

Development and evaluation of double bullock and single bullock drawn improved steel cart

■ M. Veerangouda, K. V. Prakash, Jag Jiwan Ram and M. Din

Received : 22.12.2017; Revised : 04.02.2018; Accepted : 13.02.2018

See end of the Paper for authors' affiliation

Correspondence to :

M. Veerangouda
Department of Farm
Machinery and Power
Engineering, College of
Agricultural Engineering
(U.A.S.), Raichur
(Karnataka) India
Email : m.veerangouda@rediffmail.com

■ **ABSTRACT** : In Karnataka, bullock drawn wooden carts are generally used for transportation of agricultural produce and other goods in areas. An improved steel cart suitable for operating with bullock and single bullock power have been developed and fabricated at College of Agricultural Engineering, Raichur. The steel cart power by double bullock and single bullock were tested both on asphalted road and murrum road for carrying the goods. The physiological response of bullocks were noted and analyzed. The wooden material is completely replaced by mild steel and the wheels were provided with protruded rubber to make good contact with road surface. The road surface was not damaged and problem of puncturing the wheel was avoided. The double bullock (515 kg body weight) steel cart fitted with bush bearing is capable to carry a load of 8 to 9 quintals safely. The single bullock steel cart fitted with bush bearing is capable to carry a load of 6 quintals safely. The performance of the steel carts drawn by bullock power was satisfactory.

■ **KEY WORDS** : Bullock drawn steel cart, Draft, Hauling, Loading capacity, Road surface

■ **HOW TO CITE THIS PAPER** : Veerangouda, M., Prakash, K.V., Ram, Jag Jiwan and Din, M. (2018). Development and evaluation of double bullock and single bullock drawn improved steel cart. *Internat. J. Agric. Engg.*, **11**(1) : 30-34, DOI: 10.15740/HAS/IJAE/11.1/30-34.

In Karnataka, wooden carts are very common and are used for transportation of agricultural produce, fertilizer bags, cement bags etc. Two wheeled bullock drawn wooden carts being a major means of transport of agricultural input and produce as well as other materials in rural area. The single bullock carts are generally used in city areas of APMC market for transportation of goods. The major material of their construction is wood obtained from hardwood trees like *Neem*, mango, acacia a few component like axle and wheel ring made of mild steel.

Dubey and Singh (2001) developed improved two wheeled steel cart at Bhopal with carrying capacity of 2 tonnes and that was thoroughly tested for its performance on different terrains at various payloads at the CIAE

farm and in villages near Bhopal, using bullocks as the source of power. Jogdand *et al.* (2006) conducted the survey on carts in Chattisgarh region and reported that the capacity of two wheeled steel carts varied from 1000 to 2500 kg. Keeping the basic dimensions of locally available wooden carts, a major need was to replace wood with steel in cart construction for double bullock and single bullock with suitable modifications in steel wheels.

■ METHODOLOGY

The double bullock improved steel cart and single bullock improved steel cart were developed and fabricated based on the basic dimensions available in the local region. The wooden parts were completely

replaced by steel structure to avoid the usage of wood which leads to deforestation. The steel wheels fitted with rubber shod reduced the road damage and avoided the puncture of wheels. The steel carts having the steel wheels were tested with bush bearing on different road conditions like asphalted road and murrum road. The double bullock steel cart was tested at three levels of loads namely 8, 9 and 10 quintals. The single bullock steel cart was also tested at three levels of loads namely 5, 6 and 7 quintals. The physiological response of animals at different load levels, and road surfaces were noted separately for double bullock and single bullock steel carts. The wobbling effect on steel wheels were observed during the testing both on asphalted and murrum road conditions. Two bullocks namely Karna (body weight 260 kg) and Arjun (body weight 255 kg) which are khillari breed of this region were used in testing of steel carts. Hallikeri (2000) reported on steel carts that the carrying capacity of load on different road conditions affected the physiological response of animals and bullocks were on the safer side with the fatigue score less than 20. During the trials, the data on draft, speed and power developed by the bullocks were noted for double bullock and single bullock steel cart on different road conditions.

RESULTS AND DISCUSSION

The steel carts fitted with bush bearing were tested on different road conditions. The data pertaining to physiological response, draft, speed, power developed were noted.

