Research Article

Indian Journal of Extension Education
Vol. 58, No. 3 (July–September), 2022, (99-103)

ISSN 0537-1996 (Print)
ISSN 2454-552X (Online)

Understanding Conservation Agriculture in terms of Knowledge, Perception and Application

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ARTICLE INFO

Keywords: Conservation agriculture, cognition, ecological resilience, knowledge perception, resource conservation

http://doi.org/10.48165/IJEE.2022.58321

ABSTRACT

Depleting natural resources, environmental pollution and climate change are the three major factors of concern simmering up with contemporary global agriculture. Conservation agriculture (CA) is being flagged up as a sustainable adaptation mechanism. Adoption of CA depends upon ecological as well as, farmers' level of perception, knowledge acquisition, and decision-making process. The present study was taken place in West Bengal covering both the new alluvial zone (NAZ) and terai zones (TZ) following snowballing sampling method during 2018-21. A total of 65 farm households were surveyed considering 57 different social-ecological factors operating across CA farms. The study elucidated that farmers' perception of energy, climate change perception, formal education, land fragmentation, gender ratio, irrigated area, dietary diversity, and family size came up as strong determinants of their level of knowledge of CA. Understanding and measuring the complexity of social knowledge is essential for sustainable management, with consequences for problem-solving, mutual aid, and decision-making.

INTRODUCTION

Decreasing share of agriculture in productive economy and employment is taking place at different speeds and it is generating different challenges across the regions. Though spending on agriculture and technical breakthroughs are increasing crop production and yield has stagnated to an unacceptably low proportions. Food waste and losses account for a large amount of agricultural output. While, natural resource degradation is impeding the much-needed acceleration in productivity growth, the spread of transboundary pests and diseases of plants and animals, as well as the loss of biodiversity. CA has come into context as an adaptation and mitigation mechanism for safe and healthy food and environmental sustainability (FAO, 2014; Sharma et al., 2022). With CA, growers can save from 30 per cent to 40 per cent of time and energy as compared to conventional cropping (Bharti et al., 2021). CA adoption is still stagnating in the global context (Chatterjee et al., 2021) even though farmers want to adopt more sustainable practices, and an obvious prerequisite is that they are already aware of the technology's existence (Llewellyn, 2007). D'Emden et al., (2008) found that farmers' attendance at cropping extension activities is strongly associated with the adoption of conservation tillage. Nain et al., (2019) highlighted the understanding of farmers' innovations it learning experiences for profitable farming. Gathering proper information and knowledge about sustainable farming is a highly dynamic and social process. Thus, knowledge networks and behavioural practices are to be mutually constructed to build a concrete association between people and CA technologies (Röling & Jiggins, 2007). Limitations of personal relationships with others (experts or extension agents) usually foster distrust, making local

Received 15-01-2022; Accepted 31-05-2022

knowledge networks highly resistant and long-lasting (Moore, 2011).

CA has been proven to be more knowledge-intensive than input-intensive, and its success is determined by the farmer's activities rather than the number of inputs used. (Saha et al., 2022). The traditional knowledge of the farmers also plays a crucial role in practising sustainable crop production (Lenka & Satpathy, 2020) also the factors of knowledge are equally important (Ravikumar et al., 2015). Even though large farmers have access to a variety of knowledge sources, this is not always the case for small farmers. Large farmers are facts and knowledge seekers in nature, seeking newer knowledge and cutting-edge technology (Wall, 2007), whereas small farmers are not well connected to outside information sources, even if they own a radio; televisions are not always common, and mobile and internet connections are lacking.

In India, Several State Agricultural Universities, ICAR institutions, and the Rice-Wheat Consortium for the Indo-Gangetic Plains have collaborated to disseminate CA technologies. Bilaiya et al., (2019) also found that CA despite being such a profitable technology, low adoption and knowledge rate is seen among farmers. Thus, the knowledge level of adopters and non-adopters of CA in the rice-wheat cropping system must be assessed. Indeed, lack of awareness has a significant role in determining whether or not farmers decide to participate (Higgins et al., 2017). Hence, the present study tried to elucidate the interaction between the farmers' level of knowledge of CA and operating social-ecological factors within the study regions.

