Research Article

Yield and Economics of the Oat-Paddy Cropping System Influenced by Tillage and Nutrient Management Under Medium Land Condition

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Abstract

A field experiment was conducted at forage field situated at College of veterinary science and Animal Husbandry Ranchi (Jharkhand) to study the effect of tillage and nutrient management on yield and economics of the oat- paddy cropping system during 2011 and 2012. Result showed that among the different tillage practice the higher system yield in terms of fodder oat equivalent yield recorded under zero tillage (529.28 q/ha) which were significantly superior to minimal tillage (471.36 q/ha). While, in terms of economics zero tillage significantly influenced the net return (Rs. 64,007 /ha) and B:C ratio (1.30) which were significantly superior to minimal tillage. In other hand yield and economics of the system increased with increased levels of nutrient up to 125 % RDF. Further, 100 % RDF and 75 % RDF+ Bio-fertilizer were comparable to each other with regards to yield and economics of the oat- paddy cropping system.

Keywords: Tillage, Nutrient management, RDF, Bio-fertilizer and System yield and B: C ratio.

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Introduction

India with 2.4 per cent of world geographical area constitutes about 16 per cent of human and 15 per cent of livestock population. The increasing human and animals population pressure on land has posed a major challenge before the agricultural scientist to produce more and more food and forage from limited physical and shrinking land resources. India is rearing such huge livestock population on the fodder production in 7.06 per cent of net cropped area as well as on 3.7 % of pasture/grazing land. We are providing 18.2 kg of fodder per animal or milking half fed cow. Though, India stands first in milk production in the world, the per capita availability in the country is just 240 g/ day, which is 45 g/ day/ capita- less than the international average [1].

The country's requirement of green fodder in 2010 was 1057 mt against the supply of just 395.2 mt which means 62.63 per cent deficit in supply. Thus, there is wide gap between the supply and demand of green fodder and bridging this gap is a major challenge before the researchers. Paddy for human consumption and forage oat for animal can't be ignored in India. Both crops have wide agronomical suitability and may play important role in farming system not only to put inside the belly but also provide balance diet for last consumer *i.e* human. Qualitative green forage of oat which is the source of fiber, minerals and calcium directly fed by lactating animals or small ruminants and produced qualitative milk, meat and other product. Diversified cropping systems uplifted the source of a farmer's food and income, increases their land productivity and also minimizes risks such as the build-up of pest and diseases common in rice monoculture [2]. The increasing demand for sustainability in many has led to diversifying rice-rice or rice-wheat systems. Although, Paddy is the major crop during *Kharif* in Jharkhand under present existing paddy - fallow system. Lack of moisture and stubble of paddy after harvest, tillage operation during *Rabi* becomes problematic and it is also costlier. Further, bio - fertilizer is also considerable as it improves soil health, organic matter and availability of different nutrients. Keeping all the facts about the importance of moisture, nutrient and economics in view an experiment was formulated to study the yield and economics of the oat-paddy cropping system.

Materials and Methods

A trial was carried out during *Rabi* and *Kharif* season of 2011 and 2012 at the forage field situated at College of veterinary science and Animal Husbandry Ranchi, under Birsa Agricultural University, Ranchi (Jharkhand). The soil

of field was sandy loam in texture having sand (56.8%, silt (28.0%), clay (15.2%) and water holding capacity (38.68%) with pH (6.2), Organic carbon (3.8 g/kg) with available nitrogen (232 kg/ha), available phosphorus (23.25 kg/ha), and available potassium (156.41 kg /ha). The experiment was laid out in Split- plot Design (SPD) with three tillage management, Zero tillage, Minimal tillage and Conventional tillage under main plot and four nutrient management, 125 % RDF, 100 % RDF, 75 % RDF and 75% RDF+ Bio-fertilizer (PSB+ *Azotobacter*) in sub plot treatment and replicated thrice which were applied in oat. The fodder oat (cv : Kent) was sown in the second week of November, keeping row to row distance 25 cm with recommended seed rate 100 kg/ha in 5 m X 4 m plot area under medium land condition. Fertilizers were applied at the time of sowing through urea, DAP and MOP as basal application. Bio-fertilizer was applied as seed inoculating material in the form of PSB @ 500 g/ha and *Azotobactor* @ 500 g/ha and further top dressing were carried through urea. Paddy was transplanted during *Kharif* after harvest of oat in the same laid out field at same levels of tillage and uniform fertilizer dose @100:50:25, NPK kg/ha (just 25% less than RDF). Paddy was grown at normal agronomical practice. The data on yield and economics involved in oat and paddy recorded separately and later on same was calculated for the system. Data recorded were properly analyzed in slandered format of Split- plot Design and presented below in tabular form.

