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Research Article

DRAUGHTABILITY STUDIES OF NON-DESCRIPT BUFFALOES OF CHHATTISGARH FOR PRIMARY TILLAGE IMPLEMENTS

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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 year's to come especially in Chhattisgarh. A pair of local buffaloes (930 kg/pair) of non descript breed was studied for estimating its draught ability by using CIAE animal loading car. It was observed that the local buffaloes could pull a draft load of 10 percent (93.3 kg draft) without excessive fatigue on a dirt road. The average power output per pair during four hours of operation in the summer season was maximum at 12 percent draft load. The forward speed reduced with increase is operating time and draft load. The fatigue score was well below 20 points in the summer season up to for 8 – 10 percent loading condition limiting to three hours operation. On the basis of size of buffaloes, draft capacity and observation on ploughing implements, it is suggested that the implements such as: Mould Board plough, Tendua Iron plough, Indira seed drill, Planker, Harrow patela, Puddler can be operated using buffaloes as the power source.

Keywords: Draught ability of Buffaloes, Physiological parameters, Body temperature, Respiration rate, Pulse rate, Fatigue

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Introduction

Draught animals have an important place in our agricultural farming and will continue to have the same for many more years to come especially in under developed and developing regions of the country. In this age of energy crisis, it becomes important to get maximum output from the draft animals to meet the increasing energy needs of Indian agriculture. This can be done better if draft animals are operated under optimum loading condition along with proper work rest cycle, good matching implements and better yokes / harness. The country has over 86 million work animals consisting about 75 million bullocks, 8 million he-buffaloes, 1 million of each camel and donkey and small number of yaks and elephants [1]. In India, small and marginal farmers rely mainly on draft animal power for farm operations. Normally buffaloes, like other draft animals, are used for tillage, seeding, weeding, interculture and transport work. The male Murrah buffaloes have efficient capacity especially for pulling heavily loaded carts. Though buffalo bulls are slower in movement as compared to cattle, they can pull heavier loads. They cover about 3.2 km/h as compared to 4.8-6.4 km/h by draft bullocks [2]. The buffalo bullocks sustained a draught force of 17.6 percentage of body weight. Buffalo bullocks exhibited significantly lower body temperature, respiration rate and pulse rate [3]. Male buffalo experienced fatigue at >1 h at 1.5 and 2.0 km/h speed with 14% draught of body weight of draught [4]. Draft power of buffalo varies with breed, species size and body weight. The large buffalo bulls are difficult to manage but are able to pull heavy loads like iron sheets, iron equipment's and instruments, hence move slowly [5]. Famous breeds and their characteristics are described in Table1.The buffalo is recognized as an efficient working animal in situations where speed is unimportant. The experiment aims at finding out the capacities of non-descript breed with respect to the physical responses, recovery pattern and fatigue at sustained loading under the prevailing climatic conditions with a view to develop improved matching implement to suit the draught ability of buffaloes.

Materials and Method

The materials and methods used for study on draught ability of buffalo recording of physiological parameters (Body temperature, Respiration rate, Pulse rate, Frothing, Leg coordination) during sustained working and testing of implements are represented under this section.

Variables under study

The variables under study had been divided into two parts. The first part consists of independent variables and second part for dependent variables. Draft and time are taken as independent variables and Speed and power output are taken as dependent variables for this study by which the performance of buffalo is mainly affected.

Draught ability study

A pair of medium size non-descript breed of buffaloes was used for the experiments. Different levels of draughts were applied to the animals with the help of loading car.

The information regarding buffaloes are given below.

1.	Species	Buffaloes
2.	Breed	Non-descript
3.	Sex	Male
4.	Age	5.5 years
5.	Weight	930 kg/pair

Experiments were conducted on the test track on specified draught loads. The different drought levels used for the experiment were 8, 10 and 12 percent of the body weight of buffaloes with selected yoke on tar track.

M.B. Plough Tendua Iron Plough Desi Plough

Fig-1 Different Ploughs

Loading car

For draught ability assessment of animals, the loading device [6] was used for simulation of desired loads, their control and measurement for versatility of a loading device different controls are provided to vary the load across a wide range. The loading car has the draft capacity of 300-5000 N and the braking effect on the loading car is achieved through control of outlet pressure of gear pumps run by traction wheel of car. In loading car, the load once set can be maintained irrespective of the forward speed.

