International Journal of Agriculture, Environment and Biotechnology
Citation: IJAEB: 11(1): 127-135, February 2018
DOI: 10.30954/0974-1712.2018.00178.17

AGRICULTURAL ECONOMICS

An Economic Analysis of Paddy Fodder and Livestock Management in Tunga Bhadra Project (TBP) Command Area in Karnataka

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Paper No. 660 Received: 16-09-2017 Accepted: 02-01-2018

ABSTRACT

Livestock plays an important role in the rural economy of the country. Livestock is a key source of supplementary income and livelihood, especially for small land holdings and landless rural poor households. India generates approximately 507.8 million tons of on-field crop residues, of which 43 per cent is rice and 23 per cent is wheat, remaining 16 per cent of crop residue is burnt on the field. In Thungabhadra project (TBP) command area 54 per cent were large farmers followed by medium farmers (21 %). Four methods of residue management practices were identified in TBP command area out of which removal of straw and burning of stubble method were found to be the highest (42.45%) and the major one. The main reason behind burning of residues are low cost and labour scarcity. Total cost of cultivation of paddy per acre was found to be marginally lower in case of burning of straw and stubbles method when compared (₹ 37577) to incorporating straw and stubbles (₹ 38838) method in case of high livestock density area. Among the different residue management practices the livestock possession per respondent was found to be the highest in case of the removal of straw and burning of stubbles (1.69) followed by removal of straw and incorporation of stubbles (1.52). The least was found in case of burning of straw and stubbles (1.09). Major constraints found during paddy fodder management practices were lack of technical knowledge about residue management and non-availability of custom hire service, especially reaping binder in TBP command area.

Highlights

- Majority of farmers are practicing removal of straw and burning of stubble (42.45 %) in TBP command area. In TBP command area 81 per cent of farmers harvest paddy crop using the machine (*i.e.* combine harvesters).
- The major factors which influence the decision to burn paddy crop residue are the use of combine harvesters and the scarcity of labour for collection of residue.
- The sample farmers who have the high livestock possessions were practicing removal of straw and burning of stubbles method of paddy residue management practice and those having less livestock possessions were practicing burning of straw and stubbles method of residue management practices.

Keywords: Paddy residue, livestock possession, constraints etc.

In India, nearly 58 per cent of population depends on agriculture, livestock and allied sectors for livelihood. Nearly 70 percent of country population live in rural areas. Furthermore, of the 40.7 crore poor in the country about 80 per cent are rural poor. Livestock plays an important role in the rural economy of the country. It is a key source of supplementary income and livelihood especially for small land holdings and landless rural poor households. Traditionally, agriculture and livestock are interwined in such a manner that it ensures sustainable livelihood to a large proportion of rural

population even during sub-normal rainfall/ scarcity years. Livestock is also an important asset for them and this particular sector provides employment to millions of rural people (Shah *et al*. 2011).

The total amount of residue generated by India in 2008–09 was 620 Mt out of which ~15.9% residue was burnt on farm. Rice straw contributed (40 %) of the total residue burnt followed by wheat straw (22 %) and sugarcane trash (20 %). Burning of crop residues emitted 8.57 Mt of CO, 141.15 Mt of CO2, 0.037 Mt of SOx, 0.23 Mt of NOx, 0.12 Mt of NH3 and 1.46 Mt NMVOC, 0.65 Mt of NMHC, 1.21 Mt of particulate matter for the year 2008–09 (Niveta Jain *et al*. 2014).

Crop residue are low-density fibrous materials low in nitrogen, soluble carbohydrates, minerals and vitamins with varying amounts of lignin, which act as a physical barrier and impedes the process of microbial breakdown. To meet the nutritional requirement of animals, the residues need processing and enriching with urea and molasses and require supplementing with green fodders and legume straws.

