

Energy, Time and Cost of Baler Machine for Harvested Understory Paddy Biomass

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Abstract

Rice is important food crop in India and stands first in area and second in total food production. Increase mechanization has made the paddy straw recovery and its utilization difficult for the farmer. Keeping the view the study has been carried out is for straw bale management of paddy straw for this three operation were studied manual Bale collection, transportation by tractor and loading-unloading of bale in field. Energy consumption rate is highest in transportation ($4.19 \text{ MJ t}^{-1} \cdot \text{Km}^{-1}$) and lowest in bale collection (0.46 MJ t^{-1}). From total time consumed only 8 per cent time consumed for transportation operation and for collection and loading- unloading operation time consumption is same for both operation. In cost comparison height cost require for transportation ($326. \text{ Rs t}^{-1}$) and lowest for bale collection operation ($42.47. \text{ Rs t}^{-1}$). Straw management in the combine harvested field by straw collection and baling in the field is considered as an appropriate and economically viable option for timely use of the field for subsequent sowing.

Keywords

Paddy straw management, baling, energy, cost, time.

1. Introduction.

The annual biomass production from rice and wheat straw, sugarcane trashes and residue of other major crop in India amount to nearly 300 million tones. Nearly 50% of the vegetative material is harvested as straw and the remainder is left in the field as stubbles. Retrieval of crop residues deplaned mainly on market demand either for livestock feed, fuel and other industrial uses. The farmer always would prefer a profitable outlet than burning in the field. High cost of traditional method of collection, transport, loading and unloading of straw including losses is the major cause of burning of straw by the farmer. The welcome step for utilization of biomass for bio-fuel creates avenues for retrieval of straw from the fields for more economical retune by adapting the equipment available in the country.

The burning the crop residues in the field cause several adverse effects to soil and environment. Therefore to overcome the problem associated with the open field burning of crop residues and to meet the requirement of crop residues for livestock feed, fuel and industrial use, cost effective

mechanized harvesting of crop residues by straw baler and combine have been put to use (Rautaray and Sharma, 2009).

In the northern state of India mainly Punjab, Haryana, Uttar Pradesh and Uttaranchal the traditional harvesting using sickle has been largely replaced by combine harvesting specially in case of wheat and paddy. At least 90% of paddy and 60% of wheat is harvested by combine harvesters in Punjab (Singh, 1997). The baling can be use as an option to collect the large amount of residue left combining in order to decrease the adverse effect of open field burning on environment and health of mankind. (Rajan *et al*, 2001)

Baler are new introduction in Indian agriculture and are being projected as an alternative to open field burning for collection and disposal of cereal straw as animal feed and industrial raw material. The key for the popularization of a field bailing system entirely lies in its economical use and social-economic aspects. Keeping the important to study the comparisons of paddy straw management for bale in term of cost, energy and time for collection, transport, loading and unloading paddy straw.

2. Method and Material

The experimental study was carried out for paddy straw on five farmer's field at Gangavati taluka of Koppal district(Karnataka) in 2014. Namely three operations was studied as manually collection of bale made by Baler machine, loading-unloading of bale in trolley and transportation operation with help of tractor.

Energy, time and cost for bales collection

The energy, time and cost for bale collection are calculated as based on labour required and tied bale output. The energy required for bales collection in the field was calculated as follows;

$$\text{Energy of bale collection (MJ t}^{-1}\text{)} = \frac{\text{Total labour energy for bale collection (MJ h}^{-1}\text{)}}{\text{Yield of bale straw (t h}^{-1}\text{)}}$$

The time required for bale collection in the field was calculated as follows;

$$\text{Time of bale collection (h t}^{-1}\text{)} = \text{Labour time required to collect bale (h t}^{-1}\text{)}$$

The cost required for bale collection in the field was calculated as follows;

$$\text{Cost of bale collection (Rs. t}^{-1}\text{)} = \frac{\text{Total labour cost for bale collection (Rs. h}^{-1}\text{)}}{\text{Yield of bale straw (t h}^{-1}\text{)}}$$

