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TECHNOLOGY TRANSFER TRAINING CHALLENGE: A NEWLY EXPLORED DIMENSION IN SUSTAINABLE AGRICULTURE USING PLASTICS TECHNOLOGY

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Abstract: Market-driven food grain production is always a challenge for Indian farmers. This study was undertaken to explore the factors responsible for unstable and volatile situation in Indian agricultural policy implementation with the prime focus to the farmer's capacity. In this study, total 272 small/marginal farmers have been considered as the potential respondents who are acquainted with the application of plastics/polymer technology in agriculture. Cross-sectional survey method was adopted for data collection by using seven-point Likert scale questionnaire. Exploratory factor analysis technique has been applied to analysis the data. The finding reveals four interesting interdisciplinary factors, viz., 'Structural Development for Technology Adoption', 'Appropriateness of Socio-Political Environment for Technology Adoption', 'Institutional Integration at Different Levels for Technology Adoption', 'Training Delivery Mechanism for Technology Adoption'. Four dimensional restructuring in agricultural resource deployment is the unique finding of this study, for the first time, by proposing that every dimension is expected to address all types of capacities at the same time. The research is contributing towards the theory of multifunctional closed-system agriculture.

Keywords: Agricultural policy, Plastics technology, Capacity development of a farmer, Closed system agriculture, Sustainable agriculture, Multifunctionality of agriculture.

INTRODUCTION

Institutional establishment and agricultural research are necessary for agricultural development but training and extension on the relevant technology is important in a parallel speed to get the success of a technology. One of the important pillars of agricultural training and extension is resource utilization and deployment. There are various resources like natural resources, human resources, financial resources, technology resources and institutional resources. These can be intelligently utilized by farmers to catalyze their capacity. Since farmers have limited knowledge in global climate change, soil science, water hydrology, biodiversity and all the scientific aspects of sustainable agriculture they prefer to continue with their indigenous methods. To propel high crop productivity scientists are providing the latest technologies and inputs whereas environmental sustainability is missing. Although high crop productivity addressed the immediate challenge of food crisis this endangered ecology and now the new challenges, water pollution and crisis, soil pollution, air pollution, disturbing biodiversity appear to farmers and scientists with potentially danger in nature. More scientific and farmer-centric agricultural training and extension is considered to be the vital aspects of capacity development of individual farmers. To provide the training

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to boost the farmer's own capacity non-formal training at the farmer's field is required. Conventionally, KVK provides such training in India but it is arguably insufficient. Farmers need to g*et al*l their inputs, including finance, necessary for cultivation at their field because they cannot provide one or more man-days to get or apply for availing any input or training (the possibility of availing even after application is also uncertain). So, resource redesign is expected to be deployed with a new form of mechanism. This research is able to identify the factors based on which redesigning resource deployment can be framed. The paper is divided into literature review, methodology, results and discussion and conclusion with valuable suggestions on which the whole platform is embedded.

LITERATURE REVIEW

There are various entities in natural resources, numerous divisions of human resources and ethnic groups, various categories of financial resources. Abundance sources of technologies and plenty of institutional resources. The following are some scholarly works on various resources, their utilization and capacity development of the farmers as well as agriculture.

Niekerk *et al*. (2011) undertook a Logical Framework Analysis (LFA) to find out smallholder farmers' problems as well as causes and effects of their problems. The paper suggests that smallholders can become commercially productive only when they can access sufficient training, finances and improved farming systems. The paper emphasizes more of systems context where there would be a platform to contribute all the stakeholders. To make a technology to be adopted by the user a favorable social setting (Bebbington *et al*., 2004 and Kathleen Gough,1965) is always beneficial. Village and localized politics and culture affect community-driven development. In an adverse situation how technology transfer agents face obstacle is explicitly identified by Chowdhury *et al*. (2014) by putting stress on the institutional barriers in the agricultural innovation system. The paper teaches why evolving model is necessary for agricultural innovation systems, especially in the low-income countries.

