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Research Article

PADDY CROP RESIDUE MANAGEMENT: AS A POTENTIAL SOURCE OF BIO-ETHANOL IN BARGARH, ODISHA

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Abstract: Rice plays a significant role in the economy of Odisha farming community, covering 70 percent area under cereals. At present nearly 4mha of area is covered annually under this crop (3.7 m ha during *kharif* & 0.3 m ha during *Rabi*). About 2.5-3.0 tons per ha of dry rice straw is the average net production in Odisha (State Agriculture Plan of Odisha, 2014). This creates a huge canvas to use the rice straw in a more economically feasible way without hampering the environment. One of the key alternatives being its role as a feedstock in bioethanol production. But there are various factors that determine the management of paddy straw. The present study was conducted in Bhatli district of Bargarh, Odisha which is one of the highest producing areas of paddy. A total of 50 farmers were selected for the given study. Study was conducted to list out the amount of straw used for various purposes by the farmers. Also, awareness amongst the farmers about various alternative uses of paddy straw was assessed. It was revealed that none of the farmers were aware about the use of paddy straw as a feedstock for bioethanol production. Moreover, various problems encountered by the farmers in handling of paddy straw as ranked. Thus, the study revealed that management of paddy straw is determined by various socio-economic factors and thus these factors should be considered to devise a suitable regional model to put use of paddy straw in more suitable ways. Thus, to utilize paddy straw in an effective and ecological way there should be an integrated afford made by extension agent, farmers and farmers organizations in terms of changing Knowledge, Attitude and Practice (KAP).

Keywords: *Feedstock, Paddy, Bio-ethanol, Extension, Kharif, KAP*

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Introduction

India is an agro-ecological diverse country with a population of 1.27 billion in a geographical area of 328.7 million ha. It includes 200.2 and 139.4 m ha of gross cropped and net sown area, respectively [1]. The cultivation area is about 51% of total geographical area with an average cropping intensity of 136 %. India is the world's largest producer of milk, pulses and jute, and ranks as the second largest producer of rice, wheat, sugarcane, groundnut, vegetables, fruit and cotton. It is also one of the leading producers of spices, fish, poultry, and livestock and plantation crops. Agriculture, with its allied sectors, is the largest source of livelihoods in India.

According to the Indian Ministry of New and Renewable Energy (MNRE), India generates on an average 500 million tons (Mt hereafter) of crop residue per year. The same report shows that a majority of this crop residue is in fact used as fodder, fuel for other domestic and industrial purposes. However, there is still a surplus of 140 Mt out of which 92 Mt is burned each year. It is also interesting to note that the portion burnt as agricultural waste in India, in volume, is much larger than the entire production of agricultural waste in other countries in the region.

Crop residues are materials left on cultivated land after the crop has been harvested. Retention of crop residues after harvesting is considered to be an effective anti-erosion measure. Crop residues can improve soil structure, cation exchange capacity, increase organic matter content in the soil facilitating transformation of primary and secondary plant nutrients and availability to plant, reduce soil erosion, improve water-holding capacity of the soil and reduce moisture evaporation, and help fix CO_2 in the soil. It incorporates a large number of nutrients in the soil for crop production and affects soil water movement, runoff and infiltration. Judicious crop residue management has a significant impact on the regulation of the soil microbial biomass. In a conservation agriculture system, successful management of crop residues is an integral part, and the maximum benefit of conservation agriculture can only be achieved with in-situ management. However, decomposition of crop residues has both positive and negative impacts on crop production [2].

Good residue management practices on agricultural lands have many positive impacts on soil quality. Besides, crop residues can be used in biofuel production It is estimated that 500 mt of crop residues are generated annually. As per the available data cereals generate maximum residues of 352Mt, followed by fibres (66Mt) and pulses (18Mt). Amongst them rice residues comprise 34% of the total crop residues. Open field rice straw burning causes air pollution and GHGs emission (7300 kg CO_2-equivalent per hectare), soil nutrient and biodiversity losses and human health hazards. Huge amount (731 million tons (Mt)) of rice straw is produced globally in which India contributed around 126.6 MT, and 60% of them is burnt on the field. Once a wealth, the straw now became a waste subjected to burning due to technical, structural, institutional, and socioeconomic challenges [3].