METHODOLOGY

The study was conducted in the Haringhata (twenty respondents from five villages) and Chakdaha (twenty respondents from five villages) blocks of Nadia and Balagarh (twenty respondents from five villages) and Pandua (twenty respondents from five villages) blocks of Hooghly district from NAZ of West Bengal and Coochbehar-I (thirty respondents from six villages), Coochbehar-II (thirty respondents from six villages) and Dinhata-II (thirty respondents from six villages) blocks from Coochbehar (thirty respondents from six villages) and Alipurduar-I (thirty respondents from six villages) and Falakata (thirty respondents from six villages) blocks from Alipurduar districts of TZ of West Bengal during the period 2018-21. The purposive snowball sampling technique was adopted for the present study as CA is still not adopted rapidly in the study area (Ray & Mondal, 2014). A total of 250 farmers from the aforesaid agro-climatic zones were selected. Two agro-climatic zones, NAZ and TZ have been uniquely performing in a response to their unique socio-ecological settings. While for NAZ, it just a beginning for last five years for CA, for TZ a profile of CA practice and system have already been in operation for the last ten years. TZ is receiving an average rainfall close to 3000 mm per year, for NAZ it is hovering around 1600 mm. So that reality for socializing CA speaks differently for these two zones. The study on farmers' perception, reality, and practice of CA operationalized through two sets of variables (i) independent variables (x_1-x_{53}) and (ii) dependent variable (y_3). Level of knowledge of CA (y_3) was measured through an attitude scale, modified and adapted to the given social ecology, as developed in Likert's summated rating scale. A set of items on the given perceptions were developed and rated by experts as well as farmer innovators on a 4-point scale and by following summated rating scale, 25 per cent of the items were selected and subsequently, the split-half method was followed to test the reliability. Then, during the farmer's interview scoring is done over this 4- point continuum asked questions from 4 items. Finally, the quantitative values have undergone the data normalization process. Responses from the respondents were collected through a pre-tested structured interview schedule and relationships among selected variables were analyzed through quantitative methods i.e., Coefficient of Correlation, Stepwise Regression, and Scatter-plot diagram with the help of Origin Pro version 2021 and Statistical packages for social sciences (IBM-SPSS) version 24 software.

The research setting presents a dynamic, evolving, and undulating social ecology; where both the structural and functional factors are in constant interaction with the respondents in terms of operating variables. However, the present study was able to accommodate only a few selected characters for the empirical dissertation cataloguing them as dependent and independent variables. A set of x variables are found to behave with a contributor character while the same can be with a recipient behaviour, e.g., in stepwise regression analysis, the set of 'x variables' are not considered as the only source of causal variables, the rest three 'y variables' which are promoting the particular y variable under a single study have also been considered as causal variables. Hence, in case of y_3, the rest of the y variables have to be treated like: $y_1=y_1'$; $y_2=y_2'$; $y_4=y_4'$.

RESULTS AND DISCUSSION

Predicting the significant causal variables impacting farmers' Level of knowledge of CA

The stepwise regression was first done to get segregate the marker variables out of the total fifty-seven variables taken, then other analyses were conducted as per the steps. Table 1 presented the stepwise regression analysis which elicits those 12 causal variables viz., perception of energy management (y_2'), gender ratio (x_3), calorie intake through plant protein consumed per day (x_8), family size (x_2), amount of plant protection chemicals (x_{37}), frequency of irrigation (x_{38}), perception of climate change (y_1'), formal education (x_4), energy metabolism ratio (x_{53}), number of fragments (x_{17}), CA perceived (y_4'), total input energy equivalent (x_{52}), the regression coefficient value from the model summary table shows that have been considered as the predictor variable to have influenced level of knowledge of CA (y_3) the most. These 12 predictor variables together described 59.10 per cent of total variance out of 57 variables with a Durbin Watson value of 2.031.

