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Factors Affecting on Adoption of Sustainable Agricultural Practices in Manipur

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ABSTRACT

Adoption of sustainable practices in agriculture is crucial for ensuring the long-term viability of farming systems, protecting the environment, and promoting food security and economic prosperity for future generations. If the sustainable practices are not aligned with farmers' needs, adoption status may likely to be low. To investigate the adoption behavior of farmers in the different dimensions of sustainable practices, a study was conducted in Manipur during November 2021 to July 2023. The data was gathered from randomly selected 320 respondents. The findings highlighted that the highest adopted sustainable agricultural practices was MW (manual weeding) and CR (crop rotation). Most of the respondents belonged to the medium level of adoption with a 51.53 adoption index. Using binary logistic regression, the effect of independent variables on the adoption of sustainable agricultural practices was tested. The model exhibits below moderate relationships, predicting 25.00 per cent of decisions to adopt sustainable agricultural practices, which can be explained by the independent variables. Furthermore, out of the eleven variables, seven variables were importantly influenced on the adoption of sustainable agricultural practices. Boosting farmers' confidence through technology demonstration, awareness campaigns about the benefits of sustainable technology, and implementing a well-designed, user-friendly interface with feedback mechanisms can significantly enhance adoption rates.

INTRODUCTION

Sustainable agriculture is a method that offers an acceptable degree of economic return and improves the standard of living in rural communities. This cultivation practice involves plants and animals that preserve the environment, increase the utilization of natural resources, and make use of crop residue. Among the different options available, organic cultivation, precision farming, regenerative farming, and agro-ecological system are undoubtedly stand out as effective approaches to sustainability (Ferreira et al., 2022 & Ndaba et al., 2022). Sustainable agriculture seeks to ensure the economic viability of farming operations (Oberc & Schnell, 2020). In agriculture, innovation technologies has the potential to be significantly aided the sustainability (Bukchin & Kerret, 2020) hence technology adoption improve productivity and income. It plays a crucial role in achieving sustainable agriculture by improving efficiency, reducing resource use, and minimizing environmental impacts. Educating the farmers regarding the consequences of stubble burning and the potential benefits of adopting technologies may be the potential options for sustainable management (Ragini et al., 2023). In India, adoption of sustainable technology is rapidly reshaping agriculture, uplifting rural areas, and achieving food security. It contributes to improved food security and increases the incomes of adopters (Kopalo et al., 2021; Teka & Lee, 2020) which also help in mitigating the environmental impacts comes from agricultural practices (Foguesatto et al., 2020). There have been significant advancements in adoption of agricultural technology, however the gaps in technology adoption in the agricultural sector still considered as a major concerned. Effective adoption of sustainable practices has become very essential to agricultural

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policy and practice, which can help with the restoration and management of the natural environment. It ensures a regenerative and sustainable agriculture system. For achieving greater sustainability, it is essential to adopt technologies in an effective way to avoid unfavorable decisions and technology reverses by the adopters. A study on the technology adoption helps in examining an individual's decision to accept or reject sustainable technology as well as the extent to which technology is integrated into the appropriate context. Several research findings suggest that socioeconomic factors might have a positive or negative impact on adoption. Identification of the factors influence on adoption may assist on further investigation and it may provide information to the policymakers to encourage farmers' adoption (Meena et al., 2023). However the factors influencing the adoption and acceptability of technologies in agriculture remain unappreciated (Bilali et al., 2021). Evaluation and identification of the factors contributed towards the adoption of sustainable agricultural practices will give more information in research studies and interpretation on how well socio-economic status of farmers relates with their decision on adoption of technology. Therefore, this study investigates the status of adoption of sustainable agricultural technology to understand the adoption behavior of farmers in the different dimensions of sustainable practices, which can provide more insights into its adoption level and examine the variables associated with the adoption of sustainable agriculture practices.