Where,

Labour required for bale collection for without rake (70 bale h⁻¹) = 1

Cost of labour required for bale collection = 25 Rs. h⁻¹

Man energy = 74.567 W-h

Energy, Time and Cost for Bales Transport

The energy, time and cost for bale transport are calculated as based on transport trolley and density of bale. The energy required for bale transport was calculated as follows;

$$\begin{aligned} &\text{Energy of bale transprt (MJ t}^{-1}\text{ km}^{-1}\text{)} \\ &= \frac{\text{Total energy of bale transprt (MJ)}}{\text{Wt. for bales transport per trolley volume (t)} \times \text{Transprt distance (km)}} \end{aligned}$$

The time required for bale transport was calculated as follows:

$$\begin{aligned} &\text{Time of bale transprt (h t}^{-1}\text{ km}^{-1}\text{)} \\ &= \frac{\text{Total time of bales transprt (h)}}{\text{Wt. for bales transport per trolley volume (t)} \times \text{Transprt distance (km)}} \end{aligned}$$

The cost required for bale transport was calculated as follows:

$$\begin{aligned} &\text{Cost of bale transprt (Rs. t}^{-1}\text{ km}^{-1}\text{)} \\ &= \frac{\text{Cost of bales transprt/trolley (Rs.)}}{\text{Wt. for bales transport per trolley volume (t)} \times \text{Transprt distance (km)}} \end{aligned}$$

Where,

Assuming fuel consumption of tractor for transporting = 0.200 l km⁻¹

Volume of straw = 4m × 2m × 3m = 24 m³

Density of bale = 10 kg m⁻³

Man energy = 74.567 W-h

Max capacity of the trolley can be 5 t (Rajan *et al.*, 2001)

Energy, time and cost bales loading and unloading

The energy, time and cost for bale loading and unloading are calculated based on labour required and yield of bale straw. The energy required for bale transport was calculated as follows;

The required energy for bale loading and unloading was calculated as follows;

$$\begin{aligned} &\text{Energy of bale loading and unloading (MJ t}^{-1}\text{)} \\ &= \frac{\text{Total labour energy for bale loading and unloading (MJ h}^{-1}\text{)}}{\text{Yield of bale straw (t h}^{-1}\text{)}} \end{aligned}$$

The time required bale loading and unloading was calculated as follows;

$$\text{Time of bale loading and unloading (h t}^{-1}\text{)} = \frac{1}{\text{Yield of bale straw (t h}^{-1}\text{)}}$$

The cost required for bale loading and unloading was calculated as follow;

Cost of bale loading and unloading (Rs. t^{-1})

$$= \frac{\text{Total labour cost for bale loading and unloading (Rs. h}^{-1})}{\text{Yield of bale straw (t h}^{-1})}$$

Where,

No. labour required for loading and unloading for without rake = 2

Cost of labour = 25 Rs h^{-1}

Man energy = 74.567 W-h

3. Result and Discussion

The result show that straw management through baler machine in term of cost, energy and time for collection, transport, loading and unloading paddy bale from harvested field to store place.

Utilization management of bale

The human energy consume for bale collection was 0.46 MJ t^{-1} . The time required for collecting bale manually made by baler machine was 1.70 h t^{-1} and labour charges was 42.47 Rs t^{-1} as shown in Fig-1.

