Economics of Animal Operated Rotary Transmission System for Operation of Agro-Processing Machinery – A Case Study

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Introduction:

In Indian agriculture, despite the growth of tractors and power operated machinery, bullocks are still an important source of energy for agricultural and transport purpose. Even though tractors are replacing the draft animals, in rural areas, small and marginal farmers depend on bullocks for farm operations. Normally, the actual utilization of animal hours ranges from 400-500 hours annually whereas their potential use is estimated to be around 2400 hours per year. This vast difference between the potential and actual utilization of draft animal power needs to be bridged to the greatest extent possible by developing suitable technology for the animals during off-season periods. The availability of electricity in rural areas is intermittent and farmers tend to use diesel engine operated machinery for many farm operations. At present, the cost of diesel price is increasing and farmers need an alternative source of energy/technology to avoid the use of fossil fuels.

In Karnataka, the draught animal power population is 10.5 million and they are mainly used for farming operations as well as rural transport. Many of the villages in Karnataka are facing lot of electrical power cuts by which the farmers are deprived of leading normal life. The cost of conventional fuels like petrol, diesel and coal has risen many folds. In view of this, there is a need to develop suitable technology for the use of agro-processing machines using draught animals.

Keeping in view the above facts, the Raichur centre of AICRP on

Utilization of Animal Energy developed a rotary mode transmission system involving gear box assembly for operation of small capacity (less than 1.00 hp) agro-processing machines. This would help increase the annual animal hours utilization by using bullocks for operation of agro-processing machines apart from farm operations. The agro-processing machines such as chaff cutter, winnower and castor decorticator etc. can be operated with bullock power.

Description of rotary transmission system

The rotary transmission system basically consists of gearbox assembly involving combination of crown bevel gear and pinion, pairs of helical gears, chain and sprocket, V-belt and pulleys. The animal power is being transferred at right angle through this gear box assembly to operate small capacity machines. The rotary gearbox speed is enhanced from 1.25 – 1.38 rpm to 500-rpm shaft speed. The rotary animal energy unit requires a floor space of 16 m x 16 m plain field. The rotary gear box assembly is installed at central place of circular path and requires a square space of 1.82 m x 1.82 m x 0.92 m. which is constructed with brick and cement masonry walls. The rotary gear box has the dimensions of length: 0.8 m, width: 0.46 m and height:1.14 m. From the centre of circular place, another square shape brick masonry wall of size 1.2 m x 1.2 m x 0.91 m is made at a distance of 6.1 m. to attach the suitable agro-processing machine. The horizontal shaft of length 6.1 m is placed below the ground level at a depth of 0.33 m supported by six pedestal bearings. Finally, the chain and sprocket and pulley arrangement is used to give the drive to the suitable agro-processing machine. The rotary shaft speed of 500 rpm is available at final end and accordingly the speed can be enhanced / decreased by changing the appropriate size of pulley and v- belts.

The animals work in a rotary mode and a pair of bullocks is to be used for operation. The rotary mode transmission system is shown in Fig.1 and Fig 2. There is a provision for operator to sit on seat for driving a pair of bullock. The ground wheel is provided in the system for easy movement and to avoid any thrust load. A pair of bullocks walks around the circular path by which the animal power is being transferred. The power transmission takes place to the agro-processing machine through yoke, pulling pipe, horizontal shaft (with an attached ground wheel to support its weight), vertical input shaft of rotary unit, spur gear and pinion, universal coupling, chain and sprocket and a pair of V-belts and pulleys.

The rotary mode unit does two main functions namely

1)   To change the direction of flow of input power, which is fed into a vertical input shaft and comes out as output power through horizontal shaft.

2)   To enhance the rotary speed (1.25 to 1.38 rpm) of the bullocks to output speed of about 500 rpm.

Utilization of Animal drawn Rotary transmission system for Agro-Processing at Balaji Camp village of Raichur district.

At the request of a group of farmers of Balaji Camp village of Raichur district, the AICRP on UAE Raichur Centre installed a rotary transmission system for operation of agro-processing equipment with one of the farmers as a demonstration unit to be used by farming community of the village. The three agro-processing equipment installed were chaff cutter, winnower and groundnut cum castor decorticator. The chaff cutter was used for chaffing green and dry fodder. The winnower was used to obtain clean seeds by blowing away the light chaff and impurities from the crop threshed by traditional methods in case of sunflower and other crops. The castor decorticator was used for decortication of

harvested castor crop. The details of farmers and details of use of the rotary systemare given in Table 1.

