng district, Botswana. *Draught Animal News* (in press).

Nayeri, G.D. (1978). Blood characteristics of the adult donkey. *Zentrakblatt f/r Veterin. medizin* **25**, 511-547.

Tarrant, J.M., Campbell, J.M. & Parry, B.W. (1998). Hyperlipaemia in a donkey. *Australian Veterinary Journal* **76**, 466-469.

Zinkl, J.G., Mae, D., Merida, G.P., Farver, T.B. & Humble, J.A. (l990). Reference ranges and influence off age and sex on haematologic and serum biochemical values in donkeys (*Equus asinus*). *Australian Veterinary Journal* **51**, 408-413.

(f) Ethiopia

The use of the domestic donkey in Addis Ababa

Rupert Boswall

The following researched material results from a visit to Ethiopia in 1984 when an attempt was made to collect data on the use of *Equus asinus domesticus* by Homo sapiens.

Addis Ababa – the New Flower – capital of Ethiopia, rests at the foot of the Eutoto hills, 8,000 feet above sea level. It is the highest city in Africa. This altitude has produced an almost ideal climate with an annual average temperature of 61ºF. Its only unusual feature is an annual average rainfall of 49 in. which arrives in fierce rainshowers for three months of the year: April, July and August.

For all of Addis Ababa's modern office blocks and flats, hospitals and schools, cinemas and shops, it is still visibly linked and dependent upon the surrounding countryside. This link is formed by the stream of donkeys and human porters carrying fuel on their backs into the city. There can be few major cities left in the world where such transport is in evidence to such a degree. This paper is a small assessment of the non-mechanised transport entering Addis Ababa.

Way of life

Addis Ababa is comprised of many thousands of compounds built in a haphazard fashion as the city has expanded over the last hundred years. Compounds vary in size from the residential housing on the Bole road to the poorest lean-to. The wealthiest compounds will be surrounded by dry stone or cement walls whilst the poorer ones will be made of eucalyptus branches. However, the majority of enclosures are formed by upright corrugated iron.

These figures give one an idea of the living conditions of the majority of the people in Addis Ababa. ‘Houses in the towns sprawl on tracks of open ground in a dense and haphazard pattern without much planning. In Addis Ababa in one third of the city the density is 400 people per hectare.’ Since the revolution a structure has been imposed on the city in the form of urban dwellers’ associations, popularly known as kebelles of which there are 25 higher kebelles and these are subdivided into 280 ordinary kebelles.

Urban market structure

The market structure of Addis Ababa is in three parts: the ‘meriato’, the new markets and the local ones.

The ‘meriato’ is the most important of them and is, in fact, regarded as the largest market of its kind in Africa. It is a colourful place dealing in almost anything from coaches to vegetables. The ‘meriato’ dominates the western side of Addis Ababa and in many ways the city revolves around it. The new markets are small by comparison. There are two of them, created in the last 20 years, to relieve the pressure and influence of the ‘meriato’. The local markets often comprise only 30 people, and although each has its traditional place, one often sees a single woman set up shop by the side of the road.

The market structure has changed over the years. Before the Italian occupation the market used to be at the centre of the city. One observer in 1902 was very impressed with the orderliness of the horse and mule fair on the southern side of the market. ‘The Abysinnians have an excellent rule that before a bargain is complete the vendor and the purchaser must together lead their beast before an official who registers their names, witnesses the paying over of the money and exacts a fee from both parties to the contract.’ A lucrative job. By 1935 the market had expanded considerably. The Italians decided to move it to the west of the city. They imposed a structure on the market dividing it into sections. They also contributed buildings to house the stalls – see diagram [?]. From this time, for obvious reasons, the market became known as ‘meriato’.

As the city and the ‘meriato’ expanded and Addis Ababa became a ‘modern’ city a major problem arose – congestion. Not of cars against cars but cars against donkeys. On the map of Addis Ababa below one can see that goods entering the city on the Dessie road have to cross Revolution Square and even go up Churchill road to reach the market. This is the central area of the city with the National Bank, National Theatre, airline offices, shops and hotels. It is also one of the busiest centres for car traffic.

The solution to this problem was to divert the donkey traffic to another market. However, since there was no other it had to be created. To be a solution this market had to be large enough and busy enough to attract the traders there instead of to the centre of town. Today, although there are no donkeys on Churchill road, quite a number still cross Revolution Square. Their non-existence on Churchill road is not achieved so much by the attraction of the market on the Dessie road as by the disuasion of the police. Donkeys entering the city on the Dessie road seem to cross Revolution Square and travel up behind Churchill road. Despite this the creation of the Dessie road market seems to have achieved its purpose.

The same cannot be said for Addisa Gabaya (the New Market) on the Gojjam road. The purpose of this creation was different to that of the Dessie road market. Here there is not the same problem of donkeys affecting the functioning and appearance of a modern city. Addisa Gabaya seems to have been built simply to take some of the pressure off the ‘meriato’.