The adequate uninterrupted availability of fodder is a pre-requisite for improving the productivity of livestock and to make livestock production cost efficient. Without ensuring an adequate supply of quality feed and fodder, the achievement of targeted growth of livestock sector in the coming years looks almost impossible. Feed and fodder production and its utilisation depend on the cropping pattern, climate, socio-economic condition and livestock type. The cattle and buffaloes are normally stall fed species and are fed on the fodder available from cultivated land and supplemented to a small extent by harvested crop residue. Owing to increasing pressure of population on land and higher benefit-cost ratio, currently Indian farmers focusing more on growing food grains, oilseeds and cash crops and production of fodder remains highly neglected. The current priorities given by farmers to food grains, oilseeds and cash crops are likely to worsen the supply position of fodder.

Mixed crop–livestock systems are the dominant form of agricultural production in India. Integrating crops and livestock on the same farm helps smallholder farmers to diversify the source of income and employment. Livestock act as a storehouse of capital and an insurance against crop production risks, a coping mechanism against livelihood shocks as well as a vital source of dietary protein. Development of the livestock sector provide new livelihood opportunities for women who otherwise often lack access and control over land based means of production (Deshingkar 2002). For majority of smallholders, crop residues form dual-purpose crops. The rest is made up from home grown feeds and grasses from common property resources. Owing to cash constraints, smallholder farmers in the drier semi-arid regions generally do not purchase compound feed and agro-industrial by-product in the market. In the dry months, particularly 2–3 months prior to the onset on next monsoons they face considerable feed shortages that adversely affect animal productivity.

METHODOLOGY

The study was carried out purposively in Tungabhadra Project (TBP) Command area of Karnataka, since the problem of paddy residue management is severe in this region. The stratified multistage random sampling technique was used for selection of sample farmers from TBP command areas. In the first stage, three districts of TBP area namely Koppal, Ballari, and Raichur were selected. In the second stage, the five taluks namely Gangavati, Siruguppa, Hospet, Sindhanur and Manvi from selected districts were selected based on the location on command area. In the third stage four villages from each taluka were selected based on density of livestock population *i.e.,* two villages having high livestock density and two from low livestock density. The livestock density was estimated from the data and information obtained from veterinary offices of the respective taluks. In the fourth stage five sample farmers from each village were selected. Thus, the total sample size comprised 100 farmers. The data were analyzed by using descriptive statistics and Garrett ranking technique.

Garrett ranking technique

To capture comprehensively the constraints in paddy crop residue management practices, Garrett ranking technique was used. Garrett's ranking technique gives the change in orders of constraints into numerical scores. The major advantage of this

technique when compared to simple frequency distribution is that here constraints are arranged based on their importance from the point of view of respondents. Accordingly these ranks were converted into scores by referring to Garretts table. Garretts formula for converting ranks into per cent was given by,

$$\text{Per cent position} = 100*(R_{ij} - 0.50) / N_j$$

Where, R_{ij} = Rank given for i^{th} item j^{th} farming system

N_j = Number of items ranked in j^{th} farming system

The per cent position of each rank was converted to scores by referring to tables given by Garret and Woodworth (1969). Then for each factor the scores of individual respondents were summed up and divided by the total number of respondents for whom scores were gathered. The mean scores for all the factors were ranked.

Livestock density can be worked out by using the formula of,

$$\frac{\text{Number of animals}}{\text{Livestock density}} = \text{Geographical area}$$

RESULTS AND DISCUSSION

Livestock density

Livestock possessions per respondent in different paddy residue management in TBP command area are presented in Table 1.

Table 1: Average livestock possession of sample farmers (n=100) (n=100)

