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Assessment of Suitable Remunerative Cropping System in New Alluvial Zone of West Bengal

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ABSTRACT

The experiment was carried out for find out the best cropping system in the New Alluvial Zone at Central Reserach Farm, Gayeshpur, Nadia, BCKV on 2011-12 reveals that the highest Rice Equivalent Yield (REY) was observe in Rice-Potato-Jute (CS2) (15427 kg ha^{-1}) cropping system followed by Rice-Potato-Maize (CS3) (11785 kg ha^{-1}) and Rice-Rice (CS1) (9188 kg ha^{-1}) respectively. A significant increase in REY (kg ha^{-1}) was found with mulching (M2) than non mulching (M1). The significantly more Net Return found in CS2 (Rice-Potato-Jute) followed by CS1 (Rice-Rice) and CS3 (Rice-Potato-Maize) respectively. The effect of Rice-Potato-Jute cropping system over tillage, mulch and fertilizer on system rice equivalent yield on was lowest (6853 kg ha^{-1}) in conventional tillage with 75% Recommended Dose of Fertilizer +25% Nitrogen through vermicompost interaction and highest value found in 16972 kg ha^{-1} in minimum tillage with 100% RDF interaction. The cost-benefit ratio was found significantly more in CS2 (Rice-Potato-Jute) followed by CS1 (Rice-Rice) and CS3 (Rice-Potato-Maize).

1. Introduction

Agriculture is the backbone of the Indian economy. Research on minimum tillage and mulching has been more identified and popularized by different group of researchers throughout the world for improving sustainable productivity. The practice of mulching protects the soil against the direct impact of raindrop & surface crust formation & reduces evaporation losses, check weed infestation, increase water infiltration rate, improve soil fertility & also improve plant growth. Minimum tillage involves considerable soil disturbance, though to a much lesser extent than that associated with convention tillage. Minimum tillage aimed at reducing tillage to the minimum necessary for ensuring a good seedbed, rapid germination, a satisfactory stand and favourable growing condition and increased soil organic matter and reduced operation costs (Lal *et al.*, 1994; Malicki *et al.,* 1997). The minimum tillage systems can have considerable impact on the environment through its influences on soil structure which substantially affect water quality, nutrients, sediments, pesticides and air quality and greenhouse effect (Holland, 2004; Hobbs, 2007).

Many researchers (Six *et al.*, 2000; Bhattacharyya *et al.*, 2009, Kumar et al., 2016) were worked on different tillage practices and many other researchers (Singh *et al.*, 2004; Sharma *et al.*, 2011; Vijay Kumar, 2014) were worked on different mulching techniques. So, the combination of tillage-mulch practices with cropping systems may have

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synergistic effects. Adoption of the more appropriate tillage-mulch-crop combination with regards to profitability is essential. Moreover, interactions among soil conditions, management practices and crops are influenced by variability within a system (Chivenge *et al.*, 2007). Therefore, the present investigation was framed to analyse the economics of three rice based cropping system under minimum tillage and mulching condition.

2. Materials and methods

The experiment was comprised of three rice-based cropping system viz. Rice-rice (CS1), rice-potato-maize (CS2) and rice-potato-jute (CS3). Treatment details of the experiment were given below-

Main plots (Tillage × Cropping Systems) – 6

- (a) Tillage – 2
  - T_1: Minimum tillage/SRI in rice, (one tillage operation is less than conventional tillage)
  - T_2: Conventional tillage
- (b) Cropping Systems -3
  - CS_1: Rice-Rice
  - CS_2: Rice-Potato-Jute
  - CS_3: Rice-Potato-Maize

B. Sub plots (Mulch × Fertilizer) – 4

- (a) Mulch – 2
  - M_1: No mulch,
  - M_2: Crop residue mulch (Rice straw 5 t/ha)
- (b) Fertilizer -2
  - F_1: Recommended dose of fertilizer
  - F_2:75% RDF and 25% N through vermicompost

Four factor factorial experiment was laid out in a split plot design where two factors viz. cropping system and tillage were considered as main plot treatments in (3x2) factorial. Mulching and fertilizer were considered as sub plot treatments in (2x2) factorial. All 3x2x2x2=24 treatments were replicated thrice in this layout. Statistical technique suitable for analysis split plot design was followed where error-1 will be used to estimate the main plot effects and error-2 will be used to estimate the sub plot effects along with all interaction effects related to main plot treatments. Standard error of mean and least significant difference ($p<0.05$) values were calculated whenever needed. Rice (BCKV-1) was grown in kharif season (20 cm × 15 cm). Potato (Kufri jyoti) and was grown in rabi season. Jute (JRO- 50) and maize (Hybrid-BN-1) were grown under irrigated pre-kharf season. Mulching was done with dry paddy straw @ 5 t ha^{-1} (0.43 % nitrogen and C:N ratio= 90:1) after 5 days of germination. Half the nitrogen and full P and K fertilizer was applied as basal dose and remaining nitrogen was applied in two equal splits in top dressing.

