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Organic Manure in Conservation Agriculture: Perception, Reality and Interpretation

Sreemoyee Bera[1], S. K. Acharya[2], Prabhat Kumar[3], Riti Chatterjee[4], Kabita Mondal[5] and Monirul Haque[6]*

[1]PG Scholar, [2]Professor, [4, 6]Ph.D. Research Scholar, Department of Agricultural Extension, BCKV, Mohanpur, Nadia–741252, West Bengal, India
[3]National Coordinator, ICAR- NAHEP, KAB–II, Pusa Campus, New Delhi–110012, India
[5]Assistant Professor, Department of Agricultural Extension, College of Agriculture, UBKV, Majhian, Dakshin Dinajpur-733133, West Bengal, India
*Correspondence author email id: monirulhaque441@gmail.com

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ABSTRACT

The excessive reliance on chemical fertilizers and the negligence shown to the conservation and use of organic manures (OM) have led to the exhaustion of organic carbon level, soil moisture level, and retention of microorganism population in the soil. The present study reveals that the farmers merely have any perception or they are not technically aware of the importance of the application of OM into their farming for the restoration of ecological resilience. Elucidating the factors, impacts, and perceptions of farmers, fifty respondents have been selected from Dalilpur and Kastodanga village of Nadia district by systematic random sampling for the study. The responses are collected through a structured interview schedule. The study envisaged that the livestock count, size of homestead land, size of landholding, production of organic manure, education variables have been found to exert strong and determining contribution to the application of organic manure. The socialization of proper cognitive adoption of organic manure among the farmers for the restoration of ecological resilience and popularization of resource-saving agricultural crop production is the need of the hour.

INTRODUCTION

The major difficulties of present agriculture involve ensuring food security for a rising population and alleviating poverty while maintaining agricultural production in the face of decreasing natural resources, negative impacts of climate variability, increasing input costs, and volatile food prices (Bhan & Behera, 2014). Conventional agriculture has turned both genetically fatigued and operationally tired as reflected through plateauing of agricultural productivity and quality (FAO, 2011). Indiscriminate use of chemical fertilizers in soil is causing soil to turn into less fertile or even toxic which are slow poison to human beings (Pesticide Residues in Food, 2018). Excessive dependence on chemical fertilizers, as well as a disregard for the conservation and utilization of organic sources of nutrients or OM, has resulted in soil nutrient depletion, as well as soil health issues, which have become a barrier to enhancing agricultural productivity (Chandra, 2015).

Conservation agriculture (CA) has come into view as an important priority area across the globe for fulfilling the growing demand for safe and healthy food and environmental sustainability (FAO, 2014) along with mitigating food security, biodiversity, climate change impacts on agriculture, and water scarcity (Choudhary et al., 2016). A combination of diversified farming and farming experiences helped to significantly increase income through CA (Saha et al., 2022) whereas adoption of CA is linked not only to ecological aspects, but also to the socio-ecological factors like adopter's characteristics, level of perception, and decision-making process (Chatterjee et al., 2021). Regular recycling of organic wastes in the soil is the best technique for maintaining optimum levels of soil organic matter (Chatterjee et al., 2017). Application of OM is the need of the hour to support soil fertility by enhancing the carbon content of the soil and therefore uplifting the agricultural production while minimizing environmental impacts (Diacono & Montemurro, 2010; Urra et al., 2019). It (OM) also substantially

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reduces the chemical fertilizer application up to 30 per cent in the soil while incorporating it in the soil (Zhou et al., 2022). Long-term application of OM in the field leads to higher soil organic matter, microbial biomass carbon, and beneficial nematode diversity (Su et al., 2021).

India is a country endowed with indigenous knowledge and the potential for organic agriculture. Even though India lags in the adoption of organic farming for a variety of reasons (Das et al., 2020), the key concern is that most farmers are not technically competent or aware of the importance of using organic manures in their farming to restore ecological resilience and improve soil health by increasing organic carbon levels, soil moisture levels, and microorganism population retention. So, they must have brought under proper cognitive improvement and a better understanding of the role and contribution of organic matter in terms of its ecological contribution and productive behavior and function of the ecosystem (FAO, 2017). The present study tried to understand the contribution and science of organic manure in CA from farmers' perspectives, their perception, and interpretations.