On the other side, there are various scholars worked on redesign and restructuring of agricultural training and extension. A proposal for three dimensional, viz., individual, organizational and system environmental level, extension approach is recommended by David and Samuel (2014). They emphasize on the need of conducive environment and system perspective for effective agricultural extension. The paper recommends for a complete participatory agriculture innovation system. Incentive-centric redesign has been proposed by Kiptot *et al*. (2015) by finding important incentives of volunteer farmer-trainer (VFT). Developed countries like USA and UK adopted various restructuring mechanisms for their country's agricultural development. Baumgart-Getz *et al*. (2011) highlighted on the best management practices adopted by the farmers in US. They identified some important influencing variables of agricultural technology adoption for their capacity development, viz., access of quality information, financial capacity, network with local agency and farmers' groups. Marsden *et al*. (1987) highlighted on the necessity to examine the restructuring process in British agriculture in a situation of uneven development. Ineffective farmer development, caused by mainly poor farming systems, lack of training, finances and support, led to dependency, crime, unemployment and poverty. Röling and Fliert (1994) have proposed an alternate model for knowledge-intensive sustainable agriculture based on farmers' participation and their empowerment by catalyzing their indigenous knowledge.

Farmers' Participation level variables in capacity building training programmes are studied by Obaniyi *et al*. (2014) with the context of Nigeria. Regression analysis showed that a positive relationship exists between participation levels of farmers in capacity building programmes and age, educational levels, household size, training venue, years of experience, secondary occupation, farm size and land ownership. Effect of IPM/FFS towards empowerment of local communities to protect environment is discussed by Mahboubeh and Ali (2015). The model of cooperative extension service (CES), in US context, has been analysed critically by McFall and McKelvey (1989). They have criticized the limited application of CES; it was not applied widely in other industries except agriculture only. They argued that without sufficient infrastructure and resources extension cannot reach the mass.

Research Gap and Research Problem

From all these studies it is found that there are many missing links responsible for inappropriate technology transfer training leading to misery of small and marginal farmers around the globe. The main problem is identification of the farmer-end problems due to communication, language, economy and many others.

Objective of the study

Based on the above gap and research problem this study tries to identify the indicators/ factors which may extend the redesigning process for resource deployment.

RESEARCH METHODOLOGY

For this study, field survey method was undertaken followed by face-to-face interview with seven-point Likert scale questionnaire is adopted. The target sample is the individual small and marginal farmers from selective critical/ specific zones in West Bengal (Table 1) whereas total numbers of respondents are considered to be 402.

Characteristics of the Sample

- Small and marginal farmer (holding <2 hectare land)
- Agricultural labourer
- Landless cultivator cultivating on land of others on temporary basis

Table 1: Zone-Wise Sampling

Zone/ Region	*Location*	*Climate, Crop-Pattern & Technology*	*No. of Sample*
LATERITIC	Paschim Medinipur, Bankura, Purulia (West Bengal), Jharkhand and Orissa	Mostly Single Cropping, Application of Protected Cultivation and Precision Irrigation/ Farming: Paddy, Vegetables, Fruits	82
SALINE	Contai, Digha, South 24 Pgs. (W.B.), Rohtak and Hisar (Haryana)	Organic and Protected Farming: Paddy, vegetables, Betel Leaf, cashew, Bajra, Cotton, Barley, Sugar cane	63
HILL	Darjeeling & Jalpaiguri (North Bengal), Shimla (H.P.)	Forest and Nursery-based and Temperate Fruits: Medicinal Plants, Apple, Orange and other fruits	55
FERTILE	Nadia, Burdwan, Dinajpur (W.B.), Anand (Gujarat) and Varanasi (U.P.)	Mostly Ganges Basin: Paddy, Cotton, Vegetables, Fruits, Animal Husbandry **Final Sample Size**	72 ----------- 272

Respondents' profile
Descriptive Statistics: N= 402

Table 2: Descriptive Statistics of Respondents

Variables	*Range*	*Minimum*	*Maximum*	*Mean*	*Std. Deviation*
Age	58	19	77	39.37	10.431
Experience (Year) in Cultivation	50	2	52	15.21	8.888
No. of Training Participated	49	1	50	5.56	5.358
No. of Family Members	23	3	26	5.60	1.956

Table 3: Descriptive Statistics of Respondents' Age Group

Age group (year)	*Total no. of respondents*	*Percentage (%)*
19-25	30	7.46
26-35	**136**	**33.83**
36-45	**135**	**33.58**
46-55	74	18.41
56-65	22	5.47
66-77	5	1.24

Descriptive Statistics: N = 272

So, 26 to 45 year age group is the major participant in this study representing 67% of the respondents.