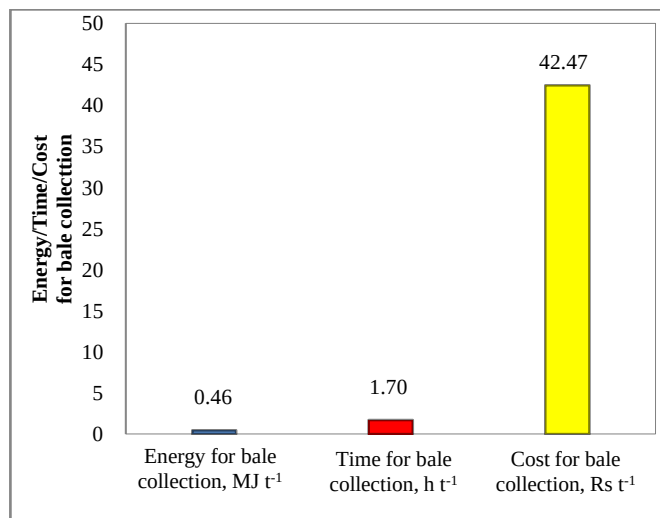


Fig. 1. Energy, time and cost for bale collection

Similarly, the total energy required for transportation by tractor was found $4.19 \text{ MJ t}^{-1} \cdot \text{km}^{-1}$, time required and cost for bale transport was found to be, $6.92 \text{ h t}^{-1} \cdot \text{km}^{-1}$ and $326.85 \text{ Rs. t}^{-1} \cdot \text{km}^{-1}$, respectively as shown in Fig-2.

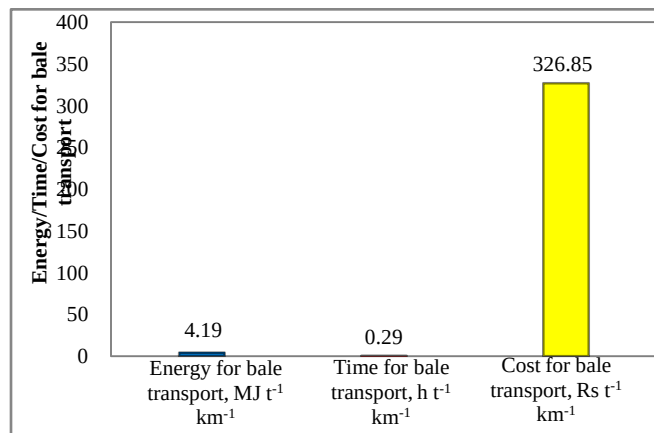


Fig. 2 Energy, time and cost for bales transport

The total energy, time and cost for bale loading and unloading was found to be 0.91 MJ t^{-1} , 1.70 h t^{-1} and 84.94 Rs. t^{-1} , respectively as shown (Fig. 3)

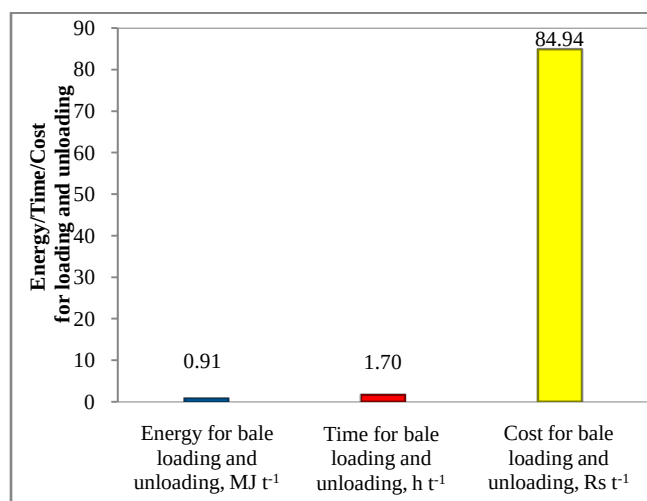


Fig. 3 Energy, time and cost for bales loading and unloading

4. Conclusion

From the above result it is concluded that energy consumption rate is highest in transportation ($4.19 \text{ MJ t}^{-1} \cdot \text{km}^{-1}$) followed by loading and unloading (be 0.91 MJ t^{-1}) and bale collection (0.46 MJ t^{-1}). From total time only 8 per cent time consumed for Transportation operation and collection of bale and loading- unloading operation time consumption is same i.e 46 per cent. In cost comparison height cost require for transportation (326.85 Rs t^{-1}) and lowest for bale collection operation (42.47 Rs t^{-1})

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