Each year in late September and October, farmers from Punjab and Haryana in particular burn an estimated 35 million tons of crop residue from their paddy fields after harvesting. This practice serves as a low-cost method of getting rid of the straw and reduces the turnaround time between harvesting and sowing for the second (winter) crop. With labour being unavailable and the time window for preparing the field for wheat cultivation being limited, the options that the farmer has are either investing in expensive implements or burning the residues, the latter being an easy way out. [4]. It causes a reduction in the ambient air quality, as well as causes soil nutrient loss of organic carbon(3850 million kg), nitrogen (59 million kg), phosphorus (20 million kg), and potassium(34 million Kg), and discharges large volumes of various air pollutants such as COX, CH_4,NOX, SOX, and particulate matters (PM10 and PM2.5) [5].

Therefore, proper and sound alternative management practices of crop residues should be devised to reduce the vicious practice of stubble burning. These methods should be cost effective as well as environmentally friendly. These include practices like mulching in reduced tillage condition, residue incorporation, investing in profitable ventures like paddy straw mushroom production. Other alternatives include turning the off-field residue to compost which can be used as a valuable organic manure. It is an appealing alternative to stubble burning owing to its ability to turn waste in a farm into a valuable fertilizer product by simply packing crop residues into piles or pits for a longtime [6]. Another interesting option is conversion of these crop residues specially rice straw as a feedstock for 2G bio ethanol production. The oil demand in India will reach more than 8 million barrels per day in 2035, where the current domestic production of crude oil has been more or less stagnant over the years. (World Energy Outlook (WEO) report to the International Energy Agency (IEA), 2016. Biofuels are considered among the most promising alternative options. It can be produced locally and can be substituted for diesel and petrol to meet the transportation sector's requirements of India. Like many other countries, is setting targets for the substitution of petroleum products by biofuels. Rice straw is one of the most important lignocellulosic materials which can be used as the potential feedstock. Several pre-treatment processes have been developed for lignocelluloses, which function by an enlargement of the inner surface area and is accomplished partly by solubilization of the hemicelluloses and partly by degradation of the lignin. The pretreatments are Milling and grinding pyrolysis, high energy radiation, high pressure steaming, alkaline or acid hydrolysis, hydrogen peroxide treatment, hydrothermal treatment, steam explosion, wet oxidation and biological treatment such as enzyme or microbial conversion [7]. 1kg rice straw has 350g of cellulose which depends upon variety and the geographical location. This can theoretically yield 220g/283ml ethanol.

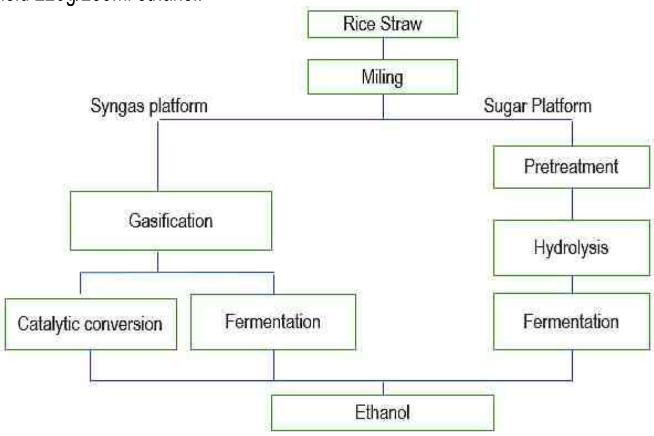

Fig-1 Schematic diagram of bioethanol production from rice straw

Paddy Field
↓
Harvesting in Progress
↓
Paddy Straw Bailing
↓
Bale Paddy Straw
↓
Transportation
↓
Collection Centres
↓
Warehousing
↓
Transport and debailing at Plant
↓
Feeding to ethanol Plant