METHODOLOGY

The present study was conducted during November 2021 to July 2023 in Manipur a north-eastern state of India. Agriculture makes a significant contribution to the state's GDP and employs 52.81 per cent of its workforce force as cultivators. There are sixteen districts in Manipur, out of this based on higher productivity and larger cultivated area, four districts were purposively selected. Two districts viz., Imphal East and Thoubal district from valley area and Churchanpur and Senapati district from hill area were selected. From each of the selected districts, two blocks were randomly selected thus 8 blocks were included for the present study. Out of these blocks, two villages were randomly selected. A total of sixteen villages were included in the present study. A list of farmers were prepared and from the list 20 farmers were selected randomly from each of the selected villages. Therefore, the present study has a sample size of 320 respondents. A well-structured schedule with open ended questions was developed for the collection of primary data. The interview schedule covered 11 independent variables and adoption of sustainable agriculture practices as dependent variable. To measure the adoption of sustainable agriculture practices 22 technologies encompassing nutrient management, soil conservation, water conservation, plant protection, weed management, restoration and rehabilitation were selected based on the literature review and field survey. The score of the adoption of the sustainable agricultural practices was kept as '1' for adopters and '0' as for non-adopters. Respondents were categories from the responses recorded and simple percentage analysis was carried. Then adoption index was measured. Depending on the total score obtained by each of the respondents, they were categorized into low adoption, medium adoption and high adoption based on the mean and standard deviation value. The study further investigated the variables that explain adoption of sustainable agricultural practices using a binary logistic regression model. This model help in estimating the likelihood effects of the various socio-economic factors considered in the study on adoption of sustainable agricultural practices by framers.

RESULTS

Nutrient management

Among sustainable agricultural practices of nutrient management, majority (70.00%) of the respondents adopted CCR, 62.19 per cent and 61.25 per cent of them adopted NFC and AM respectively. The overall mean score for sustainable practices in nutrient management was 0.64. The associated mean score signifies an above-moderate overall adoption rate, indicating a relatively balanced distribution between adopters and non-adopters. The higher adoption rates indicate a positive trend toward environmentally friendly and resource-efficient nutrient management practices.

Soil conservation

Majority (74.38%) of the respondents practiced CR sustainable agricultural practices of soil conservation followed by CCP (56.88%), NF (51.25%) and TF (50.00%) except CF (20.94%). The overall mean score of the sustainable agricultural practices for soil conservation was 0.51. The associated mean score shows an almost balanced distribution between adopters and non-adopters; it also highlights a moderate level of acceptance for soil conservation method. The interpretation of these findings involves considering the ecological, agronomic, and socio-economic factors that influence the adoption of soil conservation practices facilitating a deeper understanding of the dynamics that shape farmers' decisions regarding sustainable agricultural practices.

Water conservation

Mulching is the sustainable agriculture practice adopted by majority (56.87%) of the respondents for water conservation. Nearly 50.00 per cent of the respondents harvest rain and also do recycling of water. Around one third of the respondents only adopted for drip or sprinkler irrigation. The overall mean score for the sustainable practices of nutrient management was 0.47. The associated mean score signifies a lower adoption of such practices related to water conservation. These findings enhance our comprehension of farmers' decisions regarding the adoption of sustainable agricultural practices for water management.

Plant protection

Majority (69.69%) of the respondents planted their crops timely and 63.12 per cent of them also started using disease free seeds. Nearly half of them followed sustainable plant protection practices by maintaining crop diversity and practicing physical control. The number of farmers using biological control is less and was found nearly one third only. The overall mean score of the sustainable agriculture practices for plant protection was 0.54 which shows a balanced distribution between adopters and non-adopters of the sustainable plant protection practices.

Table 1. Distribution of adopters and non-adopters based on the adoption of sustainable agricultural practices

Dimensions of sustainable agricultural practices	Overall (N=320)		Meanscore	Overall
	Adopters (%)	Non-adopters (%)		Meanscore
Nutrient management				
Animal manure (AM)		38.75	0.61	0.64
Application of compost or crop residue (CCR)	70.00	30.00	0.70	
Nitrogen fixing crop (NFC)	62.19	37.81	0.62	
Soil conservation				
Cover crop plantation (CCP)	56.88	43.12	0.57	0.51
No-tillage farming (NF)	51.25	48.75	0.51	
Contour farming (CF)	20.94	79.06	0.21	
Terrace farming (TF)	50.00	50.00	0.50	
Crop rotation (CR)	74.38	25.63	0.74	
Water conservation				
Mulching (ML)	56.87	43.13	0.57	0.47
Drip or sprinkler irrigation (DSI)	33.75	66.25	0.34	
Rainwater harvesting (RWH)	49.38	50.62	0.49	
Recycle water (RW)	48.75	51.25	0.49	
Plant protection				
Diseases free seeds (DFS)	63.12	36.88	0.63	0.54
Biological control (BC)	33.75	66.25	0.34	
Timely plantation (TP)	69.69	30.31	0.70	
Physical control (PC)	53.44	46.56	0.54	
Maintain crop diversity (MCD)	48.44	51.56	0.48	
Weed management				
Manual weeding (MW)	95.62	4.38	0.96	0.56
Weeding by harrow or trowel (WHT)	28.13	71.88	0.28	
Plough before seeding (PW)	43.75	56.25	0.44	
Restoration and regeneration				
Waste management (WM)	28.45	71.55	0.22	0.23
Regeneration planting (RP)	33.75	66.25	0.24	

