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Development of Battery Driven Manually Operated Multi Crop Reaper

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A B S T R A C T

In India, the numbers of small and marginal farmers are very high as compared to big farmers. Agricultural census data shows that there were about 121 million agricultural holding in India and in this 99 million were small and marginal farmers. As a result small and marginal farmers account for more than 80% of the total farm. Due to poor economic condition, it is therefore not feasible for them to adopt mechanized means of harvesting. Harvesting of most popularly grown wheat crop is most commonly carried out manually. It is highly expensive and high labour consuming method of harvesting. With this view a Battery Driven Manually operated Multi Crop Reaper was developed. This Reaper was developed to solve the problem of drudgery related to manual harvesting methods, which can saves a lot of time of the farmers and also get the job done in fewer amount compared to manual harvesting methods. The performance evaluation was done on the basis of field capacity, field efficiency and cost of operation. The result showed an increase in the field capacity with the Reaper as compared to manual harvesting. The field capacity obtained with the Reaper is 0.0152 ha/h while in manual harvesting field capacity is calculated as 0.011 ha/h. Energy consumption by manual harvesting is about 534.84 MJ/ha whereas with the reaper it is reduced up to 386 MJ/ha. In this sequence cost of operation calculated by manual harvesting methods is 6665.45 Rs/ha whereas with reaper it is reduced to 5836.84 RS/ha.

Introduction

India is predominately an agricultural country with 69% of its population engaged in it. The production of grain has increased after independence due to high yielding varieties, increased of better irrigation facilities, increase use of chemical fertilizers and use of improved agricultural implements. Improved agricultural implements have contributed significantly in increasing the food production as these help in efficient utilization of all other inputs.

In spite of the fact that large number of tractors, diesel engines and improved agricultural implements are being used on India farms, still most of the farmers are using traditional tools and implements which usually are operated by either human or animal power.

These traditional tools have low initial cost but these are very slow resulting in heavy operational cost and loss of produce. Harvesting of crop is one of the most labour intensive operations in agriculture.

The most prevalent method of harvesting of crops in India is manual harvesting, which is highly labour consuming. It is estimated that harvesting and threshing of crops consume about one third of the total labour requirement to complete crop production system.

Harvesting is the process of gathering mature crops from the fields. Reaping is the cutting of grain and pulse for harvest, typically using a scythe, sickle, or reaper. The harvest marks the end of the growing season, or the growing cycle for a particular crop, and social importance of this event makes it the focus of seasonal celebrations such as a harvest festival, found in many religions. On smaller farms with minimal mechanization, harvesting is the most labour intensive activity of the growing season.

On large, mechanized farms, harvesting utilizes the most expensive and sophisticated farm machinery, like the combine harvester. Harvesting in general usage includes an immediate post-harvesting handling, all of the actions taken immediately after removing the crop-cooling, sorting, cleaning, packing up to the point of further on-farm processing, or shipping to the wholesale or consumer market. Harvesting is one of the most important processes in crop productions. Depending upon the source of power the harvesting may be manual, animal drawn or mechanical. India is predominantly an agricultural country with 69.38% of its population engaged in it. The production of grain has increased after independence due to high yielding varieties, increase of better irrigation facilities, increase use of chemical fertilizers and use of improved agricultural implements.

Materials and Methods

Operational principle of the Battery Driven Manually Operated Multi Crop Reaper: The Battery Driven Manually Operated Multi Crop Reaper which is developed is hand guided, light weight and a compact machine. It is self propelled machine with a 12v dry dc battery as a source of power and needs an operator to function it. One of the most important considerations in the design of the machine is operator safety. From this point of view, all corners of the implement are kept round and moving parts are covered. The strength, durability and efficiency of farm machinery depend on the precision of design and also upon the kind and quality of material used in its manufacturing. The machine will perform the following functions: a) Cutting b) Collecting The developed reaper consists of following main parts:

The power comes from the 12v D.C. battery and current draws to the 12 v D.C. motor through the wire. The motor rotates on 1300 rpm with a 22 kg.cm torque which rotates the cutter which is connected to the motor and harvest the cereal crop in the field. There is a parabolic collector connected on the frame which collects the harvested crop and drops it on the ground which can easily be collected.