3. Study site

The location of the experimental site was in the hot, humid subtropics under AICRP on IFS at the Central Research Farm, Gayeshpur, Bidhan Chandra Krishi Viswavidyalaya, West Bengal, India. Gayeshpur is situated in the in New Alluvial zone of West Bengal at 23º North latitude and 89º East longitude at an altitude of 9.75 m above the mean sea level (Agro-ecological zone- 15.1). The experimental site receives an average annual rainfall of approximately 1576mm and experiences mean annual minimum and maximum temperature of 12.5 ºC and 36.2ºC, respectively. The soil is hyperthermic and clay loam in text (*Aeric Haplaquepts*, US Soil Taxonomy). The yield was recorded after harvesting of each component crop of the cropping system from each plot and then it is converted to kg ha^{-1}.The yields of different crops are converted into equivalent yield of rice based on the price of the produce and it is ultimately converted into system rice equivalent yield. The system rice equivalent yield for rice-potato-jute cropping system it is calculated as follows: REY= [(tuber yield of potato x price of potato)/ price of rice] + [(fibre yield of jute x price of jute)/ price of rice] + rice yield, where price means procurement of price fixed by the Government. For rice-potato- maize it is calculated as follows: REY= [(tuber yield of potato x price of potato)/ price of rice] + [(corn yield of maize x price of corn)/ price of rice] + rice yield. The benefit-cost ratio (B:C ratio) was worked out by using following formula-

$$\text{B : C ratio} = \frac{\text{Present value of gross returns}}{\text{Present value of costs}}$$

4. Result and discussion

The data on system rice equivalent yield (REY) is given in Table 1. The highest REY (15427 kg ha^{-1}) was found in CS2 (rice-potato-jute) which followed by CS3 i.e. rice-potato-maize (10659 kg ha^{-1}) and CS1 i.e. rice-rice (9188 kg ha^{-1}) which significantly different to each other. A significant increase in REY (kg ha^{-1}) was found with mulching (M2) than non mulch (M1). Data also revealed that the effect F1 (100% RDF) on REY (kg ha^{-1}) was much

Table 1: Effect of cropping system, tillage, mulch and fertilizer on SREY (kg ha^{-1})

CS1									
F	T1			T2			Mean		
	M1	M2	Mean	M1	M2	Mean	M1	M2	Mean
1	8841	11790	10315	9986	10095	10041	9413	10943	10178
2	8837	8757	8547	8841	8653	7847	8589	7805	8197
Mean	8589	10274	9431	9413	8474	8944	9001	9374	9188
CS2									
F	T1			T2			Mean		
	M1	M2	Mean	M1	M2	Mean	M1	M2	Mean
1	16198	17746	16972	15658	16179	15918	15928	16962	16445
2	14387	15276	14831	13987	13984	13985	14187	14630	14408
Mean	15292	16511	15902	14822	15081	14952	15057	15796	15427
CS3									
F	T1			T2			Mean		
	M1	M2	Mean	M1	M2	Mean	M1	M2	Mean
1	11276	12569	11922	10877	11478	11178	11076	12023	11550
2	9695	9569	9632	9776	10034	9905	9735	9802	9769
Mean	10485	11069	10777	10327	10756	10541	10406	10913	10659
Mean									
F	T1			T2			Mean		
	M1	M2	Mean	M1	M2	Mean	M1	M2	Mean
1	12105	14035	13070	12173	12584	12379	12139	13309	12724
2	10806	11201	11003	10868	10290	10597	10837	10746	10791
Mean	11455	12618	12037	11521	11437	11479	11488	12028	11758