Sl. No.	Live-stock	RS & BS (n=25)	BS & S (n=9)	RS & IS (n=10)	IS & S (n=6)
A	**High livestock density area**				
1	Buffalo	2.76	0.56	2.70	1.50
2	Bullock	1.68	0.89	1.50	1.17
3	Cow	1.24	1.00	1.20	1.33
4	Sheep	3.16	2.44	3.00	2.67
5	Goat	2.72	2.11	2.70	2.50
6	Others	0.80	1.00	0.60	2.00
	Overall	2.06	1.33	1.95	1.86
B	**Low livestock density area**				
Sl. No	**Live-stock**	**RS & BS (n=23)**	**BS & S (n=10)**	**RS & IS (n=12)**	**IS & S (n=5)**
1	Buffalo	1.61	0.80	1.42	1.20
2	Bullock	0.70	0.60	0.75	0.80
3	Cow	0.78	0.40	0.58	0.60
4	Sheep	2.26	1.60	2.08	1.80
5	Goat	1.83	1.40	1.58	1.60
6	Others	0.57	0.40	0.50	0.60
	Overall	1.29	0.87	1.15	1.10
C	**Pooled**				
Sl. No	**Live-stock**	**RS & BS (n=48)**	**BS & S (n=19)**	**RS & IS (n=22)**	**IS & S (n=11)**
1	Buffalo	2.21	0.68	2.00	1.36
2	Bullock	1.21	0.74	1.09	1.00
3	Cow	1.02	0.68	0.86	1.00
4	Sheep	2.73	2.00	2.50	2.27
5	Goat	2.29	1.74	2.09	2.09
6	Others	0.69	0.68	0.55	1.35
	Overall	1.69	1.09	1.52	1.51

Note: (i) RS & BS: *Removal of straw and burning of stubble;* **(ii) BS & S :** *Burning of straw and stubble;* **(iii) RS &IS** *: Removal of straw and incorporation of stubble;* **(iv) IS & S:** *Incorporation of straw and stubble.*

With respect to High Livestock Density Area (HLDA), the average number of sheep was found to be the highest (3.16) in case of removal of straw and burning stubbles method of paddy residue management followed by buffalo (2.76) and goat (2.72). In case of burning of straw and stubbles and incorporation of straw and stubbles method of practicing, sheep was found the highest (2.44 and 2.67) followed by goat (2.11 and 2.50) and bullock (0.56). Similarly, in case of removal of straw and incorporation of stubbles method of practicing, sheep (3.00) was found the highest followed by buffalo (2.70) and goat (2.70). The overall livestock possession per respondents was found the highest in removal of straw and burning of stubbles (2.06) followed by removal straw and incorporation of stubbles (1.95) and the least was found in case of burning of straw and stubbles (1.33).

In respect to Low Livestock Density Area (LLDA), sheep was found highest (2.26) in case of removal of straw and burning stubbles method of paddy residue management followed by goat (1.83) and buffalo (1.61). In case of burning of straw and stubbles method and removal of straw and incorporation of stubbles methods, sheep (1.60 and 2.08) was found the highest followed by goat (1.40 and 1.58) and buffalo (0.80 and 1.42). With regard to incorporation of straw and stubbles method, sheep was found the highest (1.80) followed by goat (1.60)

and buffalo (1.20). The overall livestock possession per respondent was found to be the highest in removal of straw and burning of stubbles (1.29) followed by removal straw and incorporation of stubbles (1.15) and the least was found in case of burning of straw and stubbles (1.10).

With regards to overall data, the average number of sheep was found highest (2.73) in case of removal of straw and burning stubbles method of paddy residue management followed by goat (2.29) and buffalo (2.21). In case of burning of straw and stubbles and incorporation of straw and stubbles method of practicing, sheep was found the highest (2.00 and 2.27) followed by goat (1.74 and 2.09). Similarly, in case of removal of straw and incorporation of stubbles method of practicing, sheep (2.50) was found to be the highest followed by goat (2.09) and buffalo (2.00). The overall livestock possession per respondent was found the highest in removal of straw and burning of stubbles (1.69) followed by removal straw and incorporation of stubbles (1.52) and the least was found in case of burning of straw and stubbles (1.09).

In low livestock density area, the burning of straw and stubbles method of residue management was relatively higher than the high livestock density area, this is mainly because of low livestock population, shortage of labour, and time in the sample farmers. In TBP command area the paddy straw was used as a major source for animal feed as it had a high value. This make the farmers remain unprepared to lose the income from the paddy residue so that the major farmers in the command area are collecting the paddy residue and are burning only the remaining stubbles.

