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Development of an efficient transmission system (Rotary mode) for post harvest operation - grain cleaner cum grader

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Abstract

The bullock energy can be used in the rotary mode set up for post-harvest operations like Grain cleaning and Grading, chaff cutting, daal mill operations, flour milling and other stationery operations. The proposed research work presents the performance evaluation of the grain cleaner cum grader unit. The draft requirement varied from 480.2 N in the beginning to 421.4 N at the end. The mean draft was 434.43N which was 5.03 per cent of the bodyweight of the bullocks. The respiration rate, pulse rate as usual increased with duration. The mean respiration rate, pulse rate of B1 and B2 was observed as 24 and 25.75bpm, 56.75 and 55.25bpm respectively. The mean rpm of the Grain cleaner cum grader shaft was observed to be 320. The output of the machine gradually decreased with duration may be due to decrease in the speed of shaft of the Grain cleaner cum grader. The mean output was found to be 683.3kg/h were as the output of Grain cleaner cum grader operated with an electric motor was 760 kg/h. The mean power output from the bullock was found to be 0.538 kW. This indicated that the bullock could easily do the cleaning operation and their utilization could be enhanced. The lower value of working efficiency may be attributed due to obstruction in the in the reciprocating motion of graders sieves of Grain cleaner cum grader by the non-uniform speed of bullocks during working of the grain cleaner cum grader .The operation of Grain cleaner cum grader was found to be feasible considering the draftability of Red Kandhari bullocks and their output capacity.

Keywords: grain cleaner cum grader, red Kandhari bullock, draft, pulse rate, output

Introduction

Use of the draught animals for agriculture work is limited to tillage, sowing, Intercultivation and transport. The full potential of the animal power available is yet to be properly exploited. The average annual utilization of bullock hours in agriculture in marathwada region was found to around 500 hrs per year in rain fed agriculture and around 900 hours per year in double season irrigated areas as against an estimated potential of about 2400 hours per year. The cost of utilization is therefore, very high as the bullocks are to be fed throughout the year whether they are in use or not and thus to reduce the economic burden of owning a pair of bullock and to increase the utilization of annual hours of the bullock, use of the animal power for operating water lifting and small capacity agro processing machines operating in rotary mode is the solution. This helps in increasing the importance of draught animals as well as custom hiring through entrepreneurship development for Mahila bachat gat/ self-help groups and youth.

By using animals in the rotary mode of operation, the surplus/idle animal power available after tillage, sowing and other field operation can be utilized efficiently for different agro processing operations. This will reduce the dependency of farmers on electricity and fossil fuels. It will also enable the farmers to generate extra income when they are not engaged in agriculture operations. Also simultaneously self-help group can generate income. Small capacity agro processing machines in rotary mode using animal power is the solution in the place of electric motor or IC engine in remote villages in hill or plain areas where either the eclectic supply is not regular or erratic. Keeping the above points in view, a study was under taken. Development of matching agro processing machine 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.

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Materials and Methods

A Rotary gear unit was established at the center. The machinery was selected based on power requirement i.e 1 hp. The test was carried out for continuous 1.5 hours of operation & reading regarding the machine output, animal parameters

like Respiration rate, body temperature, pulse rate & fatigue score were recorded. The draft requirements regarding the machine were also taken with dynamometer.

Selected Agro-Processing Machine rpm Record

Table 1: Specification of agro- processing machine

Sr. No.	Machines	Electrical rpm with 1.0 Hp Motor	Rated rpm with Bullock Operating (Power Transmission unit)
1.	Grain cleaner cum Grader	330	327

Table 2: Specification of agro- processing machines

Sr. No.	Parameters	Grain Cleaner cum Grader
1.	Length (cm)	160
2.	Width (cm)	55
3.	Height (cm)	100
4.	Weight (kg)	100-110
5.	Number of screens	2(80×55)
6.	Number of sieve	2
7.	Feed rate (per cent):	71.3-81.3
8.	Efficiency (per cent):	99.1-99.5
9.	Power requirement (kw) :	2.3 -3.7
10.	Capacity (kg/h) : (depending upon the grain)	330-800

Table 3: Features of Agro- processing machines

Sr. No.	Machine	Working Features.
1.	Grain Cleaner cum Grader	<ul style="list-style-type: none"> Separates impurities from grain on basis of difference in weight and size. Used to separate impurities and broken grains from harvested grains. Cleans and grades all types of grains.