Weed management

Manual weeding is the only sustainable agriculture practice of weed management adopted by 95.62 per cent of the respondents. Hardly one third of the farmers used harrow and trowel for weeding. Majority (56.25%) of them was not adopted plough before seeding to control weed. The overall mean score of the sustainable agriculture practices for weed management was 0.56. These findings emphasize the predominant role of manual weeding. The associated mean score signifies a higher adoption rate, indicating a relatively higher distribution of adopters than non-adopters in adopting the sustainable practices in weed management.

Restoration and regeneration

Nearly 30 per cent of the respondents adopted waste management practices and regenerative planting. The overall mean score of the sustainable agriculture practices for restoration and rehabilitation was 0.23. The mean score suggests a lower adoption rate, indicating a relatively higher proportion of non-adopters compared to adopters when it comes to adopting sustainable practices for restoration and rehabilitation.

Further Table 1 revealed that the highest adopted sustainable agriculture practices was manual weeding 'MW' with a mean score of 0.96 indicating highest adopted sustainable agricultural practices similar result found in Rukundo et al., (2023) that most adopted technology was regular hand weeding with an average adoption rate was 77% whereas waste management 'WM' had the lowest mean score 0.22 indicating the lowest adopted sustainable agricultural practices. Low adoption of sustainable agriculture practices may be due to a lack of knowledge and awareness about the technology.

In the overall adoption level of sustainable agricultural practices presented in Table 2, it was found that the majority (64.38%) of the respondents had a medium level of adoption, followed by the 19.69 per cent of the respondents having a high level of adoption and the remaining 15.93 per cent had low level of adoption. The adoption index of sustainable agricultural practices was 51.53. The above findings are in line with the findings of Bhajipale et al., (2019) & Kakkad et al., (2019) that majority farmers had medium level of adoption.

Table 2. Distribution of respondents based on the overall adoption level of sustainable agricultural practices

Level of adoption	Frequency	Percentage	Adoption index
Low (<5.60)	51	15.93	51.53
Medium (5.60-9.80)	206	64.38	
High (>9.80)	63	19.69	

Mean = 7.70; SD = 2.10; Total sample size N = 320

Table 3. Socio-economic factors and the prediction of farmers adoption of sustainable agricultural practices

Variables	B Variable parameter	P value	Odds ratio
X_1: Age	0.028	0.033*	1.029
X_2: Sex	-0.011	0.967	0.989
X_3: Household size	-0.155	0.050*	0.857
X_4: Education	0.124	0.005*	1.132
X_5: Occupation	0.018	0.512	1.018
X_6: Landholding size	0.202	0.049*	1.224
X_7: Experience	0.031	0.025*	1.031
X_8: Income	0.135	0.000*	1.145
X_9: Informal information contact	0.142	0.007*	1.152
X_{10}: Social media information contact	-0.121	0.239	0.886
X_{11}: Extension contact	0.179	0.202	1.196
Constant	-2.671	0.008*	0.069

Source: Own Study; *Significant at 5% level of significant
Hosmer and Lemeshow Test: Chi-Square = 8.204, d.f = 8; sig = 0.414.
-2 log likelihood = 390.636; Cox & Snell R2 = 0.154; Nagelkerke R2= 0.250;
Overall percentage of right prediction = 67.00%
Dependent variable: Adoption of sustainable agricultural practices.

The results of the binary logistic regression model shown in Table 3 indicate that among various socio-economic factors considered, age, household size, landholding size, experience, income and informal information contact are significantly more likely to influence the adoption of sustainable agricultural practices by farmers. The R^2 Nagelkerke value of 0.250 indicates a below moderate explanatory power of the model considered and there is still more scope to incorporate with relevant variables in the model. The independent variables have statistically significant impact on the dependent variable with omnibus testing with 5% level of significance. The important variables that influence adoption of sustainable agricultural practices include X_1, X_3, X_4, X_6, X_7, X_8 & X_9.

