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Assessment of Farmers' Knowledge towards Sustainable Agricultural Practices (SAP) in Manipur

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HIGHLIGHTS

- Considerable difference of farmers' knowledge level was observed between valley region and hill region in Manipur
- Knowledge index of valley district respondents was higher in comparison to hill district respondents
- Use of Social media information sources highly influenced the knowledge index of respondents in both valley and hill districts

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ABSTRACT

This study explored disparities in farmers' knowledge of sustainable agricultural practices between valley and hilly districts of Manipur, conducted across four districts (Senapati, Churachandpur, Imphal East, and Thoubal) from 2021 to 2023. A total of 320 respondents were selected using a multi-stage random sampling method. The study measured knowledge across six areas: agronomic practices, soil and water conservation, nutrient management, pest control, disease control, and waste recycling. Results revealed that valley districts (Imphal East and Thoubal) had significantly higher knowledge (mean index = 45.07) compared to hilly districts (Senapati and Churachandpur) with a mean index of 30.76. Valley districts excelled in practices like crop rotation and water harvesting, while hilly areas showed lower knowledge, particularly in pest management and water conservation. Information sources such as social media played a critical role, especially in hilly districts. The study highlights the need for region-specific interventions and tailored extension services to address knowledge gaps and promote sustainable farming practices.

INTRODUCTION

Sustainable agriculture is crucial for feeding a growing global population and combating climate change (Mensah, 2019). It helps to protect the environment, preserve natural resources, improve soil fertility and enhance living standard of rural communities (Thangjam et al., 2024). Several factors influencing the adoption of sustainable agricultural practices and most can be contextualised within the adoption paradigms identified by Prager & Posthumus (2010). Liu et al., (2018) and revealed that factors such as information and awareness, farmer's demographics, knowledge and attitudes, characteristics of the farms, characteristics of the sustainable management practices influence the implementation of sustainable management practices. Kumar et al., (2023) highlighted the factors such as integrated soil fertility management practices, integrated pest management practices, adoption of ZBNF practices, use of live mulching and drip irrigation as significant factors for practicing sustainable agriculture. Knowledge plays a pivotal role in the adoption and successful application of sustainable agricultural methods. When individuals are exposed to innovations, they seek to understand how these methods function, initiating the learning process. Cognitive factors relate to the adoption of sustainable practices because the adoption of specific sustainable agricultural practices has been observed higher when farmers have sufficient knowledge (Thangjam & Jha 2024). In rural communities, especially in developing regions, the extent of farmers' knowledge about modern agricultural techniques, sustainable practices, and resource

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management often determines the productivity and long-term viability of farming systems. According to Karangami et al., (2019) & Gebska et al., (2020) farmers' knowledge significantly influences their ability to adopt innovations that improve both the efficiency and sustainability of agricultural practices. The shaping of farmers' knowledge is a complex and multi-stranded process which, in part, is closely linked to place according to Wojcik et al., (2019). Knowledge gained through learning or direct experience, making it crucial for the effective adoption of sustainable agricultural methods (Thomas et al., 2020). Local farmers' knowledge of sustainable agriculture represents a vast body of practical experience and the capacity for knowledge generation, both of which are crucial for achieving sustainability and development goals. Therefore, it is essential to understand the depth of farmers' knowledge regarding sustainable agricultural practices (Ghosh et al., 2020). While sustainable agriculture is inherently knowledge-intensive, many farmers, particularly in regions like Manipur, still lack the necessary understanding and skills for its effective implementation. Few studies have explored the importance of farmers' knowledge of sustainable practices, and even fewer have examined how socio-economic factors influence this knowledge in the state. Understanding these factors is critical to ensuring the successful adoption of sustainable agricultural practices (SAP) and their potential to improve farmers' livelihoods while promoting environmentally friendly production systems. This research aims to assess the knowledge levels of farmers across different districts in Manipur, using a comprehensive knowledge index to evaluate their understanding of sustainable agricultural practices.

METHODOLOGY

The present study was conducted in Manipur across four districts during 2021-23. A multi-stage random sampling method was employed in four districts; Senapati and Churachandpur districts represent the hill region while Imphal East and Thoubal districts represent the valley region having the highest cultivated area and highest crop productivity in the state. From each district, two blocks were randomly selected, arriving a total of eight blocks being selected randomly. Furthermore, two villages were selected from each block, 20 respondents were selected from each village randomly, arriving a total sample of 320 respondents. This sampling design ensured a comprehensive representation of the target population in hill and valley region of the state. Prior to this present study, a pilot study was conducted in hill district and valley districts of the state through direct interview and field visit methods. Following the pilot study, various sustainable agricultural practices were identified and lists of sustainable agricultural practices (SAP) were prepared. Among the identified SAPs, six dimensions viz., agronomic practices, soil and water conservation, nutrient management, pest control methods, diseases control methods and recycle management were selected based on the most concerned sustainable practices in agriculture engaged by the farmers of the state.