Result and Discussion

The Experiment was conducted at college of agricultural engineering and technology. Research Station Utilization of Animal Energy, VNMKV, Parbhani. The developed animal driven power transmission system was evaluated for its performance for Grain Cleaner Cum Grader operation. During the test, bullocks were hitched at a distance of 5.5 m from the centre of the vertical input shaft. The bullocks walked in circular motion that resulted on an average 2.0 rpm at vertical input shaft and 330 rpm at pulleys of Grain cleaner cum grander machine countershaft. These units of 1 hp capacity were operated by the power transmission system. The speed (kmph), draft (kg), Output (kg/h), Power developed (W), physiological responses experimental bullocks in various agro processing operations were recorded.

Performance Evaluation for Operating Selected Agro Processing Units

The comparative physiological behavior of inner and outer bullock (B1 & B2) in rotary mode of operation for agro processing units were observed. The test was carried out on the test track for continues half an hour of work duration. Selected Agro-Processing Machine was used for operation by using bullock power in rotary mode of operation.

The selected agro-processing machine can otherwise be operated with a 1 hp motor. The experiment was conducted continuously for 30 minutes with the measurement of physiological responses like respiration rate, pulse rate, body temperature of red kandhari breed of bullock (pair weight of bullocks is 880 kg.) of Maharashtra at half an hour interval and calculation of draft to know their comfortable working without inflicting any health hazards. One person was employed for work in the selected agro-processing machine

and one bullock operator was engaged for controlling a pair of bullocks in the test track of the rotary unit. The Standard technique was used for measurement of the different parameters. The experiment was conducted for three replications of 30 minutes following observation were taken at half an hour.

Rotary Gear Parameter

- Power transmission system. Gear ratios at various units of the rotary system.

Bullock Parameter both at No Load and Load Condition:

- Speed of bullock, Average draft , Power output , Physiological responses

Machine Parameter

Rpm of shaft of the machine, Working efficiency per cent

Calculation for HP of bullock and output pulleys selection:

- Let, speed of bullock = 3.67km/hr. =1.02 m/s
- Diameter of circular path = 11.30 m.
- Length of Horizontal beam = 5.0 m
- No. of bullocks = 2
- Weight of bullock = 880 kg

- Draft exerted by pair of bullock = 1/10 (430+450) : D =88kg
- Angular velocity of bullock N = 2 rpm
- Length of open belt :

$$L = \frac{\pi}{2} \times (D1 + D2) + \frac{(D1 - D2)^2}{4C} + 2C$$

Where,

L = length of belt, cm.

D1 D2= diameter of driving and driven pulley cm.

C = distance between center of pulleys = 65.50cm.

