

Performance Evaluation of Animal Driven Rotary Mode Power Transmission System to Operate Flour Mill

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ABSTRACT: The Performance evaluation of Animal Driven Rotary Mode Power transmission system for operating flour mill was undertaken at the site of the CAET, M.K.V., Parbhani. The work rest schedule of 1 hour work – ½ hour rest - 1 hour work – ½ hour rest - 1 hour work – ½ hr rest – 1 hour work was followed. The speed (kmph), draft (kg), output (kg/hour), power developed (W), physiological responses and fatigue score of experimental bullocks in operations of flour milling were recorded. Flour Mill was also evaluated for performances in developed rotary transmission system. The Power generated by the bullock pair in a developed rotary transmission system and Output of flour milling operation were varies significantly with speed of local bullock pair during all operations. The draft exerted by bullocks, speed of bullocks, power generated and output of flour Mill during work rest cycle were varied from 38.31 to 36.18 kg, 2.97 to 2.37 kmph, 0.301 to 0.234 kW and 5.45 to 5.20 kg/hr respectively. The output of flour mill by using developed animal driven rotary power transmission system was lower than that of in electrical operation. The total cost of operation of bullock operated flour mill were Rs. 82.46 per hour. Due to fluctuation of speed in rotary mode, the performance of the flour milling was lower in a rotary power transmission system than that of in the electrically operations. .

KEYWORDS: Power transmission, Flour Mill, Dynamometer, Draft, Fatigue Score.

I. INTRODUCTION

The animals are inoperative for approximately 150 to 200 days in a year. This idle time can be resourcefully utilized by establishing an animal operated agro processing unit. The bullocks can be used in rotary mode power transmission system, post harvest operations like flour milling, chaff cutting, dal milling, groundnut decortifications, oil extraction, threshing and other stationery operations. Development of matching agro processing machines to be used in rotary mode power transmission system is helpful to the farmers to use their animals in idle time and save electricity and other fuels and may earn more by lending this facility to others.

II. MATERIAL AND METHODS

Experiment was conducted at College of Agricultural Engineering and Technology, Parbhani site. The developed animal driven rotary transmission system was evaluated for its performance for flour milling operation. During the test, bullocks were hitched at a distance of 4.24 m from the centre of vertical input shaft. The bullocks walked in circular motion that resulted on an average 2.0 RPM at vertical input shaft 776 RPM at pulleys of Flour Mill. Flour mill is a machine of 1 hp capacity which is operated by developed Animal driven Rotary Power Transmission system. The developed animal driven rotary transmission system was designed for 1 hp power output. The work rest schedule of 1 hour work - ½ hour rest - 1 hour work - ½ hour rest - 1 hour work - ½ hour rest – 1 hour work was

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followed. The speed (kmph), Draft (kg), Output (kg/hour), Power developed (W), Physiological responses and Fatigue score of local bullocks flour milling operations were recorded.

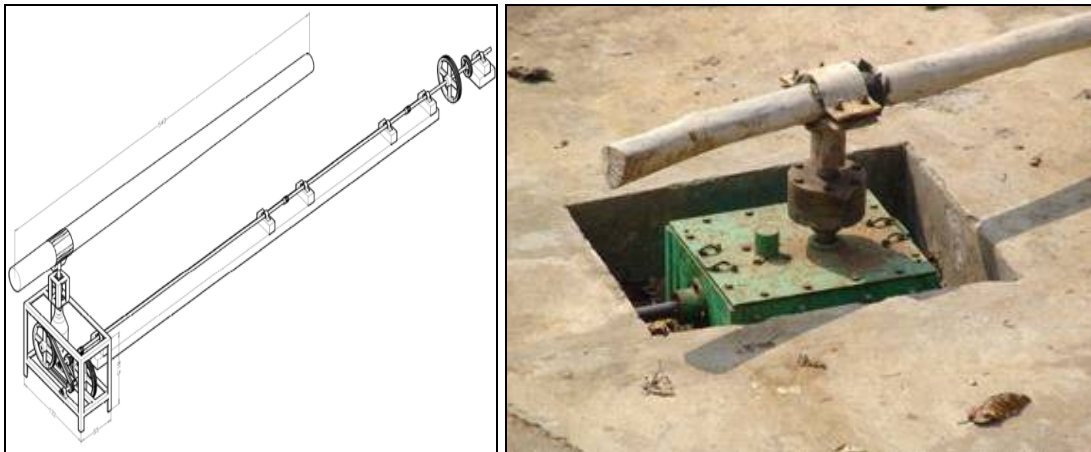


Fig:- Gear Box unit for mechanical power transmission in rotary mode.