The maximum use of the rotary system was for carrying out chaffing of green and dry fodder since three of the four farmers who used the system had milch animals. The fourth farmer, Rama Reddy did not possess any milch animals and used the system for winnowing and castor decortication. As per the prevalent practices, no chaffing of fodder was carried out by

Fig 1. Rotary mode transmission gear unit established at Balaji Camp

farmers both for green and dry fodder. The normal practice was to break the fodder by hand and feed the same to the animals. This resulted in uneven eating by the animals and led to formation of a heap of waste fodder. Winnowing operation was carried out by

Fig 2. Chaff cutting operation of jowar fodder stalk at Balaji camp

hand and consumed time and labour and resulted in drudgery of operation. Similarly castor decortication was carried out by beating with wooden sticks manually. This operation also resulted in drudgery of labour.

Table 1. Details of farmers and utilization of animal operated rotary system.

S. No	Particulars	Name of farmer			
		Ammi Reddy	Vasudev	Balavant Reddy	Rama Reddy
1.	Crops grown	Paddy (irrigated), hybrid jowar, sunflower, cotton, castor, chilli and redgram.			
2.	Area, ha	10.0	3.0	6.5	8.0
3.	Number of bullock pairs	1	1	1	1
4.	Number of milch buffaloes	14	8	6	0
5.	Number of tractors	1	0	0	1
6.	Farm operations for which bullock pair is used (other than rotary system)	Weeding and interculture and transport	Sowing, weeding and interculture, transport	Sowing, weeding and interculture, transport	Weeding and interculture and transport
7.	Annual use of bullocks (other than rotary system)	150	300	300	150
8.	Agro-processing operations for which rotary system is used	1. Chaffing of green and dry fodder 2. Cleaning of jowar, sunflower and other crops 3. Castor seed decortication	1. Chaffing of green and dry fodder 2. Cleaning of jowar, sunflower and other crops 3. Castor seed decortication	1. Chaffing of green and dry fodder 2. Cleaning of jowar, sunflower and other crops 3. Castor seed decortication	1. Chaffing of green and dry fodder 2. Cleaning of jowar, sunflower and other crops 3. Castor seed decortication
9.	Machinery used	1.Chaff cutter 2.Winnower 3.Castor decorticator	1.Chaff cutter 2.Winnower 3.Castor decorticator	1.Chaff cutter 2.Winnower 3.Castor decorticator	1.Chaff cutter 2.Winnower 3.Castor decorticator

The quantity of green and dry fodder used by the farmers during the year for feeding of milch and draught animals and the quantity of crop for winnowing and decortication is given in Table 2. The

quantity of green and dry fodder shown is the actual quantity used by farmers on an average during the year and not the actual quantity produced by him. In case of two farmers it was necessary to purchase fodder whereas one farmer had excess fodder which he sold to other farmers.

Table 2. Fodder and seed processed using the Animal operated Rotary Complex

S. No	Particulars	Name of farmer			
		Ammi Reddy	Vasudev	Balavant Reddy	Rama Reddy
1.	Green fodder, t	33	12	19	15
2.	Dry fodder, t	53	32	25	4
3.	Crop for winnowing, t				
a.	Sunflower	3	2	1	2
b.	Castor	3	2	4	3
c.	Paddy	10	5	7	6
d.	Jowar	10	5	6	8
	Total	26	14	18	19
4.	Castor crop for decortication, t	3	2	4	3

Performance data of rotary transmission system with different agro-processing machinery

The rotary mode transmission unit established at Balaji camp of Raichur district is being using for operation of different agro-processing machines like chaff cutter, winnower and castor decorticator. The main crops grown in Balaji camp are irrigated paddy, hybrid jowar, sunflower, cotton, castor, chilli and redgram.

The performance for chaff cutting of dry hybrid jowar fodder as well as that for chaffing of green jowar fodder was recorded under the farmers working conditions. The data on performance of the chaff cutter is presented in Table 3.

Table 3. Performance of rotary mode unit for chaff cutting of dry and green hybrid jowar fodder at Balaji camp using a pair of bullocks

Crop : Hybrid jowar

Work-rest schedule : 1 hr work-1hr rest-1hr work-1 hr rest-1 hr work

(Total 3 working hours)

No. of working hours	Speed (km/h)	Draft (N)	Power developed (kW)	Machine speed (rpm)	Machine output Dry fodder (kg/h)	Green fodder (kg/h)
I	3.25	476	0.43	120	88	265
II	2.85	476	0.38	100	80	245
III	2.29	476	0.31	85	70	210