Fig-2 Supply chain model of paddy straw for bioethanol plant

But there are several bottlenecks in application of alternate paddy straw management practices. These include insufficient labour during harvest period, poor market linkage, non-availability of scientific machines for baling of straws like reap binder, and happy seeder, unawareness about sound and scientific methods of paddy straw management *etc.* The present study analyses the awareness of farmers about various alternate methods of paddy straw management a major focus being its utilisation as a potential feedstock for bio ethanol production as well as rank the various problems faced by farmers in paddy straw management so as prepare a base work to devise alternate options for effective use of paddy straw.

Materials and Methods

For the purpose of study Bhatli block of Bargarh District, Odisha was selected which is one of the highest areas in terms of rice production. 50 respondents were selected 10 marginal, 20 small and 20medium farmers) by stratified random sampling. Data was collected via a structured interview schedule. Various questions were asked and discussions were held regarding problems faced in paddy straw management and what can be the way forward. The data was tabulated in a structured form and results were drawn from them [8,9].

Results and Discussion

Predominantly the cropping system in the area is rice based. Rice is grown along with diverse crops like green gram, groundnut, vegetables *etc.* This shows that there is a huge prevalence of double cropping with rice being the major crop. [Table-1]. Grain to straw ratio of paddy across different categories of farmers was also calculated [Table-2]. This indicates that a huge amount of straw is obtained as a by-product which can be used in a more suitable way.

Table-1 *Major cropping pattern in various villages of Bhatli Block*

Village	Cropping Pattern
Karlajuri	Rice-greengram
Raisobha	Rice-groundnut
Hatisar	Rice-Rice
Nuagarh	Rice-mustard
Badmal	Rice-Rice
Chandigaon	Rice-greengram
Halupali	Rice-Vegetables
Bisapali	Rice-groundnut
Kelendapali	Rice-Rice
Urduna	Rice-greengram
Mulbar	Rice-rice
Tukurla	Rice-greengram
Dumapali	Rice-Rice
Bhatli	Rice-greengram
Kasanpuri	Rice-rice
Banjipali	Rice-greengram

Tabl-2 *Straw to grain ratio of paddy for different categories of farmer*

SN	Marginal	Small	Medium	Average
Grain Yield(q/ha)	27.5	45.2	71.3	48.0
StrawYield(q/ha)	35.3	58.7	92.6	62.2
Straw to grainratio	1.28	1.29	1.30	1.29

Paddy Residue Management Practices

Various methods of utilization of paddy straw were identified amongst the respondents. Amongst them a major amount of the straw yield (52.1%) was utilized for stubble burning followed by cattle feed (19.7%), thatching (14.5%), residue incorporation (10.21%) and mulching (3.16%) as described in [Table-3]. This indicates that there is still a huge knowledge gap for better utilization of paddy straw. There is lack of awareness for utilization of paddy straw as an alternate source of energy and economically viable options like mushroom cultivation. The reasons may include less exposure of farmers, lack of knowledge about various other alternate management practices, less interaction of farmers and extension agents which leads to slow transfer of technology at the field level. Moreover, farmers are least aware about the environmental ill effects due to such practices. There is a perception that burning is the only easy and economical method for straw management.

Table-3 *Utilization of Paddy straw for different purposes by the farmer respondents*

Purpose	Marginal	Small	Medium	Overall
	(qt/ha.)			
Thatching	10.5(30.0)	15.8(27.0)	0.92(1.0)	9.07(14.5)
Burning of Straw	-	41.9(70.0)	55.6(60.0)	32.50(52.1)
Residue Incorporation	20.1(57.0)	-	-	6.70(10.7)
Mulching/composting	4.55(13.00)	1.76(3.00)	-	2.100(3.16)
Mushroom cultivation	-	-	36.1(39.0)	12.00(19.2)
Total	35.30(100)	58.7(100)	92.7(100)	62.33(100)

Note: Figures in parentheses indicate percentage of total straw yield

Awareness about alternative paddy straw management practices

Awareness of respondents about various alternate paddy straw management practices is presented in [Table-4]. It is revealed that none of the respondents were aware of the use of paddy straw as a feedstock for bioethanol production. This indicates that there is a complete lack of knowledge about the latest options available to them which depicts poor scientist -farmer interaction. About 80% of the farmers are well aware of utilization of straw for mushroom cultivation. But they are unable to do so as there is no proper market linkage to enable proper sale of mushroom products as well as no proper training available for scientific production of mushroom.