Table 1: Specifications of rotary mode power transmission system.

Sr. No.	Particulars	Dimensions
1	Wooden beam	114.3 mm diameter and 5.49 m length
2	Vertical input shaft	35 mm dia and 81 cm long
3	Differential Gear Box	1:5 speed ratio step up type
4	MS wireframe rectangular box	1219.2 mm x 558.8 mm x 812.8 mm
5	Double groove V pulley	45.72 cm diameter
6	V Belt	B size
7	Double groove V pulley	11.43 cm diameter
8	Intermediate shaft	25 mm dia &
9	Underground shaft	25 mm dia & 6 m long
10	Couple joint	25 mm inner diameter
11	Pedestal bearings	Closed type
12	Underground channel	6 x 0.3 x 0.3 m
13	Output shaft	25 mm dia and 1.5 m long
14	Single groove V pulley	45.72 cm diameter
15	Single groove V pulley	20.32 cm dia
16	Cement concrete foundation for Pedestal bearings	0.15 x 0.15 x 0.15 m

Evaluation of power transmission system:

The developed power transmission system was evaluated by computing the power, draft and power output. The load was applied only after the bullocks attained the desired working speed. The dynamometer was mounted between yoke and beam, such that the pull exerted by the bullocks was applied to the beam through the dynamometer and which showed the instantaneous pull acting at the beam. The recorded draught was used to calculate input power. Test bullocks were hitched and allowed to move on a circular track. The system was tested at no load and loads. The resulted draft was measured using dynamometer.

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Physiological Responses of Bullocks:

The trials were conducted using yoke. Tests were conducted during summer (March-April) season. Trials were conducted using following work-rest schedule.

1 h work + 0.5 h rest + 1 h work+ 0.5 h rest + 1 h work + 0.5 h rest + 1 h work

During the rest period animals were kept in shed and also given feed and water. The environmental temperature started declining in the evening session and animals work up till the natural light was available. Hence, on an average the animals worked for 3-4 hour per day.

The physiological responses such as respiration rate, pulse rate and body temperature were recorded at the start of work in both the sessions termed as initial values. Then, after every hour of work the observation were recorded for physiological responses and physical symptoms for both the bullocks separately. The bullock moving in the outer circle was termed as outer bullock and the one moving inside was called inner bullock. The average speed was also calculated.

Performance evaluation of Flour Mill:

A commercially available Flour Mill of capacity 1 Hp manufactured by Vijay Engineering, Narayangoan, Pune was used (Plate). It was modified for using it in rotary transmission unit. The Flour Mill of capacity 1 Hp was evaluated for its performance in developed animal driven rotary transmission system. Jowar grains were grinded in it. An output capacity in Kg per hour was measured in respect of animal and electric operated. The output capacity of selected Flour Mill operated by animal driven rotary transmission system was also compared with an electric operated Flour Mill of capacity 1 Hp respectively.

Economic Viability:

Cost estimation was done under two heads fixed cost and variable cost. Fixed cost consists of; cost of power transmission system, pair of bullocks, civil work (earth work) and installation of transmission unit, plastering etc. and their depreciations. Variable cost consists of labor charges, maintenance of mechanical systems, feed fodder etc. Total expenditure was calculated as sum of fixed cost and variable cost.

III. EXPERIMENTAL RESULTS AND DISCUSSION

A developed rotary transmission system was evaluated for its performances in Flour milling operation in continuous working of 3 hours at no load and load conditions. The comparative physiological behavior of inner and outer bullock (B1 and B2) in a developed rotary mode system for Flour milling operation were observed for obtaining maximum work efficiency without undue fatigue. The tests were carried out on the test track for continuous three effective hours of work duration. The various physiological parameters and physical symptoms of individual bullock were recorded during experiment. The level of fatigue was assessed using fatigue score card developed by Upadhyay and Madan (1985).