From the data it is seen that the average draft requirement for operating the chaff cutter was 476 N. During the 1st hour the walking speed of the bullocks was 3.25 km/h and the same decreased to 2.85 km/h and 2.29 km/h during the 2nd and 3rd hour respectively. The power developed by the bullocks was the highest during 1st hour of operation as 0.43 kW. The same decreased to 0.38 kW and 0.31 kW during the 2nd and 3rd hour of operation respectively. The machine speed was the highest at 120 rpm during the 1st hour and the same decreased to 100 rpm and 85 rpm during the 2nd and 3rd hour of operation respectively. The output of chopped dry jowar fodder was the highest i.e. 88.00 kg per hour which decreased to 80.00 kg per hour and 70.00 kg per hour during the 2nd and 3rd hour of operation respectively. In case of green jowar fodder, the output was highest at 265 kg per hour during 1st hour of operation and the same decreased to 245 kg and 210 kg per hour during the 2nd and 3rd hour of operation respectively. Similar trends were observed by the scientists under the experimental conditions at the Raichur centre.

Observations were also recorded on performance of winnower using a pair of bullocks with the farmer over a period of 4 working hours. This data is presented in Table 4.

Table 4. Performance of winnower using a pair of bullocks at Balaji camp.

Source of power : A pair of medium sized bullocks
Crop : Hybrid jowar Var: (MHS 5)

Hours of operation	Speed of travel (km/h)	Draft (N)	Power developed (kW)	Fan speed (rpm)	Wind velocity (km/h)	Cleaned grain output (kg/h)
I	3.35	294.3	0.28	270	14.75	1320
II	3.15	294.3	0.26	260	13.85	1200
III	2.96	294.3	0.25	255	13.50	1150
IV	2.54	294.3	0.21	230	12.45	1050

From the table it is seen that the average draft requirement for operation of the winnowing fan was 294.3 N. It is seen that, during the 1st hour of operation the walking speed of the animals was 3.35 km/h during the 1st hour of operation, and the same went on decreasing to 3.15, 2.96 and 2.54 km/h during the 2nd, 3rd and 4th hour of operation respectively. The power developed by the bullocks for this operation was 0.28 kW during the 1st hour of operation, which went down to 0.26, 0.25 and 0.21 kW during the 2nd, 3rd and 4th hour of operation respectively. The average fan speed was highest at 270 rpm during the 1st hour of operation, which decreased to 260, 255 and 230 rpm during the 2nd, 3rd, and 4th hour of operation respectively. The wind velocity generated by using this winnowing fan was the highest at 14.75 km/h during the 1st hour as measured at a distance of 1.50 meters in front of the fan. The velocity decreased to 13.85 km/h, 13.50 km/h and 12.45 km/h during the 2nd, 3rd and 4th hour of operation respectively. As a result

of the winnowing operation the clean grain output obtained was 1320 kg per hour during the 1st hour of operation, 1200 kg during the 2nd hour of operation, 1150 kg during the 3rd hour of operation and 1050 kg during the 4th hour of operation.

The performance of castor decorticator operated by a pair of bullocks at Balaji camp is shown in Table 5. The average output of different agro-processing machines used and their average capacity are present in Table 6.

Table 5. Performance of castor decorticator using a pair of bullocks at Balaji camp

Parameters	Hours of operation		
	I	II	III
Draft required (N)	564	564	564
Speed of travel (km/h)	3.5	3.4	3.1
Power developed. (kW)	0.56	0.54	0.50
Speed of machine. (rpm)	346	300	280
Speed of blower (rpm)	1700	1550	1440
Machine output. (kg/h)	118	95	92

Table 6.   Average output of animal operated various Agro - processing machines through rotary mode of operation

S. No	Type of machine used	Draft (N)	Machine out put (kg/h)
1	Castor decorticator	564.0	101.6
2	Chaff cutter		
	a. Green fodder	476	240.0
	b. Dry fodder	542	79.3
3	Winnower	244.0	1180.0

Assessment of requirement for rotary system operation

Based on the total quantity of crop available during the year, the requirement of the expected use of the animal operated rotary system was computed. This was carried out both operation-wise and farmer-wise. The estimated use of the animal operated rotary system for operation of chaff cutter, winnower and castor decorticator is computed and shown in Table 7. From Table 7 it is seen that the total use of rotary system per farmer annually varies from 158.44 to 819.22 h. The total annual use of the rotary system is 1999.52 h.

Economics of use of the animal operated rotary system.