Results and Discussion

Yield study

Tillage and nutrient management had significant effect on green fodder yield (GFY), dry fodder yield (DFY), paddy yield and on system productivity in terms of green forage oat equivalent yield (**Table1**). Green fodder yield (354.63 q/ha) and dry fodder yield (78.75 q/ha) under conventional tillage were significantly superior minimal tillage (293.29 q/ha and 63.94 q/ha) respectively. Higher yield under conventional tillage was due to cumulative effect of higher growth leading to higher yield attributing characters under conventional tillage over minimal as well as zero tillage. Under conventional tillage soil was pulverized well and created congenial condition for proper root establishment which helped to utilize ample nutrients by crop in presence of sufficient moisture and sun shine hour throughout the growth period resulted in higher production of photosynthates.

Table 1 Yield of the forage oat, paddy and oat-paddy cropping system as influence by tillage and nutrient levels (Pooled)

Treatments	Fodder oat yield (q/ha)		Paddy yield (q/ha)		System Productivity
	Green	Dry	Grain	Straw	(OEYq /ha)
Tillage Management (T)					
Zero tillage	341.53	70.18	33.60	57.64	529.28
Minimal tillage	293.29	63.94	32.08	53.24	471.36
Conventional tillage	354.63	78.75	31.37	54.38	530.31
S.Em ±	7.46	1.05	0.4	0.84	7.30
CD at 5%	29.24	6.27	1.50	3.20	28.61
Nutrient Management (N)					
125% RDF	375.11	81.15	36.46	62.70	578.94
100% RDF	336.66	71.36	32.36	54.91	515.79
75% RDF	280.62	62.79	28.54	48.76	439.94
75% RDF + Biofertilizer	327.15	68.57	32.05	53.98	505.56
S.Em ±	13.29	2.76	1.26	2.28	9.09
CD at 5%	39.47	8.19	3.74	6.77	26.99
CV %	12.09	11.66	11.68	12.41	5.355
Interaction (TXN)	Sig.	NS	NS	NS	NS

NB: Uniform fertilizer dose @100:50:25 kg/ha (NPK) were applied in paddy

As minimal tillage neither received the benefit of zero tillage in terms of soil health improvement nor the intensification or activities of roots facilitated due to deep ploughing resulting in inefficient utilization of moisture, nutrient and thereby growth and development which leads to lesser green and dry fodder yield under minimal tillage compared to both zero and conventional tillage. [3] Also reported more GFY and DFY under conventional tillage in oat over zero tillage. Zero tillage have significant effect over minimal as well as conventional tillage in case of

paddy with regards to grain yield (33.60 q/ha) and straw yield (57.64 q/ha). System productivity in terms of green fodder oat equivalent yield under Conventional tillage (530.31 q/ha) and zero tillage (5529.28 q/ha) were at par to each other and which were significantly superior over minimal tillage (471.36 q/ha). Different nutrient levels with or without application of bio-fertilizers significantly affected the yield of fodder oat as well as paddy and accordingly the system productivity too. GFY (375.11 q/ha), DFY (81.15 q/ha), paddy grain yield (36.46 q/ha), straw yield (62.70 q/ha) and OEY (578.94 q/ha) at 125 % of RDF were higher over other levels of nutrient. However, 100 % RDF was at par with 75 per cent RDF + Bio-fertilizers (**Table 2**). This might be due to improvement in growth and yield attributing characters which were more at 125 % RDF. Similarly 75 % RDF + Bio-fertilizers was comparable to 100 % RDF due to extra benefit of availability of nutrients due to microbial activity specially phosphorus as well as nitrogen which leads to better yield attributing parameters. Further, they reported that *Azobactor* inoculation was beneficial to increase forage yield with high nitrogen use efficiency and also increased yield attributing characters of the crop over un-inoculated one. [4] also justified the result obtained in similar way.