Table-4 *Awareness among farmers regarding various alternatives of paddy straw management (n=50)*

Alternatives of Paddy straw management	Frequency(f)*	Percentage (%)
As a feedstock for bioethanol production	0	0
Mushroom Production	40	80
Composting	50	100
Mulch	30	60
Residue Incorporation	30	60
Paper Mill industry	20	40
Baled Straw	0	0
In zero tillage in conservation agriculture	30	60

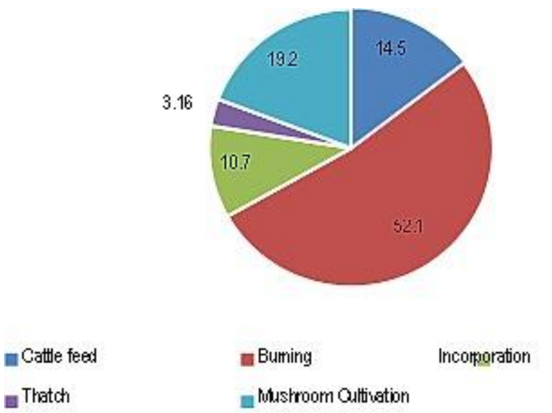

Fig-3 Paddy Straw Utilization (%)

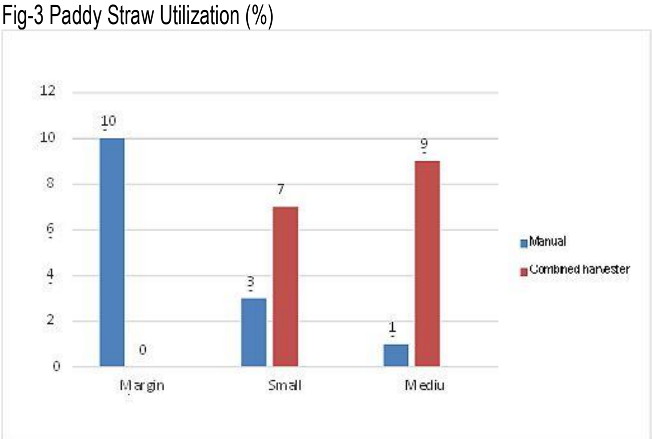

Fig-4 Methods of Harvesting adopted by farmers

Methods of Harvesting Adopted By farmers

Harvesting method adopted by farmers across the categories presented in [Fig-4]. While all the marginal farmers adopted the manual method of harvesting, the majority of small farmers (70%) and medium farmers (90%) used the combined harvester for harvesting. The main disadvantage of combined harvesting is that it leaves the straw in chopped form which makes it difficult to collect the straw. This results in stubble burning. Therefore, there is a need to introduce farmers to various alternate ways to handle the straw in a more suitable way. Thus, baling is an alternative option which helps in compressing the cut straw and provides an option for easy handling, transportation and storage of straw.

Problems Regarding Management of Paddy Straw

Respondents were asked about various problems they face in paddy straw management [Table-5]. The problem that ranked the highest was shortage of labour during peak harvesting period (100%), followed by high cost in collection of straw (42%), unavailability of subsidized machines for baling of straw (84%), non-scientific methods (76%), poor market linkage (70%), and lack of knowledge (64%). These problems were also reported by Roy and Kaur (2015) [8].

