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Effect of some Husbandry Practices on Draught Power and Field Performance of Draught Horses when Ploughing in Western Kordofan State, Sudan

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Abstract – **This study explored the draught power, live weight and body condition in relation to draught horses' field performance in Western Kordofan State, Sudan. The study followed the cross-sectional survey design on a sample of 90 farmers selected from 10 different clusters/villages following the systematic random sampling technique on geographical location. Data was collected using formal survey questionnaire in face to face interviews and direct field measurements. Field data was analysed using the Statistical Package for Social Science (SPSS 14) to produce frequency and percentage tables, while dependency tests were carried out using the chi square test and the relationship between other factors was tested using Pearson coefficient of correlation. The results showed that poor horse feeding practices resulted in horses with comparatively low live weight, although in a good body condition due to their small size. This reflected on generating moderate to high draught power. A highly significant ($p \leq 0.01$) strong ($r=0.9$) relationship was indicated between draught power and work speed, while the relationship with live weight was moderate. Farmers mostly worked at low forward speed (3.0 km/h and less) which was moderately ($r=0.6$) related to plot length. Field capacities were on the low side (0.05 ha/h for 42.2% of the sample). A strong ($r=0.8$) highly significant relationship ($p \leq 0.01$) was indicated between field capacity and area worked. Live weight did not have a significant effect on field capacity, while draught had a strong ($r=0.8$) significant ($p \leq 0.05$) relationship with field capacity. Field efficiencies were on the moderate to high range and had a weak relationship with area worked and draught power.**

Keywords – **Body Condition, Draught Power, Draught Horses, Field Capacity and Efficiency, Harness, Live Weight.**

I. Introduction

Animal traction (power) is seen by farmers and policy makers in many parts of the world as an affordable and sustainable technology which requires few external inputs [1]. Its role in the progress of human civilization throughout the history is well understood [2].

Sudan is not an exemption to this and the use of draught animals dated back to the Pharahonic era [3]. The technology was introduced during the 1970s to some parts of the traditional rainfed farming system in an attempt to assist farmers in achieving food security through both vertical and horizontal expansion. [4] emphasized that draught animal power remains a relevant form of technology in small scale agriculture, mainly for economic and agro-ecological reasons. For small scale farmers draught animal power offers a feasible alternative power source for manual power in the cultivation of food and cash crops. Nevertheless, effective use of draught animal power requires understanding of the animals' draught capability, husbandry requirements, nutrition and other factors which influence its performance. The absence of works to improve traits for work performance indicates least emphasis given to promote draught animal power. Further, [5] suggested that there is a need to know more about the power developed by draught animals when conducting primary tillage activities.

The draught characteristics of animals is usually defined by the weight of animals. Generally this is 8-10% of the body weight in cattle and buffaloes, while work output (draughtability) of the animal depends upon breed, physical condition, harnessing device, loading characteristics, rate and duration of work output, environment, feed and feeding method [6]. In contrast to this [7] suggested that work output is a function of animal body size. In addition [8] concluded that equids still make a major contribution to the wellbeing of many rural families in South Africa. However, poor harness, hitching and heavy carts and ploughs, poor veterinary services and limited feed resources all restrict the efficiency with which they can be employed. This is typical to the situation in rural Sudan.

It is important to study the draught power needed by the plough as it is one of the decisive factors that affect the extent and degree of the tillage objectives achievement as inadequate soil disturbance remains a major concern in Western Kordofan State, Sudan. Upon the introduction of draught animal technology to Greater Kordofan State and in later stages the draught power of work animals and its relation to animal live weight, body condition and soil type has not been studied. Therefore, this study was conducted to:

- Determine the draught power provided by work horses in En-Nhoud locality, Western Kordofan State, Sudan.
- Determine the work output (field capacity and efficiency) when ploughing with draught horses in the area.
- Study the effect of animal live weight and body condition on field capacity and efficiency.

II. Materials and Methods

Study Area

Field data was collected in EN-Nhoud locality, Western Kordofan State to investigate the effect of some husbandry practices, live weight and body condition on draught power and work output when ploughing with draught horses. EN-Nhoud locality is located in the semi-arid savannah zone in Western Kordofan State. The area consists of five rural councils. Different tribes live in the area with the *Hamar* being dominant. Most of the population depends on crop production beside other activities like animal breeding and poultry production. The average land holding of the family is about 4.5 feddans (1 feddan = 0.42 ha), but only 60% of that area is annually cultivated [9].

