Adoption of New Agricultural Technologies for Sustainable Agriculture in Eastern India: An Empirical Study

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ABSTRACT

Agriculture in the tropics must not only gear up for increased system productivity to obtain sufficient food, fodder and fuel for the growing population but also pay attention to utilize natural resources in a sustainable manner for future use. In a widely varied ecological condition with unfavourable topography as well as soil fertility always restrained the farmers from taking the risk of deviation from their age-old farm practices. Such type of situation is found in the plateau region of India where the incidence of poverty is very high and agriculture remains the major source of livelihood. To eradicate poverty of that region by enhancing production, this study tries to explore the ways and means for a sustainable agriculture. This paper is based on a survey in the Usri (river) watershed area of the eastern plateau of India. This study reveals that the rates of adoption of improved technologies have been higher in case of rice as compared to maize as well as socio-economic and infrastructural constraints were the prime constraints for non-adoption of modern technology in the study villages. In such an unfavourable socio-economic and agro-climatic condition, the bottom-up approach with low-cost and eco-friendly technologies would be the only way to achieve an improved and sustainable agriculture.

Keywords: *Sustainable; Ecology; Agro-climatic, Eco-friendly;*

Indian economy made many long strides towards its socio-economic progress and made substantial development in almost all the sectors of its economy during the last fifty years. However, the success was heavily dependent on the success of the primary sector i.e., agriculture. It is true that there is significant development of secondary and tertiary sectors of the national economy. Nevertheless progress in agriculture is still critical element of development. Development endeavours of the third world countries never yield expected outcome due to the existence of chronic poverty. During the last fifty years, various poverty eradication programs had been launched in India but not much has been achieved in this regard. It is also observed that the incidence of poverty in the rainfed plateau region is very high as compared to other parts of India. Agriculture is the prime source of livelihood of most of the people of this plateau region. It has been observed in India that the area under assured irrigation has already been almost optimally exploited. Therefore, from the point of view of national importance to enhance agricultural production and to fight against poverty, it becomes imperative to improve agriculture of the plateau region.

Modern farming methods matter for smallholder agricultural productivity and food security. Adoption of improved agricultural technologies has been associated with: higher earnings and lower poverty (*Kassie et al., 2011*), improved nutritional status (*Kumar and Quisumbing, 2010*), lower staple food prices (*Maniu et al., 2015*) and increased employment opportunities as well as earnings for landless labourers. Indeed, the adoption of improved technologies is heralded as a major factor in the success of the green revolution experienced by Asian countries (*Kijima et al., 2011*). At the global level, the adoption of improved agricultural technology is now considered critical to the attainment of the Millennium Development Goal (MDG) of reducing extreme poverty and hunger. The adoption of improved technology, key to agricultural development or increased productivity, basically depends on farmers' decision (*Wankhade et al., 2014 and Shanmugasundaram and Helen, 2015*). If any new technology is appropriate to farmers' circumstances and is well matched with the farmers' perception then only it will be readily adopted, else it will be rejected (*Li C. et al., 2013*). Various studies (*Dey and Sarkar, 2011*) highlighted that there is a positive association between the farm size and the adoption of HYV technology. Income is the only socio-personal variable which is found to have a significant positive relationship with adoption behaviour. Occupation, the other socio-personal variable is less significant with adoption behavior. However, it is believed that education enriches one's knowledge and skill which has positive relationship with adoption behavior (*Singh et al., 2012*). In the present study, inspite of studying the adoption behaviour of the farmers in general, we also tried to identify the constraints for adoption as well as the reasons for non-adoption of new technologies in the process of cultivation. Studies by several researchers (*Rokonuzzaman, 2012* and *Dunford, 2011*) revealed that the most important factors for non-adoption of improvement technology centered on socio-economic and infrastructural dimensions

The present study is confined to three eco-systemic zones of Usri (river) watershed area of Jharkhand State, a part of eastern plateau region in India. During 90's, a number of rainfed farming technologies have been developed but the technological adoption in the farming system of the plateau region, especially in our study area remains very insignificant. Farmers remained confined to their traditionally perceived farming system and trapped to low productive mono-cropped farming. Keeping these in minds the objectives of the present study are -

(i) To examine the nature and extent of adoption of modern technology and
(ii) To find out the reasons for low-adoption.