Experimental procedure

Experiments were conducted in summer season in the year 2017 on the test track (made up of tar having nearly oval shape with length 600 m and track width 2.50 m.) on specified draught loads. The different drought levels used for the experiment were 8, 10 and 12 percent of the body weight of buffaloes with selected yoke on two types of track. For each level of draft buffaloes were operated for four hours. Zero hour readings of respiration rate, rectal temperature and pulse rate have been also recorded at the beginning of the test. Atmospheric conditions such as humidity and ambient temperature were also recorded. The speed was recorded after 15 min of start of experiment .After one hour of work the buffaloes are stopped for 5min. and all the observations like body temperature, respiration rate and pulse rate except speed are taken similar readings were taken after every hour for the span of four hours. Pull was measured using spring type dynamometer having a load 0-500 kg, capacity was used for the test of pull. The spring type dynamometer was mounted on the beam of the loading car. Angle of pull was measured with the help of Abney level that was mounted on the hitch beam and reading of angle is degree was reported. Speed was measured by calculating the distance traveled per unit time.

Ploughing Equipment

Three animal drawn ploughing implements namely Mould Board Plough, Tendua Iron Plough and Desi Plough [Fig-1] were used for ploughing and recording of draft of implements, speed of operation, power requirement, soil inversion and field capacity and efficiency of implements by standard methodology. The specification details are given in [Table-1].

Table-1 Specification of ploughs

S	Particulars	M.B. Plough	*Tendua* Iron Plough	*Desi* Plough
1	Source of power	A pair of buffaloe	A pair of buffaloe	A pair of buffaloe
2	Made of	Iron	Iron	Wood
3	Share			
	Length, mm	21	23	21
	Width, mm	8	7.5	6.4
4	Height, mm	950	620	880
5	Size, mm	150	120	100
6	Weight with beam, kg	20.5	22.5	21.5

Result and Discussions

The draught ability study was conducted at 8, 10, and 12 percent of buffalo body weight (930 kg/pair) using CIAE animal loading car following farmers' practice of four hour work duration. Physiological responses of a non –descript pair of buffaloes after each hour of work were studied in terms of pulse rate, respiration rate and rectal temperature along with distress symptoms and speed of travel was observed after each hour of operation.

Effect of draft loads on performance and physiological responses of working buffalo Variation in pulse rate

The average variation in pulse rate of local buffalo with respect to time of working and draft load in summer season on the tar test track is given in Fig.2 and Fig.3. The data reveal that pulse rate of buffalo has increased with increase in draft load throughout the period of working. The overall average initial pulse rate (beat/min) of local buffaloes was 36 at rest and 49.66, 58.66, 62.66 and 66 after first, second, third and fourth hour of operation respectively. Thus the increase in pulse rate from initial level was 37.94, 62.94, 74.05 and 83.33 percent after same duration of operation respectively. The overall average pulse rate of 4 hours sustained working of local buffaloes at 8, 10 and 12 percent draft load of its body weight (930kg/pair) was 55.25, 59.5 and 62.75 beats/min respectively. This gave a corresponding increase of 53.47, 65.27 and 74.30 percent respectively from their initial value. It indicates that maximum increase was observed at 12 percent loading condition.

Variation in respiration rate

The average variation due to different draft loads and time of working in respiration rate of local buffalo in summer season on tar track is given [Fig-2] and [Fig-3]. The data reveal that in general there was an increase in respiration rate with an increase in operating time and draft load. The occasional increases in respiration rate with increase in draft load and operation time may be due to deep breathing of buffaloes and reduction in their speed. The overall average respiration rate of local buffaloes was 21 blows/min at rest and 52.66, 59.33, 69.33 and 73.33 blows/min after first, second, third and fourth hour of operation respectively. This indicates that respiration rate has increase up to third hour of operation uniformly, but the increase was marginal at fourth hour. It was due to reduction in speed of buffaloes as well as deep breathing during fourth hour of work. The average respiration rate (blows/min) after four hour sustained loading of these buffaloes at 8,10 and 12 percent draft loads was 59.57, 64.75 and 71.75 respectively .This shows that maximum respiration rate was at maximum draft load of 10 and 12 percent and rate of increase was more beyond 10 percent draft load . The data reveals that overall average increase in respiration rate for 8 to 12 percent draft loads and 4 hours of operation from initial respiration rate of nondescript local breed was 211.50 percent.