The main assumption in calculating the economics of animal operated rotary system is that this system is recommended for use in areas where draught animals are the main power source and where availability of grid electricity is limited. This system is not intended as an entrepreneurial venture purely for rotary system application. Keeping this in mind, while computing the economics of system, the economics for each farmer is considered. While calculating the economics, the cost of operation for other farm operations and transport normally carried out by the farmer are also considered. The major assumptions are as follows:

(1)   It is assumed that the bullock pair is available with farmer. He does not invest in pair of bullocks for operating the rotary system.

(2)   The rotary system is assumed to be a cooperative venture either by village Panchayat or by a self help group. Land rent for the area under rotary system is not considered.

(3)   The total cost of operation farmer wise is first calculated for the farm operations carried out by the pair of bullocks. Next the additional cost of operating the rotary system is calculated.

Table 7. Assessment of use of the animal operated rotary transmission system annually.

S. No	Particulars	Values			
		Ammi Reddy	Vasudev	Balavant Reddy	Rama Reddy
A	Chaffing of green fodder				
1.	Quantity of green fodder used, t	33	12	19	15
2.	Average output of chaff cutter, kg/h	240	240	240	240
3.	Total time needed for chaffing green fodder, h	137.5	50	79.17	62.50
B.	Chaffing of dry fodder				
4.	Quantity of dry fodder used, t	53	35	26	4
5.	Average output of chaff cutter, kg/h	79.33	79.33	79.33	79.33
6.	Total time needed for chaffing dry fodder, h	668.10	441.20	327.74	50.42
7.	Total time needed for chaffing both green and dry fodder, h	805.60	491.20	406.91	112.92
C.	Winnowing of crop				
7.	Quantity of crop for winnowing, t	26	14	18	19
8.	Average output of winnower, kg/h	1180	1180	1180	1180
9.	Total time needed for winnowing, h	22.03	11.86	15.25	16.10
D.	Decortication of crop				
10.	Quantity of crop for decortication, t	3	2	4	3
11.	Average output of decorticator, kg/h	101.6	101.6	101.6	101.6
12.	Total time needed for decortication, h	29.53	19.69	39.37	29.53
E	Annual use of rotary system	857.04	522.67	461.38	158.43

(a) **Calculation of cost of operation for farm and transport operations carried out by the Farmers other than operation of rotary system.**

Since only some limited and less costly farm implements like weeder and manual seed drill are used by the farmers, the fixed cost of the implements is neglected. Therefore the fixed and variable costs for

bullock pair are first calculated. The following assumptions are taken while calculating the fixed cost of operation:

(1)   The life of bullocks is considered as 6 years.

(2)   The salvage value of bullock pair is considered as 10% of the initial cost of bullock pair. The depreciation cost per year is determined as follows:

$$D = (P+S) \times R / (2 \times L \times 100) \quad \text{-------------------}(1)$$

Where

    P = Purchase price of bullocks, Rs

    D -   Depreciation cost/year

    S -   Salvage Value

    R -   Rate of depreciation in percentage, assumed as 10%

    L -   Life of the bullocks

(3)   The interest amount per year is calculated as per the formula given below:

$$I = (P+S) \times RI/(2 \times 100) \text{----------------------}(2)$$

Where

    I = Fixed cost due to interest, Rs/y

    RI = Rate of interest per year, %

(4)   The expenditure incurred for maintenance of animals is considered as 2% of the purchase price

(5)   The animals have to be fed whether they are used for work or not. When the animals are not used for work, they are fed maintenance ration. When they are used for work they are fed ration suitable for work, which includes concentrate in addition to fodder. While calculating fixed cost, the cost of maintenance ration is considered as feed cost. The additional cost of feed and fodder when the animals are used for work is taken as variable cost. In the present case, the cost of maintenance ration is considered as Rs 80/day.

Table 8. Total cost for farm operations and transport operation carried out by bullock pair

S. No	Parameters	Name of farmer			
		Ammi Reddy	Vasudev	Balavant Reddy	Rama Reddy
A	Fixed cost, Rs/y				
1.	Initial cost of bullock pair, Rs	60000/-	60000/-	60000/-	60000/-
2.	Life of bullocks (for use for draught purposes)	6 years	6 years	6 years	6 years
3.	Annual depreciation cost, Rs	4500/-	4500/-	4500/-	4500/-
4	Annual Interest, Rs	2640/-	2640/-	2640/-	2640/-
5.	Health care and maintenance cost at rate of 2% of purchase price per year	1200	1200	1200	1200
6.	Cost of feed and fodder at the rate of Rs 80/day for the full year	29200/-	29200/-	29200/-	29200/-
	Total fixed cost, Rs/y	37540/-	37540/-	37540/-	37540/-
B.	Variable cost				
7.	Additional feeding cost during working period, Rs/day	20	20	20	20
8.	Additional feeding cost, Rs/h	3.33	3.33	3.33	3.33
9.	Cost of operator at rate of Rs 150/day, 8h working per day, Rs/h	18.75	18.75	18.75	18.75
9.	Total variable cost, Rs/h	22.08	22.08	22.08	22.08
10.	Annual use of bullocks for farm operations and transport, h	150	300	300	150
11.	Total variable cost, Rs/y	3312.50	6625.00	6625.00	3312.50
12	Total cost of operation, Rs/y	40852.50	44165.00	44165.00	40852.50