Table 2 Interaction effect of tillage and nutrient management on green fodder yield (q/ha) of forage oat under oat - paddy cropping system (pooled)

Tillage Managements (T)	**Nitrogen Management(N)**				**Mean**
	125 % RDF	**100 % RDF**	**75 % RDF**	**75% RDF + Biofertilizer**	
Zero tillage	391.52	359.59	283.69	331.35	341.53
Minimal tillage	326.42	284.5	260.91	301.21	293.25
Conventional tillage	408.14	362.01	297.29	348.93	354.63
Mean	375.11	336.66	280.62	327.15	
Interaction(T x N)		S.Em ±		CD at 5%	
Between N at same T		7.68		22.83	
Between T at same or different N		7.18		31.55	

NB: Uniform fertilizer dose @100:50:25 kg/ha (NPK) were applied in paddy

Economics study

Tillage and nutrient significantly affected the gross return, net return, and B:C ratio of individual crop fodder oat, paddy and oat-paddy cropping system. The gross return and net return of fodder oat under conventional tillage (Rs 79, 689 /ha and Rs 55, 094 /ha) and zero tillage (Rs 76, 735 /ha and Rs 54, 660 /ha) were at par with each other and were significantly higher over minimal tillage. Further, B : C ratio under zero tillage (2.47) was significantly higher as compare to conventional tillage (2.24) as well as minimal tillage (1.82). In case of paddy the gross return (Rs 36,446 /ha), net return (Rs 9,348 /ha), and B:C ratio (0.34) under zero tillage were significantly higher as compared to minimal and conventional tillage. Similarly, minimal tillage was at par with conventional tillage with respect to net return and B: C ratio. These results also suggest that more tillage operation did not play any significant role in productivity of the system. So tillage practices should be minimized to reduce the cost of cultivation. [5] obtained similar yields of wheat, rape and barley under CT, ZT and MT systems.

Under oat-paddy cropping system gross return under zero tillage (Rs. 1,13,182 /ha) was at par with conventional tillage (Rs 1,11,740) which was significantly superior over minimal tillage (`Rs 98,494 /ha), while net return and B:C ratio under zero tillage was significantly superior over conventional tillage (`Rs 60,045 /ha and 1.16) and minimal tillage (`Rs 48, 059 /ha and 0.95) respectively and conventional tillage was significantly higher than minimal tillage for the same treatments. This was due to less cost of cultivation under zero tillage and cumulative monitory return from oat and rice separately under different tillage managements.

On other hand, nutrient management also influenced the economics of oat- paddy system. Gross return (Rs. 1, 23,006 /ha), net return (Rs 71, 357 /ha) and B: C ratios (1.38) were maximum under 125 % RDF. The gross return and net return of oat-paddy system at 100 % RDF (Rs 1, 09, 652 /ha and Rs 59, 003 /ha) and at 75% RDF + Bio-fertilizers (Rs 1, 06, 036 /ha and Rs 56,237 /ha) were at par with each other while, B:C ratio of the system at 100 % RDF was higher over 75% RDF but was at par with 75% RDF + Bio-fertilizers (**Table 3**). As input requirement under different tillage and nutrient management practices were different thus, varied in cost of cultivation. Further, treatment combination affected the economics of the fodder oat differently. Maximum gross return was recorded under conventional tillage and it was due to high green forage yield. However, net return under zero tillage (even after