Thus, when it comes to knowledge on CA acquired by the farmers, their status of formal education and their perception of CA i.e., both perception and cognition come on the list. In addition, energy components are also found to be important in the study areas as the farmers have very little perception of energy. Where plant protection chemical has been taken a consideration because farmers must know before adopting CA that in the initial years, they may have to apply weedicides because of weed problems,

Table 1. Stepwise Regression of level of knowledge of CA (y_3) vs. 56 causal variables (x_1-x_{53} and y_1', y_2', y_4') (here, y_1=y_1'; y_2=y_2'; y_4=y_4')

S.No.	Variables	Reg. coef. B	S.E. B	Beta	t value	R^2 (In 44th Step)	Durbin Watson Value
1	x_2	.069	.036	.115	1.906		
2	x_3	.151	.072	.091	2.099		
3	x_4	-.018	.010	-.115	-1.819		
4	x_8	4.032	.913	.189	4.415		
5	x_{17}	.036	.015	.119	2.408		
6	x_{37}	-.155	.075	-.102	-2.071	59.1%	2.031
7	x_{38}	-.026	.010	-.129	-2.606		
8	x_{52}	.083	.006	1.003	13.002		
9	x_{53}	.672	.074	.581	9.117		
10	y_4'	18.857	1.207	1.434	15.627		
11	y_1'	-.365	.053	-.416	-6.919		
12	y_2'	-.447	.053	-.581	-8.393		

y_2'-perception of energy management, x_3- gender ratio, x_8-calorie intake through plant protein consumed per day, x_2- family size, x_{37}- amount of plant protection chemicals, x_{38}- frequency of irrigation, y_1'- perception of climate change, x_4-formal education, x_{53}- energy metabolism ratio, x_{17}- number of fragments, y_4'-CA perceived, x_{52}-total input energy equivalent.