The dominant system of agriculture in EN-Nhoud locality is the traditional rainfed farming system which is known as a small holding farming system that is mainly characterized by being subsistence oriented. No systematic agricultural rotation is followed; and farmers always tend to the horizontal expansion to increase crop production [10]. The land is flat to undulating and there are only a few seasonal water streams (*Khors*). However, the soil is mostly sandy to sandy loam, while clay soil (*Gardood*) covers the southern parts of the area. Groundnuts, hibiscus *"Karkade"*, sorghum, sesame and water melon are the main crops in the area. The area is famous for production of groundnuts as the main cash crop [9]. The agricultural production of both food and cash crops depends mainly on family labour mostly in an agricultural sharing system. The area is well known for livestock production for milk and meat.

Sampling

This study was based on the cross-sectional survey design. A sample of 90 farmers was selected from 10 villages (clusters) following the systematic random sampling technique based on geographical location. The first of every four farmers was chosen along a survey line drawn across the farming area in each cluster starting at the upper end until 9 farmers had been selected.

Data collection and analysis

The main parameters considered in this study were:

- Animal feeding.
- Animal harnessing (type, padding and condition).
- Draught power.
- Animal body condition and live weight.
- Field capacity and efficiency.

Data were collected using a formal survey questionnaire in a face to face interview for literacy reasons and by direct field measurements during land preparation. Some information was recorded as observations to avoid farmers' bias on issues they can consider "sensitive". Direct field measurements were concerned with determining field capacity and field efficiency in accordance with [11]-[12]. Two stop watches and a tape measure were used to record the total and net times of operation and the land dimensions, respectively.

Other parameters computed from the field performance data were working speed (km/h), effective field capacity (ha/h) and field efficiency (%), expressed as:

Working speed = distance of run (km) / overall time taken (h)

Then the effective field capacity (ha/h) was taken as the product of dividing the area worked (ha) by the total time (h) as follows:

Effective field capacity (F.C) = Area (ha)/Total time (h)

And the field efficiency = Net productive time/Total time of operation

Draught power (Hp) was determined using a simple spring dynamometer following the method described by [13].

Body condition was determined following the body condition scoring system, while animal live weight was determined from the measurements of heart girth and animal length applied in a nomogram following [14].

Survey data were entered as individual readings into an SPSS computer programme (SPSS 14.0), then some of the variables were grouped into new variables to test the dependency. Data were analysed to produce frequency and percentage tables and the different parameters were assessed using the *chi* square test. Further some relationships were assessed using Pearson coefficient of correlation.

III. Results and Discussion

A. Animal Feeding Practices, Body Condition and Live Weight

Results of animal feeding practices, body condition and live weight are presented in Table 1. Most of the farmers (93.3%) feed their animals before the season starts in an attempt to increase/improve their live weight when they are required to most of the work. This practice is typical in draught animal technology in Sub-Saharan Africa as presented by [15].

Time before work when animals are fed affects animals' capacity to work and the efficiency of the feed in supplementing the energy required for work (during work). The majority of the farmers (62.2%) feed their animals two hours or more before work; giving ample time to digest the feed and get ready to work without any constraints from working on a full stomach. This complies with [15] who mentioned that animals need to be fed 2 hours before work to be given ample time to digest the feed.

Animal feeding practice and feed type during the dry period and prior to the season start resulted in horses with comparatively low live /body weight as 88% of the horses were less than 250 kg and 51% were less than 200kg in weight. This can be somehow misleading as animal age can influence its weight. Young animals are still developing and have comparatively smaller sizes and low body weight. Live weight is the best indicator of animals' capacity to work and the draught power they are capable of generating as reported by [6].

The argument of body weight in relation to animal size and age remains valid when horses' body condition is considered. Most of the horses (90%) were in a good body condition, while poor and moderate body conditions were recorded for marginal portions of the surveyed horses. Although body condition does not relate directly to horses' draught power, it still provides a good view on feeding practices and horses' capacity to withstand heat stress in the field while working.