METHODOLOGY

The present study has been conducted in the varied geomorphology, physiography and agro-ecosystem of the Usri watershed area of Chotanagpur plateau belonging to the present Giridih district of Jharkhand. The heterogeneity in the agro-climatic characteristics of the plateau region poses great problems in choosing proper representative sample. In an earlier study, the distribution of villages of the Usri watershed area were done on the basis of topography, varied agro-ecological divisions, multiethnic and access to block head quarters etc. In that study, the entire Usri watershed area was divided into three agro-climatic zones, namely,

(i) *Ecosystem-I (Eco-I):*The upper part of Usri watershed area having traditionally settled low productive system;
(ii) *Ecosystem-II (Eco-II):*The middle part of Usri watershed area having a market-oriented production system;
(iii) *Ecosystem-III (Eco-III):* The lower part of Usri watershed area having forest-based low productive system.

We randomly chose one village from each of the three agro-ecosystems of the Usri watershed area and each of the selected villages was totally enumerated. There were altogether 303 households in the selected villages.

Structured questionnaire schedule was used to collect data and a nine scale Pearson's adoption behvioural index (*Rogers, 1962*) for individual farmer was computed from the adoption scores for the improved cultivation practices. We also used some statistical parameters like, co-efficient of variation, Pearson Co-efficient of correlation and test of significance of co-efficient of correlation and rank correlation co-efficient for analyzing the different objectives set forth in the study.

RESULTS AND DISCUSSION

The nature and extent of technological adoption: Table 1 and Table 1a represent the distribution of adopter categories of farmers in Eco-I, Eco-II and Eco-III villages. Here, for the present purpose we classified our farmers as high, medium and low adopter according to their extent of technological adoption. From Table 1, it is observed that number of high adopter in rice cultivation was highest in Eco-II (24.76%) followed by Eco-I (23.81%). In maize cultivation the highest percentage goes to Eco-II (12.82%) followed by Eco-I (11.58%) and Eco-III villages respectively (Table 1a). In case of medium adopter for rice, we observed that Eco-II had the highest percentage (34.29) followed by Eco-III (25.81%) and Eco-I (24.76%) whereas for maize, medium adopter was highest in Eco-III (40.32%) followed by Eco-I and Eco-II. Moreover, the number of low adopter category for rice and maize cultivation was maximum in Eco-III (73.12 & 54.84%) followed by Eco-I (51.43 & 50.53%) and Eco-II (40.95 & 50%). Thus it is clear that majority of farmers are still low adopter for both maize and rice cultivation in the region irrespective of villages.

We know that for aman rice cultivation several management practices are adopted by the farmers to enhance production. Table 2 shows the distribution of adopters of rice-technologies in our study villages. It is revealed from the table that the overall rate of adoption is highest in Eco-II (71.31%) village and lowest in Eco-III (54.47%) village. In case of maize cultivation, there were some of the modern technologies adopted by the farmers. The distribution of adopters of the maize-technologies in our study villages is given in Table 2a. It is evident from the table that the overall rate of adoption is highest in Eco-I (40%) village and lowest in Eco-II (30.46%) village. Now, from the technology adoption point of view, we find in our study villages that the rates of adoption of improved technologies have generally been higher in case of rice compared to maize.

We also observed that the rate of technology adoption is highly related to the farmer's socio-economic status of the study villages. Table 3 shows the relationship between adoption and socio-economic status with respect to rice and maize cultivation in the ecosystem. For both the crops, farmers' category and income were significantly correlated with rate of adoption in the entire ecosystem. From the above results we conclude that agricultural development through adoption of improved technologies critically hinges on the socio-economic status of farmers.

Reasons for low-adoption: Transfer of technology plays a vital role in the process of agricultural development. Transformation necessitates that farmers should be convinced to accept and work for the change. They need to be prepared mentally and emotionally to accept the new agricultural technology with the continuous effort of the government and other extension agencies. Most of the farmers are well informed about the new development in agriculture and they are ready to adopt the new farming technology but are not in a position to adopt the improved technology at full scale due to certain constraints faced by them in day-to-day life. For making an in-depth study regarding the reasons behind this non-adoption of improved technologies for rice and maize cultivation, we collected data on field level constraints for both crops as perceived by the farmers of our study villages. For the sake of analysis, we put scores to different constraints according to the degree of its effect as perceived by the farmers.