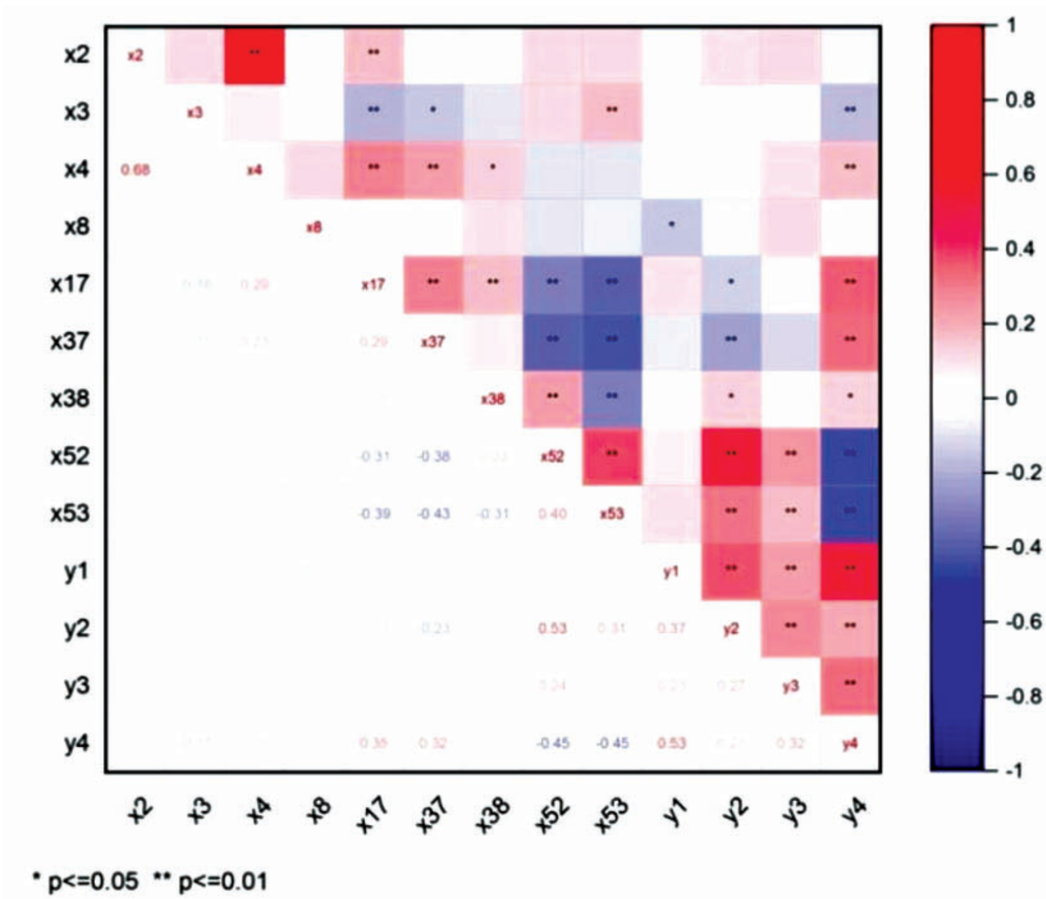

Figure 1. Coefficient of Correlation (r) of level of knowledge of CA (y_3) vs. 56 independent variables (x_1- x_{53} and y_1, y_2, y_4) (here, y_1=y_1'; y_2=y_2'; y_4=y_4')

however in subsequent years when crop residues will be able to build a cover, the weed infestation gets reduced. Jat et al., (2014) reported that knowledge of the existence of CA and how to implement it (know-how), mindset (tradition, prejudice), and poor policies are considered to be major barriers to the adoption of CA techniques, for example, commodity-based subsidies, and direct farm payments, unavailability of appropriate equipment and machines, and suitable management strategies to facilitate weed and vegetation management, including mechanical, biological, and chemical options as herbicides (especially for larger farms in low-income countries) (Jat et al., 2014; Friedrich et al., 2011; Farooq & Siddique, 2014).

Gender ratio has also come up as in both the zones women also have constituted a considerable part along with men in both family and farm decision making, thus, it must be taken into consideration before adopting CA whether it is gender-inclusive and responsive in its all the way. Nyanga (2012) found from their study that the women pulse crop farmers demonstrated that CA can improve household food security if the cover crops are utilized to form part of local diets. CA also has the potential for increasing women's incomes. Besides, pulse crop insertion in the existing cropping system is coming up as a good predictor both for the farm family and agro-ecological health.

Relation between level of knowledge of CA (y_3) and selected socio-ecological variables

Figure 1 showed the correlation between level of knowledge of CA (y_3) and 56 independent variables. It has been found Total input energy equivalent (x_{52}), energy metabolism ratio (x_{53}), perception of climate change (y_1'), and perception of energy management (y_2') have recorded positive and significant correlation with level of knowledge of CA (y_3). Two integers to CA are climate-smart and energy-smart components. Hence, when a farmer gathers knowledge or persuades on CA, he or she will be exposed to the energy-efficient and climate adaptive sides of CA at the same time. Nyanga et al., (2011) also stated that actors involved in the promotion of CA technologies have often not taken into consideration the perceptions of smallholder farmers in climate change and CA as an adaptation strategy. The perception about climate change has deeply been embaded amidst farmers cognitive domain in the form of indigenous knowledge and wisdom, which has classically been desended over decades. The Smallholder farmers' perceptions of floods and droughts were substantially correlated with the adoption of CA, according to this study. Smallholder farmers, on the other hand, had a low perception of CA as a climate change adaptation strategy.This coined out the existence of other important reasons for practicing CA than adaptation to climate change.

Scatter-plot diagram showing the relation of level of knowledge of CA (y_3) with Energy Metabolism Ratio (x_{53}) and perception of energy management (y_2')

Energy metabolism ratio (x_{53}) and perception of energy management (y_2') were found to be in increasing trend with level of knowledge of CA (y_3) (Figure 2 and 3). Thus, when farmers develop their knowledge on CA principles; their on-farm energy management moves in the right direction. CA is all about rationalization of tillage operation, injudicious input application and a prodical management of farms. The scatter diagram depicts that the input variable perception on energy metabolism has isochronously contributed to knowledge of CA and perception of energy management. On the other hand knowledge of CA of respondents has organically been linked with the energy management behaviour of the farmers. Acharya & Chatterjee (2019) also found that CA may help in re-building agroecology by maintaining carbon sequestration, maintaining soil health, checking soil erosion and groundwater depletion, energy balance, mitigating climate change related problems through maintaining ecosystem services.