Similar results were reported (Rosmiza *et al*. 2014) in Malaysia, The area of paddy is an important factor influencing the various residue management practices. Area has a significant negative influence on the removal of straw and burning of stubbles because area increases the collection or removal of straw as it requires more labour. This turned the farmers impassive as there was more of residue collection. The number of animals of respondents is an important factor influencing the residue management practices and it has a significant influence on the removal of straw and burning of stubbles. Because farmers collect the residue to feed their animals.

Farm Machineries Possession

The availability of farm implements per respondent were presented in the Table 2. In case of High Livestock Density Area (HLDA), the sprayer was found the highest (0.68) in removal of straw and burning stubbles method of practices followed by bullock cart (0.44) and power tiller (0.44).

Table 2: Average farm machineries possession of sample farmers (n=100) (n=100)

Sl. No.	Farm Implements	RS & BS (n=25)	BS & S (n=9)	RS & IS (n=10)	IS & S (n=6)
A	**High livestock density area**				
1	Bullock cart	0.44	0.00	0.60	0.3
2	Tractor	0.36	0.11	0.40	1.0
3	Power tiller	0.44	0.11	0.40	1.0
4	Rotavator	0.36	0.11	0.40	1.0
5	Leveler	0.36	0.11	0.40	0.7
6	P.P. Equipment/ sprayer	0.68	1.00	0.80	0.5
	Overall	0.44	0.24	0.50	0.75
B	**Low livestock density area**				
Sl. No.	**Farm Implements**	**RS & BS (n=23)**	**BS & S (n=10)**	**RS & IS (n=12)**	**IS & S (n=5)**
1	Bullock cart	0.35	0.00	0.42	0.20
2	Tractor	0.43	0.30	0.42	0.60
3	Power tiller	0.35	0.10	0.50	0.20
4	Rotavator	0.30	0.20	0.50	0.40
5	Leveler	0.26	0.20	0.42	0.40
6	P.P. Equipment/ sprayer	0.65	0.70	0.75	1.00
	Overall	0.39	0.25	0.50	0.47
C	**Pooled**				
Sl. No.	**Farm Implements**	**RS & BS (n=48)**	**BS & S (n=19)**	**RS & IS (n=22)**	**IS & S (n=11)**
1	Bullock cart	0.40	0.00	0.50	0.27
2	Tractor	0.40	0.16	0.41	0.82
3	Power tiller	0.40	0.11	0.45	0.64
4	Rotavator	0.33	0.21	0.45	0.73
5	Leveler	0.31	0.16	0.41	0.55
6	P.P. Equipment/ sprayer	0.67	0.84	0.77	0.73
	Overall	0.42	0.25	0.50	0.62

Note: i) RS & BS: *Removal of straw and burning of stubble;* **(ii) BS & S :** *Burning of straw and stubble;* **(iii) RS &IS** *: Removal of straw and incorporation of stubble;* **(iv) IS & S:** *Incorporation of straw and stubble.*

In case of burning of straw and stubbles also sprayer was found to be the highest (1.00) followed by tractor (0.11). Similarly, in case of removal of straw and incorporation of stubbles method of practicing, the sprayer was found highest (0.80) followed by bullock cart (0.60). With regard to incorporation of straw and stubble method of practicing, tractor was found the highest (1.00) followed by power tiller (1.00). The overall farm implements per respondent was found to be the highest in incorporation of straw and stubbles (0.75) followed by removal straw and incorporation of stubbles (0.50) and the least was found in case of burning of straw and stubbles (0.24).

Whereas, in case of Low Livestock Density Area (LLDA), in the practice of removal of straw and burning stubbles method the sprayer was found highest (0.65) followed by tractor (0.43) and bullock cart (0.35). In case of burning of straw and stubbles and incorporation of straw and stubble method of practices also sprayer was found highest (0.70 and 1.00) followed by tractor (0.30 and 0.60). Similarly in case of removal of straw and incorporation of stubbles method practicing the sprayer was found the highest (0.75) followed by power tiller (0.50). The overall farm implements per respondent was found the highest in removal of straw and stubbles (0.50) followed by incorporation of straw and stubbles (0.47) and the least was found in case of burning of straw and stubbles (0.25).