Table 4: Descriptive Statistics of Respondents on Education, Caste and Crop Pattern

Variables	*Frequency*	*Percent*
Education		
Graduate/ Post graduate	208	52
Non-graduate	194	48
Caste		
Reserve category	285	71
General	117	29
Crop pattern		
Only paddy	87	21
Other crops with/ without paddy	315	79

From this table we observe that the major percent (52%) of respondents are graduate/ post graduate under which majority (71%) is under reserved category involved in non-paddy activity (79%). The following conclusions may be drawn:

- The most interested group in training is the age group of 26 to 45 years having average cropping experience of 15 years
- The family size of 5 to 6 members
- They are having exposure of 6 trainings on an average
- Substantial percentage is shifting from only paddy crop to other more profit-making crops like vegetable, fruits, and other cash crops
- Most of the cultivators are under reserved/ under-privileged community

Exploratory factor analysis technique is undertaken for data analysis.

RESULTS AND DISCUSSION

The quantitative data were analyzed using Exploratory Factor Analysis (EFA) technique. The analysis of variables provides the value of Cronbach's Alpha as 0.847 which is more than 0.5; thus it is considered as acceptable. The KMO (Kaiser-Meyer-Olkin Measure of Sampling Adequacy) value of the variables is 0.760 which is higher than the acceptable threshold, 0.05, and the significance value is 0.000. Therefore, the data are appropriate to perform factor analysis. According to communalities result respective variables were taken for factor analysis. There are four factors extracted based on their respective eigenvalue. The extracted factors have an eigenvalue greater than one and total variance explained. The factors have been taken after rotation of the component matrix in Varimax with Kaiser Normalization. The identified factors of technology adoption are 'Structural Development for Technology Adoption', 'Appropriateness of Socio-Political Environment for Technology Adoption', 'Institutional Integration at Different Levels for Technology Adoption', 'Training Delivery Mechanism for Technology Adoption'. The important outcome of this study is the identification of the interdisciplinary factors related to redesigning resource deployment.

There are four factors extracted under this construct. The first one implies that the structural development of the institution, viz., KVK is important for technology adoption; upgradation of the infrastructure as well as the management needs to be updated. The second one says that socio-political, broadly, anthropological unrest directly hinders the normal livelihood of the common mass. So, appropriateness of socio-political environment for technology adoption is compulsory. Third factor indicates that inter-institutional integration at different levels needs to be prioritized. KVK, ATMA, NABARD, MANAGE alongwith state and national departments and universities are working relentlessly for agricultural development. The final factor opens our eyes that in spite of all such efforts due to lack in training delivery mechanism the farmers get deprived to get the actual benefit

Table 5: Findings of EFA under RRD

Factors	*Underlying variables*
Structural Development for Technology Adoption	Structural reorganization of institutions like KVK (technology, extension), ATMA (technology management, integration within agriculture related stakeholders, NABARD (financing the suitable/prospective one) in such a manner which will enable farmers and farmers' organizations to utilize the prevailing resources.
Appropriateness of Socio-Political Environment for Technology Adoption	Developing social and cultural atmosphere, political stability, transparency, social security and justice, respecting farmers and agricultural scientists can contribute a favourable environment for introduction of any technology and hence enhance the capacity of the farmer.
Institutional Integration at Different Levels for Technology Adoption	Social and community integration through NGO and technology-centric integration through GO can boost the process of technology adoption. Further, within NGOs, within GOs, and GO-NGO integration escalate farmer's capacity of utilization of various resources and possible resource creation.
Training Delivery Mechanism for Technology Adoption	Based on various categories of natural and human resources like landscape, biodiversity, water bodies, empathy, cooperation the training schedule and venue should be chosen. This will enhance the capacity of individual farmer as well as group of farmers.

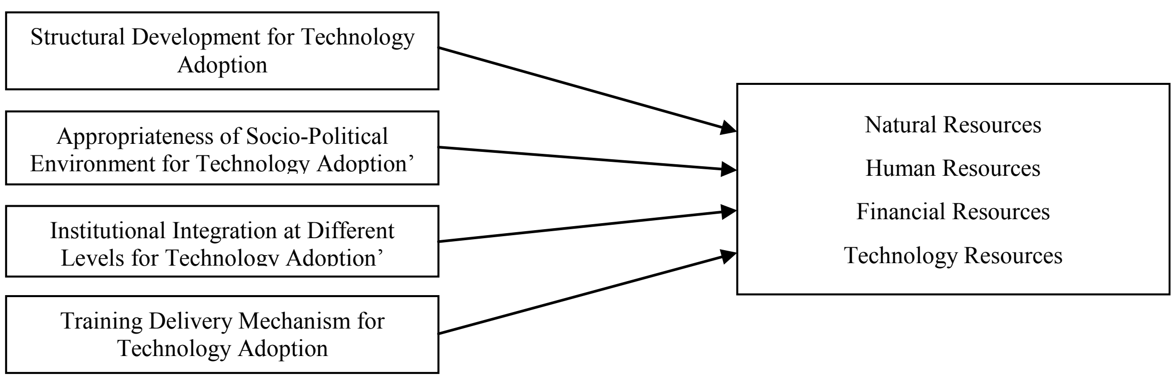

Figure 1: A Multifuntionality Approach towards Resource Utilization

of technology; technology adoption can be of better shape if the training part is taken care with more attention.