Variation in body temperature

The average variation in body temperature of buffalo in summer season on tar track it could be seen from the [Fig-2] and [Fig-3] that a high difference 0.32°C of average body temperature between 8 and 10 percent loading condition as compare to 0.13°C of average body temperature between 10 and 12 percent loading condition. On the other hand, within the time span of operation sudden increase in body temperature after first hour operation.

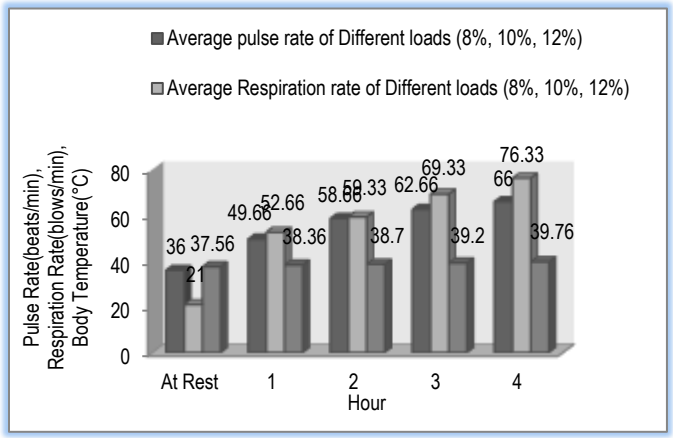

Fig-2 Physiological responses of buffalo during 4hour working on tar track

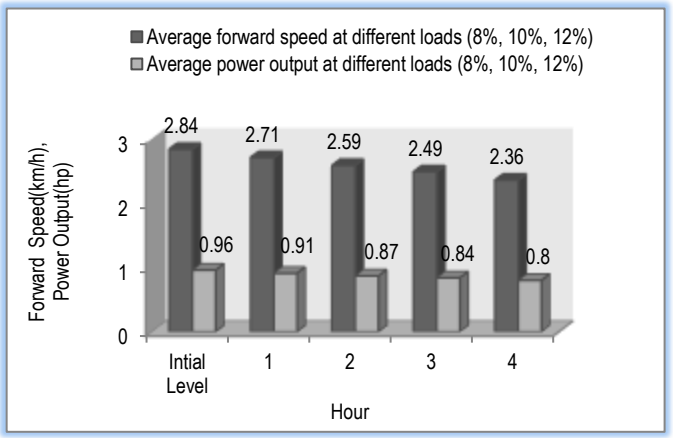

Fig-4 Workout-put of working buffalo during 4hour work on tar track

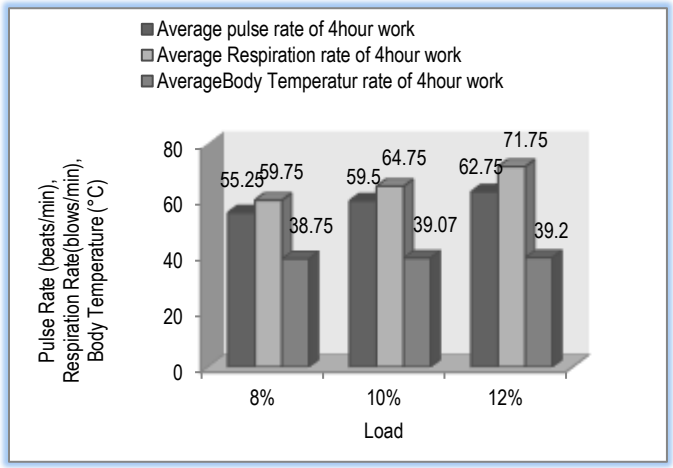

Fig-3 Physiological responses of buffalo at different loads on tar track

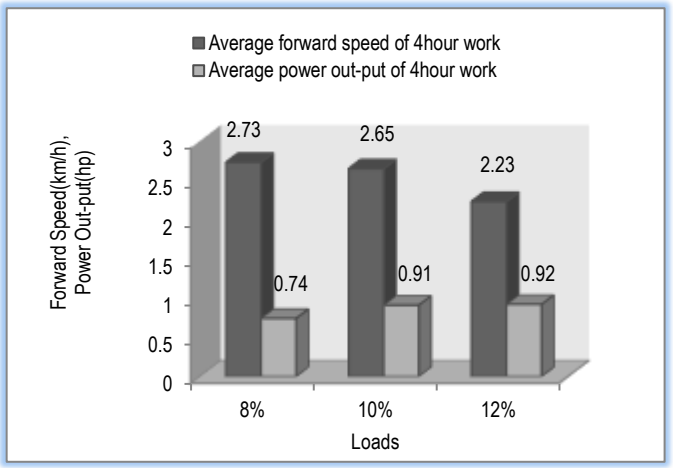

Fig-5 Workout-put of working buffalo at different loads on tar track

M.B. Plough Tendua Iron Plough Desi Plough

Fig-7 Ploughing with different ploughs

The maximum difference of 1.64°C and 2.2°C was recorded at third and fourth hour working respectively at different loads (8, 10 and 12 percent).The maximum variation in rectal temperature was observed at 12 percent draft load and at the end of longest duration of work is the working buffaloes. This indicates that the increase in body temperature within permissible limit in case of working buffaloes.

Variation in forward speed

During summer season the changes in forward speed (km/h) on tar track is given in [Fig-4] and [Fig-5]. The overall speed was 2.71, 2.56, 2.49 and 2.36 km/h respectively for first, second, third and fourth hour of operation. The average speed during four hour sustained working condition was 2.73, 2.65 and 2.23 km/h at 8, 10 and 12 percent of buffaloes body weight respectively. There was 12.77, 11.07 and 7.85 percent decrease in the speed during operation as compared to the initial speed was observed at 8, 10 and 12 percent loading conditions respectively. The reduction in speed with that of 8 percent draft loads was 11.07 and 7.85 percent at 10 and 12 percent draft loads. This indicates that reduction in speed was high beyond 12 percent draft load.

Variation in power out-put