With regards to overall data, the sprayer was found highest (0.67) in case of removal of straw and burning stubbles method of practices followed by tractor (0.40) and bullock cart (0.40). Whereas, in burning of straw and stubbles, sprayer was found highest (0.84) followed by rotavator (0.21). Similarly in case of removal of straw and incorporation of stubbles method practicing the sprayer was found the highest (0.77) followed by power tiller (0.45). In regard to incorporation of straw and stubble method of practicing tractor was found to be the highest (0.82) followed by sprayer (0.73). The overall farm implements per respondent was found the highest in incorporation of straw and stubbles (0.62) followed by removal of straw and incorporation of stubbles (0.50) and the least was found in case of burning of straw and stubbles (0.25).

The farmers who owned their farm implements like tractor and other farm implements were practicing the incorporation of straw and stubbles followed by removal of straw and incorporation of stubbles in TBP command area. The burning of straw and stubbles method of residue management was relatively higher, which is mainly because of non-availability of farm implements, shortage of labour and time in the sample farmers.

Land holding pattern of sample farmers

The landholding pattern of sample farmers in TBP command area were presented in Table 3.

Table 3: Land holding pattern of sample farmers

Sl. No.	Size of landholding	RS & BS	BS & S	RS & IS	IS & S	Overall
A	**High livestock density area**					
1	Marginal farmers (<1ha)	3.00 (12.00)	0.00 (0.00)	1.00 (10.00)	3.00 (50.00)	7.00 (14.00)
2	Small farmers (1-2ha)	2.00 (8.00)	0.00 (0.00)	1.00 (10.00)	1.00 (16.67)	4.00 (8.00)
3	Medium farmers (2-4 ha)	5.00 (20.00)	2.00 (22.22)	0.00 (0.00)	2.00 (33.33)	9.00 (18.00)
4	Large farmers (>4 ha)	15.00 (60.00)	7.00 (77.78)	8.00 (80.00)	0.00 (0.00)	30.00 (60.00)
	Overall	25.00 (100.00)	9.00 (100.00)	10.00 (100.00)	6.00 (100.00)	50.00 (100.00)
B	**Low livestock density area**					
1	Marginal farmers (< 1ha)	4.00 (17.39)	0.00 (0.00)	1.00 (8.53)	3.00 (56.00)	8.00 (16.00)
2	Small farmers (1-2ha)	3.00 (13.04)	0.00 (0.00)	3.00 (25.00)	0.00 (0.00)	6.00 (12.00)
3	Medium farmers (2-4 ha)	7.00 (30.43)	1.00 (10.00)	2.00 (16.67)	2.00 (40.00)	12.00 (24.00)
4	Large farmers (>4 ha)	9.00 (39.13)	9.00 (90.00)	6.00 (50.00)	0.00 (0.00)	24.00 (48.00)
	Overall	23.00 (100.00)	10.00 (100.00)	12.00 (100.00)	5.00 (100.00)	50.00 (100.00)
C	**Pooled data**					
1	Marginal farmers (< 1ha)	7.00 (14.58)	0.00 (0.00)	2.00 (9.09)	6.00 (54.55)	**15.00 (15.00)**

2	Small farmers (1-2ha)	5.00 (10.42)	0.00 (0.00)	4.00 (18.18)	1.00 (9.09)	**10.00 (10.00)**
3	Medium farmers (2-4 ha)	12.00 (25.00)	3.00 (15.79)	2.00 (9.09)	4.00 (36.36)	**21.00 (21.00)**
4	Large farmers (>4 ha)	24.00 (50.00)	16.00 (84.21)	14.00 (63.64)	0.00 (0.00)	54.00 (54.00)
	Overall	48.00 (100.00)	19.00 (100.00)	22.00 (100.00)	11.00 (100.00)	100.00 (100.00)