It is, however, underused. This is not a fault of the design of the market. The planners have obviously gone to some trouble finding out what type of stalls were required. It is a fault of position. The distance from Addisa Gabaya to the 'meriato' is too small to diminish the latter's overpowering attraction. The majority of people entering on the Gojjam road are simply prepared to walk the extra mile or so for a wider range of goods and a livelier atmosphere.

The difference in size of the three types of market are naturally reflected in the selection of goods. The local markets deal usually only in vegetables, fruit, charcoal, firewood, grass, small pots and spices. One sometimes also sees a blacksmith. These markets are run mostly by women. Generally speaking the goods listed above are 'female' goods. Men are usually involved in the sale of chickens, rope and metal products. Since no study has been made of the market system one can only speculate

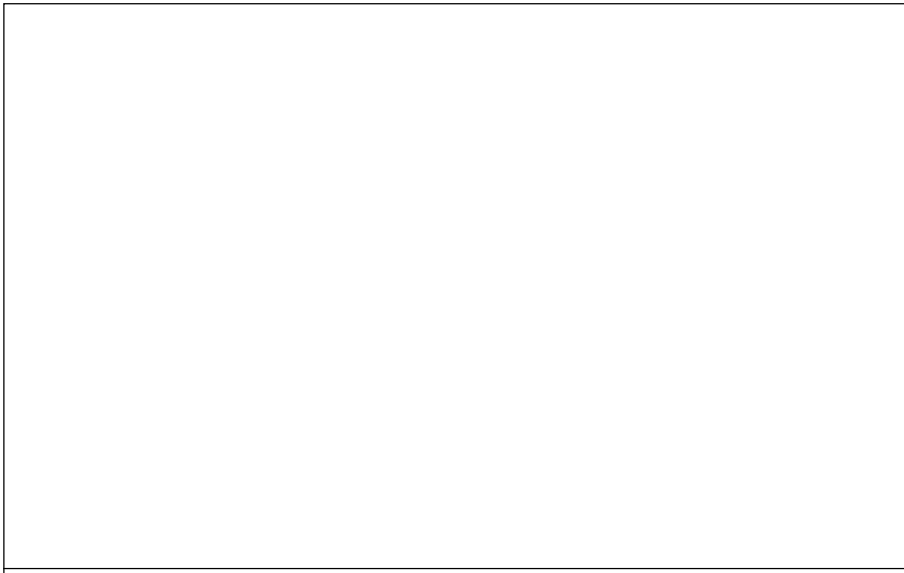

Plate 6: Donkeys bringing wood into Addis Ababa, Ethiopia (A. Pearson)

as to its mechanism. Some of the goods sold in these local markets will have been grown or collected by people living outside the city and brought in by taxi, bus or on foot to be sold. It is likely that others are simply goods bought from the 'meriato' in bulk (ie. a sack of potatoes) and then sold in these outer markets. Since the vendor has carried them nearer to the demand he can add a few cents to the price and make a small profit. For many, however, this service is irrelevant, their shortage of money is so acute that any walk is worth saving any money.

At the two new markets the major additions to the range of goods are cloth and larger earthenware products. At Addisa Gabaya the stalls most used are by the tailors. The people selling earthenware do not rent a stall; pots are not spoilt by the rain. Oil and hay are also sold.

In the ‘meriato’ there is genuinely no limit to what can be bought. The market days in Addis Ababa are Wednesday and Saturday and of the two, Saturday is the larger. In the ‘meriato’ though, even during the week one would think it was a market day. Every space seems to contain a stall. One can get lost in acres of vegetables, spices, leather or cloth.

Three major products are controlled by the kebelles: grain, coffee and wood. The grain is mainly teff for injera, also available are maize and wheat. The wood is firewood which is not suitable for construction purposes. These three important goods are distributed through kebelle service co-operatives. In the yard of each kebelle one can see large stocks of firewood and one also sees trucks unloading grain and coffee into kebelle controlled warehouses. This control is an attempt to prevent food and fuel shortages by fair distribution. Families are restricted often to one bundle of wood a week. Restrictions on the consumption of teff are achieved through price increases.

Element of goods which enter via non-mechanised means

Although many thousands of donkeys and porters enter Addis Ababa, the variety of their loads is limited. There are in fact seven major loads: eucalyptus, hay, straw, dung, charcoal, teff and maize. One will occasionally see rope, vegetables, cheese and milk being moved but in small and often negligible quantities.

Of all the commodities the transportation of eucalyptus is far and away the most voluminous. The tree enters the city on foot in three forms: as short logs, thin leafy branches and long trunks. The small logs are for firewood. Although they vary in length on average they are 45 cm long. The wood is carried by all three forms of non-mechanised transport, namely men, women and donkeys. Donkeys carrying firewood usually carry three shekims strapped onto them in a triangular formation.

