Energy, Cost and Time Utilization for Paddy Straw

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Abstract

Rice is one of the most important food crop in india. Every year 300 Mt of paddy straw is produce. A farmer has to burn this paddy straw in field due to high cost and time consume for straw utilization. Keeping the view the comparisons inenergy, cost and time utilization for non-densified straw andbales. The result show that energy consume for collection, transportation and loading-unloading of loose straw and paddy bale was 35.59 and 5.56 MJ t^{-1}respectively. Time and cost required for all operations for loose straw and paddy bale were 20.25 h t^{-1} , 3.09 h $t^{-1}$and 3490.27Rs t^{-1}, 454.26 Rs t^{-1}respectively. 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

Energy, Cost, Time, Rice Straw, Baler

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 resides 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, Utter 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 non-densified (loose straw) and bale in term of cost, energy and time for collection, transport, loading and unloading paddy straw.

2. Method and Material

The experimental study has been carried out for traditional management of paddy straw in Gangavati taluka of Koppal district(Karnataka). The survey was carried out in Gangavati

Taluka and randomly three villages in taluka were surveyed. For each village, data of five farmers of each category were collected and analyzed for the energy, time and cost of traditional management of non-densified paddy straw for collection, transport, loading and unloading.

Energy, time and cost for non-densified paddy straw collection

The energy, time and cost for non-densified paddy straw collection are analysed as based on collecting farmer information. The energy required forcollection of non-densified paddy straw in the field was calculated by following formula;

$$\text{Enegry required of non-densified paddy straw collection (MJ t}^{-1}\text{)} = \frac{\text{Total labour energy for non-densified paddy straw collection (MJ ac}^{-1}\text{)}}{\text{Yield of straw (t ac}^{-1}\text{)}}$$

The time required for collection of non-densified paddy straw in the field was calculated by following formula;

$$\text{Time required of non-densified paddy straw collection (h t}^{-1}\text{)} = \frac{\text{Total labour time for non-densified paddy straw collection (h ac}^{-1}\text{)}}{\text{Yield of straw (t ac}^{-1}\text{)}}$$

The cost required for collection of non-densified paddy straw in the fieldwas calculated by following formula;

$$\text{Cost required of non-densified paddy straw collection (Rs. t}^{-1}\text{)} = \frac{\text{Total labour cost for non-densified paddy straw collection (Rs. ac}^{-1}\text{)}}{\text{Yield of straw (t ac}^{-1}\text{)}}$$

Energy, time and cost for non-densified paddy straw transport

The energy, time and cost for non-densified paddy straw transport are analysed as based on collecting farmer information. The energy required for transport of non-densified paddy straw in field to storage place was calculated by following formula;

$$\text{Energy required of non-densified paddy straw transport (MJ t}^{-1}\text{ km}^{-1}\text{)} = \frac{\text{Total energy for non-densified paddy straw transport (MJ)}}{\text{Wt. of non-densified paddy straw transport per trolley volume (t)} \times \text{Transport distance (km)}}$$

The time required for transport of non-densified paddy straw in field to storage placewas calculated by following formula;

$$\text{Time required of non-densified paddy straw transport (h t}^{-1}\text{ km}^{-1}\text{)} = \frac{\text{Total distance non-densified paddy straw transport (h)}}{\text{Wt.of non-densified paddy straw transport per trolley volume (t)} \times \text{Transport distance (km)}}$$

The cost required for transport of non-densified paddy straw in field to storage place was calculated by following formula;

$$\text{Cost required of non-densified paddy straw transport (Rs. t}^{-1}\text{ km}^{-1}\text{)} = \frac{\text{Cost of two way transport/trolley (Rs.)}}{\text{Wt.of non-densified paddy straw transport per trolley volume (t)} \times \text{Transport distance (km)}}$$

