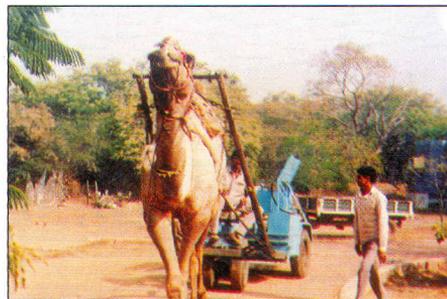


# DRAUGHTABILITY OF ANIMALS



**Co-ordinating Cell**  
**All India Co-ordinated Research Project on**  
**Increased Utilization of Animal Energy**  
**With Enhanced System Efficiency**



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**CENTRAL INSTITUTE OF AGRICULTURAL ENGINEERING**  
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# INTRODUCTION

Indian farming system basically consists of small and scattered holdings. In spite of rapid growth of conventional fuel run power units in recent years, the draught animals continue to be the main source of farm power in the whole country leaving aside states of Punjab, Haryana and Western Uttar Pradesh, where tractors are widely used as source of farm power. About 60-65% of the total cultivated area is being managed with draught animals as against about 17-19% by tractors. Draught animal popularization is either stagnant or showing marginal increasing trend in Maharashtra and eastern part of the country. It is expected that draught animals would continue to remain as a major source of farm power for at least next 25-30 years. For efficient use of available draught power, it was felt necessary to determine the draughtability of different breeds of draught animals, which are used in the different parts of the country. The muscle power of animal provides work output when harnessed. The draught force or tractive effort of animal(s) in sustained basis, endurance, and power output of draught animal is usually determined by its working capacity on sustained basis. It is a function of different muscle, body weight of animal and muscle/bone arrangement of limbs rather than body fat. The muscles, through their contractile units namely Sarcomeres, are the fundamental unit of force production. While, their speed is related to the number of sarcomeres arranged in series and to the

sites of attachment of a muscle to a bone. The endurance of muscle is dependent upon the ability of its sarcomeres to obtain and utilize oxygen and nutrients. Draught efficiency is directly related to the animal's work capacity and the transmission efficiency for tractive purposes for the implements to be drawn or operated by them. Their working capacity is very much dependent of their anatomical differences due to species besides their physical condition, breed characters, temperament, age, feeding and care, their training, management and climatic environment. The muscles produce lactic acid when animals work. This is reflected by various fatigue parameters. The rest provided to animals diffuses lactic acid and animals get ready to take work again.

In past, animals were loaded according to a thumb rule upto 10% of their body weight for safety and health consideration. In practice, they even worked even to 6-8%. There was absence of scientific knowledge on the subject to what extent animals could be loaded without causing deleterious effect on their health. Systematic study was conducted to find out the draught capacity of different breeds of draught animals under sustained working under standard test track and in different weather conditions. It is expected that the information generated on draughtability of animals would be useful for selecting, designing and improving the appropriate equipment so that draft capacities of the animals are fully utilized for greater output resulting into increased command area for timely farm operations without causing deleterious effect on their health.

## Studies on Different Breeds of Animals in Different Centres

Sl.No.	Centre	Animal(s)	Breeds
1.	Bhopal	Bullock	Local & Malvi breed bullocks
2.	Ludhiana	Bullock	Haryana breed bullocks
3.	Pantnagar	Buffaloe	Murrah breed buffaloes
4.	Raichur	Bullock & Donkeys	Khillari breed bullocks & donkey
5.	Udaipur	Camels & Donkeys	Camels & donkeys, local
6.	Allahabad	Bullock & Mule	Haryana breed bullocks & mules
7.	Rewari	Bullock & Camel	Nagori breed bullocks & camels

### Parameters Measured

Time (h), load (kgf.), heart rate (beats/min), respiration rate (Nos./min), rectal temperature (°C), speed (km/h), pull and angle of pull, power (watts), fatigue score card value (No.) and ambient condition i.e. temperature, humidity, wind velocity and intensity of sunshine.

### Methods and Techniques

The animals were tested for their draughtability under sustained working conditions on standard tar test track. The physiological reactions such as change in pulse rate, respiration rate and rectal temperature of animals were measured at every one-hour interval

during test. The respiration rate was counted by placing the flat palm near the nostril of the animal and counting breaths per minute. The body temperature of animal was taken by clinical thermometer in the rectum for about one minute. The pulse rate was measured by placing stethoscope and keeping that near the left fore arm near the heart or sensing the palpitation at coaxygoal artery at tail of animal. The number of beats per minutes was counted. Various symptoms such as hurried respiration, watering from nostrils and mouth, open mouth with protruded tongue, painful stimulus were observed visually. The speed of the animal was measured by observing the time taken to travel 50 metre distance. CIAE animal loading car was used for application of load on animals. During trials representative animals were subjected to predetermined load by operating valves on the loading car and restricting passage of flow of hydraulic oil till desired load was obtained. Load cell and load indicator were used to monitor the load. The pull and angle of pull was measured by using load cell with indicator and abney level respectively.