Eucalyptus enters as thin, leafy branches. This again is used as fuel although its use is specific to the cooking of injera in a way that the eucalyptus firewood is not. Apparently the leaves are thought to be necessary to the making of good injera because their oil content makes them burn with a quick, hot flame. There is a large variation in the quantity of leaves being transported. One the one hand, the lengths of branch have been cut uniformly and methodically tied onto the donkey. On the other much longer pieces have been attached lengthways on the donkey and drag on the ground. These always look as if they are about to fall off.

Hay is a significant product entering the city. There are a number of cows in town and it is not unusual travelling by car to have to wait for a cow to leave the road before progressing. Hay enters solely on donkeys. It is either strapped on open to the air or packed into bags. (I have only ever seen two men carrying hay and I am sure they were carrying it a very short distance.) Straw is also brought in in bags. It is used for animal bedding and for thatching. Most, however, is for bedding as thatched houses are a rare sight today. From the air Addis Ababa is a mass of the tiny reflections of camero [?] roofing. It is possible to distinguish the straw that is going to be used for thatch as it is usually carried separately by men on the end of their wooden poles. Tied at one end, the effect is fan-like.

Grass has certainly declined in importance with modern times. According to Horvath, ‘Grass was probably the most important commercial item supplied during the first decades of Addis Ababa’s history.’ ‘Grass for thatch, weaning, animal feed and floor decoration is most important.’

Grass is, in fact, used in one other way – as fuel mixed in with manure producing a dung cake. In Ethiopia in general manure is used as a fuel and not as a fertiliser. Although men do carry dung cakes the majority seem to be carried on the backs of donkeys and women. The uneven surfaces of the cakes mean that they wedge together very easily. Often this is irrelevant since they are carried inside large stretches of cloth.

Donkeys are still used in the Addis Ababa construction business. Groups of donkeys walking in single file move stone from small 'quarries' to a building site. The weight of the loads limit this to a very local affair. It is perhaps surprising that in the city donkeys are used to move stone at all. In the country their use is necessitated by the terrain. (Incidentally, an architect at the Ministry of Education remembered one primary school complex requiring 800 donkey-loads of material.) However, in Addis Ababa trucks carrying stone can get anywhere. It seems likely their use is ensured by the need for smaller quantities of stone to be moved than is profitable for trucks to move. The stones are placed onto wooden structures which are fixed to the donkey.

Earthenware enters the city in two basic forms, as pots and as mitads (plates on which injera is made). The pots are made in many sizes from the enserra to a coffee pot. The mitads are of standard size. Donkeys are much more efficient carriers of pots than humans. They can carry three of the enserras, five of the middle size pots and many of the smaller sized ones. A human alternatively could only carry one enserra and two of the lesser pots. Often it is difficult to tell whether the pot on a woman's back is being taken for sale or to fetch water. The mitads can be carried as easily by humans or donkeys. When the earthenware is made it is not fired to a very high temperature. The resultant pots are likely to break quite easily. Therefore, although a great deal of earthenware is moved in cars and buses, there is still room in the market for donkey and human transportation since it is more protective of the pottery.

Plate 7: Donkeys transporting water on the edge of Addis Ababa, Ethiopia (A. Pearson)

In addition to the commodities discussed, when in season teff, teff straw and maize are brought in solely by donkey. A small amount of charcoal also comes in usually by donkey though sometimes carried by women. Milk and cheese used to come into the city in large quantities carried by people and some donkeys. However, there now exists a system whereby the milk is carried to collecting points in the countryside and then brought in by truck. Some women still bring in their cheeses.

When transporting goods, donkeys invariably have sacks over them to protect their backs. Despite this many backs display open sores. Abyssinians are described by J. Boyer as being 'the most adept people at mule parking that I have seen in any part of the world' [mules are used as transport animals in difficult terrain; however, the term is frequently used by travellers to cover both donkeys and mules – this seems likely to be a statement intended to include both animals]. This may well be the case today, if one ignores the state of the donkey's health as a consideration. Very few loads fall off.

There are five major roads into Addis Ababa: Dessie, Gojjam, Amto, Jimma and the road to the lakes. The goods travelling by non-mechanised means do not enter on these roads uniformly. The volumes are naturally related to the quantity and location of both the source of supply and the population. In the case of the eucalyptus the evolution of the forest around the city has been determined by the position of the roads.

Since the majority of non-mechanised transportation is of eucalyptus products, the lack of forest on the lakes road means there are very few porters and donkeys at all. In fact it is almost possible to drive the length of the road to the outskirts of town and not see one. Something one could never do on any of the other roads.

By the 1960s a system of planting and harvesting had developed around the production of the tree.

The peasants and residents enter or re-enter the city by many routes. The tracks that they have created are direct paths from the most productive parts of the forest to the market. The roads, since they were not constructed with this in mind, are less direct. The numbers of porters and donkeys on the roads in the dry season are quite probably equalled by those out of view on tracks through the houses. In the wet season the tracks are muddy, slippery and difficult. Some of the steeper ones will be impossible. Therefore many more people use the roads.