B.Animal Harnessing

Farmers mostly (95.6%) harness their horses with collars and ropes (Table 2). Back saddles are optional, yet the majority of the farmers (70%) use them with collars to improve fixing the collar in place and to encounter any vertical forces resulting from animal movement at higher pace. A marginal portion (4.4%) harness their horses with breast straps which are rather common in donkeys harnessing in the study area. [16] reported comparable results in the same study area.

Most of the harnesses (72%) were padded, while slightly more than one-fourth of them (28%) were not. The latter condition can successfully be attributed to farmers' belief that cotton harnesses do not need padding, while leather ones which are more common need padding to avoid rubbing against animal body. Further, the same Table shows that all the harnesses (except for three) were in a good condition and are not expected to expose the horses to any threats of injury, nor are they expected to affect draughtability of the plough 'apart from the effect of traces condition'.

C. Draught Power

All the ploughs in the sampled group are sharp, with nuts well tightened and rust free. Farmers operated on sandy soils (97%) and loamy soils (3%). They all used cotton ropes as traces to swingle trees to which ploughs are hitched. Draught power varied between 0/1 Hp and 0.79 Hp. The highest percentage of the farmers (31%) recorded 0.25 – 0.30 Hp (Table 3). These are followed by farmers who recorded 0.31 – 0.40 Hp (25.1%). Interestingly one fifth (20.0%) of the farmers recorded 0.20 Hp and less (Table 3). The latter is a comparatively low draught and can possibly be attributed to low work speed and/or poor horse condition and weight as suggested by [6] who presented rate and duration of work as factors on which work output (draughtability) depends. Nearly one fourth (23.2%) of the farmers recorded draught power of 0.41 Hp or more. This is unusual with draught horses, yet can be successfully attributed to both light soil and animal live weight in relation to plough type and dimensions. This is evident from the moderate relationship between animal live weight and draught power as determined using Pearson's coefficient of correlation (r=0.5). The test however, did not show a significant relationship. On the other hand, the results showed a strong (r=0.9) highly significant (p≤0.01) relationship between draught and work speed. This result is in accordance with that of [4].

D. Field Capacity and Efficiency

The majority (54.4%) of the farmers worked at moderately-low to low work speeds of less than 2.5 km/h, while one fifth (20%) of them worked at moderately higher speeds (2.5 and less than 3.0 km/h). Slightly more than the latter group (22.2%) worked at 3.0 km/h and less than 5.0 km/h (Table 4). Comparatively different speeds were reported by [16] for the same study site. It is obvious that work speed is not only influenced/affected by animals' live weight, body condition and draught, but also by plot length and harness characteristics. A moderate (r=0.6) highly significant (p≤0.01) relationship was indicated between work speed and plot length, while the relationship between work speed and live weight was on the weak side (r=0.1). This complies with [15] who reported that "although it has been suggested that draught animals should be in good condition, with adequate fat reserves to work efficiently, there is little conclusive evidence to show that animals in good body condition work faster and/or longer than those in poor condition at the start of the working season".

The moderately low to low work speed resulted in a comparatively low field capacity as slightly more than two fifths (42.2%) of the farmers recorded field capacities of 0.05 ha/h or less (Table 4). An almost equal portion (41.1%) recorded 0.06 – 0.1 ha/h, while a marginal portion (4.4%) recorded comparatively higher capacities of 0.15 – 0.20 ha/h. Higher results were recorded for the same study site [16]. A strong (r=0.8) highly significant relationship (p≤0.01) was indicated between field capacity and area worked, while a weak one (r=0.1) was indicated between field capacity and horse live weight. The latter can be attributed to the same presentation made by [15]. This is in accordance with [17] who reported that at body condition score of (3) and above, poor body condition does not influence work capacity as long as animals are well fed during work. Further, field capacity was strongly (r=0.8) related to draught power (p≤0.01).

Harness type from its side did not affect field capacity as shown in figure 1, with higher capacities associated with collar harness compared to breast straps. Comparable results were reported by [18] – [16] in the same farming system. Farmers training and capacity/experience can add to this. Although [6] mentioned harnessing as one of the factors that affect work output of the animal, the results of this study were statistically similar suggesting that it's the harness condition that affects work out put more rather than harness type.