Where,

Assuming fuel consumption of tractor for transporting = 0.20 l km^{-1}

Volume of trolley = 4× 2× 3m = 24 m^3

Density of non-densified straw = 10 kg m^{-3}

Man energy = 74.567 W-h (Firouziand Aminpanah, 2012)

Energy, time and cost for non-densified paddy straw loading and unloading

The energy, time and cost for non-densified paddy straw loading and unloading are analysed as based on collecting farmer information. The energy required for loading and unloading of non-densified paddy straw was calculated by following formula;

$$\text{Energy required of non-densified paddy straw loading and unloading (MJ t}^{-1}\text{)} = \frac{\text{Total energy for non-densified paddy straw loading and unloading (MJ ac}^{-1}\text{)}}{\text{Yield of straw (t ac}^{-1}\text{)}}$$

The time required for loading and unloading of non-densified paddy straw was calculated by following formula;

$$\text{Time of non-densified paddy straw loading and unloading (h t}^{-1}\text{)} = \frac{\text{Total time of required for non-densified paddy straw loading and unloading (h ac}^{-1}\text{)}}{\text{Yield of straw (t ac}^{-1}\text{)}}$$

The cost required for loading and unloading of non-densified paddy straw was calculated by following formula;

$$\text{Cost required of non-densified paddy straw loading and unloading (Rs. t}^{-1}\text{)} = \frac{\text{Cost required of non-densified paddy straw loading and unloading (Rs. ac}^{-1}\text{)}}{\text{Yield of straw (t ac}^{-1}\text{)}}$$

Energy, time and cost for bale collection, transport, loading and unloading

After the baling operation the energy, time and cost of bale for collection, transport, loading and unloading without and with rake was calculated .The different operation for field to staking *i.e.* collection, transport, loading and unloading of bale are disused in below.

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

Labour required for bale collection for with rake (140 bale h^{-1}) = 2

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;

$$\text{Energy of bale transoprt (MJ t}^{-1}\text{ km}^{-1}\text{)} = \frac{\text{Total energy of bale transoprt (MJ)}}{\text{Wt. for bales transport per trolley volume (t)} \times \text{Transoprt distance (km)}}$$

The time required for bale transport was calculated as follows:

$$\text{Time of bale transoprt (h t}^{-1}\text{ km}^{-1}\text{)} = \frac{\text{Total time of bales transoprt (h)}}{\text{Wt. for bales transport per trolley volume (t)} \times \text{Transoprt distance (km)}}$$

The cost required for bale transport was calculated as follows:

$$\text{Cost of bale transoprt (Rs. t}^{-1}\text{ km}^{-1}\text{)} = \frac{\text{Cost of bales transoprt/trolley (Rs.)}}{\text{Wt. for bales transport per trolley volume (t)} \times \text{Transoprt distance (km)}}$$

Where,

Assuming fuel consumption of tractor for transporting = 0.200 l km^{-1}

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

Density of non-densified straw = 10 kg m^{-3}

Man energy = 74.567 W-h (Firouzi and Aminpanah, 2012)

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;

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

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

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

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

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

Where,

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

No. labour required for loading and unloading balesfor with rake = 3

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

Man energy = 74.567 W-h

3. Result and Discussion

The result show that straw management for non-densified (loose straw) and bale in term of cost, energy and time for collection, transport, loading and unloading paddy straw

Utilization management of non-densified paddy straw

The total energy, time and cost for collection, transport and loading and unloading for non-densified paddy straw was calculated based on survey data of non-densified paddy straw which was found to be 2.71 MJ t^{-1}, 8.98 h t^{-1} and 224.53Rs. t^{-1}, respectively (Fig. 1). The total energy, time and cost for non-densified straw transport was found to be 30.10 MJ t^{-1}, 2.08 h t^{-1} and 2346.49 Rs. t^{-1}, respectively (Fig. 2). The total energy, time and cost for non-densified paddy straw loading and unloading was found to be 02.78 MJ t^{-1}, 9.19 h t^{-1} and 919.25 Rs. t^{-1}, respectively (Fig. 3)