Based on above method, the fixed cost of bullock pairs for carrying out farm operations and transport as well as for rotary mode operations is calculated and the data is presented in Table 8. This fixed cost is the same for all farmers since the life of bullock pair and initial

cost is assumed same. The fixed cost of animal drawn implements for weeding, sowing and transport are neglected since the implements are traditional low cost implements.

The variable cost due to farm operations and transport is mainly due to two factors, additional feed and fodder fed during work period at rate of Rs 20/day which works out to Rs 3.33/h assuming 6h working of bullock pair per day and the operator cost at the rate of Rs 150/day for 8h working, which works out to Rs 18.75/h. The total variable cost works out to be Rs 22.08/h.

On the basis of the above assumptions, it is seen from Table 8 that the fixed cost value is Rs 37540/- in case of all the four farmers since the initial cost of bullocks and the life of bullock pair is assumed the same. The variable cost varies depending on annual use of bullocks for farm operations and transport. The variable cost in case of the farmers Ammi Reddy, Vasudev, Balavant Reddy and Rama Reddy are Rs 3312.50, 6625/-, 6625/- and 3312.50 per year respectively. The total cost of operation considering both fixed and variable costs in the case of the farmers Ammi Reddy, Vasudev, Balavant Reddy and Rama Reddy is Rs 40852.50, 44165.00, 44165.00 and 40852.50 per year respectively.

(b) Calculation of cost of operation for different farmers for operation of rotary mode system with attachments

Next the cost of operation for operation of the rotary system is computed annually farmer-wise. It is assumed that all the costs will be shared among the farmers. The method of calculation of fixed cost is the same as in the case of calculation of bullock pair. In this case however, instead of health care and maintenance cost, a repair and maintenance cost at the rate of 2-5% of purchase price per year is considered for rotary system and gadgets. Also the costs of appointing a person to look after the repair and maintenance of system are considered in the case of rotary system. In the case of variable costs the additional feed and fodder cost and the labour cost are considered. Table 9 gives the annual fixed costs for operation of

rotary transmission system and the different gadgets. From Table 9 it is seen that the fixed cost for operation of rotary transmission system, chaff cutter, winnower and castor decorticator works out to Rs 9.76, 0.93, 5.55 and 6.62 per hour respectively.

The next step is to calculate the fixed cost of operation of the different combinations of equipment, for example rotary transmission and chaff cutter or rotary transmission +winnower. This is carried out the adding fixed cost per hour for the combination desired. The variable cost of operation is determined is a similar manner as for bullock pair and implement described in previous section. In this case the labour cost is calculated considering the cost of two persons, one for operating bullock pair and the second for loading of material in chaffcutter, winnower etc and collecting the material after the operation, ie. chaff cutting winnowing etc. The details of fixed cost, variable cost and total cost per hour is given in Table 10. From Table 10 it is seen that the total cost of operating the animal operated rotary

Table 9. Total fixed cost for operation of rotary transmission system and the different gadgets.

S. No	Parameters	Rotary transmission system	Chaff cutter	Gadgets Winnower	Castor Decorti-cator
1.	Initial cost, Rs	50000	12000	3000	6000
2.	Life, years	8	6	8	8
3.	Interest rate, %/y	8	8	8	8
4.	Salvage value, % purchase price	10	10	10	10
5.	Repair and maintenance cost, % of initial price per year	5	5	2	3
6.	Annual use, h	2000	1817	65	118
6.	Depreciation cost, Rs/y	2812.50	750	168.75	337.50
7.	Interest, Rs/y	2200	440	132	264
8.	Repair and maintenance cost, Rs/y	2500	500	60	180
9.	Cost of hiring person for repair and maintenance, Rs/y	1200	0	0	0
10.	Total fixed cost, Rs/y	19512.50	1690	360.75	781.50
11.	Total fixed cost, Rs/h	9.76	0.93	5.55	6.62

transmission system with chaff cutter, winnower and castor decorticator is Rs 51.51, 56.14 and 57.21 respectively.