Draft, speed and power output of double bullock improved steel cart :

The performance of double bullock improved steel

cart at three load levels namely 8, 9 and 10 quintals is presented in Table 1.

It was observed that the average draft requirement for pulling the cart at a load condition of 8 quintal on a murrum road was 51.30 kg, the walking speed of bullocks ranged from 3.29 km/h in the beginning to 3.18 km/h towards the end of the working period. The power output developed by the bullock pair ranged from 0.60 to 0.58 kW.

At 9 quintal loading murrum road, the draft requirement was 52.60 kg and the power output developed by the bullock pair ranged from 0.58 kW to 0.56 kW. At 10 quintal loading, the draft requirement was 54.25 kg and the speed range was 2.85 km/h in the beginning to 2.80 km/h towards the end of the working period. The power output developed by the bullock pair ranged from 0.55 to 0.54 kW. It was observed that with increasing level of loading the draft requirement increased and the walking speed has decreased. The power developed by the bullocks also decreased with increasing load condition.

Evaluation of double bullock improved steel cart :

The data on physiological response of bullocks for double bullock steel cart on asphalted track and murrum road are presented in Table 2 and 3, respectively.

From the Table 2, it is observed that at 8 quintal loading, based upon the differences in the respiration rate (RR), rate (PR) and body temperature (BT) the contribution to the fatigue score of bullock Karna were 2, 2 and 2, respectively and based upon the behavioural response of the bullock a total of 3 more fatigue score points were added, taking the total fatigue score fatigue score to 9 at the end of six hours of work. In a similar manner the total fatigue score of bullock Arjun was 10.

Table 1 : Performance of double bullock improved steel cart with bush bearing on different road conditions

Sr. No.	Parameters	Double bullock improved steel cart					
		Asphalted track			Murrum road		
1.	Loading level, (Quintal)	8	9	10	8	9	10
2.	Draft, kg	50.10	52.15	53.40	51.30	52.60	54.25
3.	Speed, km/h						
	Maximum	3.65	3.45	3.40	3.29	3.10	2.85
	Minimum	3.48	3.29	3.16	3.18	2.99	2.80
4.	Power output, (kW)						
	Maximum	0.65	0.64	0.63	0.60	0.58	0.55
	Minimum	0.62	0.61	0.60	0.58	0.56	0.54

It means that a bullock pair weighing 515 kg is capable of transporting 8 quintals of goods on a tar road for six hours and still the pair is not fatigued.

With 9 quintal load, it was observed that the two bullocks reached a total fatigue score of 17 and 18, respectively and these values are very close to the maximum permissible fatigue score of 20 for bullocks, which means that the bullocks get totally fatigued after

6 hours of work at this load level. At 10 quintal load, it was observed that after 3 hour of work, the two bullocks reached a fatigue score of 22 and 21, respectively.

From the Table 3, at 8 quintal loading it was observed that based upon the differences in the respiration rate (RR), pulse rate (PR) and body temperature (BT) the contribution to the fatigue score of bullock Karna were

Table 2 : Physiological response of bullocks for double improved steel cart on asphalted track

Sr. No.	Parameters	8 quintals		9 quintals		10 quintals	
		Kaarna	Arjuna	Karna	Arjuna	Karna	Arjuna
1.	Physiological response of Bullocks- before works						
	Respiration rate (RR)	23.0	25.0	36.0	32.0	22.0	28.0
	Pulse rate (PR)	22.0	20.0	25.0	23.0	19.0	17.0
	Body temperature (BT)	36.8	36.5	36.0	34.9	34.5	35.0
2.	Physiological responses at the end of work	After 6.00 hours of work		After 6.00 hours of work		After 3.00 hours of work	
	Respiration rate (RR)	58.0 (2)	54.0 (1)	65.0 (1)	63.0 (2)	69.0 (3)	64.0 (2)
	Pulse rate (PR)	49.0 (2)	48.0 (2)	61.0 (3)	57.0 (3)	67.0 (4)	62.0 (4)
	Pulse temperature (BT)	38.2 (2)	38.4 (4)	38.9 (5)	39.3 (5)	38.7 (5)	38.9 (5)
3.	Physical behavioural symptoms						
	Frothing	(1)	(1)	(2)	(2)	(2)	(2)
	Inhibition of progressive movement	(1)	(1)	(2)	(2)	(2)	(2)
	Leg un- coordination	(0)	(1)	(2)	(2)	(2)	(2)
	Excitement	(0)	(0)	(1)	(1)	(2)	(2)
	Tongue protrusion	(1)	(0)	(1)	(1)	(2)	(2)
	Total score	(9)	(10)	(17)	(18)	(22)	(21)