Table-5 *Problems in Management of Paddy Straw*

SN	Problems in rice straw management(n=50)	Frequency (%)	Rank
1	Shortage of labour during peak harvesting period	50(100.0%)	I
2	High Cost in collection of straw	42 (84.0%)	II
3	Unavailability of subsidized for machines baling of straw	40 (80.0%)	III
4	No scientific training available for better handling of paddy straw	38(76.0%)	IV
5	Poor market linkage to sale the products	35(70.0%)	V
6	Un awareness about paddy straw useful as a feedstock for bioethanol production i.e. poor extension agent- farmer interaction	32 (64.0%)	VI

Conclusion

Crop residues are of great economic importance in terms of industrial material, as a source of bio energy as a source of organic manure in the form of compost, as mulch for soil fertility enhancement. If managed well it can turn out into a source of additional income for farmers without hampering the environment. Likewise, paddy straw has immense potential for being used for mushroom cultivation, packaging material, and a mulching material.

The potential of paddy straw to be used as a source of 2G bioethanol feedstock is immense. It is one of the abundant lingo- cellulosic materials available. But this needs a strategy for a sound and scientific management of paddy straw. There are several socioeconomic factors which affect the management of paddy straw. These include insufficient and high labour cost during harvesting season, difficulty in collecting the straw and storing it, unavailability of subsidized machines which makes baling operation easy, poor market –farm linkage for the sale of products and poor farmer scientist interaction. Therefore, there is a dire need for dissemination of scientific methods for handling of paddy straw, to devise awareness programs about harmful effects of stubble burning, to demonstrate about various implements needed for straw collection like happy seeder, rice baler and reap bounder. For this a region-specific model should be developed.

Application of research: An integrated role of extension agent, farmers and farmer producing organizations is the need of the hour to promote sustainable paddy straw management practices through method demonstrations, publications, exposure visits to progressive farmer's field.

Research Category: Bio-ethanol production

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Research project name or number: PGDSRD, Research station study

Author Contributions: All authors equally contributed

Author statement: All authors read, reviewed, agreed and approved the final manuscript. Note-All authors agreed that- Written informed consent was obtained from all participants prior to publish / enrolment

Study area / Sample Collection: Bhatli block of Bargarh District, Odisha

Cultivar / Variety / Breed name: Rice

Conflict of Interest: None declared

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.
Ethical Committee Approval Number: Nil

References

[1] Anonymous (2014) State Agriculture Plan of Odisha.
[2] Sarkar S., Skalicky M., Hossain A., Brestic M., Saha S., Garai S., Ray K. and Brahmachari K. (2020) *Sustainability*, (12), 1-24.
[3] Bhattacharyya P., Bisen J., Bhaduri D., Priyadarsini S., Munda S., Chakraborti M., Adak T., Panneerselvam P., Mukherjee A.K., Swain S.L., Dash P.K., Padhy S.R., Nayak A.K., Pathak H., Kumar S. and Nimbrayan P. (2021) *Science of the Total Environment*, 775.
[4] Mukherjee P. (2016) *Crop Burning: Punjab and Haryana's killer fields. Down to Earth.*
[5] Parmod K., Surender K., Joshi L. (2015) *Socioeconomic and Environmental Implications of Agricultural Residue Burning: A Case Study of Punjab, India*, ISBN 978-81-322-2146-3
[6] Misra R.V., Roy R.N. and Hiraoka H. (2003) *On-Farm Composting methods Land and Water Discussion Paper 2, UN-FAO: Rome, Italy*.
[7] Nicola G.D., Santecchia E., Santori G. and Polonara F. (2011) *Advances in the Development of Bioethanol: A Review. In (Ed.), Biofuel's Engineering Process Technology. IntechOpen*.
[8] Roy P. and Kaur M. (2015) *Int Journal of Advances in Agricultural and Engg*., 2(1), 23-24.
[9] Anonymous (2021) *Annual Report 2020-21. Department of Agriculture, Cooperation and Farmer's Welfare, Ministry of Agriculture and Farmer's Welfare, Govt. of India*.