METHODOLOGY

The study was conducted in the Nadia district of West Bengal during the year 2020-21. Purposive as well as simple random sampling techniques were adopted for the study (Ray & Mondal, 2014). A score of fifty farmers of Kastodanga and Dalilpur village of Haringhata block from the aforesaid district were selected. The district, block, and villages were purposively selected for the study as the area was under high-intensity agriculture, rice and vegetable-based farming, decline trend of productivity, livestock count, and organic carbon. The number of respondent selection limitations depended upon the COVID-19 situation, socio-political situation, and level of responsiveness from the farmers. Although the study focuses on the Nadia district, it is held that the results generated from this study are relevant to many nearby areas of Nadia district with similar climate and socio-economic conditions. The study on farmers' perception, reality, and interpretation of organic manure in conservation agriculture operationalized through two sets of variables (i) independent variables (x_1-x_{23}) and (ii) dependent variable (y). Application of organic manure (y) by the farmers is collected through a pre-tested structured interview schedule and relationships among selected twenty three variables are analyzed through quantitative methods i.e., Coefficient of Correlation, Multiple Regression, Stepwise Regression, and Path Analysis with the help of IBM SPSS v26.0 and the web-based application OPSTAT (Sheoran et al., 1998).

RESULTS AND DISCUSSION

Relation between application of organic manure and selected socio-ecological variables

Table 1 presents the coefficient of correlation and multiple regression between the application of organic manure (y) and 23 independent variables (x_1-x_{23}). The variable number of land fragments (x_6) has recorded a significant but negative correlation with the dependent variable, application of organic manure (y). It is well discernible that when the number of land fragments is increasing, the application of organic manure has been reduced. The more is the number of land fragments; the complex is the land and resource management. If the number of land fragments is more, then another possibility is that some few fragments are taken care of for better management while others are left aside. The variable on farm income (x_{14}) has recorded a positive but significant correlation with application of organic manure (y). The relation is obvious because whenever farm income is generating more, the intensity of management and caring goes up. The respondents, who are experiencing more income from their farms, are becoming more sensitive to soil health and land care and the application of OM has been upscaled. The variable livestock count (x_{20}) has recorded a significant and positive correlation with application of organic manure (y). This relationship is quite noticeable because the primary source for OM for the farmers in this region is the count of livestock and crop residues. Whenever the count of livestock is increasing, the application of organic manure in their lands is also increasing simultaneously. The variable production of organic manure (x_{23}) has recorded a strong positive correlation with the application of organic manure (y). The relationship is quite discernible simply because whenever at the house and farms production of organic manure is increasing the application of organic manure will also be increasing proportionately. Beta coefficient of the variable total hours of irrigation (x_{19}) has been positive and significant implies that for proper decomposition of organic manure to transform it into available plant nutrients; a dedicated supply of water is a must. A dedicated supply of water depends on total hours of irrigation given. Whereas beta coefficient of the variable total input cost has been recorded positive and significant which implies that input cost has been reduced in a response to better application of organic manure. Whenever organic manure is applied to the soil it will replace the need for the application of chemical fertilizer then ecological resilience will be maintained and cost of input will be downsized and sustainability will be enhanced. The beta coefficient of the causal variable land under irrigation has also been positive and significant. It implies that in an irrigated agro-based ecosystem the energy and input management system are very much sensitive and we have to be careful because the number of irrigations involves energy. When energy is more, then the application of fertilizers will become more. At the same time when it is intensive agriculture under irrigated agro-based ecosystem, the total number of labours engaged will before means it has got energy equivalent. So, that is how it has got tremendous associating effect or ability to influence characters of other variables. The R square value stands at 96.40 per cent can be inferred that the combination of 23 causal variables has been quite justified, effective, and able to explain 96.40 per cent of the variance in the consequent variable application of organic manure. A similar study also revealed that the most stable yield and the highest yields were obtained when socio-ecological variables were handled over recurring crop cycles by integrating biennial fallow, gravity flow irrigation, and manure application (Altaweel, 2008).