Table 10. **Fixed, variable, and total cost of operation per hour for combination of rotary transmission system with different gadgets.**

S. No	Parameters	Values		
		Rotary system + chaff cutter	Rotary system+ winnower	Rotary system + castor decorticator
1.	Fixed cost of rotary + gadget, Rs/h	10.69	15.31	16.38
2	Variable cost			
(a)	Cost of additional feed and fodder at the rate of Rs 20.day assuming 6h working of bullock pair, Rs/h	3.33	3.33	3.33
(b)	Labour cost for 2 no labour for operation of bullocks and assistance in operation at rate of Rs 150/day per worker for 8h working per day, Rs/h	37.5	37.5	37.5
3	Total cost of operation, Rs/h	51.52	56.14	57.21

The next step is calculation of total cost of operation. This calculation is carried out farmer wise and also for total use of rotary system. The details are given in Table 11. The data presented in Table 7 and Table 10 is used for calculation of total cost of operation. From Table 11 it is seen that total cost of operation for rotary system with chaffcutter is Rs 41504.02, 25306.21, 20963.96 and 5817.72 for the farmers Ammi Reddy, Vasudev, Balwant Reddy and Rama Reddy respectively. The total cost of operation for chaffing operation for all the farmers is Rs 93591.91 annually.

Table 11. Annual cost of operation for utilization of animal operated rotary transmission system with different gadgets on farmer basis and operation basis.

S. No	Parameters	Cost of operation, Rs				Total, Rs
		Name of farmer				
		Ammi Reddy	Vasudev	Balavant Reddy	Rama Reddy	
A.	Chaffing					
1.	Total time for chaffing with rotary system, h	805.60	491.20	406.91	112.92	1816.62
2.	Cost of operation, Rs/h	51.52	51.52	51.52	51.52	
3.	Total cost of chaffing, Rs	41504.02	25306.21	20963.96	5817.72	93591.91
B	Winnowing					
1.	Total time for winnowing with rotary system, h	22.03	11.86	15.25	16.10	65.25
2.	Cost of operation, Rs/h	56.14	56.14	56.14	56.14	
3.	Total cost of winnowing, Rs	1236.97	666.06	856.37	903.94	3663.35
C	Castor decortication					
1.	Total time for castor decortication with rotary system, h	29.53	19.69	39.37	29.53	118.11
2.	Cost of operation, Rs/h	57.21	57.21	57.21	57.21	
3.	Total cost of castor decortication, Rs	1689.34	1126.23	2252.46	1689.34	6757.38
D	Total cost of rotary mode operations, Rs	44430.75	27098.76	24072.99	8411.07	104013.56

Note: The hours of use for different operations of rotary system with gadgets are taken from Table 7 and the total cost of operation per hour is taken from Table 10.

In a similar manner it is seen that total cost of operation for rotary system with winnower is Rs 1236.97, 666.06, 856.37 and 903.94 for the farmers Ammi Reddy, Vasudev, Balwant Reddy and Rama Reddy respectively. The total cost of operation for winnowing operation for all the farmers is Rs 3663.35 annually.

In the case of operation of rotary system with castor decorticator, it is seen from Table 11 that total cost of operation for rotary system with castor decorticator is Rs 1689.34, 1126.23, 2252.46 and 1689.34 for the farmers Ammi Reddy, Vasudev, Balwant Reddy and Rama Reddy respectively. The total cost of operation for castor

decortications operation for all the farmers is Rs 6757.38 annually.

If all the rotary mode operations are considered, it is seen from Table 11 that total cost of operation for rotary system with different gadgets is Rs 44430.34, 27098.51, 24072.78 and 8411.01 for the farmers Ammi Reddy, Vasudev, Balwant Reddy and Rama Reddy respectively. The total cost of operation for all the operations for all the farmers is Rs 104012.63 annually.

Benefit of Chaff cutting operation

Farmers of the village do not carry out chaffing operation for feeding of milch and draught animals. The existing practice is to break the fodder by hand practice and feed to animals. Due to this the animals do not eat the hard portion and there is lot of wastage of fodder. When the rotary system is used for chaff cutting, the animals easily consume the chaffed feed. Due to better utilization of feed, there is increase in body weight. In the case of milch animals, the consumption of fodder results an increased milk yield for milch animals. Thus the cost of chaffing is an additional cost as compared to the traditional operation. Studies were carried out as regards chaffing of jowar fodder on milk production. The data is presented in Table 12. From the table it is seen that there is a benefit of Rs 11.63/day/animal.