Note: *Figures in the parentheses indicate percentages to the column sample total;* **RS & BS:** *Removal of straw and burning of stubble;* **BS & S:** *Burning of straw and stubble;* **RS &IS:** *Removal of straw and incorporation of stubble;* **IS & S***: Incorporation of straw and stubble.*

It was observed that in High Livestock Density Area (HLDA), the size of land holding of sample farmers in removal of straw and burning stubbles method of practicing the highest was found in large farmers (60.00%) followed by medium farmers (20.00%), marginal farmers (12.00%) and small farmers (8.00%). Whereas in case of burning of straw and stubbles method of practicing the highest were found in case of large farmers (77.78%) followed by medium farmers (22.22%). With regard to removal of straw and incorporation of stubbles method of practicing the highest was found in large farmers (80.00%) followed by marginal farmers (10.00%) and small farmers (10.00%). In case of incorporation of straw and stubbles method of practicing the highest was found in marginal farmers (50.00%) followed by medium farmers (33.00%), and least was found in small farmers (8.00%). In overall 60 per cent of farmers are large farmers and 18 per cent of farmers are medium farmers followed by marginal farmers (14.00%) and small (8.00%) respectively.

In Low Livestock Density Area (LLDA), the size of land holding of sample farmers in removal of straw and burning stubbles method of practicing the highest was found in large farmers (39.13%) followed by medium farmers (30.43%), marginal farmers (17.39%) and small farmers (13.04%). Wereas in case of burning of straw and stubbles method of practicing the highest was found in large farmers (90.00%) followed by medium farmers (10.00%). With regards to removal of straw and incorporation of stubbles method of practicing the highest was found in large farmers (50.00%) followed by small farmers (25.00%) and medium farmers (16.67%). In case of incorporation of straw and stubbles method of practicing the highest was found in marginal farmers (60.00%) followed by medium farmers (40.00%). In overall, 48 per cent of farmers are large farmers and 24 per cent of farmers are medium farmers followed by marginal farmers (16.00%) and small (12.00%) respectively.

In case of overall data, the size of land holding of sample farmers in removal of straw and burning stubbles method of practicing the highest was found in large farmers (50.00%) followed by medium farmers (25.00%), marginal farmers (14.58%) and small farmers (10.48%). Whereas in case of burning of straw and stubbles method of practicing the highest was found in large farmers (84.21%) followed by medium farmers (15.79%). With regard to removal of straw and incorporation of stubbles method of practicing the highest was found in large farmers (69.64%) followed by small farmers (18.18%) and medium farmers (9.09 %). In incorporation of straw and stubbles method of practicing the highest was found in marginal farmers (54.55%) followed by medium farmers (36.36%), and least was small farmers (9.09%). In overall, 54 per cent of farmers are large farmers and 21 per cent of farmers are medium farmers followed by marginal farmers (15.00%) and small (10.00%) respectively.

Cropping pattern in study area

Details pertaining to cropping pattern of sample of farmers were given in the Table 4.

Table 4: Cropping pattern of sample farmers in TBP command area during (2015-16)

Sl. No.	Season/ crop	(n=100)	
		Area (acre)	per cent
A	***Kharif***		
	Paddy	1895.00	50.73
	Cotton	177.50	4.75
	Maize	55.00	1.47
	Bajra	25.00	0.67
	Groundnut	128.00	3.43
	Chilli	32.00	0.86
	Sub total	2312.50	61.91
B	***Rabi/Summer***		
	Paddy	1250.00	33.46
	Sorghum	45.00	1.20
	Maize	65.00	1.74

Groundnut	25.00	0.67
Mustard	38.00	1.02
Sub total	1423.00	38.09
Gross cropped area	3735.50	100.00

It was observed from the table that out of total gross cropped area, about 61.91 and 38.09 per cent of area were used for *Kharif* and *rabi* season, respectively in TBP command area. Whereas, the crops paddy (50.73%), Cotton (4.75%) and maize (1.47%) accounted for the major portion of area in *Kharif* season and whereas, in case of *rabi* season, crops paddy (33.46%), Maize (1.74%), Sorghum (1.20%) and Mustard (1.02%) accounted the major portion of area.