Table 1. Distribution of adopter categories for rice cultivation among the farmers of study villages

Villages	Adopter			
	Non	Low	Medium	High
Eco-I (n = 105)	0(0)	54(51.43)	26(24.76)	25 (23.81)
Eco-II (n = 105)	0(0)	43(40.95)	36(34.29)	26(24.76)
Eco-III (n = 93)	0(0)	68(73.12)	24(25.81)	1(1.07)

Table 1a. Distribution of adopter categories for maize cultivation among the farmers of study villages

Villages	Adopter			
	Non	Low	Medium	High
Eco-I (n = 95)	0(0)	48(50.53)	36(37.89)	11 (11.58)
Eco-II (n = 78)	0(0)	39(50.00)	29(37.18)	10(12.82)
Eco-III (n = 62)	0(0)	34(54.84)	25(40.32)	3(4.84)

Table 2. Extent of adoption of improved technologies (Rice)

Technology	Eco-I (n = 105)	Eco-II (n = 105)	Eco-III (n = 93)
Off-season ploughing	51 (48.57)	44 (41.90)	25 (26.88)
Management of pre-monsoon rain	82 (78.09)	97 (92.38)	58 (62.36)
Land preparation by M.B. plough	32 (30.47)	32 (30.47)	00 00
Variations of FYM application	91 (86.57)	97 (92.38)	86 (92.47)
Use of improved seeds	51 (48.57)	67 (63.81)	35 (37.63)
Line sowing	105 (100.00)	105 (100.00)	93 (100.00)
Use of fertilizers	88 (83.81)	94 (89.52)	58 (63.36)
Intercultural operation	105 (100.00)	105 (100.00)	93 (100.00)
Use of insecticides /pesticides	29 (27.61)	33 (8.60)	08 (33.42)
Overall adoption (%)	67.08	71.31	54.47

Figures in the parentheses indicate percentage to total farmers

Table 3. Correlation coefficient ('r') of adoption and socio-economic status with respect to rice and maize cultivation in varied agro-ecosystems

Socio-eco.	Eco-I		Eco-II		Eco-III	
factors	Rice	Maize	Rice	Maize	Rice	Maize
Farmers'	0.58*	0.44*	0.76*	0.53*	0.52*	0.39*
Income	0.51*	0.40*	0.74*	0.41*	0.56*	0.39*
Education	0.22**	0.21**	0.28*	0.23**	0.17NS	0.20NS
Occupation	0.02NS	0.12NS	0.53*	0.37*	0.48*	0.36*

*Significant at 1% level, **Significant at 5% level,

Table 2a. Extent of adoption of improved technologies (Maize)

Technology	Eco-I (n = 95)	Eco-II (n = 78)	Eco-III (n = 62)
Off-season ploughing	31 (32.63)	21 (26.92)	17 (27.42)
Management of pre-monsoon rain	23 (24.21)	10 (12.82)	13 (20.97)
Land preparation by M.B. plough	31 (32.63)	09 (11.54)	00 00
Variations of FYM application	49 (51.58)	18 (23.07)	26 (41.94)
Use of improved seeds	19 (20.00)	08 (10.25)	02 (3.23)
Sowing through behind the plough	82 (86.32)	58 (74.36)	58 (93.55)
Mixed cropping practiced	19 (20.00)	37 (47.44)	49 (79.03)
Use of fertilizers	37 (38.95)	15 (19.23)	07 (11.29)
Intercultural operation	51 (53.68)	40 (51.28)	33 (53.23)
Overall adoption (%)	40.00	30.76	36.74

Figure in the parentheses indicate percentage to total farmers,

Table 5. Perception on socio-economic and infrastructural constraints by the farmers of study villages

Constraints	Perception score			Rank		
	Eco-I	Eco-II	Eco-III	Eco-I	Eco-II	Eco-III
Availability of inputs	46	72	62	6	5	4
Availability of human labour	18	15	42	8	9	8
Availability of animal labour	25	32	50	7	8	6
Drainage	65	82	78	3	4	3
Credit	142	135	128	1	2	1
Transport	15	45	18	9	7	9
Cost and return	75	165	115	2	1	2
Management	61	70	57	4	6	5
Ext. service	50	85	46	5	3	7

Rho value = 0.850** [Between Eco-I and Eco-II], Rho value = 0.917* [Between Eco-I and Eco-III], Rho value = 0.750** [Between Eco-II and Eco-III], * significant at 1 per cent level, ** significant at 5 per cent level.

