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Crop Residue Management through Its Alternate Use: A Case Study in Koshi Zone of Bihar

Santosh Kumar[1*], Ashutosh Singh[2], Amit Kumar Pandey[2], Anand Chaudhary[3], Pankaj Kumar Ray[3], Prem Chand Kumar[2] and Umesh Singh[2]

[1]Regional Research Station, Bihar Agricultural University, Sabour, 852201, India.
[2]Mandan Bharti Agriculture Collage, Bihar Agricultural University, Sabour, 852201, India.
[3]Krishi Vigyan Kendra, Saharsa, Bihar Agricultural University, Saharsa, Sabour, 852201, India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Biomass assessment study in *Koshi* zone of Bihar was carried out at regional Research Station, Agwanpur, Saharsa during 2015-2016. Study was focused only on ACZ-II in first phase. For the study of different fate of residues of crops in *Zone-II* of Bihar, it was concentrated in the districts of *Purnea, Katihar, Saharsa, Supaul, Madhepura, Khagaria, Araria* and *Kishanganj*. In first scenarios were feeding of livestock with dry biomass for 200 days in a year, it was observed that all the districts were deficient in providing biomass to live stock. However, in second scenario were feeding of livestock with dry biomass for 300 days in a year, all the district except *Araria* were deficit in providing biomass to livestock. There is no such problem arises for management of excess crop residue in these areas as these areas are already in deficit condition for biomass.

Keywords: Crop residue; fodder; biomass.

1. INTRODUCTION

Agriculture has a major share in the overall economy of India. Agriculture and animal husbandry in India are interwoven with the intricate fabric of the society in cultural, religious and economical ways as mixed farming and livestock rearing forms an integral part of rural living. Traditionally, agriculture is the prime sector of rural economy and rural employment [1]. In different regions of India, a wide range of crops are cultivated across the vast majority of

**Corresponding author: E-mail: santoshcool184@gmail.com;*
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land with significant quantity of crop residue that are left in the field after harvest [2]. 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. According to the Indian Ministry of New and Renewable Energy (MNRE), India generates on an average 500 Million tons (Mt here after) of crop residue per year [3]. Crop residues can improve soil structure, increase organic matter content in the soil, reduce evaporation, and help fix CO_2 in the soil. Good residue management practices on agricultural lands have many positive impacts on soil quality. Besides, crop residues can be used in bio fuel production. Waste crop residues have been recognized as a potential cellulosic feed-stock and the largest source of biomass [4,5]. Information on residue cover guides policies for promoting beneficial management practices and helps to estimate soil carbon.

The agricultural production systems in India are based upon mixed farming in which two major enterprises are crops and livestock. Farmers mix these two enterprises to diversify the use of their resources for maximizing family income. Livestock production is the backbone of Indian agriculture contributing 7% to National GDP and a source of employment and ultimate livelihood for 70% of the population in rural areas. To meet out the needs of the ever increasing livestock population the production as well productivity of fodder is to be increased. However, the increasing cultivation of cereal and cash crops has, in fact, contributed towards a decline in the area under fodder cultivation. Therefore, there is a tremendous pressure of livestock on available total feed and fodder, as land available for fodder production has been decreasing. At present, the country faces a net deficit of 61.1% green fodder, 21.9% dry crop residues and 64% concentrate feeds [6]. Forage and biomass species offer many benefits for conservation. More specifically, these species can be grown for grazing, hay, silage, bio fuel, or industrial use and are among land-use options available to generate economic return and provide other agro ecosystem services. Once established, these perennial species protect soil from erosion, improve water infiltration, reduce runoff, retain nutrients that might otherwise enter a waterway, provide shelter and sustenance for wildlife, build soil organic matter, increase soil nitrogen (N) through root and nodule turnover, support food and bio fuel production, ensure food security, add to farm income, and contribute to the quality of rural life.