Relation between livestock and crop residue management

Mixed crop–livestock systems are the dominant form of agricultural production in India. Integrating crops and livestock on the same farms help smallholder farmers to diversify the sources of income and employment. In case of High livestock density area majority of farmers are practicing removal of straw and burning of stubble mainly because the straw were used as feed for the fodder.

Cost and returns structure from paddy under different residue management practices

It is observed that total variable cost per acre was higher in incorporation of straw and stubbles (₹ 30029.25) followed by removal of straw and burning stubbles (₹ 29345.33) and removal of straw and incorporation of stubbles (₹ 29345.33), whereas the lowest was recorded in burning of straw and stubbles (₹ 26616.61). For total fixed cost per acre incorporation of straw and stubbles, removal of straw and incorporation of stubbles and removal of straw and burning stubbles recorded the cost of ₹ 11816.00, ₹ 11810.40 and ₹ 11799.20 respectively. The lowest of ₹ 11794.72 was observed in burning of straw and stubbles. In case of the total cost per acre the incorporation of straw and stubbles (₹ 41845.65) was recorded highest whereas burning of straw and stubbles (₹ 38411.33) recorded the lowest. The removal of straw and burning stubbles and removal of straw and incorporation of stubbles recorded a cost of ₹ 41405.46 and ₹ 41155.73, respectively. The highest yield per acre was recorded in the incorporation of straw and stubbles (29.75q/acre), followed by removal of straw and incorporation of stubbles (29.15q/acre) and removal of straw and burning stubbles (28.58q/acre), whereas, burning of straw and stubbles recorded the lowest yield of (28.11q/acre). Return per rupee of spent was slightly higher in farmers practicing removal of straw and burning stubbles (1.30) followed by removal of straw and incorporation of stubbles (1.27) method of paddy residue management practices, compared to burning of straw and stubbles (1.23) and incorporation of straw and stubbles (1.20). In overall, the total variable cost per acre was (₹ 26895.34), total fixed cost per acre (₹ 11805.08), total cost per acre (₹ 38700.42), yield (28.86q/acre), returns per rupee of investment (1.25) Table 5.

Constraints for non-adoption of environment friendly paddy residue management practices

Some of the limitations associated with adoption of environment friendly paddy crop residue management practices system expressed by the farmers were presented in the Table 6.

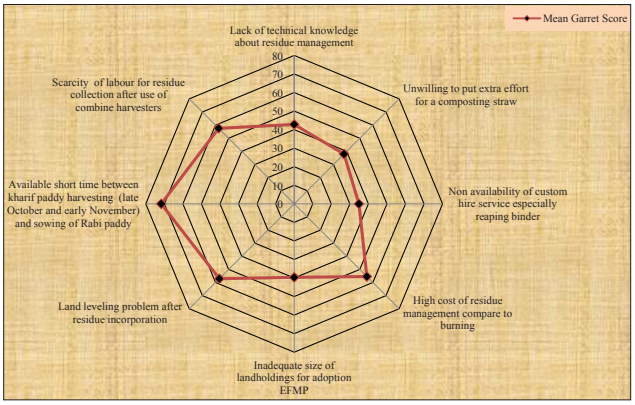

Fig. 1: Constraints for non-adoption of environment friendly paddy residue management practices in TBP command area

The major constraint faced by the respondent farmers was observed as the availability of short time between *kharif* paddy harvesting (late October and early November) and sowing of *rabi* paddy and it stands Rank- I (71.66 mean Garret score) followed by scarcity of labour for residue collection after use of combined harvesters Rank - II (57.59), land leveling problem after residue incorporation Rank - III (57.06), high cost of residue management compared to burning Rank - IV (55.39), lack of technical knowledge about residue management Rank -V (42.81), inadequate size of landholdings for