Addis Ababa residents will walk as far as 14 km out from the city to collect wood. According to Berlan, 'outsiders' will travel on foot from as far as Holeta and Sendafa to the 'meriato'. Certainly some people will still do this on a Saturday. However, since Berlan's time of writing the markets at Holeta and Sendafa have expanded. I should think the number of people for whom it is worth travelling such a distance is small.

The people in charge of the donkeys may not appear to consider their donkeys' plight very often and they do not. But one thing that is judged carefully is the weight of the load relative to the distance travelled. If one sees a very over-burdened donkey one can be fairly sure it is only having to travel a short distance.

Data

The figures below are far from comprehensive (Table 13). As has been explained there are a great many routes into the markets of Addis Ababa. If one wished to count every single person and donkey entering the city to sell produce it would be a major operation.

Table 13: Volume of traffic, and its make-up, in three roads in Addis Ababa in 1984.

Time	Firewood: donkey	Firewood: human	Leaves: donkey	Leaves: human	Hay: donkey	Dung: donkey	Dung: human
Gojjam Road – Wednesday, 13 June 1984							
8.15–9.15	40	124	17	6	20	3	15
9.15–10.15	88	131	65	13	325	11	11
10.15–11.15	86	135	66	7	248	4	12
11.15–11.45	2	37	7	–	–	–	–
Dessie Road – Wednesday, 20 June 1984							
8.15–9.15	228	8	69	48	122	1	4
9.15–10.15	76	4	68	47	42	10	4
10.15–11.15	30	14	32	42	6	4	9
11.15–11.45	2	–	6	5	–	–	–
Amto Road – Wednesday, 27 June 1984							
8.15–9.15	13	54	7	62	2	–	3
9.15–10.15	9	87	44	7	–	–	–
10.15–11.15	38	197	180	–	–	–	–
11.15–11.45	16	18	2	4	–	–	–

Table 14: Volume of traffic in three roads in Addis Ababa on market days, Wednesday and Saturday, and including one other day for comparison.

Place/date	Firewood: donkey	Firewood: human	Leaves: donkey	Leaves: human	Hay: donkey	Dung: donkey	Dung: human
Gojjam							
Mon, 11 June	107	175	65	13	126	10	12
Wed, 13 June	216	427	155	26	606	18	37
Sat, 23 June	144	282	100	13	850	12	87
Dessie							
Fri, 15 June	140	47	112	148	12	3	12
Wed, 20 June	336	26	175	142	170	15	17
Sat, 16 June	490	49	213	183	195	22	62
Amto							
Fri, 29 June	7	209	87	54	2	2	3
Wed, 27 June	76	356	233	75	30	–	3
Sat, 7 July	139	441	250	96	49	3	24

Note: These figures are incomplete. They do not include charcoal, grass, teff, maize, vegetables, earthenware or straw carried by people. Of these commodities teff and maize were the most numerous. No exact figure can be given for them since they were both in sealed bags. Some horses, though very few (I counted only seven), are used to transport hay, wood or leaves. They carry no more than a donkey.

Although some goods are transported by porter or donkey at all times of the day seven days a week the busiest period is in the morning.

To take the Gojjam road as an example. A man intending to take wood to the market from the Sullulta area will collect it the day before he intends to walk with it. He will not have time to do both in one day. Since the peak time of the market is from 10.00–11.00 am and it takes about 3–3½ hours to walk there from Sullulta, he will set off

therefore at about 6.30–7.00 am. The time of the market and the distance most of the people are coming from means that very few people will pass by the checkpoint before 8.15 am although there will be some. As the figures on all three roads show, the volume of traffic is very small by 11.45 am. Again, a number of people and donkeys will pass by during the remainder of the day. These will probably be people travelling from a greater distance or else people from closer by bringing in a second load.

One would expect the volume of goods to be least on the non-market day and most on the Saturday. For most of the goods this is true on the Amto and Dessie roads. However, on the Gojjam road, with the exception of hay and man-carried dung, the impression is that Wednesday is the most important day. It seems likely that the reason for this is the abnormal quantity of hay being transported. These 850 hay-carrying donkeys are almost twice as many as any other product on any other day on any of the three roads. It is simply that hay has to be harvested, transported and sold at a particular time of year. Therefore, donkeys which carry wood most of the year will carry hay in June because that is what *must* be moved before it rots. They will most probably revert to wood and leaf carrying when the season is over. (The same process will occur with the teff straw crop.)

Table 15: Variations in totals of goods carried by humans and donkeys.

	Gojjam			Dessie			Amto		
	Mon	**Wed**	**Sat**	**Fri**	**Wed**	**Sat**	**Fri**	**Wed**	**Sat**
Donkey	326	1,026	1,112	304	870	1,183	102	339	441
Human	200	490	452	207	202	294	266	434	561

On the Gojjam and Dessie roads significantly more donkeys carry goods than people. On the Amto road significantly more people carry goods than donkeys.

The most likely explanation for this is the comparative abundance of wood on the Amto road. As the previous diagram of the forest shows [?], the Amto road is the one with the largest wedge of forest next to the road. With the wood being so close for everyone donkeys are not needed.

