

ESTIMATION OF DRAUGHT ABILITY OF ONGOLE BULLOCKS BY DIFFERENT METHODS*

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ABSTRACT

The draught ability of 55 Ongole bulls was evaluated by overall draught ability method and horse power (hp) generation method. The age and weight groups of the bulls had significant influence on respiration rate (RR), pulse rate (PR) and rectal temperature (RT) before carting. The per cent increase in PR and RT after ploughing was significantly affected by the age of the bulls but not by the weight. The overall means for per cent increase in RR, PR and RT were 55.84, 22.76 and 1.71, respectively in carting and 92.07, 30.38 and 2.07, respectively in ploughing. The overall increase in the RR, PR and RT after work in horse power generation method were 101.36, 25.17 and 1.20, respectively and the overall means for the speed of walking, draught force and horse power generated were 1.59 meters per second, 28.19 kg and 0.57 hp, respectively. The phenotypic correlations between the age, body weight and body measurements of the bulls included in the draught ability study were highly positive and significant. The Spearman's rank correlation between the ranks of sires obtained by overall draught ability method and horse power generation method was negative and not significant.

Key words: Draught ability, Ongole bulls, Pulse rate, Rectal temperature, Respiration rate

The Ongole cattle are efficiently used for both work and milk production. The bullocks are suitable for heavy ploughing or carting and cows are fair milkers. Because of its hardiness, thriftiness, faster growth rate, natural tolerance to tropical heat, disease resistance, good beef conformation and a tendency to grow leggy with sparse light carriage, it was the first Indian breed, which gained recognition all over the world. Although much work has been done on the production and reproduction traits of Ongole cattle, the information on its draught ability

is scanty. Therefore, the present study was aimed to estimate the draught performance of Ongole bulls by different methods.

MATERIALS AND METHODS

The draught performance of a total of 55 Ongole bulls was estimated by overall draught ability (ODA) (Thomas 1995) and horse power generation methods. The ODA was obtained by

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measuring the capacity for carting and ploughing. The carting ability, which assesses the load carrying capacity, speed and endurance to work under heat stress as a single metric measurement, was carried out on 30 bullocks during the summer. The single animal cart was allowed to carry a load of double its body weight including the cart weight, over a distance of 10 km on leveled asphalt road and the time taken to cover the initial one km and final one km distance was noted. The experiment was repeated six times and the average measurements on each bullock were calculated. The carting ability was computed as the ratio of increase in time to cover the final one km distance to time taken to cover initial one km distance and expressed as percentage. The ploughing ability, which measures the ability of the animal for speedy and sustained work under thermal stress, was carried out on 30 bullocks in summer season. The test was carried out on a 200 meter leveled elliptical ploughing tract containing equal proportions of sand and clay. The bull, after fitted with a single harness plough, was made to plough the track continuously for two hours and the time taken to complete one lap at the beginning and at the end of two hours period were recorded. The experiment was repeated six times and the average for each bullock was computed. The ploughing ability, expressed in percentage was calculated as the ratio of increase in time to cover one lap at the end of lap to time taken to cover one lap in the initial stage. The ODA of a bull was estimated by the formula:

$$\text{ODA} = 100 - \frac{\text{Carting ability} + \text{ploughing ability}}{2}$$

The horse power generated by the bullocks was measured using a single harness plough system consisting of two-wheel bullock cart fitted with a digital dynamometer. The dynamometer converts the animal force and the load it pulls and the reading given was proportionate to the force exerted. The bullocks under test were subjected to work on a

60 meter long elliptical track for about an hour or till fatigue sets in them. The speed of walking was measured as time taken to travel a particular distance while the draft was calculated as pull in kg multiplied by COS AE, where AE is the angle the beam makes with the ground. Force in kg was obtained with the help of digital dynamometer and the horse power generated was computed by the equation:

$$\text{Horse power (hp)} = \frac{\text{Draft} \times \text{speed}}{75}$$

The test was conducted three times on each bullock and the average values were worked out. The respiration rate, pulse rate and rectal temperature of all the bulls were recorded before and after work. The influence of age and weight groups of the animals on draught capacity were estimated by analysis of variance (Snedecor and Cochran 1967) and the phenotypic correlations computed. The bullocks were ranked based on their overall draught ability and horse power generated and the Spearman's rank correlation was estimated.