Table 5: Cost and returns structure from paddy under different residue management practice (₹/acre)

Sl. No	Particulars	Highest livestock density (n=50)				Lowest livestock density (n=50)			
		Removal of straw and burning of stubble	Burning of straw and stubble	Removal of straw and incorporation of stabble	Incorporation of straw and stabble	Removal of straw and burning of stubble	Burning of straw and stubble	Removal of straw and incorporation of stubble	Incorporation of straw and stubble
1	Total Variable Cost (₹)	25807	25782	26307	27022	25166	24961	24403	24802
2	Total Fixed Cost (₹)	11799	11795	11810	11816	11799	11795	11810	11816
3	Total Cost (₹)	37606	37577	38117	38838	36965	36756	36213	36618
4	Yield (q)	28.90	28.33	29.25	29.50	28.85	28.06	28.73	29.25
5	By- product value (₹)	5250	0	3200	0	5250	0	3200	0
6	Gross Return (₹)	56837	50569	55411	52658	56747	50092	54474	52211
7	Net Return (₹)	19231	12992	17294	13820	19782	13336	18261	15594
8	Returns to rupee of spent (₹)	1.51	1.35	1.45	1.36	1.54	1.36	1.50	1.43

the adoption of environment friendly management practices (EFMP) Rank - VI (39.62) and unwillingness to put extra effort for a composting straw Rank - VII (37.89), non-availability of custom hire service especially reaping binder Rank - VIII (34.89) (Fig. 1).

Table 6: Constraints for non-adoption of environment friendly paddy residue management practices in TBP command area

Sl. No.	Reasons	n=100	
		Garret Score	Rank
1	Lack of technical knowledge about residue management	42.81	V
2	Unwillingness to put extra effort for a composting straw	37.98	VIII
3	Non-availability of custom hire service especially reaping binder	34.89	VII
4	High cost of residue management compared to burning	55.39	IV
5	Inadequate size of landholdings for the adoption EFMP	39.62	VI
6	Land leveling problem after residue incorporation	57.06	III
7	Available short time between *kharif* paddy harvesting (late October and early November) and sowing of *Rabi* paddy	71.66	I
8	Scarcity of labour for residue collection after use of combine harvesters	57.59	II

Similar results were reported by Rosmiza *et al*. (2014) that farmers had a low level of knowledge towards the range of possible rice straw-uses. Results show that several factors are influencing the stagnation of better straw- utilization. It includes weather (humidity and rain); incentives that are not commensurate to farmers; inefficient straw collection technology; lack of logistic facilities such as baler machines, storage and transportation; low level of skills and knowledge of farmers; inefficient management from agricultural agencies; and lack of capital to manage straw in their fields. They often had a lack of information on how straw development could offer more benefits to their further socio-economic development. This seems to be due to the weakness of agricultural extension delivery systems and information technology.

CONCLUSION

In TBP command area 81 per cent of farmers harvest paddy crop using the machine (*i.e.* combine harvesters). Majority of farmers are practicing removal of straw and burning of stubble (42.45 %) in TBP command area. The major factors which influence the decision to burn paddy crop residue are the use of combined harvesters and scarcity of labour for collection of residue. The sample farmers

having the high livestock possessions practice removal of straw and burning of stubbles method of paddy residue management practice and those having less livestock possessions practice burning of straw and stubbles method of residue management practices.

Relatively lower number of farmers expressed that burning of paddy residue reduced the microbial activity in soil thereby reducing the fertility level in soil. Lack of technical knowledge about residue management and non-availability of custom hire service especially reaping binder in TBP command area can be the reasons behind poor growth.

For the sustainable environmental friendly use of paddy residue in the command areas, there is a need to increase the livestock population by providing a subsidy for the purchase of animals. Therefore increased livestock population will not only help paddy residue management but will also provide organic manure in addition to regular employment as well as income to farmers for sustainable livelihood.

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