In addition to milch animal, chaffing operation also benefits the draught animals. The feeding of chaffed fodder improves the food intake and digestibility, which in turn results in additional body weight. This is reflected in decreased fatigue of animals and higher working hours per day. This increases the output and reduces the cost of operation. Although no specific study has been carried out in this case, based on findings of the Project in general it is assumed that feeding of chaffed fodder will cause 10% decrease in operational costs due to increased output. This is reflected both for

Table 12. Feed intake of 6 buffaloes per day as un-chopped and chopped dry jowar fodder and its effect on milk yield of buffaloes and profit.

Animal No.	Body Weight (Kg)	Actual daily dry matter intake (kg/day)		Daily milk yield (lit/day)		Daily net profit (Rs)		Increase in daily net profit (Rs)
		Un-chopped fodder	Chopped fodder	Un-chopped fodder	Chopped fodder	Un-chopped fodder	Chopped fodder	
1	410	8.00	11.50	4.30	5.15	32.50	45.25	12.75
2	450	6.75	10.90	4.60	5.30	37.00	47.50	10.50
3	480	7.30	11.70	4.80	5.60	40.00	52.00	12.00
4	500	8.35	11.40	5.40	6.00	49.00	58.00	09.00
5	520	7.80	12.25	5.50	6.40	50.50	64.00	13.50
6	550	8.25	12.15	5.30	6.10	47.50	59.50	12.00
Total		46.45	69.60	29.90	34.55	56.50	326.25	69.75
Av.		7.74	11.65	4.98	5.76	42.75	54.30	11.63
		3.91 kg/d increase in intake per animal		0.78 l/d increase in milk yield per animal				Av. 27% increase in net profit/d/animal in case of chopped feeding.

* Cost of jowar fodder @ Rs. 3.00 per kg
** Cost of concentrate @ Rs. 12.00 per kg
***Jowar fodder offered per day @ 10 kg to each animal.

farm operations in field and for transport as well as rotary mode operations.

Cost of operation of winnowing and castor decortication by traditional method

As per the traditional practice, winnowing is carried out manually using the winnowing basket. Observations were taken as regards rate of winnowing by manual operation. The average rate of operation was Rs 100 per day. The labour wages was taken as Rs 150/day for 8h working. The annual cost of operation for manual winnowing for the farmers Ammi Reddy, Vasudev, Balvant

Reddy and Rama Reddy was Rs 4875/-, 2625/-, 3375 and 3562.5 respectively. The total cost of operation for manual winnowing annually works out to Rs 14437.50. In the case of castor decortication, the traditional method followed in the village was manual decortication by beating with sticks. Based on observations taken, the average rate of operation was found to be 12 kg/h. The annual cost of operation for manual decortication for the farmers Ammi Reddy, Vasudev, Balvant Reddy and Rama Reddy was Rs 4687.50, 3125/-, 6250 and 4687.50 respectively. The total cost of operation for manual winnowing annually works out to Rs 18750/-. The total annual cost of operation for manual winnowing and decortication for the farmers Ammi Reddy, Vasudev, Balvant Reddy and Rama Reddy was Rs 9562.50, 5750/-, 9625/- and 8250/- respectively. The total cost of operation for manual winnowing and decortication annually works out to Rs 33187.50. The data for the cost of operation for traditional winnowing and decortication is given in Table 13.

Economic benefits to the farmers due to utilization of rotary system.

The overall economic benefits are presented in Table 14. The villagers are not carrying out chaffing operations traditionally. The chaffing operation is an additional operation. Due to this reason, the total cost of operations with animal operated rotary system is higher since traditionally no cost of operation is incurred in chaffing. The benefits of chaffing has already been discussed in the earlier section. Considering that on an average, milch animals are milked for 300 days a year, the benefit due to additional milk production was found to be Rs 48846/-, Rs 27912/- and Rs 20934/- for the farmers Ammi Reddy, Vasudev and Balvant Reddy. Sri Rama Reddy did not have any milch animals and as such had no benefit in increased milk production. However he incurred an

Table 13. Cost of operation for operation carrying out Agro-Processing operations by traditional method.