Brief testing of developed prototype

The field testing of Battery Driven Manually Operated Multi Crop Reaper was carried out in the month of May 2016 at Village - Daulatpur, district- Kaushambi Uttar Pradesh. The wheat harvesting was done at full maturity of the crop.

Measurements

To evaluate the performance of the Battery Driven Manually Operated Multi Crop Reaper. The following parameters were measured:

Crop conditions: Crop density and height of plant are measured under this parameter. The

height of 25 individual plants (tillers) was measured with the help of measuring tape. These 25 values were averaged.

For crop density, A one square meter frame was placed at 5 places chosen randomly in the plot to evaluate the density of the crop. The crop was cut manually at these places. The number of plants cut from these places gave the crop density in plants per square meter.

Height of cut : The height of cut of plants was measured to find out the closeness with which the implement cut the plants above the ground level. To measure the height of cut a metallic scale was used. The height of cut for both machine and manually harvested crops was measured from the tip of the cut stalk to ground level. This process was replicated 25 times.

Forward travelling speed : Forward travelling speed of the reaper was measured after operating the machine for some time when the speed has stabilized. A 20 m distance was marked by two poles on each side of plot in the centre.

Sufficient distance was left on each side of pole to allow the machine to come in actual working condition before the measurement of speed. As the blade of the reaper came in line with the other two poles placed at the 20m distance knowing the time taken to cover 20m distance by the reaper.

Working width of implement : It gives the width of cut per stroke of implement in the field. It is an important variable in finding out the effective field capacity of the implement. This will be calculated using anthropometric data.

Field capacity: It is defined as the actual area covered by the implement per hour when the implement is actually working in the field while the theoretical field capacity is the area covered per unit time based on 100 percent rated width.

It is an important measure of performance of any field implement. On the basis of data's of rated working width and rated speed and the actual width of the reaper recorded during the test in the field, the field capacities were calculated as below:

Theoretical field capacity

$$= \frac{width\ of\ cut\ (m)\ x\ speed\ (\frac{km}{hr})}{10} \quad \text{(Eq. 1)}$$

Actual field capacity

$$= \frac{Total\ area\ covered\ (ha)}{Total\ time\ taken\ (hr)} \quad \text{(Eq. 2)}$$

Field efficiency: It is the ratio of effective field capacity and the theoretical field capacity. It takes into account the time losses encountered in the field due to various reason. Field efficiency was calculated as below:

Field Efficiency(%)

$$= \frac{Effective\ field\ capacity}{Theoretical\ field\ capacity}\ x\ 100 \quad \text{(Eq. 3)}$$

Electricity consumption : The total electricity consumed by battery for charging is given by following formula:

Electricity to charge the battery = Volt of battery(V) x battery capacity (Ah) x K (Eq. 4)

Where K is charging factor which is taken as 1.5

Energy consumption : Energy consumed by a man while working in the field = 1.96 MJ/h

Energy consumed per ha = total working time to cover 1 ha x energy consumed per h x number of man working in the field. (Eq. 5)

Cost Analysis : The cost of operation was divided into two parts:

Fixed cost

Depreciation

It is the loss in the value of capital item due to change in model, wear and tear, breakdown etc. Straight-line method is used to calculate depreciation as give.

$$\text{Depreciation} = \frac{P-S}{LXH} \quad \text{(Eq.6)}$$

Where,
P = Initial cost of machine (Rs.)
S = salvage value
L = useful life (year)
H = number of working hours (h/yr)

Interest

Interest of the investment in the form is a legitimate cost, since the money spent in buying a machine can't be used for other productive purposes. The rate of interest (I) was taken as 13 percent/annum as prevalent in the market. Interest was calculated as shown below :

$$I = \left\{\frac{P+S}{2}\right\} X \left(\frac{i}{H}\right) \quad \text{(Eq.7)}$$

Where,
I is interest rate per annum

Repair and maintenance

Repair and maintenance was calculated as the 10% of the purchase price per year.

Variable cost

Electricity cost

The cost of electricity was calculated by using following formula
E = unit of electricity x charge per unit of electricity.

Labour charges

Considering the working hours as 6 hours per day the labour charge was taken as the present daily wages.