It is also worth noting the difference in ratio (human : donkey) between the Gojjam and Dessie roads. The non-market days are of almost equal volume and therefore cancel each other. On the two market days though the Gojjam road has roughly twice as many donkeys as people, whilst the Dessie road has roughly four times.

Donkeys can carry goods longer than humans and therefore further. So if there was a greater use of donkeys it would suggest that more of the goods were coming from a greater distance. However, there is not a greater use of the donkey. The total number of donkeys used is approximately the same – 1,183 and 1,112 – on Saturday, the day when one would expect the greatest difference were there going to be one. The difference in ratio is created by the variation in the people. The people on the Dessie road are very roughly half those on the Gojjam road. This is difficult to explain. If one reverses the above argument one must say: humans carry goods for shorter time and consequently shorter distances. Therefore the lack of human transportation suggests, since wood is the major commodity, that there is a shortage of wood at a close distance to the market.

(g) Zimbabwe

Optimising Draught Animal Power for cropping

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Executive Summary

This DfID funded project, Livestock Production Programme Project R7352, held a second stakeholder workshop from 21–22 September 2000 in Harare, Zimbabwe to discuss the progress achieved in the first year of the project (Livestock Production Program, Project R7352), within the context of the latest developments in draught animal technology for crop production in southern Africa. The project activities comprise mainly on-farm trials, on-station trials and community surveys.

The findings of the on-farm trials have shown that the quality of ploughing could be improved by using well maintained and correctly adjusted implements and hitching arrangements. This was demonstrated in split-plot experiments comparing renovated and correctly set ploughs with the farmers' typical practice. This improvement generally led to healthier (maize) crops with higher yields (average 0.12 t/ha or 14%), but not always without some increase in crop establishment problems. These were attributed to poorer germination resulting from seeds being planted deeper (through the farmers' usual practice of third furrow planting) in the better ploughed land. The farmers also commented that operating a properly set plough was less stressful to both themselves and the draught. The average cost of renovating the ploughs of the participating farmers was equivalent to 0.16 t of maize. The first season's on-station trials, undertaken in atypical weather conditions, are focused on the requirements and effects of ripping. To

Plate 8: Use of draught animal power in crop production in Zimbabwe (D. O'Neill)

Table 16: Crop production costs excluding household supplied resources.

	RG1			RG2			RG3			RG4		
	Total (Z$)	**Per acre (Z$)**	**%**	**Total (Z$)**	**Per acre (Z$)**	**%**	**Total (Z$)**	**Per acre (Z$)**	**%**	**Total (Z$)**	**Per acre (Z$)**	**%**
	2.8 acres			*2.4 acres*			*2.0 acres*			*1.6 acres*		
Seed	558	*79*	*33*	442	*74*	*43*	331	*61*	*49*	238	*55*	*50*
Manure[1]	505	*71*	*30*	262	*44*	*26*	62	*11*	*9*	33	*8*	*7*
Fertiliser	206	*29*	*12*	121	*20*	*12*	51	*9*	*8*	47	*11*	*10*
Chemicals	144	*20*	*8.5*	51	*9*	*5*	19	*3*	*3*	12	*3*	*2.5*
Bags	65	*9*	*3.8*	19	*3*	*2*	7	*1*	*1*	2	*0*	*0.5*
Hired labour	171	*24*	*10*	53	*9*	*5*	38	*7*	*6*	23	*5*	*5*
Hired DAP	3	*0*	*0.2*	48	*8*	*5*	121	*22*	*18*	111	*26*	*23*
Hired tractors	9	*1*	*0.6*	18	*3*	*2*	17	*3*	*2.5*	4	*1*	*1*
Other	31	*4*	*2.0*	19	*3*	*2*	23	*4*	*3*	10	*2*	*2*
Total	**1,691**	***238***	***100***	**1,033**	***174***	***100***	**670**	***123***	***100***	**481**	***110***	***100***

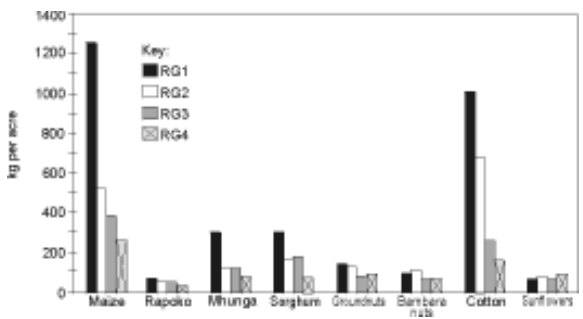

Figure 8: Average yields per acre for main crops grown

gain a balanced view, six designs of ripper and two ploughs were tested in a split-plot experiment with primary land preparation as the main plot factor. The main findings, indicated no significant differences in crop yield with respect to ripper design and that ploughing (e.g. winter ploughing) before ripping reduced the draught demand. This was attributed to the significantly (at $p < 0.01$ level) lower penetration resistance of the ploughed plots. This is a valuable finding as it would counter any exaggerated claims that might be made by a manufacturer for a particular design of ripper. Nevertheless, the discussion on the rippers was inconclusive, implying the need for further work.