RESULTS AND DISCUSSION

Over all draft ability method

The means of various physiological parameters before and after carting, before and after ploughing, the percent increase on carting and ploughing, carting ability, ploughing ability and the overall draft ability (ODA) of the bulls under test are presented in Table 1.

Age group

The age group of the bullocks significantly influenced the respiration rate (RR), pulse rate (PR) and rectal temperature (RT) before carting, RR and PR after carting, RT after ploughing

and the per cent increase in PR and RT on ploughing. The highest means for RR, PR and RT before carting and after carting were recorded in the bullocks of 60 to 71 months age, whereas the animals older than 72 months had the lowest means for all the three physiological parameters studied before as well as after carting. The highest mean RT of 103.31^o C after ploughing was recorded in the bullocks of more than 72 months age, while the per cent increase in RT after ploughing was highest (39.89%) in the bullocks of 60 to 71 months age, which could be due to the exertion of work. The age group of the bulls also had significant influence on the per cent increase in PR and RT on ploughing. The per cent increase in PR was highest (39.89%) in the bulls of 60 to 71 months while the increase in RT was highest (2.62%) in the bulls older than 72 months. There was no specific trend with regard to the increase or decrease in the PR and RT between the various age groups studied. The age of the bulls in the present study was found to have no significant influence on their carting and ploughing abilities and overall draft ability. The ODA among the various age groups ranged from 82.13 % (24-35 months) to 85.39 % (48-59 months age).

Weight group

The weight group of the bulls had significant effect on the RR, PR and RT before carting, RR after carting and ploughing, while it had no significant influence on the per cent increase on carting and ploughing, carting ability and ploughing ability and overall draft ability. The ODA of the bulls weighing 300 to 399 kg was the highest (84.86 %), while it was the lowest in the bulls weighing 100 to 199 kg (79.11%). However, the differences in the ODA among the weight groups of the bulls were statistically not significant. Although the mean physiological parameters in the bulls

weighing more than 500 kg were significantly lower than those in the bulls weighing 100 to 199 kg, there was no specific trend in their decline.

Horse power generation method

The means of RR, PR, RT, draught and horse power generated by the Ongole bulls by the horse power generation method, before work, after work and per cent increase on work are detailed in Table 2.

Age group

The age group of the bulls had no significant influence on the RR, PR and RT before work, after work, speed of walking of the bulls, draught ability and horse power generated. However, the per cent increase in RR and RT after work was significantly affected by the age group of the bulls. The per cent rise in RR increased linearly as the age group of the bulls increased due to stress of work. The per cent rise in RT declined as age of the bulls increased, which might be due to good thermoregulatory mechanism of the bulls. The overall mean per cent increase in RR, PR and RT after work was 101.36, 25.17 and 1.20, respectively. The overall mean horse power generated by the bulls was 0.57 and it ranged from 0.56 (in 24 to 35 months age group) to 0.60 (in 48 to 59 months age group).

Weight group

The weight group of the bulls affected the RR before work, per cent increase in RR and RT and the speed of walking significantly. The bulls weighing 400 to 499 kg, which had the highest mean RR before work (30.84 per minute) recorded lowest per cent increase in RR (53.47%) after work, whereas the bulls belonging to the weight group of 200 to 299 kg, which had the lowest mean RR before work (18.50 per minute) recorded the highest mean per

cent increase in RR (132.60%). In similarity to the mean RR before work, the bulls weighing 400 to 499 kg had the highest mean per cent increase in RT (1.81) and mean speed of walking (1.79 meters per second). An increase in the physiological responses of the bulls after work was also reported by Chakravarthi *et al.* (2004). Anil and Thomas (1994) observed an increase in RR, PR and RT by 285, 48 and 26.2%, respectively at the end of ploughing in cattle. The mean speed of walking of Ongole bulls in the present study was slightly higher than that reported in Kangayam cattle by Kumaravelu *et al.* (1997). The variation in speed of walking by the bulls may be due to the differences in their age and body weights. The variation in draught and horse power (hp) generated by the bulls belonging to various weight groups was, however, not significant (Table 2). The overall draft force obtained in the present study was similar to that reported in Haryana bullocks (Devadattam and Maurya, 1978). The overall mean horse power generated by the Ongole bulls in the present study was 0.57 hp, which was on par with the mean horse power generated by purebred Haryana bullocks (Upadhyay and Madan 1985), but slightly lower than the mean horse power reported in Kangayam bullocks (Kumaravelu *et al.*, 1997).