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Performance evaluation of developed animal driven rotary transmission system under an operation of Flour Mill at no load condition:

Sr. No	Parameters	Duration, hour							Mean
		In	0.5	1.0	1.5	2.0	2.5	3.0	
1	Atmospheric temperature	41.4	41.4	41.4	41.4	41.5	41.5	41.5	41.44
2	Breed of bullock pair	Local	Local	Local	Local	Local	Local	Local	
3	Body weight of bullock pair	700	700	700	700	700	700	700	700
4	Draft, Kg		25.08	24.68	23.88	23.57	21.89	18.31	22.90
5	Percentage body weight, %		3.58	3.53	3.41	3.37	3.13	2.62	3.27
6	Speed of bullocks, kmph		3.15	3.10	3.00	2.96	2.75	2.30	2.88
7	Speed available at machine, RPM		882	876	865	846	818	684	828.44
8	Power output, kw		0.215	0.208	0.195	0.190	0.164	0.115	0.181
9	Output of machine, Kg/hr		-	-	-	-	-	-	-
10	Fatigue score	0	0	3	4.5	7.5	13.5	15.5	6.29

Table 2: Performance of Flour Mill in a developed animal driven rotary transmission system at continuous work for 3 hr at no load condition:

Table 2 shows that at no load condition an average speed of local bullock pair was decreased from 3.59 to 2.62 kmph during three hours of work. Draft exerted by the bullock pair was varies from 25.08 to 18.31 kg. Speed available at flour mill was also observed to be decreased from 882 to 684 RPM. Similarly, power generated was also decreased from 0.215 to 0.115 kW at the same condition. The respective average values of Draft, Percentage of draft to body weight of bullock pair, Average speed of bullock pair, Speed available at flywheel and Power output were 22.90 kg, 3.27 %, 2.88 kmph, 828.44 RPM and 0.181 kW respectively at no load condition.

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Performance evaluation of developed animal driven rotary transmission system under an operation of Flour Mill at load condition:

Table 3. Performance of Flour Mill in a developed animal driven rotary transmission system at continuous work of 3 hrs at load condition

Sr. No	Parameters	Duration, hour							Mean
		In	0.5	1.0	1.5	2.0	2.5	3.0	
1	Atmospheric temperature	41.7	41.7	41.8	41.8	41.8	41.8	41.9	41.79
2	Breed of bullock pair	Local	Local	Local	Local	Local	Local	Local	
3	Body weight of bullock pair	700	700	700	700	700	700	700	700
4	Draft, Kg		36.35	36.18	36.60	34.38	37.93	31.13	35.43
5	Percentage body weight, %		5.19	5.17	5.23	4.91	5.42	4.45	5.06
6	Speed of bullocks, kmph		3.00	2.96	2.84	2.78	2.62	2.15	2.73
7	Speed available at machine, RPM		840	836	819	795	779	639	784.71
8	Power output, kw		0.297	0.292	0.283	0.260	0.271	0.222	0.271
9	Output of machine, Kg/hr		5.50	5.47	5.36	5.20	5.10	4.19	5.136
10	Fatigue score	0	4.5	10	14.5	15.5	17.5	21.5	11.93

Table 3 demonstrate that at load condition an average speed of local bullock pair was decreased from 3.00 to 2.15 kmph during three hours of work. Draft exerted by the bullock pair was varies from 36.35 to 31.13 kg. Speed available at flour mill was also observed to be decreased from 840 to 639 RPM. Similarly, Power generated was also decreased from 0.297 to 0.292 kW at the same condition. The output of flour mill was varies from 5.50 to 4.19 kg/hr. The respective average values of Draft, Percentage of draft to body weight of bullock pair, Average speed of bullock pair, Speed available at flour mill, Power output and Output of flour mill were 35.43 kg, 5.06 %, 2.73 kmph, 784.21 RPM, 0.271 kW and 5.14 kg/hr respectively at load condition.