S. No	Parameters	Values, Rs				Total, Rs
		Name of farmer				
		Ammi Reddy	Vasudev	Balavant Reddy	Rama Reddy	
A.	Chaffing					
1.	Total cost of chaffing with traditional system, Rs (No chaffing is carried out)	0	0	0	0	0
B	Winnowing					
1.	Quantity for winnowing, t	26	14	18	19	77
2.	Rate of manual winnowing, kg/h	100	100	100	100	100
3.	Time required for manual winnowing, h	260	140	180	190	770
4.	Cost of manual winnowing, Rs	4875	2625	3375	3562.50	14437.50
C	Castor decortication					
1.	Quantity of crop for castor decortication, t	3	2	4	3	13
2	Rate of manual decortication, kg/h	12	12	12	12	12
2.	Time required for manual decortication, h	2250	166.67	333.33	250	1000
5.	Cost of manual decortication, Rs	4687.50	3125	6250	4687.50	18750
D	Total cost of operations for traditional method	9562.50	5750	9625	8250	33187.50

additional cost for chaffing of fodder for draught animals. The total benefit of all farmers due to increased milk production was Rs 97692/-. As already explained chaffing of fodder also increased the work capacity of animals through lesser fatigue. Considering the use of bullock pair in farm operations and transport operations, the benefit due to saving in operation cost was found to be Rs 331.25, 662.50, 662.50 and 331.25 for the farmers Ammi Reddy, Vasudev and Balvant Reddy and Rama Reddy respectively. The total benefit was Rs 19875/-. Similarly there was 10% lesser cost of operation for rotary mode operations due to feeding chaffed fodder. The

Table 14. Total benefits to farmer due to utilization of animal operated rotary system

S. No	Parameters	Values, Rs				Total, Rs
		Name of farmer				
		Ammi Reddy	Vasudev	Balavant Reddy	Rama Reddy	
1.	Total cost of operation					
a.	Total cost of operation for all operations with rotary system, Rs (Table 11)	44430.75	27098.76	24072.99	8411.07	104013.56
b.	Total cost of operation for all operations with traditional system, Rs (Table 13) Note: Chaffing operation is not carried out	9562.50	5750	9625	8250	33187.50
2.	Additional cost of operation in rotary mode operations, RS	34868.25	21348.76	14447.99	161.07	70826.06
2.	Benefit					
a.	Benefit due to milk production					
i	Number of milch animals	14	8	6	0	28
ii	Average benefit due to increase in milk production, Rs/day	11.63	11.63	11.63	11.63	11.63
iii	Benefits due to increased milk production, Rs	48846	27912	20934	0	97692
b.	Benefit of chaffing of fodder for draught animals in cost of operation for farm operation and transport as well as rotary mode operations					
i.	Total variable cost of operation for farm operations and transport	3312.50	6625.00	6625.00	3312.50	19875
ii	Saving in cost of operation of farm operation and transport (10% of total)	331.25	662.50	662.50	331.25	1987.50
iii.	Benefit due to saving in cost of operation of rotary mode operations (10% of cost of operation of rotary system)	4443.07	2709.88	2407.30	841.11	10401.36
3.	Total benefit (a(iii) +b(ii)+b(iii))	53620.32	31284.38	24003.80	1172.36	110080.86
4	Total profit (3)-(2)	18752.07	9935.62	9555.81	1011.29	39254.79

benefit due to saving in operation cost was found to be Rs 4443.07, 2709.88, 2407.30 and 841.11331.25 for the farmers Ammi Reddy, Vasudev and Balvant Reddy and Rama Reddy respectively. The total benefit was Rs 10401.36.

Considering the benefits of increased milk production and saving in cost of operation for farm operations, transport and rotary system, the overall benefits worked out to Rs 53620.32, 31284.38, 24003.80 and 1172.36 for the farmers Ammi Reddy, Vasudev and Balvant Reddy and Rama Reddy respectively. The total benefit worked out to Rs 110080.86. On the other hand due to chaffing operation the additional cost of operation for the farmers Ammi Reddy, Vasudev and Balvant Reddy and Rama Reddy was Rs 34868.25, 21348.76, 14447.99 and 161.07 respectively. The total additional cost of operation was Rs 70826.06. Subtracting the additional cost, the overall benefits for the farmers Ammi Reddy, Vasudev and Balvant Reddy and Rama Reddy worked out to Rs 18752.07, 9935.62, 9555.81 and 1011.29 respectively. The total annual profit worked out to Rs 39254.79 annually. The minimum profit was observed for farmer Rama Reddy since he did not have any milch animals. Thus the investment of the rotary system can be recovered by the farmers after two years.

धरती की नर्म कोख की भाषा
जानता है बैल
हल जानता है,
यह ट्रैक्टर
नहीं जानता कोई भाषा
चीरता है तो
चीरता चला जाता है धरती
इसे सुनाई नहीं देता कोख का रूदन.

लीलाधर मंडलोई
महानिदेशक आकाशवाणी, नई दिल्ली