Unlike field capacity, field efficiency was rather on the high side as 48.9% of the farmers' recorded efficiencies more than 80%, while nearly one third (30%) of them recorded efficiencies of 60% and less (Table 4). The relationship between field efficiency and area worked and animal live weight was weak (r= 0.23 and 0.21, respectively). Further, higher field efficiencies were associated with collar harness compared to breast straps (Figure 2). However, farmers training, skills and experience can possibly have its effect on field efficiency as it is a direct indicator of the time lost during field operations.

IV. Conclusion

Horses are poorly fed and this reflected on comparatively low live weight, while their body condition was on the good side due to their small size. This reflected on generating moderate to high draught power. A highly significant (p≤0.01) strong (r=0.9) relationship was indicated between draught power and work speed, while the relationship with live weight was moderate. Farmers mostly worked at moderately low to low forward speed (3.0 km/h and less) which was moderately (r=0.6) related to plot length. Field capacities were on the low side (0.05 ha/h for 42.2% of the sample). A strong (r=0.8) highly significant relationship ($p \leq 0.01$) was indicated between field capacity and area worked. Live weight did not have a significant effect on field capacity, while draught had a strong (r=0.8) significant ($p \leq 0.05$) relationship with field capacity. Field efficiencies were on the moderate to high range and had a weak relationship with area worked and draught power.

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Table 1. Frequency Distribution and Percentage of the Draught Horses by Feeding Practices, Body Condition and Live Weight

	Frequency	Percent
	Times when animals are fed differently	
At the beginning of season	6	6.7
Before the beginning of the season	84	93.3
	Time before work when animals are fed (minutes)	
1 hour	34	37.8
2 hours	56	62.2
	Animal Body Condition	
good	81	90
moderate	5	5.6
poor	4	4.4
	Live Weight (Kg)	
200 kg and less	46	51.1
201 - 250 kg	33	36.7
251 - 300 kg	9	9.9
301 - 350 kg	2	2.2

Table 2. Frequency Distribution and Percentage of the Draught Horses by Harnessing Parameters

	Frequency	Percent
	Type of harness	
Collar and ropes	86	95.6
Breast straps	4	4.4
	Harness padding	
Yes	65	72.2
No	25	27.8
	Harness condition	
Worn and has ties	3	3.3
Good	87	96.7

Table 3. Frequency Distribution and Percentage of the Draught Horses by Draught Power

Draught (Hp)	Frequency	Percent
0.20 Hp and less	18	19.8
0.21 - 0.30 Hp	28	30.9
0.31 0.40 Hp	23	25.5
0.41 - 0.50Hp	9	9.9
0.51 - 0.60 Hp	6	6.6
0.61 - 0.95 Hp	6	6.6
Total	90	100

Table 4. Frequency Distribution and Percentage of the Draught Horses by Field Performance

	Frequency	Percent
	Work Speed (km/h)	
less than 1 km/h	3	3.3
1 and less than 1.5 km/h	11	12.2
1.5 and less than 2 km/h	18	20
2 and less than 2.5 km/h	20	22.2
2.5 and less than 3.0 km/h	18	20
3.0 and less than 4 km/h	8	8.9
4.0 - 5.0 km/h	12	13.3
	Field Capacity (ha/h)	
0.05 ha/h and less	38	42.2
0.06 - 0.10 ha/h	37	41.1
0.11 - 0.14 ha/h	11	12.2
0.15 - 0.20 ha/h	4	4.4
	Field Efficiency (%)	
less than 50%	10	11.1
50 and less than 60%	6	6.7
60 and less than 70%	11	12.2
70 and less than 80%	19	21.1
80 and less than 90%	23	25.6
90% and more	21	23.3