Determination of work rest schedule for bullock for developed rotary power transmission system in operation of selected matching gadgets:

A pair of bullock was used to operate flour mill having 1 hp capacity. The work rest schedule of 1 hour work - ½ hour rest - 1 hour work- ½ hour rest - 1 hour work - ½ hour – 1 hour work, was followed for flour milling operation. This work rest cycle was adopted to get maximum performance from the selected local bullocks. It is due to the fact that, the bullocks gives better performance in continuous 1 hour of work. During the experiment period, fatigue score of bullock noted according to Madan and Upadhyay (1985) by observing behavioural changes as well as by recording physiological responses after half an hour.

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Comparison of outputs of animal drawn rotary power transmission system and Electrical operated flour mill:

The comparison between outputs of bullock operated, and electrical operated flour mill shows that output of bullock operated flour mill is 5.5 to 6.0 kg/hr of flour. Output of an electrically operated flour mill was 8 to 9 kg /hr of flour. It is clear that, an output of bullock operated flour mill are lower than that of output of an electrically operated.

Cost economics of animal driven rotary transmission system for operating flour mill

The total cost of developed rotary power transmission unit for operating Flour Mill with pair of bullock is Rs. 82.46 per hour Cost.

IV. CONCLUSION

1. The fatigue developed in inner and outer bullocks at no load condition in a continuous 3 hour working of Flour Mill were 16 & 15 respectively. In case of load conditions, these were 21 & 22 respectively.
2. The bullock pair gives better performance during first hour operation of flour milling The fatigue developed at no load condition in respect of flour milling operation was observed to be well within the safer limit.
3. The draft exerted by bullocks, speed of bullocks, Speed available at machine and power output in a continuous 3 hour working of Flour Mill were varied from 25.08 to 18.31 kg, 3.15 to 2.30 kmph, 882 to 684 RPM & 0.22 to 0.12 kW at no load condition and from 36.35 to 31.13 kg, 3.0 to 2.15 kmph, 840 to 639 RPM and 0.297 to 0.222 kW respectively.
4. The Power generated by the bullock pair in a developed rotary transmission system and Output of flour milling operation were varies significantly with speed of local bullock pair during all operations.
5. The draft exerted by bullocks, speed of bullocks, power generated and output Flour Mill during work rest cycle were varied from 38.31 to 36.18 kg, 2.97 to 2.37 kmph, 0.301 to 0.234 kW and 5.45 to 5.20 kg/hr respectively.
6. The output of flour mill by using developed animal driven rotary power transmission system was lower than that of in electrical operation.
7. The total cost of operation of bullock operated Flour mill were Rs. 82.46 per hour.
8. Due to fluctuation of speed in rotary mode, the performance of the flour milling was lower in a rotary power transmission system than that of the in the electrically operations.

REFERENCES

- [1] Swain, S.K., M.K. Ghoshal, A.K. Dash and A.K. Mohapatra, "A study on bullock energy utilization through rotary mode power transmission system in operating potato peeler and slicer for chips making as value added product of potato", *International Journal of Agriculture Engineering*, Volume 6, Issue 2, pp. 529-536, 2013.
- [2] Behera, D., Behera, B.K., Mohapatra, A.K. and Swain, S, "Draught animal status in Orissa and its utilization pattern in few selected villages", *Agric. Engg. Today*, Vol. 30 (5 & 6) pp. 1-6, 2006.
- [3] Behera, B.K., Swain, S, Behera, D. and Mohapatra, A.K., "Studies on draftability of non-descript bullocks of Orissa", *J. Agric. Engg.*, Vol.43 (1), pp. 35-41, 2006.
- [4] Srivastava, N.S.L., "Animal energy in agriculture", *Agric.Engg. Today*, Vol.24 (2), pp. 24-26, 2000.
- [5] Doshi, C.P. and Tiwari, G. "A review of draught animal power as a prime mover for site specific operations", *Agricultural Mechanization in Asia, Africa & Latin America*, Vol.39 (3), pp. 37-41, 2008.
- [6] Singh, C.D. and Singh, R.C. "Study on physiological response of malvi breed bullocks in rotary mode transmission system for electricity generation", *Agric. Engg. Today*, Vol. 37(1), pp.1-6, 2013.
- [7] Khurmi, R.S. and Gupta J.K, " A Text Book of Machine Design", Eurasia Publishing House Pvt. Ltd., New Delhi. pp. 97, 398, 832, 868,1997.