Dimensions of pulley

$$D2 = \frac{D1 \times N1}{N2}$$

Where,

D1D2 = Diameter of driving and driven pulley, mm

N1 N2 = Speed of driving and driven pulley, rev/min



Plate 1: Top View of Power Transmission Unit

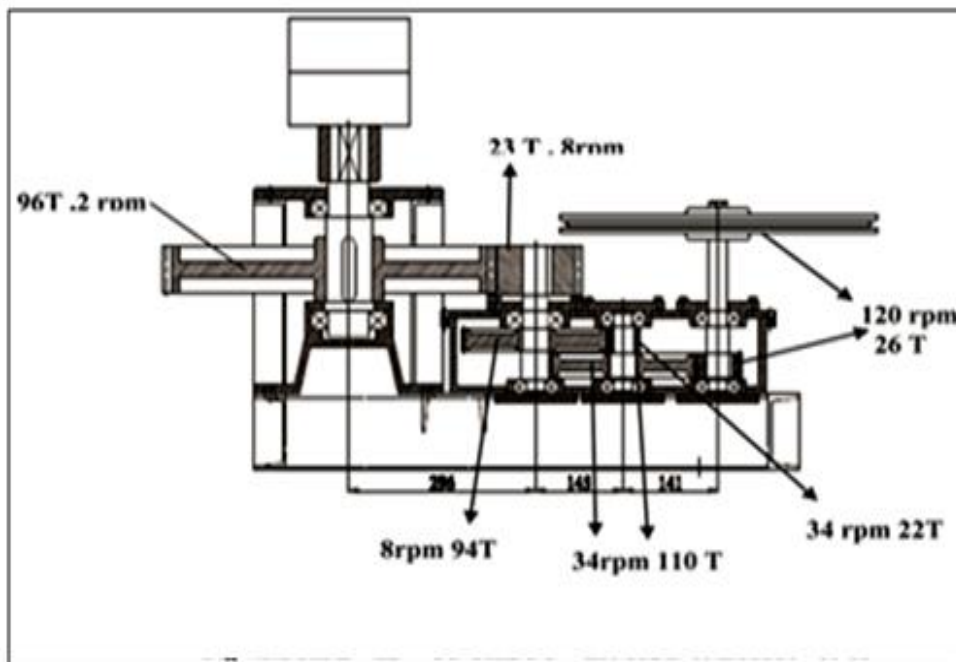


Fig 1: Side View of Power Transmission Unit

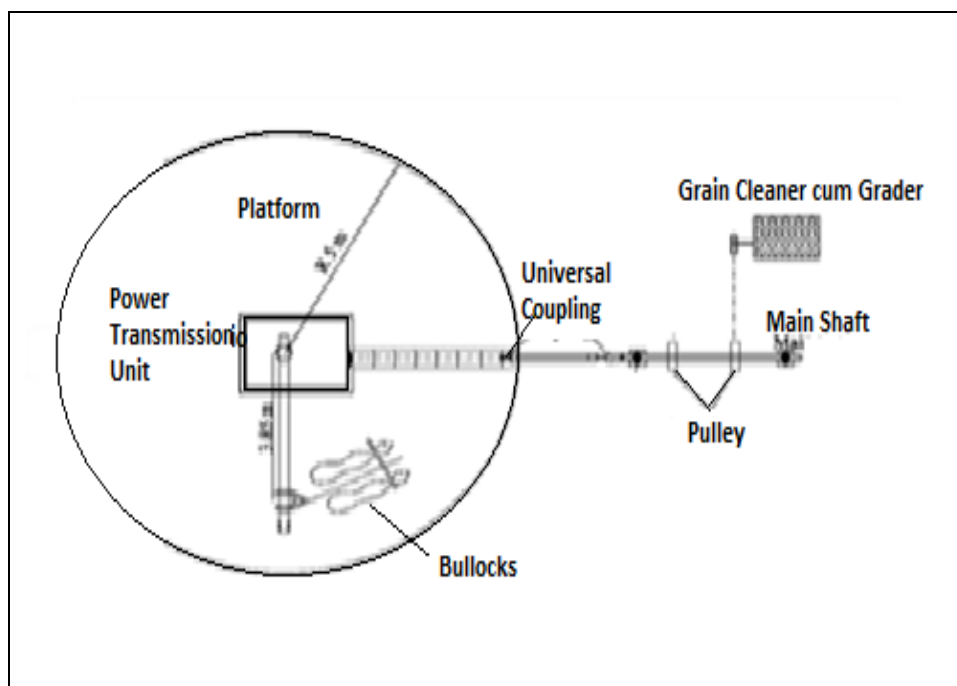


Fig 2: Top View of Rotary Mode Agro –Processing Unit

Performance Evaluation of Grain Cleaner Cum Grader: Performance evaluation of grain cum grader at no load condition

First of all the Grain cleaner cum grader was operated at no load conditions with the help of Red Kandhari bullock available in UAE center to compare the experimental data with corresponding parameters during load condition. The results are presented in table. It was observed that the draft requirement was initially 362.6N and reduced to 323.4 N after half hour of operation taking three times trials the mean value of the corresponding draft is 343 N which is 3.97 per cent of

body weight of Red Kandhari bullock (880 kg / pair). The speed of operation of bullock varied between 5.04 km/h and 4.53 km/h from 30 minutes of operation of three times replication. The mean Respiration rate, Pulse rate, Body temperature of B1 and B2 were found to be 22.27 and 24 bpm, 54.75 and 54.25 bpm, 37.4 and 37.5° c respectively. The average power output from the bullock over 30 minutes trials was taken for three times working of Grain cleaner cum grader were 0.442 kW. The mean rpm of Grain cleaner cum grader shaft during no load was observed to be 347.