One skilled labour for cutting 160 Rs/day
Two unskilled labours for gathering and bundling 140 Rs/day

Total variable cost = Electricity cost + labour charge (Eq. 8)

Total cost of operation

Total cost of operation (Rs per hour) = total fixed cost + total variable cost

Total cost of operation (Rs./ha)

$$= \frac{Cost\ of\ operation\ (\frac{Rs}{\square r})}{Effective\ field\ capacity\ (\frac{\square a}{\square r})} \quad \text{(Eq.9)}$$

Results and Discussion

Brief testing report

This section of the chapter evaluates the performance of the manual cum battery driven reaper. The parameters on which the performance evaluation of the reaper is based are field efficiency, field capacity and loss of grain in the field while harvesting.

Table.1 Major Components of the prototype

S.No.	Components	Specification
1	Dry Battery (D.C.)	12 volt
2	Charger	12 volt 9Amp
3	Switch	1 Amp
4	Connecting Rod	1050 mm
5	D.C. moto	1300 rpm, 22 kg cm torque
6	Parabolic collector	510 mm length
7	Motor supporting frame	Cast iron
8	Electric copper wire	2 meter
9	Cutting blade	203.2 mm dia (high carbon steel)
10	Handle	187.5 mm length

Table.2 Brief testing report of the developed reaper

Crop Condition	**Average height of plant**	**23.3**
	Crop density	112 plants/m^2
Height of cut	Reaper	5-8 cm
	Manual	3-5 cm
Speed of operation	0.30 km/hr	
Working width of implement	0.52-0.55 m	
Field capacity	Actual	0.0165 ha/hr
	Theoretical	0.0208 ha/hr
Field efficiency	88%	
Electricity consumption	0.0222kWh	
Energy consumption	By reaper harvesting	324 MJ/ha

Table.3 Cost analysis of the developed reaper

1	**Fixed cost**	**Depreciation**	**10.02 Rs/hr**
		Interest	1.06 Rs/hr
		Repair and maintenance	2.13 Rs/hr
2	Variable cost	Labour charge	72 Rs/hr
		Electricity charge	0.10 Rs/hr
3	Total cost of operation	85.22 Rs/hr	
		5524.65 Rs/ha	

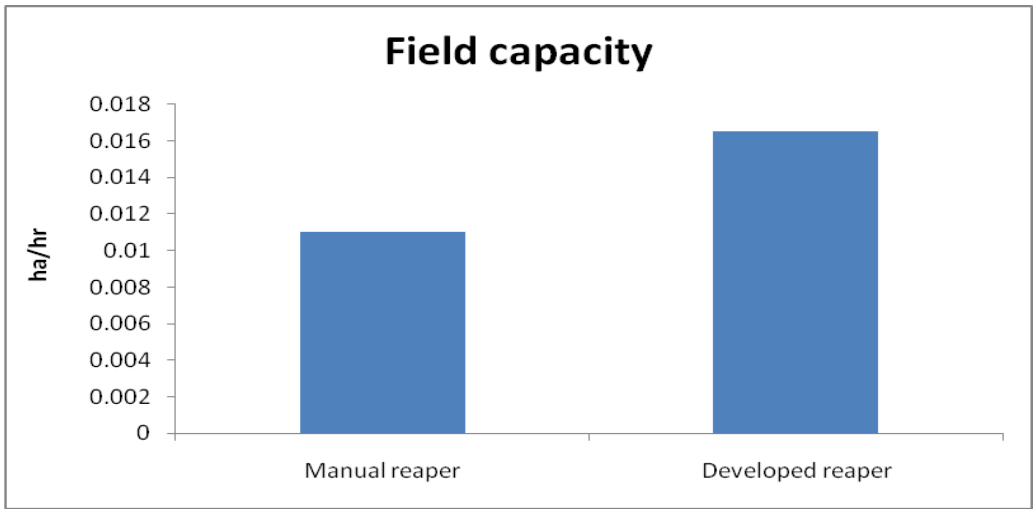

Figure.1 Graph showing field capacity in ha/hr of manual reaper and developed reaper