S.E. m (±) and CD values due to factorial split plot analysis-

	CS	**T**	**M**	**F**	**CS×T**	**CS×M**	**CSxF**	**TxM**	**T×F**	**M×F**	**CSxTxM**	**CS×T×F**	**CS×M×F**	**T×M×F**	**CS×T×M×F**
S.E.m (±)	105.02	18.42	138.22	138.22	148.52	239.40	239.40	195.47	195.47	195.47	338.56	338.56	338.56	276.43	478.79
C.D. (5%)	330.93	58.04	435.53	435.53	NS	NS	NS	615.93	NS	615.93	1066.82	NS	NS	NS	NS

CS1: Rice-rice; **CS2**: Rice-potato-jute**; CS3**: rice-potato-maize
T1-minimum tillage; **T2**-conventional tillage
M1-non mulch; **M2**-mulch
F1-100% RDF; **F2**-75% RDF +25% N through vermicompost
Price: kharif paddy=Rs.14/kg, summer paddy=Rs. 15/kg, potato=RS. 5 Rs/kg, jute: Rs. 22 Rs/kg, maize=Rs.10.00/kg

pronounced effect on REY compared to F2 (75% RDF & 25% N through vermicompost). The highest value was 16972 kg ha^{-1} in the interaction of CS2 vs. T1 vs. F1 and lowest value was 6853 kg ha^{-1} in T2 vs. F2 interaction.

It is evident from the Table 2, cropping system has much pronounced effect on net return. A significantly more net return found in CS2 (rice-potato-jute) followed by CS1 (rice-rice) and CS3 (rice-potato-maize) respectively. Data also revealed that a significant increase in net return found in T1 (minimum tillage) compared to T2 (conventional tillage). The mulch effect (M2) on net return was statistically at par with non mulch (M1). It also found that F1 (100% RDF) gives significantly more net return compared to F2 (75% RDF & 25% N through vermicompost). The highest net return was 154821 Rs. ha^{-1} associated with T1 (minimum tillage), F1 (100% RDF) and with mulching in CS2 (rice-potato-jute) cropping system.

Cost-benefit ratio which is defined at the ratio between total economic return and total cost of cultivation were also influence by various treatments (Table 3). The results showed that a significantly more B: C ratio in CS2 (rice-potato-jute) followed by CS1 (rice-rice) and CS3 (rice-potato-maize) which significantly differ from each other. From the table it was observed that T1 (minimum tillage) has significantly more B: C ratio than T2 (conventional tillage) irrespective of cropping system. These results are in agreement with those of Sharma *et al.* (2011) who concluded that maximum B: C ratio was recorded with minimum tillage. Bonciarelli and Archetti (2000) concluded that reducing soil tillage always resulted in notable savings of fuel consumption and working time. The use of minimum tillage management practices for maize production is increasing because it reduces time, fuel as well as labour requirement. The result also revealed that F1 (100% RDF) has more B: C compared to F2 (75% RDF & 25% N through vermicompost) irrespective of cropping system.

5. Conclusion

From the experiment it was clearly discriminated that minimum tillage has much pronounced effect on total yield as well as net profit over conventional tillage irrespective of cropping system. It has found that rice-potato-jute cropping system are most profitable cropping system over rice-rice and rice- potato-maize cropping system in New Alluvial Zone of West Bengal. It is also found that 100% recommended dose of fertilizer gave higher profit over 75% recommended dose of fertilizer along with 25% nitrogen through vermicompost application, though it improves soil quality in long-term. Therefore, minimum tillage along with 100% recommended dose of fertilizer most suitable cultivation practice with respect to profitability.

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Table 2. Effect of cropping system, tillage, mulch and fertilizer on NR (Rs ha^{-1})

CS1									
F	T1			T2			Mean		
	M1	M2	Mean	M1	M2	Mean	M1	M2	Mean
1	66026	100307	83166	79800	74335	77068	72913	87321	80117
2	45291	44179	44735	50102	15264	32683	47696	29721	38709
Mean	55659	72243	63951	64951	44799	54875	60305	58521	59413
CS2									
F	T1			T2			Mean		
	M1	M2	Mean	M1	M2	Mean	M1	M2	Mean
1	140143	154821	147482	129208	129503	129355	134675	142162	138419
2	91172	96620	93896	82204	75155	78680	86688	85887	86288
Mean	115657	125720	120689	105706	102329	104018	110682	114025	112353
CS3									
F	T1			T2			Mean		
	M1	M2	Mean	M1	M2	Mean	M1	M2	Mean
1	66233	77334	71783	57277	58698	57987	61755	68016	64885
2	20483	11725	16104	18251	14864	16558	19367	13294	16331
Mean	43358	44529	43944	37764	36781	37273	40561	40655	40608
Mean									
F	T1			T2			Mean		
	M1	M2	Mean	M1	M2	Mean	M1	M2	Mean
1	90801	110820	100811	88762	87512	88137	89781	99166	94474
2	52315	50841	51578	50186	35094	42640	51250	46968	47109
Mean	71558	80831	76194	69474	61303	65388	70516	71067	70791