Table 4: Performance of Grain Cleaner cum grader in rotary mode at no load

Parameters	Duration, h								Mean	
	In		0.5		1.0		1.5			
	B1	B2	B1	B2	B1	B2	B1	B2	B1	B2
Respiration rate, bpm	15	16	19	20	26	27	31	33	22.27	24.00
pulse rate, bpm	47	46	54	53	58	59	60	59	54.75	54.25
Body temp, °C	36.8	36.9	37.1	37.2	37.6	37.7	38.1	38.2	37.4	37.5
Draft, kg	—		38		33		34		35	
Percentage body weight	—		4.31		3.75		3.86		3.97	
Draft, N	—		372.4		323.4		333.2		343.0	
rpm of bullocks/0.5h	—		71		67		65		67.6	
Speed, m/s	—		1.36		1.28		1.24		1.29	
Speed, km/h	—		4.89		4.60		4.49		4.66	
rpm at m/c shaft	—		335		360		345		347	
rpm at Blower	-		875		890		888		884	
Power output of Bullock (kW)	—		0.506		0.413		0.413		0.44	

Performance Evaluation of Grain Cleaner Cum Grader operated at load conditions

The data on the performance evaluation of Grain cleaner cum grader in rotary mode has been presented in table. The draft requirement varied from 480.2 N in the beginning to 421.4 N at the end. The mean draft was 434.43N which was 5.03 per cent of bodyweight of the bullocks. The respiration rate, pulse rate as usual increased with duration. The mean respiration rate, pulse rate of B1 and B2 was observed as 24 and 25.75 bpm, 56.75 and 55.25 bpm respectively. There was not much variation in body temperature of B1 and B2 and was observed as 38 and 37.9°C. The rpm of bullocks were 70 to 62 and gradually decreased with duration in three trials of, 30 minutes.

The mean rpm of the Grain cleaner cum grader shaft was

observed to be 320. The output of machine gradually decreased with duration may be due to decrease in the speed of the shaft of the Grain cleaner cum grader. The mean output was found to be 683.3 kg/h were as the output of Grain cleaner cum grader operated with electric motor was 760 kg/h. The mean power output from bullock was found to be 0.538 kW. This indicated that the bullock could easily do the cleaning operation and their utilization could be enhanced. The lower value of working efficiency may be attributed due to obstruction in the in the reciprocating motion of graders sieves of Grain cleaner cum grader by the non uniform speed of bullocks during the working of the Grain cleaner cum grader. The operation of Grain cleaner cum grader was found to be feasible considering the draftability of Red Kandhari bullocks and its output capacity.

Table 5: Performance of Grain Cleaner cum grader in rotary mode at load

Parameters	Duration, h								Mean	
	In		0.5		1.0		1.5			
	B1	B2	B1	B2	B1	B2	B1	B2	B1	B2
Respiration rate, bpm	16	17	19	21	28	29	33	36	24	25.75
Pulse rate, bpm	48	47	55	53	60	59	64	62	56.75	55.25
Body temp, °C	37.7	37.8	37.8	37.9	38.1	38.2	38.4	38.4	38	37.9
Draft, kg	—		48		42		46		45.33	
Percentage body weight	—		5.45		4.77		5.22		5.14	
Draft, N	—		470.4		392.0		450.8		467.7	
rpm of bullocks/0.5h	—		68		65		62		65	
Speed, m/s	—		1.30		1.24		1.28		1.24	
Speed, km/h	—		4.69		4.49		4.28		4.27	
rpm at machine shaft	—		320		330		310		320	
rpm at Blower	—		860		880		875		871	
Power output of Bullock (kW)	—		0.611		0.486		0.540		0.545	
Output (Kg/h)	—		680		720		650		683.3	



Plate 2, 3: Grain cleaner cum grader in rotary mode operation



Plate 4, 5: Cleaned Soybean Seed Obtained from Bullock Operated Power Transmission System

Conclusions

1. It is observed that the selected gadget can be operated on bullock power with the rotary mode.
2. The power output and the speed are mainly dependent on draft of animal and all three are interrelated among themselves.
3. Bullocks can operate 1.5 hours continuously all the selected gadget without fatigue
4. The output of selected gadget i.e grain cleaner cum grader machine is 150 kg /hr respectively.
5. The ideal period of draught animals can be efficiently utilized and annual use can be increased by operating small post harvest machine like Grain cleaner cum grader.

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