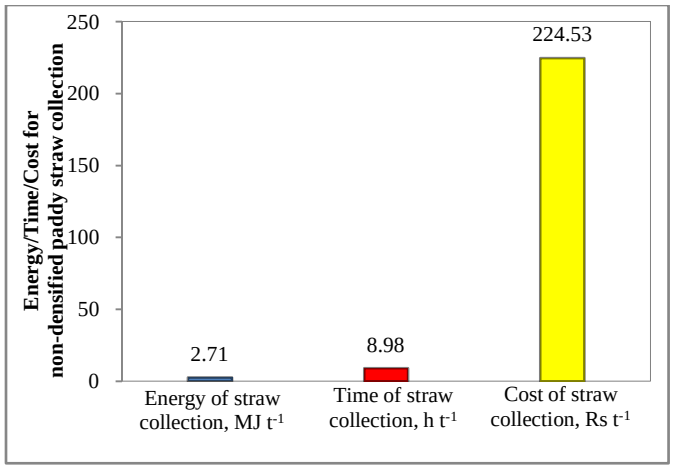

Fig. 1 Energy, time and cost for non-densified paddy straw collection manually

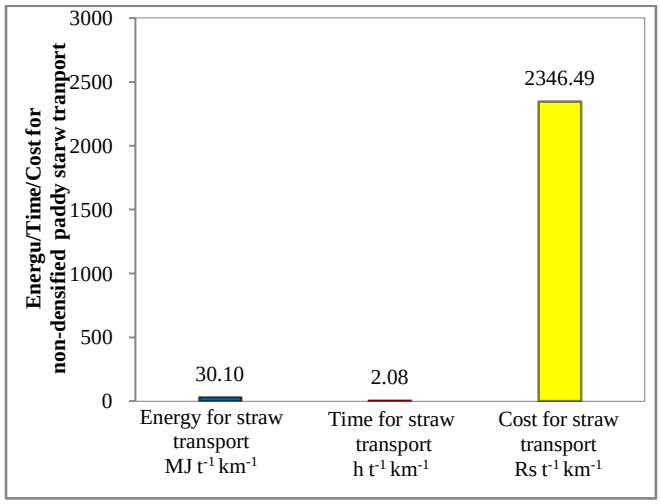

Fig. 2 Energy, time and cost fornon-densified paddy straw transport by Tractor

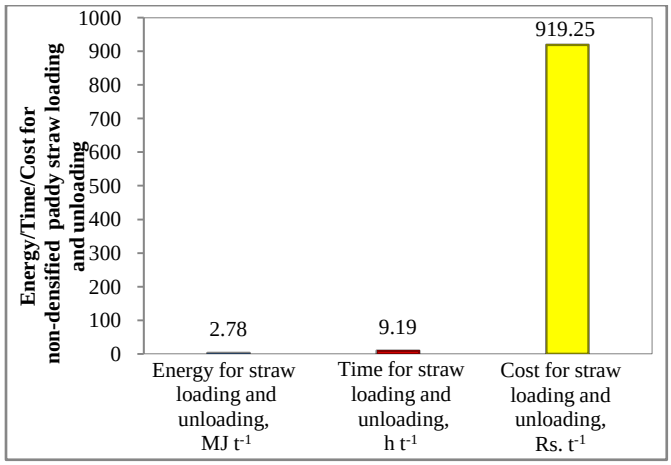

Fig. 3 Energy, time and cost fornon-densified paddy straw loading and unloading manually

Utilization management of bale

The energy, time and cost for bale collection, transport, loading and unloading for bale with baling operation was found to be 0.46 MJ t^{-1}, 1.70 h t^{-1} and 42.47 Rs. t^{-1}, respectively (Fig. 4). The total energy, time and cost for bale transport was found to be 4.19 MJ t^{-1}, 6.92 h t^{-1} and 326.85 Rs. t^{-1}, respectively (Fig. 5). 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 (Fig. 6).