During summer season the average power out-put of different loads (8, 10 and 12 percent) of working buffaloes on tar track was found 0.91, 0.87, 0.84 and 0.8 hp/pair at first, second, third and fourth hour working respectively [Fig-4]. The average power out-put of local buffaloes was 0.74, 0.91 and 0.92 hp/pair at 8, 10 and 12 percent draft loads of their body weight respectively [Fig-5]. This indicates that there was continuous increase in power out-put of local buffaloes for 8 to 12 percent draft. Since, power output is a product of draft and speed, higher power output at higher draft loads was due to higher amount of draft, in spite of lower speeds. It indicates that, the reduction in speed was proportionately less as compared to increase in corresponding load.

Effect of draft loads and time on fatigue score of buffaloes

Upadhyay and Madan (1985) suggested a "Fatigue Score Card" based on the physiological reactions, distress symptoms and behavioral manifestations. The "Fatigue Score Card" based on their body theory with the progress of work physical reactions such as respiration rate, pulse rate and body temperature increase after every hour. Number is given after certain rate is reached these physiological changes other behavioral reaction like frothing, leg coordination, excitement , inhibition to progressive movement and protrusion of tongue are given numbers by visual observation. When the score is reached to a level of 20, it is presumed that animal has attained to a fatigue level beyond which it is not advisable to put them to further work.

Variation in fatigue score

Fatigue score is an important indicator to compare the performance of animals. It shows combined effect of changes in different physiological parameters observed. Fatigue score is depicted in [Fig-6] for draughts equal to 8, 10 and 12 percent of body weight of the buffaloes, Higher fatigue score indicates higher fatigue of buffaloes and beyond certain value of fatigue score, the animals will not be able to work, unless they are given rest for certain period. The [Fig-6] indicates that, the fatigue score increased with increase in draught and with advancement in time. The highest fatigue score was found to be 29 at 12 percent draught of the 4 hours of work on tar track. It is followed by 20 and 23 at 8 and 10 percent draught respectively. Buffaloes performance with 8 percent draught shows the lowest corresponding fatigue score as compared to 10 and 12 percent draught. It is also revealed from the [Fig-6] that buffaloes were declared fatigued when score points reaches 20 or more at after fourth hour at 8 percent, after third hour at 10 percent and after second hour at 12 percent draft loads.