S.E. m (±) and CD values due to factorial split plot analysis-

	CS	**T**	**M**	**F**	**CS×T**	**CS×M**	**CSxF**	**TxM**	**T×F**	**M×F**	**CSxTxM**	**CS×T×F**	**CS×M×F**	**T×M×F**	**CS×T×M×F**
S.E. m (±)	1470	1200	1935	1935	2079	3352	3352	2737	2737	2737	4740	4740	4740	3870	6703
C.D. (5%)	4633	3783	NS	6097	NS	NS	NS	8623	NS	8623	14935	NS	NS	NS	NS

CS1: Rice-rice; **CS2**: Rice-potato-jute**;** **CS3**: rice-potato-maize
T1-minimum tillage; **T2**-conventional tillage
M1-non mulch; **M2**-mulch
F1-100% RDF; **F2**-75% RDF +25% N through vermicompost
Price: kharif paddy=Rs.14/kg, summer paddy=Rs. 15/kg, potato=RS. 5 Rs/kg, jute: Rs. 22 Rs/kg, maize=Rs.10.00/kg

Table 3: Effect of cropping system, tillage, mulch and fertilizer on B:C ratio

CS1									
F	T1			T2			Mean		
	M1	M2	Mean	M1	M2	Mean	M1	M2	Mean
1	2.14	2.55	2.35	2.33	2.11	2.22	2.24	2.33	2.28
2	1.63	1.56	1.60	1.68	1.19	1.43	1.66	1.38	1.52
Mean	1.89	2.06	1.97	2.01	1.65	1.83	1.95	1.85	1.90
CS2									
F	T1			T2			Mean		
	M1	M2	Mean	M1	M2	Mean	M1	M2	Mean
1	2.62	2.65	2.63	2.44	2.33	2.39	2.53	2.49	2.51
2	1.83	1.82	1.83	1.72	1.62	1.67	2.78	1.72	1.75
Mean	2.22	2.24	2.23	2.08	1.98	2.03	2.15	2.11	2.13

CS3									
F	T1			T2			Mean		
	M1	M2	Mean	M1	M2	Mean	M1	M2	Mean
1	1.72	1.78	1.75	1.60	1.58	1.59	1.66	1.68	1.67
2	1.18	1.10	1.14	1.15	1.12	1.14	1.17	1.11	1.14
Mean	1.45	1.44	1.45	1.38	1.35	1.36	1.41	1.39	1.40
Mean									
F	T1			T2			Mean		
	M1	M2	Mean	M1	M2	Mean	M1	M2	Mean
1	2.16	2.33	2.24	2.12	2.01	2.06	2.14	2.17	2.15
2	1.55	1.49	1.52	1.52	1.31	1.41	1.53	1.40	1.47
Mean	1.85	1.91	1.88	1.82	1.66	1.74	1.84	1.78	1.81

S.E. m (±) and CD values due to factorial split plot analysis-

	CS	**T**	**M**	**F**	**CS×T**	**CS× M**	**CSxF**	**TxM**	**T×F**	**M×F**	**CSxT xM**	**CS×T ×F**	**CS× M×F**	**T×M× F**	**CS×T ×M×F**
S.E. m (±)	0.013	0.011	0.028	0.028	0.019	0.048	0.048	0.039	0.039	0.039	0.068	0.068	0.068	0.055	0.096
C.D. (5%)	0.041	0.034	NS	0.087	0.058	NS	0.151	0.123	NS	NS	0.213	NS	NS	NS	NS

CS1: Rice-rice; **CS2**: Rice-potato-jute**;** **CS3**: rice-potato-maize

T1-minimum tillage; **T2**-conventional tillage

M1-non mulch; **M2**-mulch

F1-100% RDF; **F2**-75% RDF +25% N through vermicompost

Price: kharif paddy=Rs.14/kg, summer paddy=Rs. 15/kg, potato=RS. 5 Rs/kg, jute: Rs. 22 Rs/kg, maize=Rs.10.00/kg