Data on ambient conditions such as ambient temperature, relative humidity, wind speed and sunshine hour were collected from meteorological laboratory. Upadhyay's score card was used for assessing fatigue of the animals.

### **Equipment/Instrumentation Used**

- CIAE animal loading car was used for loading the animals and varying the load on animals.

- Load cell and indicator were used for measuring the load exerted on animals.
- Student physiograph for measuring the heart rate (beats/min.) and respiration rate (Nos./min.).
- Veterinary thermometer for measuring the rectal temperature (°c).
- Stop Watch for measuring the time.

## Assessment of Draft Capacity of Animals in Sustained Working

### a) Bullocks

Draughtability studies on bullocks were conducted at UAE centres located at Bhopal (Fig. 1 & 2), Ludhiana, Allahabad, Rewari and Raichur. The studies were conducted in sustained working conditions on standard test track on whole day basis of 6-8 hours, in two shifts with a break of about 1 hour in between the two shifts.

The study was conducted at draft loads equivalent to 8-20% of body weight of bullocks in pair and their physiological responses, speed and distress symptoms were recorded on hourly basis and fatigue score was assigned to fatigue parameters for taking into account their level of fatigue. Studies at Bhopal, Allahabad and Rewari centres were conducted for 7 hours/day in two shifts. While, at Ludhiana and Raichur the studies were conducted for 6 hour/day in two shifts. The results were specific to animal type breed and season (Table-1).

**Table-1: Draftability of work animals under sustained working conditions on whole day basis**

Draft load as % of body weight

S. N.	Centre	Breed Percent/ load	Summer			Winter		
			Load range studied	Max. Load negotiated	Load for max. Output	Load range studied	Max. Load negotiated	Load for max. Energy output
1.	Bhopal a) with improved yoke	i) Malvi	8-14	13	12	8-18	17	15
		ii) Local	8-15	13	12	8-18	17	15
	b) with local yoke	i) Malvi	8-12	12	10	8-16	14	12
		ii) Local	8-12	12	10	8-16	14	12
2.	Rewari with local yoke	i) Nagori	8-14	14	14	8-16	14	14
		ii) Haryana	8-14	14	12	8-16	14	12
3.	Allahabad with local yoke	i) Haryana	8-14	12	10	8-16	14	12
		ii) Local	8-14	12	10	8-16	14	12
4.	Ludhiana with local yoke	Haryana	8-14	12	10	8-14	14	10
5.	Raichur with local yoke	i) Khillari	8-20	20	16	8-20	20	16
		ii) Local	8-16	14	12	8-16	14	12
<b>Median values</b>			<b>8-14</b>	<b>13</b>	<b>12</b>	<b>8-16</b>	<b>14</b>	<b>12</b>

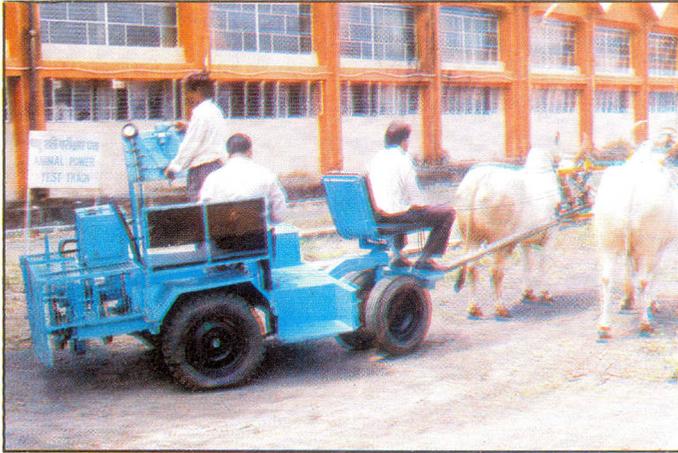


Fig. 1 Draughtability studies on Local Malvi bullocks at CIAE on test track using animal loading car