Phenotypic correlations

The phenotypic correlation coefficients between the age, body weight, height at withers, body length, per cent increase in physiological responses, speed, draught and horse power generated are presented in Table 3. The correlations between age, body weight and body measurements of the bulls were highly positive and significant. The correlations of age, body weight and body measurements with per cent increase in the physiological responses of the bulls after work, except that between age and per cent increase

in PR, were found to be positive and significant. Among the three physiological parameters, the per cent increase in RR was found to be correlated negatively and significantly with per cent increase in PR and RT, whereas the per cent increases in PR and RT were positively and significantly correlated. The per cent increase in RR was correlated negatively and significantly ($P < 0.05$) with speed of the bulls, while the per cent increases in PR and RT were correlated positively and significantly with speed. The speed of walking of bulls was found to be correlated positively and significantly ($P < 0.01$) with horse power.

Ranking of the bulls based on draught ability

The Spearman's rank correlation coefficient between the bulls ranked by the overall draught ability method and horse power generation method was negative and not significant (-0.30), which revealed that the two methods studied were independent in assessing the draught ability of the bulls. The number of bulls utilized in the present study was small and there was a wide variation in the age and body weights among the bulls tested. Further studies utilizing larger number of bulls with greater uniformity in their age and body weights are needed to draw more valid conclusions on the draught ability of Ongole bulls.

Table 1. Means of respiration rate (RR, per minute), pulse rate (PR, per minute), rectal temperature (RT, °C), carting ability (CA, %), ploughing ability (PA, %) and overall draught ability (ODA, %) of Ongole bulls by overall draught ability method