Table 3 : Physiological response of bullocks for double improved steel cart on murrum road

Sr. No.	Parameters	8 quintals		9 quintals		10 quintals	
		Kaarna	Arjuna	Karna	Arjuna	Karna	Arjuna
1.	Physiological response of bullocks- before works						
	Respiration rate (RR)	22.0	27.0	28.0	33.0	30.0	31.0
	Pulse rate (PR)	20.	22.0	24.0	25.0	25.0	20.0
	Body temperature (BT)	36.0	36.0	36.1	37.0	35.6	36.1
2.	Physiological responses at the end of work	After 6.00 hours of work		After 6.00 hours of work		After 3.00 hours of work	
	Respiration rate (RR)	63.0 (2)	61.0 (1)	67.0 (2)	61.0 (1)	72.0 (2)	62.0 (2)
	Pulse rate (PR)	62.0 (3)	68.0 (4)	62.0 (2)	68.0 (3)	68.0 (4)	58.0 (3)
	Body temperature (BT)	38.3 (3)	39.3 (4)	38.5 (4)	39.3 (4)	38.2 (5)	39.8 (5)
3.	Physical behavioural symptoms						
	Frothing	(1)	(1)	(2)	(2)	(2)	(3)
	Inhibition of progressive movement	(0)	(0)	(2)	(2)	(2)	(2)
	Leg un- coordination	(1)	(1)	(2)	(2)	(3)	(2)
	Excitement	(1)	(0)	(2)	(2)	(2)	(2)
	Tongue protrusion	(0)	(0)	(2)	(2)	(2)	(2)
	Total score	(11)	(11)	(18)	(18)	(20)	(21)

Table 4 : Performance of single bullock improved steel cart on different road conditions

Sr. No.	Parameters	Single bullock improved steel cart					
		Asphalted track			Murrum road		
1.	Loading level, (Quintal)	5	6	7	5	6	7
2.	Draft, kg	48.00	48.80	49.60	49.10	50.10	51.30
3.	Speed, km /h						
	Maximum	2.05	1.90	1.76	2.06	1.97	1.76
	Minimum	1.88	1.67	1.60	1.89	1.68	1.59
4.	Power output, (kW)						
	Maximum	0.35	0.33	0.31	0.36	0.35	0.32
	Minimum	0.32	0.29	0.28	0.33	0.29	0.29

Table 5 : Physiological response bullock for single bullock improved steel cart on asphalted track

Sr. No.	Parameters	5 quintals	6 quintals	7 quintals
1.	Physiological response of Bullocks- before works			
	Respiration rate (RR)	28	30	32
	Pulse rate (PR)	23	28	30
	Body temperature (BT)	38.3	38.0	38.2
2.	Physiological response at the end work	After 6.00 hours of work	After 6.00 hours of work	After 6.00 hours of work
	Respiration rate (RR)	84.0 (3)	82.0 (3)	84.0 (3)
	Pulse rate (PR)	75.0 (4)	79.0 (5)	81.0 (5)
	Body temperature (BT)	39.7 (2)	39.5 (3)	39.7 (3)
3.	Physical behavioural symptoms			
	Frothing	(1)	(2)	(2)
	Inhibition of progressive movement	(1)	(1)	(2)
	Leg un – co-ordination	(0)	(2)	(2)
	Excitement	(0)	(1)	(2)
	Tongue protrusion	(0)	(1)	(2)
	Total score	(11)	(18)	(21)

Table 6 : Physiological response of bullock for single bullock improved steel cart on murrum road

Sr. No	Parameters	5 quintals	6 quintals	7 quintals
1.	Physiological response of Bullocks- before works			
	Respiration rate (RR)	30	41	28
	Pulse rate (PR)	26	39	25
	Body temperature (BT)	38.1	38.0	38.2
2.	Physiological response at the end work	After 6.00 hours of work	After 6.00 hours of work	After 6.00 hours of work
	Respiration rate (RR)	69.0 (2)	89.0 (3)	85.0 (3)
	Pulse rate (PR)	72.0 (4)	82.0 (4)	84.0 (5)
	Body temperature (BT)	39.9 (3)	39.5 (3)	39.7 (3)
3.	Physical behavioural symptoms			
	Frothing	(1)	(2)	(2)
	Inhibition of progressive movement	(1)	(2)	(2)
	Leg un – co-ordination	(0)	(1)	(2)
	Excitement	(0)	(1)	(2)
	Tongue protrusion	(0)	(1)	(2)
	Total score	(11)	(17)	(21)