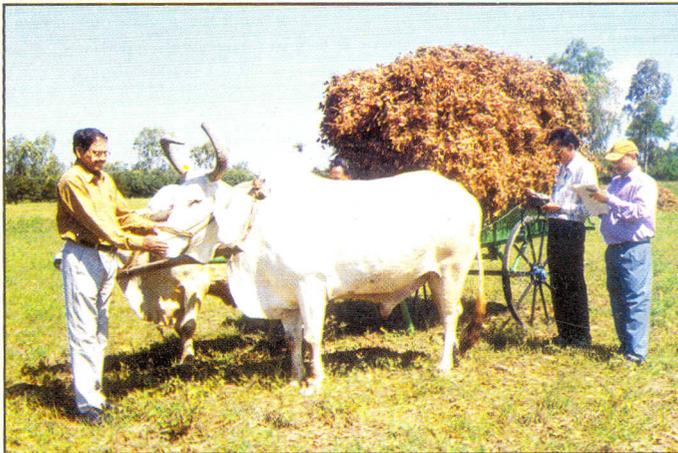


Fig. 2 Field studies on haulage by malvi bullocks at CIAE Farm

Based on the studies on draughtability of bullocks under sustained working following recommendations were made:

- i. The output of different breed of bullocks differed from each other. With local and improved yokes and harnesses, the maximum draft load negotiated under sustained working varied between 8-20% depending upon breeds of bullocks. Although the bullocks could negotiate higher loads, the average power developed and energy output/day was maximum at optimum loads as there was a drop in working speed at higher loads due to fatigue developed in animals while working on sustained basis.
  
- ii. Season showed pronounced effect in work output of animals. In Bhopal region Malvi and local bullocks, using local yoke, worked under sustained working, upto a maximum draft load of 12% of body weight for 7 hours duration during summer in 2 shifts of 4 and 3 hours with a break of 1 hour in between. However, during winter the bullocks could work upto 14% load for 7 hours in 2 shifts. The maximum output of Malvi and local breeds of bullocks were at draught loads equivalent to 10 and 12% of the body weight during winter and summer seasons, respectively. With improved Allahabad three padded collar harness, both Malvi and local breeds of bullocks worked upto draft load equivalent to 17% of body weight during winter, while during summer they only worked upto 13% load. The maximum work output in case of Malvi and local bullocks were

at draft loads of 15 and 12% during winter and summer seasons respectively.

- iii. The work output of Nagori, Khillari and Haryana breeds of bullocks were varying but had similar trend as the one obtained at Bhopal. At Rewari centre, it was reported that Nagori breed could negotiate maximum draft load upto 14% of body weight using local yoke, both, during summer and winter seasons and the maximum work output was at 14% load. Khillari breed could negotiate draft load equivalent to 20% of their body weight in both, summer and winter seasons, but the maximum work output was available at 16% load. Similarly non descript local breed of Karnataka could negotiate draft load equivalent to 14%, in both the seasons using local yoke, but the maximum work output was at 12% in both the seasons.
- iv. Depending upon the weight and breed of the bullocks, the power developed ranged from about 600 watts in case of local breed to 1 kW in case of Malvi and 1.46 kW incase of Khillari breed of bullocks. The total energy output/day ranged from about 4.2 kwh to 8.4 kwh.

## **b. Buffaloes**

Draftability studies on he-buffaloes were conducted at Pantnagar centre (Fig. 3). The buffaloes were subjected to

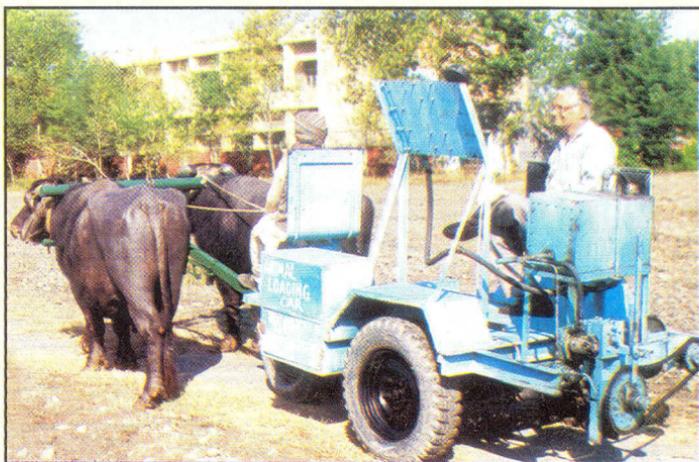


Fig. 3 Studies on draughtability of buffaloes at GBPUA&T, Pantnagar



Fig. 4 Studies on draughtability of buffaloes on rotary mode at Pantnagar centre

draft loads equivalent to 6, 8, 10 and 12% of body weight. The study was done both in rotary (Fig. 4) and linear modes of operation, on whole day basis. Maximum draught load negotiated by the buffaloes in sustained working of 6 h, in two sessions, using local yoke, was equivalent to 12% of their body weight, in both summer and winter seasons.