The aim of the paper is to assess the possibility of regions according to their potentials of biomass production in the Bihar. Particularly rice, wheat and maize are the the major crops grown in Bihar through which residues are left in the field. Biomass is a term for all organic material that stems from plants (including algae, trees and crops). Biomass is produced by green plants converting sunlight into plant material through photosynthesis and includes all land- and water-based vegetation, as well as all organic wastes [7]. Management of these crop residues are one of the major challenge in these days in the state. These residues produces huge amount of carbon dioxide during its burning in the field and hence accelerate in global warming [8]. From last decade, the idea of using biomass for liquid fuels, or bio fuels for sustainable energy production has been attracting more and more interest from policy makers, scientists and investors, in the hope of providing an answer to the energy crisis and to the need to reduce greenhouse gas (GHGs) emission. Clean energy produced from locally harvested biomass can increase these energy shortages and provide alternative economic source for farm community. Converting biomass to methanol and substituting it for fossil-fuel-based energy production is one viable option in locations that generate high biomass waste supplies [9]. Bio fuels are also believed to offer a new source of income to farmers and generate employment opportunities in rural areas, both in developed and developing countries.

2. MATERIALS AND METHOD

Biomass assessment study in *Koshi* zone of Bihar was carried out at regional Research Station, Agwanpur, Saharsa during 2015-2016 utilizing simulation models, secondary data analysis and supported by extension expert on field study. For the purpose of study agro climatic zone (ACZ) were considered. Bihar is divided in mainly four ACZs based on soil characterization, rainfall, temperature and terrain. Out of these four agro climatic zones, zone- IIIA and IIIB were ruled out due to single crop production in whole year and lack of irrigation facilities. These ACZ are draught prone and if draught happens biomass availability will be severely affected. Hence, study was focused only on ACZ-II in first phase. For the study of different fate of residues of crops in *Zone II* of Bihar, it was concentrated in the districts of *Purnea, Katihar, Saharsa, Supaul, Madhepura, Khagaria, Araria* and *Kishanganj*. Considering all ACZs total 91% crop

area is under Wheat, Maize and Paddy hence these crops are considered for the purpose of evaluation. Other biomasses are available in negligible quantities and not sufficient for production Bio fuel and other uses.

A balanced ration should provide protein, energy, minerals and vitamins from dry fodders, green fodders, concentrates, mineral supplements etc., in appropriate quantities to enable the animal to perform optimally and remain health. Maintenance ration may be defined as the feed required maintaining the essential body processes at their optimum rate without gain, loss in body weight or changing in body composition. Under Indian condition, farmers fed their animals very little concentrates unless the animal is in productive stage. Organized farms, progressive farmers and now a day's farmers with medium producing animals are also practicing scientific feeding for more returns. In the calculation of feed requirement for small animals, it was discarded as there requirement was mitigated by the grasses and kitchen wastage. However, in some area their feed demand was compensated by the biomass of minor crops like pulses and oilseeds. In case of big animals daily solid feed requirement is considered up to 8 kg on average.

3. RESULTS AND DISCUSSION

The production scenario of major cereals for which residue management is given priority of districts of ACZ under study is not less than average production of the state. Farmers of these districts broadly adopted and practiced two major cropping systems *i.e.* of rice/maize-wheat-fallow and rice-maize-summer pulses. In that situation when the biomass of only rice and wheat were taken the highest biomass production was observed in *Araria* where as lowest was in *Khagaria* district (Table 1). However, when the biomasses of all the major crops were taken *i.e*. for rice, wheat and maize, same districts were found to be the highest and lowest. Biomasses of other crops are available in negligible quantities and not sufficient for production fodder and other uses (Table 2).

The crop calendar is a tool that provides timely information about local crop production. In the present context, crop calendar is useful in two ways. Firstly, it helps in identifying the window of crop harvest and secondly, it also provides the information about the expected quantity of biomass availability in a particular period. March-April and October-December are the major harvesting periods during which availability of biomass is very high at lower prices.

Livestock rearing is one of the major occupations in India that provides manure, draught power for agriculture and local transportation and forms important source of food and cash income to millions of households spread across various parts of the country [10]. The sector assumes still higher significance as it forms the most critical means of supporting the earning capacity of landless pastoralists and those of marginal and small farmers, especially those living in drought-prone, hilly, tribal and such other areas where crop production, dependent mainly upon vagaries of nature, is not certain. In these area livestock is a crucial and integral part of the livelihoods of households which is the major benefactor of residual biomass in the region. During the study small animals were not considered as they consume very negligible amount of biomass of these crops and surplus availability depends mainly on population of big animals in the district. The population of big animal was observed maximum in *Kisanganj* followed by Supaul and Madhepura.