DISCUSSION

In terms of the adoption of sustainable agricultural practices, the findings suggest that more than 50 percent farmers adopt sustainable nutrient management, followed by weed management, plant protection, and soil conservation practices with an adoption rate of above average. It indicates the willingness of farmers to adopt the environmental friendly technologies, which can improve sustainability. This findings is similar with Rukundo et al., (2023) & Midamba et al., (2024). Adoption is average as there is low adoption in the particular sustainable practices which is shown in Table 1 under the different dimensions of sustainable practices suggesting many interventions are still needed to increase to its full adoption level. Further, more than 50 per cent farmers do not adopt the sustainable practices in water management, regeneration, and restoration. This may be attributed to lack of infrastructure, and technical knowledge pose significant barriers to the adoption. The main barriers of implementing the adoption mentioned by farmers was lack of awareness about the benefit of the technology and prioritize short-term economic gains over long-term sustainability. Regarding the adoption level of respondents, farmers adopt medium to high level adoption it might be farmers perceived technology as moderately complex to implement and manage, however some farmers adopt the technology with maximum benefits. The findings are parallel with Singh & Sharma (2019); Jat et al., (2022) & Boora et al., (2023). Farmers may require technical support for efficient and effective adoption to make full use of the technology. Medium level adopters may have awareness of the technology but lack of comprehensive information about the benefits or long-term impacts of technology can reduce the rate of adoption. Limited access to extension services, training programs, or demonstration of technology could also contribute to the gap in knowledge therefore decline adoption level. Further binary logistic regression analysis was carried out to determine the influence of the independent variables in adoption behaviour of farmers. The results can summarize that adoptions of sustainable agricultural practices technology significantly associated with 7 variables indicating the most important variables in adoption of sustainable agricultural practices. Age of the farmers is an important explanatory variable influence on adoption of the sustainable agricultural practices, it is evident from the study Kumar et al., (2020); Musafifiri et al., (2020) & Serebrennikov et al., (2020) that the likelihood of adoption increase as farmers get older. Adult farmer with more experience of farming are most likely to take the risk to improved the sustainability of the existing farm. Education is a crucial predictor on the adoption of sustainable agricultural practices that farmers with higher degree have more knowledge and likely to seek more information to sustain the adoption of the technology thus educated farmers have higher acceptability of technology adoption. Similar findings found in the study of Digal & Placencia (2019); Priya & Singh (2022) & Midamba et al., (2024). However increasing the household size of farmers are less likely to adopt the sustainable agricultural practices. This agree with the findings of Massresha et al., (2021) & Midamba et al., (2024) who state that as the number of family members increases in a household, the rate of technology adoption declines. Higher landholding farmers are more likely to take risks and adopt the innovation, which is why this variable is a key indicators of the adoption of sustainable agricultural practices Kumar et al., (2020); Serebrennikov et al., (2020); Kumar et al., (2023). Farm size is a strong predictor of technological adoptions. Moreover, it is generally hypothesized that farmers with higher farm income induces the farmers adoption rate. Income is found as strong and favorable variable in adoption of sustainable agricultural technology. Laosutsan et al., (2019); Marenya et al., (2020); Pathak & Amardeep (2024) also found that adoption of sustainable and diverse farm enterprise increase farmers income. Further, informal information contact influence the adoption of sustainable agricultural practices. According to Kumar et al., (2018) farmers with higher experience in farming are more likely to learn about new technology and increased exposure to demonstrations from informal sources. It suggest that farmers who access more informal information contact have the higher tendency to adopt the sustainable agricultural practices. However the variables sex, occupation, social media contact and extension contact are less likely to influence the adoption in the study. The impact of these variables on the adoption of sustainable agricultural practices may not be favourable to induce the rate of adoption of farmers.

CONCLUSION

The results of this study suggest that the most widely adopted sustainable agricultural practices were 'MW' manual weeding, whereas the least adopted were 'WM' waste management. Most farmers were found in the category of medium adoption, with an adoption index of 51.53. Additionally, the study revealed that socio-economic factors that positively influence the adoption of sustainable agricultural practices are income, informal information contact, education, age, landholding size, experience, and family type indicated that these significant variables are the important predictors of adoption behaviors. Considering these predictors while implementing the intervention, policymakers, agricultural extension services, and researchers can minimize the risk associated with adoption and promote the widespread adoption of sustainable agriculture practices. Additionally, to improve technology adoption, establishing a well-designed interface and user-friendly technology enabled feedback mechanisms to gather input from farmers can significantly enhance adoption rates.

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