Predicting application of organic manure from selected variables

Table 2 presents the stepwise regression analysis which elicits those five causal variables livestock count (x_{20}), size of homestead

Table 1. Coefficient of Correlation and Multiple Regression Analysis of Application of organic manure (y) vs. selected causal variables (x_1-x_{23})

Independent Variables	'r' Value	Unstandardized Coefficients		Standardized Coefficients	t Value
		Reg. Coef. B	S.E. B	Beta	
Age (x_1)	0.071	-3.406	9.605	-0.058	-0.355
Education (x_2)	0.130	98.716	51.968	0.283	1.900
Functional education (x_3)	-0.124	-108.100	78.577	-0.299	-1.376
Family size (x_4)	0.113	-44.179	56.499	-0.103	-0.782
Size of land holding (x_5)	-0.244	-4.558	41.694	-0.014	-0.109
Number of land fragments (x_6)	-0.446**	-2.386	4.498	-0.108	-0.531
Average size of land fragment (x_7)	-0.120	-0.280	0.631	-0.115	-0.444
Mean distance between two land fragments (x_8)	-0.025	21.762	14.515	0.295	1.499
Size of homestead land (x_9)	0.105	-132.406	76.095	-0.344	-1.740
Number of crops cultivated (x_{10})	-0.150	0.008	0.014	0.115	0.572
Total yield of crops cultivated (x_{11})	-0.116	0.009	0.007	0.192	1.280
Total marketed surplus of crops cultivated (x_{12})	-0.078	0.003	0.001	0.284	2.399
Total input cost (x_{13})	0.010	0.001	0.000	**0.382**	2.239
On farm income (x_{14})	0.438**	0.003	0.002	0.239	1.646
Family expenditure (x_{15})	0.138	-0.001	0.002	-0.090	-0.700
Annual savings (x_{16})	0.059	-22.808	41.021	-0.136	-0.556
Land under irrigation (x_{17})	-0.226	2.842	1.399	**0.358**	2.031
Cropping intensity (x_{18})	-0.064	0.026	0.325	0.013	0.080
Total hours of irrigation (x_{19})	-0.074	180.378	43.116	**0.626**	4.184
Livestock count (x_{20})	0.916**	-0.562	3.217	-0.030	-0.175
Communication variable (x_{21})	0.023	0.090	0.092	0.106	0.980
Consumption of coal, firewood, fuelwood (x_{22})	0.136	0.078	0.061	0.251	1.280
Production of organic manure (x_{23})	0.330*	-3.406	9.605	-0.058	-0.355

**Correlation is significant at the 0.01 level; *Correlation is significant at the 0.05 level; R square: 96.40%; The standard error of the estimate: 258.639

Table 2. Stepwise Regression Analysis: Application of organic manure (y) Vs. 23 Causal Variables (x_1-x_{23})

Independent Variables	Unstandardized Coefficients		Standardized Coefficients	t value
	Reg. coef. B	S.E. B	Beta	
Livestock count (x_{20})	165.152	22.540	0.574	7.327
Size of homestead land (x_9)	33.749	5.762	0.458	5.858
Size of land holding (x_5)	-64.023	14.058	-0.381	-4.554
Production of organic manure (x_{23})	0.098	0.025	0.314	3.863
Education (x_2)	62.346	28.627	0.179	2.178

R square: 86.90%; The standard error of the estimate: 268.368

land (x_9), size of landholding (x_5), production of organic manure (x_{23}) and education (x_2) has come out with stronger determining character on the application of organic manure (y). These five causal variables together have contributed 86.90 per cent of the variance. This indicates that the contribution of these causal variables has been substantive that rate of (23-5) i.e. 18 causal variables has contributed (96.40-86.90) per cent i.e. only 9.5 per cent. This indicates that to increase the application of organic manure, livestock count should be increased. Both the homestead land and the size of landholding are conjointly contributing to the application of organic manure and soil health. Homestead land plays a very determining role in inviting and managing livestock resources and when it is managed at homestead ecology, the possibility of the requirement of family members for livestock management grows high. Homestead land perhaps has not been able to draw much attention from agricultural scientists and ecologists. The social ecology of farming cannot be possible without comprehensive analysis and interpretation of homestead land ecology and its dynamics. The obvious advantage of owning a big and organized homestead land is that it provokes and promotes horticulture, kitchen garden, livestock, fishery, and poultry enterprises. Perhaps most or all of these enterprises generate a steady income as well as a dedicated volume of organic residues that can be applied in other components of farming. Education has also come out as one of the crucial determinants in scaling up organic characters of farming. These five variables have got a strong and disciple impact from the consequence of organic manure in the operative form for both the restoration of soil health and ecological management of farming. These five variables vis-a-vis should be dealt with attention and management skills. A similar study also revealed that the farmers' traditional knowledge is vital for the sustainable agricultural development of the country (Lenka & Satpathy, 2020).