Table 1. Biomass production of major crops of the districts of ACZ-II

Name of the district	Biomass production (M.T.)				
	Rice	Wheat	Maize	Total (R+W)	Total (R+W+M)
Supaul	604771	141921	94673	746692	841365
Saharsa	530100	155478	278098	685578	963676
Madhepura	544670	146303	361938	690973	1052911
Khagaria	130998	123530	416894	254528	671422
Kisanganj	691054	193059	4678	884113	888791
Araria	826879	100478	580128	927357	1507485
Total	**3328472**	**860769**	**1736409**	**4189241**	**5925650**

Table 2. Biomass production of minor crops of the districts of ACZ-II

Crop	Production (tonnes)	Biomass (Million tonnes)
Arhar	37134	0.09
Urad	12048	0.02
moong	94361	0.12
Kulthi	7210	0.01
Ghaghra	488	0.00
Other Pulses	1625	0.00
Gram	58545	0.06
Lentil	140439	0.28
Pea	17941	0.02
Khesari	50987	0.07
Rape seed/Mustard	94392	0.19
Linseed	12911	0.03
Groundnut	501	0.00
Sugarcane	15498950	6.20
Total		7.09

Table 3. Livestock population and biomass availability of focused districts of ACZ- II (In thousands)

Name of district	Population	Feed requirement (M.T. per year)	Biomass availability (M.T.) for 200 days	Biomass availability (M.T.) for 300 days	Biomass surplus (M.T.)	Biomass surplus (M.T.)
	Big animal	Big animal	(Rice +Wheat + Maize)	(Rice + Wheat + Maize)	Scenario-I	Scenario-II
Supaul	7,09,031	1701674	560910	841365	-1140764	-860309
Saharsa	4,45,244	1068586	642450.7	963676	-426135	-104910
Madhepura	6,19,481	1486754	701940.7	1052911	-784813	-433843
Khagaria	440,178	1056427	447614.7	671422	-608812	-385005
Kisanganj	907,000	2176800	592527.3	888791	-1584273	-1288009
Araria	512478	1229947	1004990	1507485	-224957	277538
Total	3633412	8720188	3950433	5925650	**-4769755**	**-2794538**

Considering the livestock population and fodder consumption pattern, it has estimated surplus biomass availability based on two scenarios. Feeding of livestock with dry biomass for 200 days in a year, remaining days dependent on open grazing and other minor crops like mustard, black gram, chickpea, lentils etc. another is feeding of livestock with dry biomass for 300 days in a year, remaining days dependent on open grazing and other minor crops. In first scenarios were feeding of livestock with dry biomass for 200 days in a year, all the district were deficient in providing biomass to live stock (Table 3). However, in second scenario were feeding of livestock with dry biomass for 300 days in a year, All the district except *Araria* were deficit in providing biomass to livestock. Considering overall biomass availability in ACZ II, there is a sever scarcity of fodder for livestock as these are mainly provided by the biomass of the major crops grow in these area.

4. CONCLUSION

Based on the result of the study it is concluded that there is sever scarcity of fodder to the livestock is prevailing in zone-II and this can urgently be met out. The possible way to mitigate this situation can be by adopting new technologies for enhancing productivity and through alteration in cropping system. These results also reflect that the area under study is not prone for excess biomass production and its management but rather these areas are deficit to biomass. Hence, there is no any such issue of excess biomass in these areas of Bihar. Only focus must be given to supply or mitigate the fodder scarcity to livestock.

In future it can be done by utilizing low lying area with fodder crop, Intensifying cropping system from rice-wheat to rice-wheat-summer maize or rice-wheat-Summer rice and Replacing rice/wheat/maize straw as feed from other nutritive crops like green gram, chickpea, lentil *etc.*

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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