	Overall (30)		Age group (months)						>72 (6)						Weight group (kg)																			
	M	SE	24-35 (7)	36-47 (7)	48-59 (7)	60-71 (3)	72-84 (3)	85-97 (3)	100-119 (3)	120-139 (3)	140-159 (3)	160-179 (3)	180-199 (3)	200-219 (2)	220-239 (2)	240-259 (2)	260-279 (2)	280-299 (2)	300-319 (7)	320-339 (4)	340-359 (4)	360-379 (4)	380-399 (4)	400-419 (4)	420-439 (4)	440-459 (4)	460-479 (4)	480-499 (4)	>500 (14)					
RR	11.99	0.20	12.74 ^a	0.34	12.24 ^{ab}	0.33	11.84 ^b	0.38	12.89 ^b	0.24	10.55 ^c	0.15	13.47 ^c	0.24	12.30 ^b	0.90	12.07 ^b	0.28	12.20 ^b	0.59	11.55 ^c	0.30	12.07 ^b	0.28	12.20 ^b	0.59	11.55 ^c	0.30	12.07 ^b	0.28	12.20 ^b	0.59	11.55 ^c	0.30
PR	44.53	0.27	45.43 ^a	0.51	44.09 ^b	0.50	45.04 ^{ab}	0.50	45.67 ^b	0.77	42.83 ^c	0.29	46.00 ^c	0.83	46.70 ^c	0.10	44.47 ^{ab}	0.45	43.40 ^b	0.28	44.26 ^b	0.42	44.47 ^{ab}	0.45	43.40 ^b	0.28	44.26 ^b	0.42	44.47 ^{ab}	0.45	43.40 ^b	0.28	44.26 ^b	0.42
RT	100.65	0.04	100.72 ^{ab}	0.06	100.60 ^{ac}	0.09	100.72 ^b	0.03	100.82 ^b	0.11	100.48 ^c	0.09	100.80 ^{bc}	0.14	100.94 ^b	0.10	100.64 ^{ac}	0.04	100.51 ^{ac}	0.07	100.63 ^{ac}	0.06	100.64 ^{ac}	0.04	100.51 ^{ac}	0.07	100.63 ^{ac}	0.06	100.64 ^{ac}	0.04	100.51 ^{ac}	0.07	100.63 ^{ac}	0.06
CA	18.69	0.38	19.57 ^a	0.84	18.95 ^b	0.40	18.76 ^b	0.82	21.00 ^c	0.82	16.11 ^d	0.28	20.33 ^c	0.58	18.30 ^b	2.10	18.68 ^b	0.67	19.15 ^b	1.10	18.13 ^b	0.62	18.68 ^b	0.67	19.15 ^b	1.10	18.13 ^b	0.62	18.68 ^b	0.67	19.15 ^b	1.10	18.13 ^b	0.62
PA	54.67	0.50	55.77 ^a	0.33	54.98 ^b	1.14	55.33 ^b	0.88	56.44 ^b	0.67	51.36 ^c	1.34	56.33 ^b	0.64	57.40 ^b	0.20	55.23 ^b	0.78	54.00 ^b	1.77	53.83 ^b	0.85	54.00 ^b	1.77	53.83 ^b	0.85	54.00 ^b	1.77	53.83 ^b	0.85	54.00 ^b	1.77	53.83 ^b	0.85
RT	102.38	0.07	102.55	0.12	102.37	0.17	102.28	0.13	102.60	0.05	102.10 ^b	0.21	102.72	0.08	102.58	0.22	102.35	0.12	102.33	0.30	102.30	0.11	102.33	0.12	102.33	0.30	102.30	0.11	102.33	0.12	102.33	0.30	102.30	0.11
ODA	55.84	1.83	53.67	5.53	55.06	2.35	58.34	4.20	63.19	8.21	52.68	2.15	55.49	4.22	48.33	6.22	55.13	5.65	57.08	5.62	56.98	2.41	55.13	5.65	57.08	5.62	56.98	2.41	55.13	5.65	57.08	5.62	56.98	2.41
RR	22.76	0.86	22.82	0.92	24.71	2.34	22.84	1.38	23.61	0.63	19.91	2.96	22.50	0.91	22.91	0.17	24.26	1.87	24.41	3.81	21.88	1.32	24.26	1.87	24.41	3.81	21.88	1.32	24.26	1.87	24.41	3.81	21.88	1.32
RT	1.71	0.06	1.82	0.12	1.77	0.16	1.55	0.13	1.77	0.10	1.68	0.17	1.91	0.18	1.62	0.12	1.70	0.14	1.82	0.26	1.66	0.09	1.70	0.14	1.82	0.26	1.66	0.09	1.70	0.14	1.82	0.26	1.66	0.09