The following table (Table 5) connects the four identified factors with five categories of potential resources. The findings of this research reveal the new dimensions of capacity development of the farmers. Most of the previous studies have pointed out the subject-wise resources like natural resource, financial resource, human resource whereas this study has captured the structure-wise design dimensions of agricultural resources like considering all types of resources required for agricultural technology transfer at a time. This is the unique finding of this study.

The study supports the following well established methodologies of agricultural training and extension. Training and Visit (T&V) system of extension was introduced by the World Bank in the late 1960s (Bindlish, and Evenson, 1997). T&V extension agents would meet with a small group of contact farmers who were expected to disseminate information to their respective community members and convey farmers' opinions back to the extension staffs creating a feedback mechanism (Godtland *et al*., 2016). Improved production methods and new technologies were introduced to the farmers' field level. T&V aimed to closing the gap between the yields attainable using best-practice technologies and the yields farmers actually achieve. Feder *et al*. (1984) elaborate the operations and effects of T&V system approach adopted in Haryana area in India. The paper draws attention to the village extension worker (VEW) and their substantial contributions. Another important context, supply and demand of extension agents, is also undertaken in the analysis. Alemneh Dejene (1989) has emphasized various crucial aspects of T&V in the rainfed agriculture in Ethiopia. The paper says that for effective diffusion of agricultural innovations

Table 5: Redesigning Options in Agricultural Resources

Dimensions	*Natural Resources*	*Human Resources*	*Financial Resources*	*Technology Resources*	*Institutional Resources*
Structural Development	Land reform, soil reclamation, use of rangeland/ graze land, landscape/ biodiversity	People having specialized knowledge and demonstrated skills must have some room to utilize their talent.	Institutional establishments engaged in agriculture are expected to choose the financial provider for farmers in any technology adoption process.	KVKs and farm science clubs will be connected to various technology generating institutions like IITs, NITs, universities, innovators.	Institutions close to farmers' filed are to be encouraged to equipped to help nearby farmers.
Appropriateness of Socio-Political Environment	Discourage political influence of utilization of land, water bodies, forest etc.	People having noble, cultural and innovative thoughts are to be engaged in the main stream of agricultural development.	Money to be released to the exact beneficiary to ensure transparency in financial transaction without any socio-political barrier.	Farmers will be encouraged to culture advanced and positive thinking to adopt new technologies. Superstition and rumors must be discouraged.	Local NGOs and educational institutions must take leading role to create a hospitable atmosphere to welcome new technologies.
Institutional Integration at Different Levels	Agriculture, forest, water and environment department will work together to frame sustainable policy on natural resource management and disseminate the same to NGOs and farmers' clubs for action.	The effective and innovative trainers, subject matter specialists and researchers may act collaboratively to effective delivery of training.	Choosing the potential NGOs in facilitating technology transfer to the exact beneficiaries will ensure the proper utilization of funds; the nodal body (like ATMA) will act in integrated way.	Technology refinement will be undertaken in every step to avoid chances of crop failure. This is to be done with appropriate hand holding in Govt. organization-NGO-farm science club.	Institutions dedicated to farmers are required to work together to transmit non-confusing message to the farmers.
Training Delivery Mechanism	Farmers' training will be conducted on their own field/ location on the use of natural resources in a sustainable way.	Training schedule and delivery will be undertaken based on the congenial and convenient location to be selected by the potential farmers.	Sufficient and flexible fund for training at farmer level will be encouraging.	Specific technology is expected to be demonstrated at the exact place of cultivation.	The trainers to be chosen from the institutions will be capable enough to deliver training in a farmer-friendly manner.

there is important role of extension agents and contact farmers. Women are to be encouraged to participate the training. The findings of the study support the applicability of T&V in the fertile regions whereas limited applicability in the resource-poor and drought-prone regions.