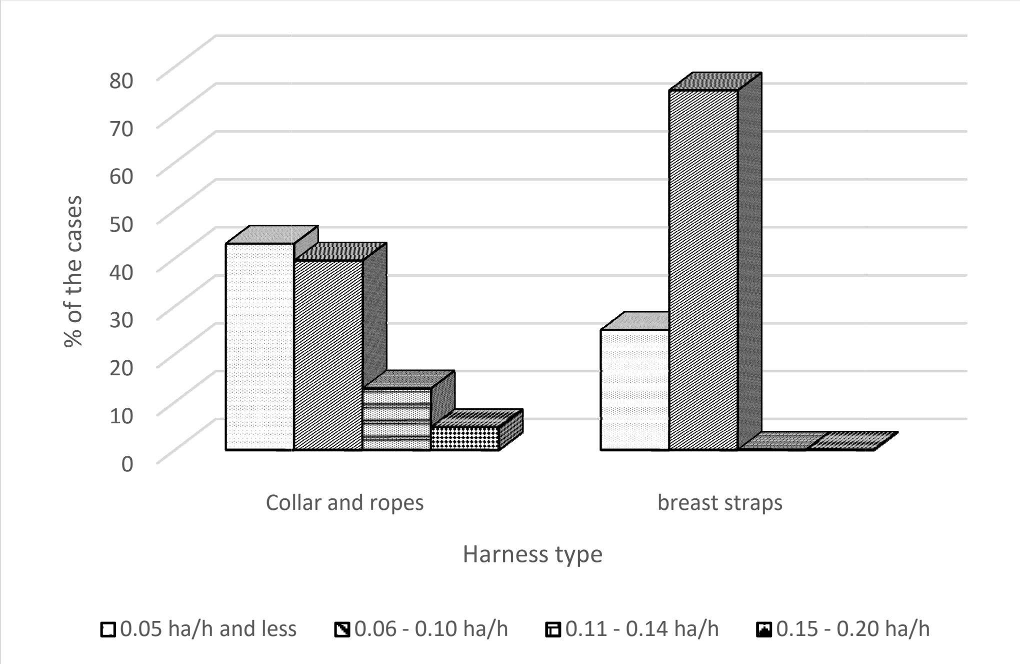

Fig. 1. Distribution of the Draught Horses by Harness Type and Field Capacity

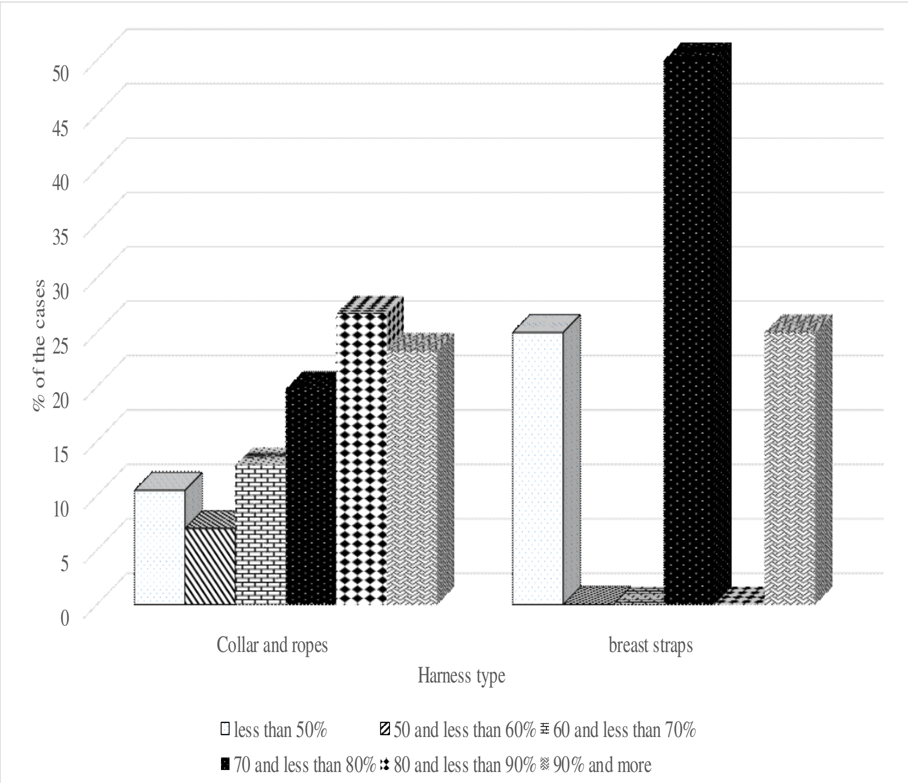

Fig. 2. Distribution of the Draught Horses by Harness Type and Field Efficiency