CA	13.16	0.16	13.36	0.23	13.05	0.44	13.39	0.30	1.35	0.67	12.47	0.29	13.47 ^a	0.57	14.50 ^b	0.50	13.35 ^{ab}	0.11	12.20 ^b	0.28	13.07 ^{bc}	0.25	13.35 ^{ab}	0.11	12.20 ^b	0.28	13.07 ^{bc}	0.25	13.35 ^{ab}	0.11	12.20 ^b	0.28	13.07 ^{bc}	0.25
PR	45.80	0.20	45.94	0.31	45.26	0.52	46.16	0.34	46.11	0.74	45.67	0.59	46.33	0.53	46.60	1.20	45.43	0.36	44.95	0.44	45.99	0.32	45.43	0.36	44.95	0.44	45.99	0.32	45.43	0.36	44.95	0.44	45.99	0.32
RT	100.77	0.05	100.78	0.11	100.82	0.12	100.75	0.06	100.90	0.19	100.67	0.14	100.91	0.27	101.00	0.36	100.78	0.09	100.65	0.07	100.74	0.07	100.78	0.09	100.65	0.07	100.74	0.07	100.78	0.09	100.65	0.07	100.74	0.07
ODA	25.6	1.02	24.77	1.87	26.90	2.79	22.91	0.91	30.78	6.44	24.42	1.39	25.80	4.47	31.30	11.90	24.54	0.86	22.95	0.57	25.52	1.54	24.54	0.86	22.95	0.57	25.52	1.54	24.54	0.86	22.95	0.57	25.52	1.54
RR	59.71	0.63	58.66	0.63	58.90	1.12	58.32	0.56	64.61	4.87	61.06	1.35	58.87	1.55	57.80	1.80	59.25	0.77	57.00	0.89	61.17	1.20	59.25	0.77	57.00	0.89	61.17	1.20	59.25	0.77	57.00	0.89	61.17	1.20
RT	102.86	0.06	102.67 ^{ab}	0.06	102.84 ^b	0.12	102.74 ^b	0.14	102.73 ^b	0.05	103.31 ^c	0.16	102.75 ^b	0.04	102.62	0.22	102.82	0.16	102.86	0.08	102.94	0.11	102.82	0.16	102.86	0.08	102.94	0.11	102.82	0.16	102.86	0.08	102.94	0.11
CA	92.09	6.14	84.85	11.53	104.05	14.25	70.20	7.45	124.66	35.22	95.84	10.11	89.74	25.08	113.29	74.71	88.93	6.96	88.23	4.04	94.75	9.44	88.93	6.96	88.23	4.04	94.75	9.44	88.93	6.96	88.23	4.04	94.75	9.44
PR	30.38	1.26	27.69 ^a	1.28	30.20 ^b	2.60	26.38 ^c	1.56	39.89 ^b	8.42	33.65 ^{ab}	1.87	27.06	3.16	24.02	0.67	30.48	2.21	26.82	1.90	32.97	2.24	30.48	2.21	26.82	1.90	32.97	2.24	30.48	2.21	26.82	1.90	32.97	2.24
RT	2.07	0.08	1.88 ^b	0.10	2.01 ^b	0.19	1.97 ^b	0.09	1.82 ^b	0.14	2.62 ^c	0.18	1.83	0.23	1.60	0.14	2.02	0.18	2.19	0.04	2.18	0.13	2.02	0.18	2.19	0.04	2.18	0.13	2.02	0.18	2.19	0.04	2.18	0.13
CA	9.52	0.44	9.86	0.65	8.99	0.90	10.05	0.71	9.99	0.06	8.88	1.80	9.86	0.35	10.41	0.57	10.06	0.93	8.47	1.18	9.36	0.80	10.06	0.93	8.47	1.18	9.36	0.80	10.06	0.93	8.47	1.18	9.36	0.80
PA	23.30	1.44	25.85	4.07	26.58	3.14	19.17	2.05	24.70	7.34	20.61	0.96	31.91	8.61	30.08	9.54	20.22	1.83	23.79	1.49	21.89	1.99	20.22	1.83	23.79	1.49	21.89	1.99	20.22	1.83	23.79	1.49	21.89	1.99
ODA	83.69	0.75	82.13	2.01	83.64	1.47	85.39	0.97	82.66	3.68	84.08	1.88	79.11	4.23	84.76	0.52	84.86	1.03	83.87	1.16	83.87	1.25	84.86	1.03	83.87	1.16	83.87	1.25	84.86	1.03	83.87	1.16	83.87	1.25