less gross return) remained at par with conventional tillage due to less cost of cultivation under zero tillage resulted in higher B:C ratio under zero tillage. Gross return increased with increasing nutrient levels due to high yield at higher nutrient level. Similarly the cost of cultivation was also higher due to high amount of nutrient applied at higher nutrient levels which had a negative effect on net return and B: C ratio. Thus increased level of nutrient improved the net return and B : ratio of oat up to 125 % RDF. [6, 7] also observed the similar trend and supported the justification. With regards to the economics of paddy are concerned, gross return, net return and B: C ratio of paddy was significantly influenced by the residual effect of tillage and nutrient management. The gross return, net return and B:C ratio under zero tillage compared to the other two tillage management. This was due to higher yield under the said tillage. [8] also reported the similar economics from rice und rice-wheat system. [9] reported that zero tillage rice field enriched with organic matter which also improved the available nutrient which led to higher yield of rice under rice-wheat system. [10] reported higher productivity and profitability through inclusion of fodder crops as well as vegetables and pulses in rice-based cropping system.

Table 3 Economics of the forage oat, paddy and oat-paddy cropping system as influence by tillage and nutrient levels (Pooled)

Treatments	Forage oat			Paddy			Oat- paddy cropping system.		
	Gross return (Rs/ha)	Net return (Rs/ha)	B:C ratio	Gross return (Rs/ha)	Net return (Rs/ha)	B:C ratio	Gross return (Rs/ha)	Net return (Rs/ha)	B:C ratio
Tillage Management (T)									
Zero tillage	76735	54660	2.47	36446	9348	0.34	113182	64007	1.3
Minimal tillage	65881	42546	1.82	32612	5514	0.2	98494	48059	0.95
Conventional tillage	79689	55094	2.24	32050	4952	0.18	111740	60045	1.16
S.Em ±	785	785	0.02	548	548	0.01	710	710	0.01
CD at 5%	3077	3077	0.08	2148	2148	0.03	2783	2783	0.04
Zero tillage	76735	54660	2.47	36446	9348	0.34	113182	64007	1.3
Nutrient Management(N)									
125% RDF	83904	59353	2.41	39102	12004	0.44	123006	71357	1.38
100% RDF	76876	53329	2.26	32776	5678	0.21	109652	59003	1.16
75% RDF	63141	40598	1.8	29386	2288	0.08	92528	42886	0.86
75% RDF+ Biofertilizers	72486	49785	2.19	33549	6451	0.23	106036	56237	1.13
S.Em ±	1980	1980	0.05	594	594	0.01	2040	2040	0.03
CD at 5%	5880	5880	0.14	1764	1764	0.03	6059	6059	0.1
CV %	8.01	11.7	8.08	5.28	26.94	11.25	5.67	10.66	8.42
Interaction(TXN)	NS	NS	NS	NS	NS	NS	NS	NS	NS

Forage oat under zero tillage at 20 DAS

Forage oat under minimal tillage at 20 DAS

Forage oat under conventional tillage at 30 DAS

Forage oat after first cut under zero tillage

Forage oat after first cut under minimal tillage

Forage oat after first cut under conventional tillage

Forage oat under conventional tillage at 125 % RDF during second cut

Transplanted paddy at 75% RDF after oat at 30 DAT

Figure Real crop view at different stages of growth

Interaction

Total green forage yield (GFY) under zero, minimal and conventional tillage managements increased with increased level of nitrogen up to 125 % RDF. Total GFY under conventional tillage was at par with zero tillage at each level of RDF, while both the treatments were significantly higher over minimal tillage in similar nutrient level. Green forage yield under conventional tillage at 125 % RDF (408.14 q ha^{-1}) was significantly higher over all the treatment combinations except zero tillage at the same level of nutrient which was 56.42 per cent more than the minimum under minimal tillage at 75% RDF (Table 2).

Conclusion

Oat grown under zero tillage at 25 % more doses of nutrient and paddy transplanted at uniform levels of nutrient produced more system yield which results into better economics and benefit cost ratio over conventional as well as minimal tillage.

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