In connection to the focus of non-formal education, extension, Nederlof and Odonkor (2006) define farmer field school (FFS), introduced during 1990, as a form of adult education using experiential learning methods, and aimed at building farmers' decision-making capacity and expertise. In this study the impact of FFS was assessed on the implementation of Integrated Pest Management (IPM) practices of cowpea farmers in West Africa. According to this study, the FFS is a tool to transfer messages, rather than to foster experiential learning among farmers. In this study it has been revealed that FFS has been used as a mechanism of 'transfer of technology'. The model has been used to introduce the technologies, developed by the scientists, to the farmer whereas the farmers' ability of technology choice and make their decision is neglected. The gap of FFS is that the opportunity loss with respect to the collaborative work with the farmers and mutual respect and trust between scientists and farmers. According to Tripp *et al*. (2005) commented that FFS contributes in increased skills and reduced tendency of insecticide use by the farmers. They found the major drawback in FFS is low diffusion of training output amongst non-participants. Integrated Pest Management (IPM), an integral part of FFS programme, has been introduced as early as 1979 in Indonesia (Roling and Fliert, 1994) and subsequently throughout the world to train farmers in using synthetic chemicals in crop protection, more specifically, pesticides (Berg and Jiggins, 2007). The result encourages farmer-cented training and supports the valuable role of farm science clubs; these are nothing but a category of FFS by supporting training at the farmers' field.

Farmers' knowledge through extension workshop in integrated pest management (IPM) has been considered a prerequisite to IPM adoption (Hashemi *et al*., 2008). This paper investigates that workshop participants acquire significant higher knowledge as compared to the non-workshop counterpart. Another observation in this study is that very little knowledge, acquired from workshop, diffusion happens from workshop participants to the other community members. This emphasizes the importance of technology intensive workshop participation. Once the fundamental issues in agricultural production are addressed then only we can boost the agri-business platform. One of the important dimension from this research is to value and protect indigenous knowledge of the farmer help utilize natural resources.

Indigenous farming practice

In cultivation, the community knowledge is the key asset. Land character differs from time to time due to ecological, environmental and man-made change. The way the fore-fathers defended various natural/ anthropogenic disasters can be only known through the story telling. The potential information is to be documented and to be modified with the change of time and modernization.

Initiatives are there on global as well as on more local scales for transforming the conditions of agriculture and rural resource management. Progressively, farmers and other resource managers face challenges in decisions for which their experience provides inadequate guidance. To cope up with the speed of changes, their significance and the varied form they take for different rural groups which is a challenge not only to farmers themselves, but also to institutions that aim to support their decision making on resource management: for these institutions as well, agri-business this is not a viable option. Since farmers' stake in natural resource is high: the capacity of rural people to adapt their decisions about resources, collectively, jointly or individually managed, with the gradually transforming ecological, social and economic circumstances is key to their own well-being and to any meaningful sense of sustainable development.

CONCLUSION

In practice farmers trust on the farming knowledge developed by farmers, collect ideas from outside and judiciously integrate them with their own judgments to apply them into complex farming decisions. The conventional assumption of development of certain technology and applying the same into farmer's field does not fit as such with the farmers' own model. The finding reveals four important interdisciplinary factors, viz., 'Structural Development for Technology Adoption', 'Appropriateness of Socio-Political Environment for Technology Adoption', 'Institutional Integration at Different Levels for Technology Adoption', 'Training Delivery Mechanism for Technology Adoption' to be addressed while redesigning resource deployment process in agricultural activities. Four dimensional restructuring in agricultural resource deployment is the unique finding of this study and for the first time it is proposing that every dimension is expected to address all types of capacities at the same time. So, the paper focuses on redesign-wise categorization of resource deployment. The main observation in this paper is that farmers' have their own capacity, creativity, self-confidence, social energy and most of the time all these get bypassed, overlooked or neglected. The suggestion is that for investment in extension in designing and practice farmers must be seen as experts and the model should help them in boosting their own capacity. Application of plastics technology like green house, poly house, shed net, drip and sprinkler irrigation, foggers, lay frat tube for irrigation, vermi-compost beds etc. can help the farmers in enhancing their capacity. The results support the concept of multifunctionality of agriculture, sustainable agriculture and closed system agriculture.

This is a unique study prioritizing the need of the individual small and marginal farmers. Farmer-centered research is very rare particularly in India. The study is first of this kind considering all the pin-point problems in agricultural extension. The findings will help the farmers to address their issues in more precise fashion, can contribute enormously in research towards new theory in agribusiness management, and finally, it will help a lot to the policy makers whenever any agricultural reconstruction will be taken place, especially considering KVKs.

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