The role played by draught animal power (DAP) in smallholder farmers' livelihood strategies is discussed with particular reference to households (n = 248) in Masvingo Province. The households were categorised into four groups with different levels of access to DAP as the underlying criterion, thereby representing different ranges of physical and financial capitals. As would be expected, the better resourced households were able to invest more in crop production (Table 16) and achieved higher yields, particularly for maize and cotton (Fig 8). Contrasting the best and worst resourced groups, the proportions of income from dryland crops and livestock reduced from over 50% to just 7%. Efforts should, therefore, be directed at improving the poorest households' use of DAP. The cost of doing so through better maintained implements would be considerably less than through the purchasing or hiring of animals. The issues associated with implement maintenance and setting, from the farmers' perspective, are discussed. The farmers offer a number of reasons for poor maintenance, the most prominent being cost and availability of access to spares, and lack of training. The parts needing most frequent replacement were found to be shares, landsides and wheel assemblies (Table 17).

Table 17: Frequency of replacement of parts (n=16).

Part	Replaced	% of farmers
Share	14	88
Landside	13	81
U-piece and set screw	11	69
Draw-bar assembly	9	56
King bolt	8	50
Wheel assembly	8	50
U-clamp	7	44
Regulator hake assembly	6	38
Mouldboard bolts	3	19
Frog	1	6
Mouldboard	1	6

The farmers' perspectives were more broadly determined and how farmers acquire and use their agricultural knowledge was analysed and the main factors that influence farmers' practices were examined. In general, the use of draught animals seemed to have been learned from parents. Knowledge of plough operation was found to vary quite widely and several farmers indicated that they did not always practice what they had been shown by AGRITEX (their main source of knowledge). The reasons included not remembering, having difficulty translating theory to practice, and not being motivated to spend time and energy making adjustments for very small plots. This paper also

revealed the existence of certain practices, such as bending the frog for a wider cut, which were new to most of the research and extension staff.

The paper on innovative practices generated much discussion with, as might have been expected, several disagreements. The main discussion points indicate that ripping and the use of green manures would be innovative and that there is also scope for innovation in alternative uses of the plough and in different draught animal spanning arrangements, particularly the use of single oxen.

SHORT NOTES AND NEWS

Request from Martin Bwalya, Regional Coordinator, African Conservation Tillage Network: The African Conservation Tillage Network has established a database of literature and information on conservation tillage techniques and dissemination approaches focusing on Africa. The database is linked to the ACT website (www.fao.org/act-network). The database has to be updated regularly. Therefore, the Network Secretariat undertakes to collect publications and information materials from all possible sources, especially from Network members on issues of CT in Africa. Suitable publications include:

- Scientific papers
- Proceedings of workshops, seminars, etc
- Working papers/documents
- Extension handbooks/materials
- Training handbooks/materials
- Technical project/activity reports

As many Network members and potential members do not have access to well furnished libraries or literature services, the ACT literature database does not limit itself to references only, but whenever possible provides access to full documents.

In order to enlarge the database and make it a useful tool we require:

• Copies of original papers/documents/handbooks, or
• Datafiles of the documents, or
• CD-ROMs

For this your cooperation is needed. Please send copies of relevant documents, hardcopies and/or datafiles. Martin's address is c/o Institute of Environmental Studies, Box MP 167, Harare, Zimbabwe.

Useful websites

• World Transport Policy and Practice, a quarterly journal edited by Professor John Whitelegg, is available free of charge as Adobe Acrobat PDF files on the internet at:
http://www.ecoplan.org/wtpp/wt_index.htm.
Volume 7, Number 1, 2001 has just been placed as a 1.1 MB PDF file. You are welcome to browse the site for back issues such as their special issue (Volume 3, Number 3) on transport in Calcutta. If you have difficulty in downloading the file, please contact eric.britton@ecoplan.org. Eric recommends you use MS Internet explorer.

• Paul Starkey has produced web pages for the Rural transport and travel programme. It can be found at:
http://www.animaltraction.com His email is P.H.Starkey@reading.ac.uk .

LETTERS TO THE EDITOR

Steve Preston has written to us. He is working in Eritrea for DANIDA on an Agricultural Sector Support Programme (crop research, seed matters and IPM). In Eritrea one of the features of agriculture is the very high proportion of female-headed farming households and these face special problems with ploughing etc. Also a large number of households have lost animals and implements as a result of the invasion.