Table 3 presents the path analysis wherein the total effect of the exogenous variable on the consequent variable has been decomposed into direct, indirect, and residual effects. It has been found that the variable total hour of irrigation has exerted the highest direct effect. This implies that for proper decomposition of organic manure to transform it into available plant nutrients; a dedicated

Table 3. Path Analysis: Decomposition of Total Effect into Direct, Indirect and Residual Effect: Application of organic manure (y)

Independent Variables	TE	DE	IE	HIE
Age (x_1)	0.071	-0.058	0.129	0.048(x_5)
Education (x_2)	0.130	0.282	-0.152	-0.169(x_5)
Functional education (x_3)	-0.124	-0.299	0.175	0.060(x_5)
Family size (x_4)	0.113	-0.103	0.216	-0.130(x_5)
Size of land holding (x_5)	-0.244	-0.014	-0.230	0.831(x_{17})
Number of land fragments (x_6)	-0.446	-0.108	-0.338	-0.742(x_5)
Average size of land fragment (x_7)	-0.120	-0.115	-0.005	-0.754(x_5)
Mean distance between two land fragments (x_8)	-0.025	0.293	-0.318	-0.311(x_5)
Size of homestead land (x_9)	0.105	-0.344	0.449	-0.138(x_5)
Number of crops cultivated (x_{10})	-0.150	0.114	-0.264	0.194(x_{18})
Total yield of crops cultivated (x_{11})	-0.116	0.192	-0.308	0.701(x_5)
Total marketed surplus of crops cultivated (x_{12})	-0.078	0.284	-0.362	0.790(x_5)
Total input cost (x_{13})	0.010	0.382	-0.372	0.134(x_9)
On farm income (x_{14})	0.438	0.237	0.201	-0.174(x_5)
Family expenditure (x_{15})	0.138	-0.090	0.228	-0.383(x_5)
Annual savings (x_{16})	0.059	-0.136	0.195	-0.832(x_5)
Land under irrigation (x_{17})	-0.226	0.358	-0.584	-0.988(x_5)
Cropping intensity (x_{18})	-0.064	0.013	-0.077	0.170(x_5)
Total hours of irrigation (x_{19})	-0.074	**0.626**	-0.700	-0.958(x_5)
Livestock count (x_{20})	0.916	-0.030	**0.946**	0.425(x_5)
Communication variable (x_{21})	0.023	0.106	-0.083	-0.180(x_5)
Consumption of coal, firewood, fuelwood (x_{22})	0.136	0.251	-0.115	0.491(x_5)
Production of organic manure (x_{23})	0.330	-0.055	0.385	0.239(x_5)

TE- Total effect; DE- Direct effect; IE – Indirect effect, HIE- Highest Indirect Effect; Residual effect: 0.036

supply of water is a must. A dedicated supply of water depends on the total hours of irrigation given. The variable livestock count has exerted the highest indirect effect and it is also an important determinant for the volume of organic manure to be produced by the farmer. The real concern in West Bengal agriculture is that the count of livestock is alarmingly declining hence the natural source of organic manure in the form of cow dung has been jeopardized i.e., how to escalate the possibility and performance of CA, the count of livestock must have to enhance otherwise that the restoration and augmentation of ecological resilience will remain an illusion. On the other hand, the size of the farm indicates the land resources and it also implies the resource endowment of the farmer. The higher is the size of holding, the bigger would be the investment ability and risk absorbing capability and that is how this variable has figured up as many as 20 out of 23 times to correct ionized the consequent variable application of organic manure. The residual value is 0.036 it infers that a little over 3 per cent cannot be explained with this combination of 23 variables. It has been supported by the R square value 96.40 per cent as well. Similar study also revealed that the achievement motivation of the farmers plays a crucial role in practicing organic farming (Bhattacharjee et al., 2021).

CONCLUSION

Land remains and continues to be the prime determinant in ecofriendly agriculture. The crux of Indian land crisis is that the holdings are not only small but fragmented as well. The marginalization and fragmentations of holding invite to make average farmland energy and resource prodigal. This also offers a barrier to socializing conservation agriculture effectively for the small land size category. The study also reveals another shocking fact regarding a sharp decline in livestock count at village level. This is one of the reasons why the organic carbon level is dipping so fast for Indian soils. The strong path coefficient between livestock count and application of organic manure has been self-explanatory. The study also reveals the domination of non-cognitive adoption of organic manure in Indian farming, this is high time to transform each of these non-cognitive adoptions into a logical, assertive, and conscious ecological tradeoff between farm and resource ecosystems.

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