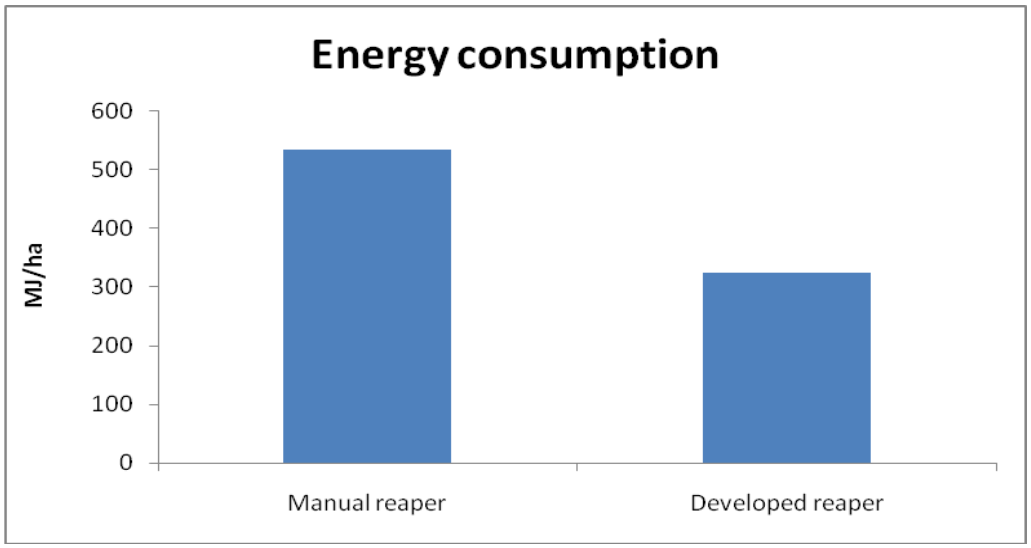

Figure.2 Graph showing energy consumption in MJ/ha of manual reaper and developed reaper

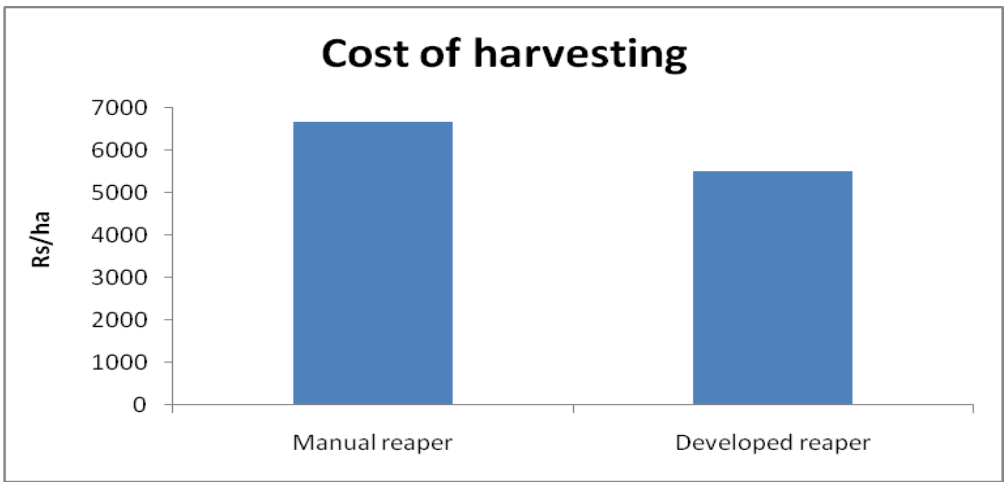

Figure.3 Graph showing cost of harvesting in Rs/ha of manual reaper and developed reaper

The performance evaluation of the reaper has been explained under the following heads:

Crop Condition
Energy consumption
Height of cut
Forward travelling speed
Working width of implement
Field capacity
Field efficiency
Electricity consumption

A manual cum battery driven reaper was tested for its performance and evaluation in the month of May 2016. The performance of the reaper with respect to field capacity, height of cut, forward travelling speed, working width of implement, energy consumption, labour requirement and cost of operation was studied and compared to manual harvesting method on the basis of results obtained the following conclusions are drawn.