CONCLUSION

Access to and application of proper knowledge is being simmered up as one of the prime determinants in sustainable and environmentally sound agriculture in eastern India by incubating

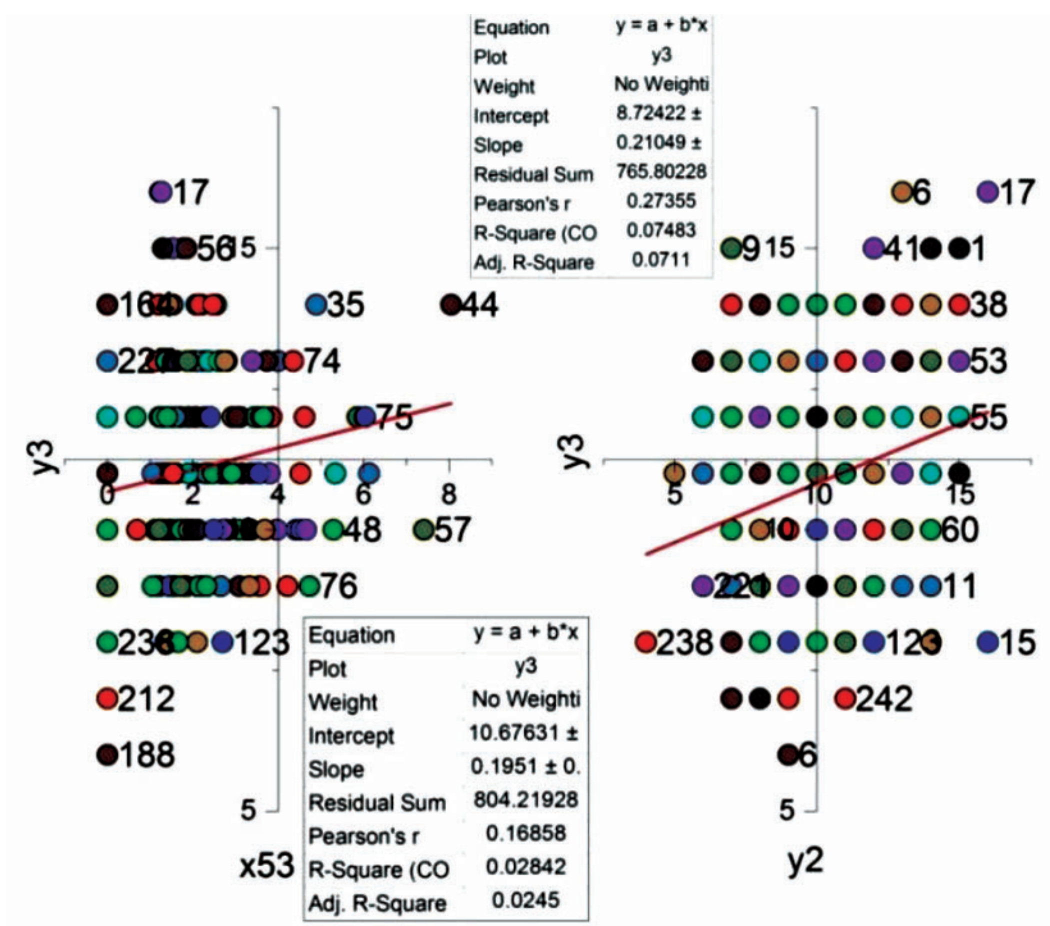

Figure 2 and 3. Scatter-plot diagram of level of knowledge of CA (y_3) with Energy Metabolism Ratio (x_{53}) and perception of energy management (y_2') (here, y_1=y_1'; y_2=y_2'; y_4=y_4').

scientific pursuits and perception amongst farmers operating with CA. It has found that farmers are quite aware of the ill effect of climate change on agriculture and want to mitigate it, however, did not hear the term ‘energy’. Here, CA is the best option to provide climate-smart farming technologies along with energy efficiency and sustainable livelihood within a single package. However, at every corner, a major constraint to the adoption of CA practices continues to be knowledge about the existence of CA and how to do it, mindset, lack of location-specific training, and inadequate policies are visible. Hence, proper understanding and measuring social-ecological knowledge diversity is an important part of long-term management with consequences for resolving disputes, group action, and policymaking.

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