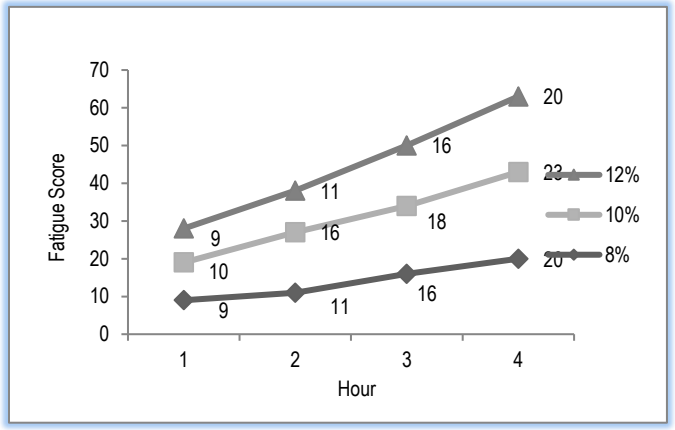

Fig-6 Variation in fatigue score at different loads on tar track

Table-2 Field performance of different plough

SN	Particulars	M.B. Plough	*Tendua* Iron Plough	*Desi* Plough
1	Draft (Kg)	58.34	67.40	68.70
2	Speed (km/h)	2.15	2.09	2.05
3	Average width of cut (cm)	14	11.23	9.68
4	Average depth of cut (cm)	10.15	8.09	8.24
5	Theoretical field capacity (ha/h)	0.032	0.024	0.020
6	Actual field capacity (ha/h)	0.020	0.014	0.011
7	Field efficiency	62.5	58.33	55
8	Power (hp)	0.46	0.52	0.522
9	Soil inversion	75.25	70.10	71.32

Performance of animal drawn plough

The field performance of different types of plough is given in [Table-2]. The actual field capacity of Mould Board plough was recorded highest followed by Tendua Iron plough and Desi plough. It was 30 percent and 45 percent higher than Tendu Iron plough and Desi plough respectively. It is very well reflected by high time required for ploughing operation and was lowest under Mould Board plough. The draft requirement was well within the capacity of buffaloes i.e. on the basis of their body weight. However the lowest draft (58.34 kg) was observed for Mould Board plough. The estimated power developed for Desi plough was highest followed by Tendua Iron plough (0.718 hp) and Mould Board plough (0.638 hp). The average cross sectional area of cut found maximum in the Mould Board plough than other two ploughs. It was also observed that soil inversion obtained by Mould Board plough is superior as compared to other ploughs and recorded as 75.25 percent, which is higher than Tendua Iron plough and Desi plough by 6.84 percent and 5.22 percent respectively. The Mould Board plough was observed to be rank first in capacity and draft requirement within the capacity of local buffaloes. The actual field capacity of Desi Plough was found to be lowest in comparison to both the plough. On the basis of implement performance, draft requirement and body weight of local buffaloes the Mould Board plough was superior over other ploughing implements. On the basis of draught ability study it can be said that the size of the buffaloes ranges between 700 to 1000 kg and the buffaloes can be put under load for three hours during summer season. It suggests that buffalo are capable for developing 10 percent draft capacity and hence following set of implements can be used for suggested operation using buffalo as the power source:

Summary and Conclusion

The experiment aims to the find out the capacities of non-descript breed of buffaloes at three loading conditions under the prevailing climatic conditions with a view to develop improved matching implement to suit the buffaloes. The draught ability study was conducted at 8, 10, and 12 percent of buffalo body weight (930 kg/pair) using CIAE animal loading car of four hour work duration. The average power out-put during 4-hour work of non-descript buffalo on standard test track was 0.74, 0.91 and 0.92 hp/pair at 8,10 and 12 percent loading condition respectively. It could be inferred that increase in power out-put was quit high till 10 percent loading condition and there after no or very little increase was recorded. Buffaloes performance with 8 percent draught shows the lowest corresponding fatigue score as compared to 10 and 12 percent draught. Out of the results stated above, following can be concluded:

1. Buffalo can be used for three hour continuous work at 8 and 10 percent loading condition of its body weight during summer season without fatigue condition.
2. The performance of Mould Board plough was better compared to rest of the plough. The capacity of buffaloes suggested that implements like Tendua Iron plough, Desi plough, Planker, Seed cum fertilizer drill, Zigzag puddler and Rotary Blade puddler can be used for different operation using buffaloes as main power source.

Application of research: This research will be help to designing of farm machinery implements.

Research Category: Agricultural Engineering.

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