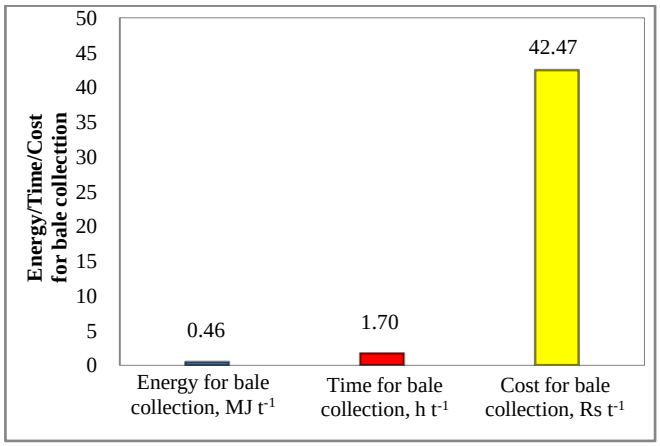

Fig. 4 Energy, time and cost for balecollection

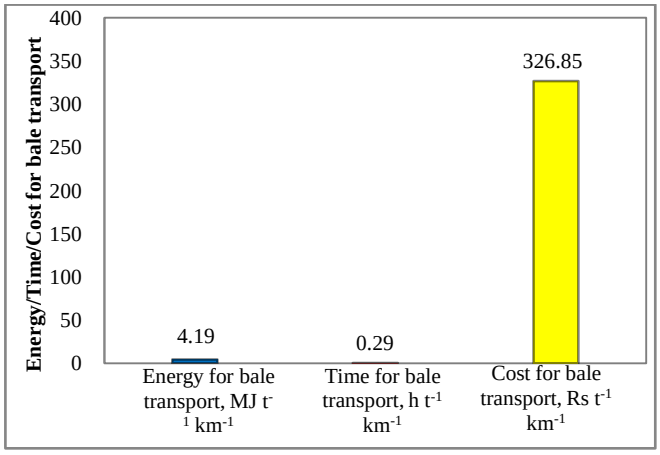

Fig. 5 Energy, time and cost for bales transport

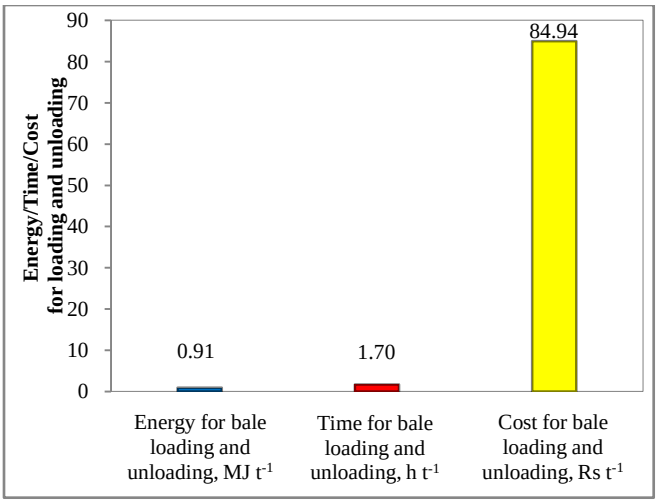

Fig. 6 Energy, time and cost for bales loading and unloading

4. Conclusion

The most of biomass production by the farmer of northen karnataka are in the form crop wastes including straw, stubbles, etc. which are not significantly being utilized. In many intances, these wastes are either simply under utilized or openly burned in farm field.this is mainly due to non utilization suitable farm machinery to economically collect and bale the paddy straw on the field by using the tractor operated square baler is collected paddy straw after combine harvester and form bale. The main advantages derived from the bale is easy collecion, transport, loading and unloading as compare to traditional management of non-desified straw and also economical help to farmer and proper utilization of paddy straw.

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