### c. Camels

Draftability studies on camels under sustained working conditions were conducted by Udaipur and Rewari centres (Fig.5).

On the basis of draftability tests, it was concluded that the optimum draft for camels in sustained working corresponded to 18% of their body weight for 6-7 h, in 2 session, with a rest of 1-2 h in between, however, they could exert a maximum draft of 26 percent of body weight for 6 hour of work, following a work rest schedule of 2 h work and 2 h rest. At lighter draft loads (upto 14% of body weight), the camels could work for 7-8 h/day requiring 1 h rest in between the two working sessions.

### d. Donkeys

Draftability studies on donkeys were conducted by Udaipur and Raichur (Fig. 6) centres. The results of trials of the above two centres have shown that donkeys could be operated for six hours per day in two sessions of 3 h each with no sign of

fatigue upto the draft load equivalent to 22% of body weight giving 1 h rest between the work sessions. At the draft loads equivalent to 22 to 32% of body weight, the donkeys showed sign of fatigue after 2 h of work, however, they could be operated for 6 h in three sessions of 2 h duration requiring 1 h rest between the sessions. They were also able to work at draft load of 33-36% for 4 h in four sessions with 1 hour rest between the sessions and 40% for 1 to 2 hour in two sessions with rest of 1 hour during the sessions. The maximum work output was at draft load of 32%.

### Matching Implements

Implement package for tillage sowing and interculture operations have been identified. Trials of existing equipment have shown that there was good scope of increasing the sizes of implements by 30-70% to match the draught power available from the animals.

Some of the implements identified for matching with the draught power of animals are as under:

1. Improved yoke
2. Mould Board plough
3. Disc harrow
4. Puddler
5. Blade harrow (bakhar)
6. 3 and 5 tyne cultivator/sweep
7. 3-5 row seed-cum-fertilizer drill/planter
8. Potato/groundnut digger

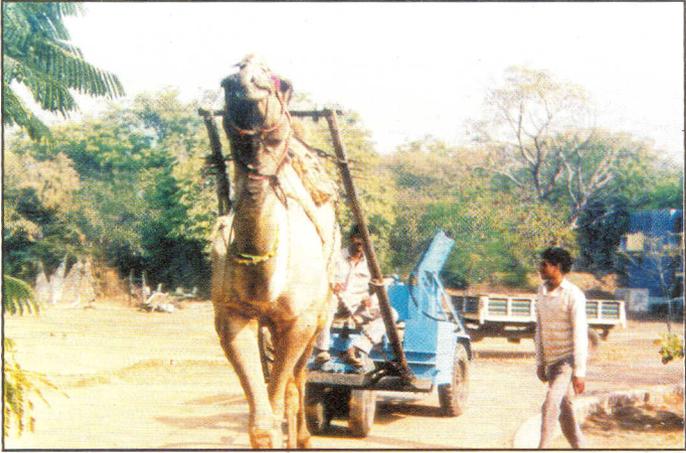


Fig. 5 Draughtability studies on camel using animal loading car at MPUAT, Udaipur and KVK, Rewari

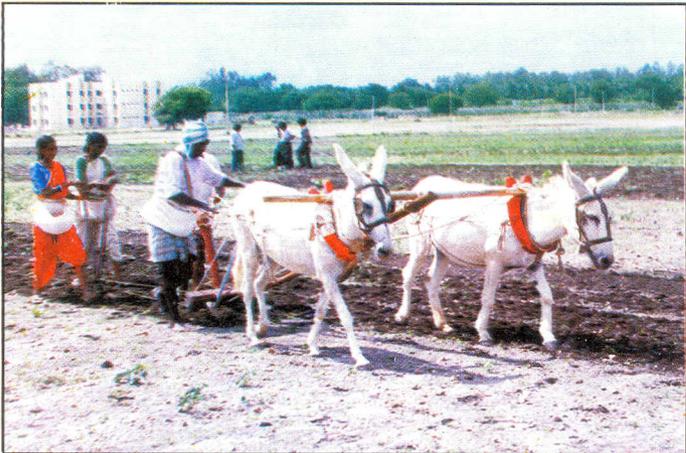


Fig. 6 Draughtability studies on donkeys at CAE, Raichur on field operations