Means followed by the same superscript(s) within the age group and weight groups do not differ significantly (P<0.05).

Figures in parentheses indicate the number of bullocks.

Table 2. Means of respiration rate (RR, per minute), pulse rate (PR, per minute), rectal temperature (RT, °C), speed (s, m/s), draught (d, kg) and horse power (hp) of Ongole bulls by horse power generation method

	Overall (25)	Age group (months)						Weight group (kg)															
		24-35 (8)		36-47 (5)		48-59 (3)		60-71 (4)		>72 (5)		100-199 (4)		200-299 (2)		300-399 (6)		400-499 (4)		>500 (9)			
		Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE		
		Before work																					
RR	23.86	1.11	25.54	2.38	26.53	3.03	23.89	3.37	20.06	0.50	21.52	1.06	22.25 ^{ab}	2.98	18.50 ^{ab}	0.50	26.56 ^{ab}	1.18	30.84 ^{ab}	1.30	20.87 ^b	0.65	
PR	41.71	0.88	39.58	1.94	40.23	1.58	42.33	3.48	44.06	0.67	44.35	0.89	40.67	1.03	43.50	0.50	40.58	1.37	38.56	1.78	44.22	0.55	
RT	100.93	0.09	101.01	0.16	100.65	0.11	101.04	0.19	100.98	0.28	100.95	0.23	101.23	0.20	101.20	0.20	100.79	0.07	100.57	0.10	100.97	0.17	
		After work																					
RR	46.09	0.97	44.54	1.62	48.00	1.82	45.11	1.95	49.63	3.94	44.43	1.30	43.67	3.01	43.00	0.01	47.45	0.82	47.67	0.76	46.74	1.97	
PR	51.67	0.63	51.13	1.62	52.87	1.58	51.67	0.33	51.38	0.63	51.60	1.14	50.42	1.38	52.00	0.01	51.22	0.97	54.78	1.36	51.50	0.66	
RT	102.14	0.09	102.35	0.15	102.09	0.21	102.36	0.09	101.86	0.24	101.95	0.21	102.53	0.21	102.15	0.35	102.06	0.08	102.39	0.16	101.91	0.15	
		Percent increase on work																					
RR	101.36	8.74	81.55 ^a	11.53	91.34 ^{ab}	24.56	96.37 ^b	27.09	148.54 ^d	23.45	108.35 ^d	11.01	100.79 ^d	11.79	132.60 ^{ab}	6.29	87.23 ^{ab}	9.42	53.47 ^{bc}	6.61	126.21 ^c	13.24	
PR	25.17	2.99	31.01	6.59	32.40	7.46	23.64	9.37	16.63	1.27	16.33	0.67	24.45	6.53	19.36	1.37	29.05	4.21	42.71	6.24	16.47	0.63	
RT	1.20	0.08	1.32 ^a	0.16	1.43 ^b	0.23	1.30 ^{ab}	0.17	0.87 ^{bc}	0.09	0.99 ^c	0.13	1.28 ^{cd}	0.31	0.94 ^d	0.15	1.27 ^{de}	0.06	1.81 ^{de}	0.06	0.93 ^e	0.08	
S	1.59	0.03	1.62	0.04	1.70	0.09	1.54	0.17	1.57	0.08	1.51	0.07	1.65 ^a	0.07	1.48 ^{ab}	0.09	1.54 ^{ab}	0.02	1.79 ^b	0.10	1.54 ^b	0.05	
D	28.19	0.55	29.90	0.83	25.76	1.63	29.23	0.32	27.80	0.93	27.58	1.00	29.59	1.25	29.41	0.15	28.42	0.79	26.07	1.39	27.68	0.65	
hp	0.57	0.03	0.56	0.08	0.58	0.04	0.60	0.07	0.58	0.04	0.55	0.01	0.65	0.05	0.58	0.04	0.47	0.05	0.62	0.04	0.56	0.02	

Means followed by the same superscript(s) within the age group and weight groups do not differ significantly (P<0.05).

Figures in parentheses indicate the number of bullocks.

Table 3. Correlations among age, body weight, body measurements and draught parameters

	Age	Body weight	Height at withers	Chest girth	Body Length	% RR	% PR	% RT	Speed	Draught	hp
Age	1.000	0.789**	0.424**	0.737**	0.662**	0.209	-0.406*	-0.370	-0.275	-0.131	-0.034
Body weight		1.000	0.822**	0.968**	0.937**	0.054	-0.142	-0.202	-0.114	-0.146	-0.081
Height at withers			1.000	0.866**	0.916**	-0.136	0.100	0.065	0.082	-0.284	-0.137
Chest girth				1.000	0.931**	0.116	-0.144	-0.165	-0.089	-0.269	-0.110
Body length					1.000	-0.035	-0.055	-0.047	-0.034	-0.223	-0.072
% RR						1.000	-0.633**	-0.628**	-0.498	-0.255	-0.079
% PR							1.000	0.715	0.441	0.286	-0.204
% RT								1.000	0.524**	0.189	0.037
Speed									1.000	-0.157	0.508**
Draught										1.000	-0.049
Hp											1.000

*Significant at P<0.05. **Significant at P<0.01.

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