2, 3 and 3, respectively and based upon the behavioural response of the bullock a total of 3 more fatigue score points were added, taking the total fatigue score to 11 at the end of six hours of work. In a similar manner the total fatigue score of bullock Arjun also was 11. It means that a bullock pair weighing 515 is capable of transporting 8 quintals of goods on a murrum road for six hours and still the pair is not fatigued.

With a 9 quintal load, it was seen that the two bullocks reached a total fatigue score of 18 and 18, respectively. At 10 quintal load, it was seen that after 3 hours of work, the two bullocks reached a fatigue score of 20 and 21, respectively, which gives a clear indication that it is better to extract only about 2 hours of work from bullocks of this size at this load level on a murrum road.

Draft, speed and power output of single bullock steel cart :

The performance of single bullock improved steel cart at three load level namely 5, 6 and 7 quintals is presented in Table 4.

From Table 4, it is observed that the average draft requirement for pulling the cart with a load of 5 quintal on a murrum road was 49. 10 kg, the walking speed of bullocks ranged from 2.06 km/h in the beginning to 1.89 km/h towards the end of the working period. The power output developed by the bullock ranged from 0.36 to 0.33 kW. At 6 quintal loading, the draft requirement was 50. 10 kg. At 7 quintal loading, the draft requirement was 51. 30 kg and the speed range was 1.76 km/h in the beginning to 1.59 km/h towards the end of the working period. The power output developed by the bullock ranged from 0.32 to 0.29 kW. It was observed that with increasing level of loading, the draft requirement also increased and the walking speed has decreased. The power developed by the bullock also decreased with increasing load condition.

Evaluation of single bullock improved steel cart:

The data on performance of single bullock improved

steel cart on asphalted track and murrum road are presented in Table 5 and 6, respectively.

For the single bullock improved cart, bullock Karna weighing 260 kg was used for the experiment, on asphalted as well as murrum road surfaces at loading levels of 5, 6 and 7 quintals, respectively. At 5 quintal loading, total fatigue score accounts to 11 at the end of six hours of work. It means that a bullock weighing 260 kg is capable of transporting 6 quintals of goods on an asphalted surface for six hours and still animal is not fatigued. With 6 quintal and 7 quintal loads, the bullock reached a fatigue of 18 and 21, respectively.

Conclusion:

The double bullock improved steel cart is capable to carry a load of 8 to 9 quintals safely within the physiological response of bullocks. The single bullock improved steel cart is capable to carry a load of 6 quintals safely within the physiological response of bullocks. The performance of the steel cart by bullock power was satisfactory in terms of avoiding road damage by fixing rubber shod on the rims of steel wheels.

Authors' affiliations:

K.V. Prakash, Department of Farm Machinery and Power Engineering, College of Agricultural Engineering (U.A.S.), **Raichur (Karnataka) India** Email : prakashkv07@yahoo.co.in — — — — —

Jag Jiwan Ram and M. Din, AICRP on Utilization of Animal Energy, College of Agricultural Engineering (U.A.S.), **Raichur (Karnataka) India**

REFERENCES

- Dubey, U. C. and Singh, R. C. (2001)**. ORP on improved two wheeled cart. Biennial report of AICRP on UAE 2000-02 Central Institute of Agricultural Engineering, Bhopal Center, 78-84 pp.
- Hallikeri, R.C. (2000)**. Evaluation of two wheeled and four wheeled steel carts. Consolidated Report of AICRP on UAE Scheme 2000-02 Raichur Center, 5-19 pp.
- Jogdand, S., Victor, V. M. and Sinha, B. L. (2006)**. Survey of two wheeled and four wheeled Bullock carts used in the region. Biennial report of AICRP on UAE Scheme 2004-06 Raichur Center, 101-106 pp.

11th
Year
★★★★★ of Excellence ★★★★★