Steve has the task of identifying suitable innovative equipment for pest control (=weed control) in the highlands (wheat/barley/teff) and lowlands (sorghum/millet). This task is loosely interpreted to mean anything from knapsack or tractor mounted sprayers, inter-row cultivators, sorghum planters, even mobile seed cleaners and equipment to treat seed with chemicals. As an alternative to large, expensive tractor-powered machinery Steve would like to test some improved animal-drawn implements and look into the possibility of their local fabrication and is asking for more information on and contacts for suppliers of 'improved' oxen, camel or donkey drawn implements. If you can help please contact him on stevep@eol.com.er

FORTHCOMING EVENTS

The Southern and Eastern African Association for Farming Systems Research-Extension (SEAAFSR-E)

8th REGIONAL CONFERENCE

'Challenges to the Farming Systems Approach Past, Future and Present'

This will be held at KARI Headquarters, Nairobi, Kenya. From 20–24 August, 2001. For more details and for anyone interested in membership of SEAAFSR–E contact: The SEAAFSR–E Sectretariat, PO Box 344, Mbabane, SWAZILAND.

Membership is open to all those interested in practising or promoting farming systems approaches in eastern and southern Africa.

SECOND ANNOUNCEMENT

Fourth International Colloquium on Working Equines

The Fourth International Colloquium will be held at the Apamee Cham Palace Hotel by the Faculty of Veterinary Medicine, Al-Ba'ath University, Hama, Syria from 21–26 April 2002

There will be one keynote session and individual sessions for submitted papers on recent developments in:

- veterinary science relevant to working equids
- in the role of equids in transport
- implementation of extension and development projects
- animal health and husbandry relevant to working equids
- land preparation and cropping with equids
- experiences in training and education.

Field visits and demonstrations of equipment and harnessing will also feature.

The meeting will be in English and Arabic. The registration fee will be US$100 (does not include accommodation or meals). The cost of a single room plus full board is US$65 per day at the Apamee Cham Palace Hotel in Hama.

Participants are asked to submit papers (Maximum 4500 words) to the secretariat by January 30 2002. Those people selected to present the papers orally at the meeting (15 minutes presentation + 5 minutes discussion) will be informed by February 28 2002. Papers should be submitted as hard copy and on disk, preferably as word/word perfect files (Times new roman, 12 point).

Participants are requested to bring along posters (A1 max size) and/or any materials they would like to demonstrate at the meeting. These could be implements, harnesses or health or husbandry techniques.

A limited number of scholarships are available for people who submit good quality papers.

To attend the meeting and book accommodation please contact the secretariat if outside Syria, or the organisers if in Syria:

Organisers:

Prof. Dr. M.A. Alimadi
Dean of the Faculty
Prof. Dr. Darem Tabbaa
Animal Protection Project (SPANA)
Faculty of Veterinary Medicine
Al-Ba'ath University, Hama, Syria

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Fax: + 44 (0) 207 630 5776
Email: SPANA.HQ@dial.pipex.com
Website : www.spana.org

CIHEAM **International Centre for Advanced Mediterranean Agronomic Studies**

CIHEAM are running courses from October 2001 to June 2002. These are:

I	Feeding and Nutrition	1 October 2001 – 7 June 2002
II	Breeding and Genetics	7 January – 22 March 2002
III	Reproduction	8 April – 7 June 2002

For further information contact:

Mediterranean Agronomic Institute of Zaragoza
Montañana 1005 – Apartado de correos 202 – 50080 Zaragoza (Spain).
Tel: +34 976 716000 – Fax: +34 976 716001
Email: iamz@iamz.ciheam.org – Web: http://www.iamz.ciheam.org

NEW BOOKS

'Meeting the Challenges of Animal Traction'

Edited by
Pascal Kaumbutho, Anne Pearson &
Timothy Simalenga

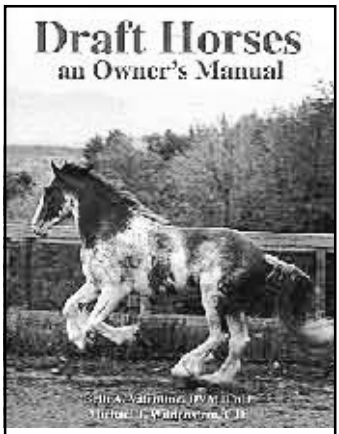
ISBN 0–907146–10–4

This book was published by the Animal Traction Network for Eastern and Southern Africa.

It reports the papers presented, discussion and recommendations made, including the participants who attended the ATNESA International Workshop held in September 1999 at Mpumalanga, South Africa. Topics covered included research and dissemination techniques, gender issues, animal economics, country experiences and future opportunities.

The book is available from:
ADB Joubert, SANAT,
Animal Traction Centre
Department of Agronomy
University of Fort Hare
Private Bag X 1314, Alice 5700, RSA.

Rural Heritage
http:\\www.ruralheritage.com



236 pages • US$32.00
ISBN: 1–893707–12–1

Visit the Rural Heritage web site for details of new books which include:

- Preventing Laminitis in Horses by the author of the popular Preventing Colic in Horses
- Horsedrawn Tillage Tools, the latest volume in the horse farming series by Lynn Miller.