Table 4 shows the perception of field level constraints (sixteen) by the farmers of study villages for both kharif crops. To test the homogeneity or heterogeneity of the perception regarding field level constraints, Spearman's Rank Order Correlation Co-efficient was computed taking two villages at a time. Rho-value obtained between Eco-I and Eco-II was 0.705 (significant at 1% level). Similarly, significant (at 1% level) Rho-value (0.755) was observed between Eco-I and Eco-III village. But in case of Eco-II and Eco-III village, the Rho-value (0.488) was significant at 5 per cent level of significance. So, it is apparent from the above discussion that the farmers of said villages are more or less homogeneous in nature regarding their perceptions about the field level constraints.

Table 4. Field level constraints as perceived by the farmers of different agro-ecosystems for rice and maize cultivation

Constraints	Perception score			Rank		
	Eco-I (105)	Eco-II (105)	Eco-III (93)	Eco-I	Eco-II	Eco-III
Drought	150	142	112	1	2	3
Soil	55	42	79	9	13	5
Land fragment.	82	78	58	4	7	8
Land unevenness	68	40	95	6	14	4
Availability of inputs	46	72	62	12	8	7
Quantity of seeds	85	95	48	3	4	11
Availability of human labour	18	15	42	15	16	14
Availability of drought animal	25	32	50	13	15	10
Pest & disease management	20	65	12	14	10	16
Weeds	52	60	45	10	11	13
Drainage	65	82	78	7	6	6
Credit	142	135	128	2	3	1
Transport	15	45	18	16	12	15
Cost and return	75	165	115	5	1	2
Management	61	70	57	8	9	9
Ext. service	50	85	46	11	5	12

Rho value = 0.705* [between Eco-I and Eco-II], Rho value = 0.755* [between Eco-I and Eco-III], Rho value = 0.488** [between Eco-II and Eco-III], *Significant at 1 per cent level, ** Significant at 5 per cent level and n = no. of farmers.

We also classified the total identified constraints to adoption into three broad categories such as (a) environmental and situational, (b) technological and (c) socio-economic and infrastructural. In order to make a homogeneity test, we estimated rank correlation coefficient of the above three categories of constraints among three eco-zones. In case of (a) and (b) we did not find any prominent difference among the farmers' perception of constraints between eco-systems. However, in case of (c), i.e., socio-economic and infrastructural constraints, the farmers' perceptions in three eco-systems were found to be highly significant (Table 5). This signifies that socio-economic and infrastructural constraints are the prime constraints for low adoption of modern agricultural technology in our study villages.

CONCLUSION

In the eastern plateau region especially in Usri watershed area, we found that some of the improved technological inputs like intercultural operation, line sowing, use of FYM, use of fertilizer etc., are universally adopted in all the villages irrespective of different agro-ecosystems. It was also observed that the rate of adoption of improved technologies were generally higher in case of rice compare to maize in all the study villages. Whereas, the overall scenario of adoption for both crops was not satisfactory in the region as a whole. It was also found that the rate of technological adoption is highly related to the socio-economic status of the farmers in varied agro-ecosystems.Again, the perception of field level constraints for both rice and maize cultivation by the farmers of our study villages revealed that socio-economic and infrastructural constrains rather than technological constraints were the prime constraints for non-adoption of modern technologies. The region, like eastern plateau of India where widely varied eco-system accompany with unfavourable topographic and soil fertility, the top-down approach failed to generate confidence to the practicing farmers to adopt modern techniques of cultivation. In such a situation bottom-up approach i.e., identifying the constraints at the grass-root level and prescribed low cost and eco-friendly technologies, would be the only way to break the trap of low productive mono-cropped farming and pave the way for a sustainable agriculture.

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