The operating speed of reaper could be varied from 0.30 to 0.32 km/hr.
The average operating width of the reaper was found to be 0.55 m.
The height of cut varied from 5 to 8 cm.
The Actual field capacity of the reaper is 0.0165 ha/hr.
The Theoretical field capacity of the reaper is 0.0208 ha/hr.
Field efficiency of the reaper is 85%.
The cost of harvesting with reaper was only 5524.65 Rs/ha whereas with manual harvesting, the cost was 6665.45 Rs/ha with 17.12% saving.
The total energy consumed by man and battery while working with modified reaper in field is 324 MJ/ha.
The total energy consumed by man while harvesting manually is 534.84 MJ/ha.
Total energy consumed by battery is 0.022 MJ/hr.

References

Adisa, A. F; 2013 Effect of Stripper Peripheral Speeds on Grain Purity, Field Capacity and Field Efficiency of a Developed Self Propelled Stripping Harvester Vol. 6, No 1, 1943-2429

Adisa, A. F; 2013 Estimating Field Loss of a Modified Rice Stripper Harvester in Nigeria Vol. 2, No 4

Bawatharani, R; Jayatissa, D N; Dharmasena, D. A. N; And Bandara, M. H. M. A.; 2015 Field Performance of a Conventional Combine Harvester in Harvesting Bg-300 Paddy Variety in Batticaloa, Srilanka Vol. 4, 33-35

Bhatiya, P.S; and Tiwari, P.S, 1990 Development and testing of engine cum manually operated reaper

Chauhan, A.M; Bhatia, B.S; and Dhingra, H.S; 1994 Adoption behaviours of farmers oon tractor operated reaper in Punjab AMA Vol. 25, No. 1, 34-39

Chegini, G.R; 2013 Determine of Optimum Operating Conditions of Combine Harvester with Stripper-Header Vol. 23, No 10, 1399-1407

Dube, P; 1978 Development and testing of manual cum-entine operated harvester, MSc Ag. Engg Thesis A.A.I. Allahabad

Gavazza, M.I.A; Bassoi, M.C; Carvalho, T.C.D; Filho, J.C.B; And Panobianco, M; 2012 Method for assessment of pre harvester sproutingin wheat Vol. 47, No 7, 928-933

Gupta, A.K; 2011 Wheat Harvesting Techniques Vol. 23, No 3

Kurhekar, S.P; And Patil, S.R; 2011 Performance evaluation of self-propelled walking type vertical conveyor reaper Volume 2, 29-31

Mishra, S.K; and Chaudhary,A, 2005 Performance evaluation of a self-propelled vertical conveying reaper

Murumkar, R.P; Dongarwar, U.R;Borkar, P.A; Pisalkar, P.S; and Phad, D.S. 2014

Performance Evaluation of Self Propelled Vertical Conveyor Reaper Vol. 3, No 5, 1701-1705

Mirzazadeh, A; Abdollahpour, S; Mahmoudi, A; and Bukat, A.R; 2012 Intelligent Modelling of Material Separation in Combine Harvester's Thresher by ANN Vol. 4, No 23,1767-1777

Pliny, R; 1954 Design of a stripping machine Agri. Engg. Vol. 6, No. 3, 20-29

Post, C; 1997 Agricultural revolution Vol. 61, No. 2, 216-228

Singh, A; Gautam, U.S; Singh, R; and Paliwal, D; 2014 Ergonomic Study of Farm Women during Wheat Harvesting by Improved Sickle Vol. 9, No 18, 1386-1390

Shahid, L.A; and Singh G; 1996 Modification and field performance evaluation of a Windrower for rapeseed in Pakistan AMA Vol. 27, No. 4, 38-46

Srivastava, A.K; Goering, C.E; Rohrbach, R.P; and Buckmaster, D.r; 2006 Grain Harvesting Vol. 2,403-436

Tahir, A.R; Khan, F.U.H; and Ejaz, K; 2003 Techno-Economic Feasibility of Combine Harvester (Class Denominator)- A Case Study Vol. 5, No.1, 57-60

Yadav, B.G; and Yadav, R.N.S; 1992 Design and development of CIAE bullock drawn reaper AMA Vol.23, No. 2, 34-43.

Yadav, B.G; and Yadav, R.N.S; 1985 Design and development of tractor drawn soyabean reaper. Procedings of silver jubilee convention ISAE 88-94.

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