Rural Heritage is pleased to announce the publication of a new book *Draft Horses, an Owner's Manual* based on the latest research related to draft horse maintenance and health care. This manual covers the unique aspects of caring for draught horses. It starts with the basics and the monitoring of horse health going on to describe things that can go wrong and what to do if they do. It is co-authored by Beth A. Valentine DVM, PhD (a diagnostic pathologist at Oregon State University, Corvallis) and Michael Wildenstein CJF (Resident farrier at Cornell University in Ithaca, New York.

RECENT PUBLICATIONS

Astake, A. & Gebresenbet, G. (1998). Draft animal power and its research in Ethiopia. *Ama, Agricultural Mechanization in Asia, Africa and Latin America*, **29**, 4, 15–21.

Araujo, A. G.,de, Figueiredo, P. R. A. de & Casao Junior, R. (1999). Field evaluation of animal traction equipment for soil tillage in Brazil. *Ama, Agricultural Mechanization in Asia, Africa and Latin America*, **30**, 3, 23–27.

Arene, C. J. & Jaafar, F. M. (1998). Impact of fascioliasis (liverfluke disease) productivity of animal traction technology in Adamawa State of Nigeria. *Journal of Agriculture Technology and Education*. **3**, 1&3, 34–38.

Bolanos Ortega, M. de F. (1999). Situation and importance of animal traction in several areas in Nicaragua. (Spanish). *Tropenlandwirt*, **100**, 1, 31–49.

Biswas, H. S., Ingle, G. S. & Ojha, T. P. (1999). Development of animal-drawn weeders in India. *Ama, Agricultural Mechanization in Asia, Africa and Latin America*. **30**, 4, 57–62.

Havard, M. Thic, G. le & Vall, E. (1998). Stock numbers and use of animal traction in sub-Saharan and French speaking Africa. *Ama, Agricultural Mechanization in Asia, Africa and Latin America*, **29**, 4, 9–14.

Henriksson, M. & Lindholm, E. L. (2000). The use and role of animal draught power in Cuban agriculture, a field study in Havana province. Minor Field Studies – International Office, Box 7070, SE-750 07 Uppsala, Sweden. No 100. 46 pp.

Ibanez, M., Reyes, J. F., Lanuza, P. & Melo, P. (1998). Design construction and evaluation of an animal drawn grain drill for small farmers, by reusing parts of discarded seeders. (Spanish). *Agro-Ciencia*. **14**, 2, 347–351.

Melaku, Tefesa & Fesha Gebreah (2001). A study on the productivity and diseases of camels in Eastern Ethiopia. *Tropical Animal Health and Production, **33**, 265–274.*

Mota, R. A., Brito, M. F., Castro, F. J. C. & Massa, M. (2000). Mormo em eqüídeos nos Estados de Pernambuco e Alagoas (Glanders in horses and mules of the states of Pernambuco and Alagoas, Braxil. *Pesquisa Veterináris Brasileira*, **20**(4), 155–159.

Narkhede, N. N. & Ingle, P. O. (1999). Status of utilization of various implements in Akola district. +*The PKV Research Journal*, **23**, 1, 44–45.

Nunez, J. E. V., Amaral Sobrinho, N. M. B., Palmieri, F. & Mesquita, A. A. (1999). Influence of different soil tillage methods on the contamination of soils, sediments and water by heavy metals. (Portugese). *Revista Brasileira de Ciencia do Solo*, **23**, 4, 981–990.

Palluet, B. & Vautherin, P. (1999). Skidding by animal traction of small softwood stems. (French). *Foret-Entreprise,***128**, 57–59.

Pearson, R. A., Archibald, R. F. & Muirhead, R. H. (2001). The effect of forage quality and level of feeding on digestibility and gastrointestinal transit time of oat straw and alfalfa given to ponies and donkeys. *British Journal of Nutrition*, **85**, 599–606.

Ponce Ceballos, F., Vento Tielves, R. & Sims, B. G.(2000). Comparative study of influence of animal traction and light tractors on soil compaction in Cuba. *Ama, Agricultural Mechanization in Asia, Africa and Latin America.* **31**, 3, 19–23.

Raj Kishor, Verma, S. C., Virendra Kumar & Singh, T. R. (1999) Comparative economics of sugarcane cultivation on tractor operated and bullock operated farms in District Sitapur (UP). *Cooperative Sugar,* **31**, 2, 105–112.

Shetto, R. M., Mkomwa, S. & Mkoga, Z. J. (1998). Role of animal traction in alleviating labour constraints in rural households in the Southern Highlands of Tanzania. Research and Training Newsletter (Dar es Salaam). **13**, 1, 5–12.

Stegmann, G. F. & Bester, L. (2001). Socioeconomic, health and management aspects of working donkeys in Moretele 1, North West Province, South Africa. *Journal of the South African Veterinary Association*, **72(1)**, 37–43.

Zekele, M. & Bekele, T. (2001). Effect of season on the productivity of camels (*Camelus dromedarius*) and the prevalence of their major parasites in Eastern Ethiopia. *Tropical Animal Health and Production*, **33**, 321–329.