The knowledge indexes (KI) of the respondents were measured by conducting a face to face interaction and direct interview method with the help of the interview schedule consisting close ended questions. Respondent's response was recorded and the analysis included binary scores with the answer "yes" coded as 1, while the answer "no" coded as 0 for each question which were added together to get a knowledge score for developing knowledge index. 't' value was also calculated to know the significant difference of knowledge level of farmers on sustainable agricultural practices between hill districts and valley districts. The six dimensions were also ranked separately for valley districts and hill districts based on the mean score of knowledge level to illustrate the knowledge gap among the dimension of SAP across the districts. Regression analysis was carried out to identify and quantify the relationships between socio economic factors and knowledge level of the farmers.

RESULTS

Table 1 presents the knowledge index for sustainability practices across four districts: Thoubal, Imphal East, Senapati, and Churachandpur. The analysis reveals notable differences in farmers' knowledge of sustainable farming practices, with farmers of Thoubal and Imphal East generally exhibiting higher knowledge levels compared to farmers of Senapati and Churachandpur. In agronomic practices, farmers of Thoubal led in knowledge of improved varieties (56.25%), followed by farmers of Imphal East (52.50%). Farmers of Senapati (35.00%) and Churachandpur (30.00%) showed lower knowledge levels. For the sustainable practice crop rotation, farmers of Thoubal (75.00%) had the highest knowledge index followed by Imphal East (70.00%), while farmers of both Senapati and Churachandpur districts had moderate knowledge (62.50%). For inter-cropping, farmers of Churachandpur (70.00%) had the highest knowledge, followed by farmers of Imphal East (50.00%) and Senapati (47.50%), whereas farmers of Thoubal had the lowest (43.75%) knowledge.

In soil and water conservation, farmers of Thoubal (40.00%) and Imphal East (37.50%) had below-moderate knowledge of conservation tillage, with farmers of Senapati (22.50%) and Churachandpur (37.50%) showing even lower levels. For pond water harvesting, farmers of Thoubal (57.50%) had the highest knowledge, followed by farmers of Imphal East (51.25%), while farmers of Senapati (23.75%) and Churachandpur (11.25%) had significantly lower knowledge. In mulching, farmers of Imphal East (50.00%) had the highest knowledge, followed by farmers of Thoubal (42.50%), with farmers of Senapati (30.00%) and Churachandpur (33.75%) districts showing below-moderate knowledge. In nutrient management, farmer's knowledge of cover crops was low across all districts- with Imphal East (38.75%), Senapati (40.00%), Thoubal (37.50%), and Churachandpur (28.75%). In green manure, farmers of Imphal East (37.50%) had the highest knowledge, followed by farmers of Thoubal (33.75%), but both Senapati (23.75%) and Churachandpur (20.00%) districts' farmers had very low levels of knowledge. For organic fertilizers, farmers of Thoubal (47.50%) had the highest knowledge, followed by farmers of Imphal East (43.75%), while farmers of Churachandpur (41.25%) and Senapati (31.25%) had lower levels. Regarding pest control, farmers of Imphal East (48.75%) had the highest knowledge, followed by farmers of Thoubal (40.00%), with farmers of Churachandpur (21.25%) and Senapati (13.75%) showing very low knowledge. In biological control, farmers of Imphal East (41.25%) led, though still below-moderate, while farmers of Thoubal

Table 1. Knowledge level of sustainable agricultural practices (SAP) in sampled districts

Dimensions of SAP	Sustainable practices	Knowledge index (KI)		KI of valley districts	Knowledge index (KI)		KI of hill districts
		THB (n=80)	IME (n=80)	(n=160)	SNP (n=80)	CCP (n=80)	(n=160)
Agronomic practice	Improved variety	56.25	52.50	54.38	35.00	30.00	32.50
	Crop rotation	75.00	70.00	72.50	62.50	62.50	62.50
	Inter-cropping	43.75	50.00	46.88	47.50	70.00	58.75
Soil and water conservation	Conservation tillage	40.00	37.50	38.75	22.50	37.50	30.00
	Pond water harvesting	57.50	51.25	54.38	23.75	11.25	17.50
	Mulching	42.50	50.00	46.25	30.00	33.75	31.88
Nutrient Management	Plantation of cover crop	37.50	38.75	38.13	40.00	28.75	34.38
	Green manure	33.75	37.50	35.63	23.75	20.00	21.88
	Organic fertilizer	47.50	43.75	45.63	31.25	41.25	36.25
Pest control method	Physical control	40.00	48.75	44.38	13.75	21.25	17.50
	Biological control	23.75	41.25	32.50	6.25	10.00	8.13
	Cultural control	30.00	15.00	22.50	18.75	22.50	20.63
Diseases control method	Physical control	43.75	37.50	40.63	28.75	36.25	32.50
	Biological control	36.25	46.25	41.25	6.25	12.50	9.38
	Cultural control	30.00	35.00	32.50	16.25	18.75	17.50
Recycle management	Field waste	78.75	76.25	77.50	41.25	37.50	39.38
	Animal waste	36.25	18.75	27.50	35.00	30.00	32.50
	Plant waste	62.50	57.50	60.00	61.25	40.00	50.63

(23.75%), Churachandpur (10.00%), and Senapati (6.25%) had very low knowledge levels. For cultural control, farmers of Thoubal (30.00%) and Churachandpur (22.50%) exhibited higher knowledge compared to Imphal East (15.00%) and Senapati (18.75%), thus, farmers of all districts had below-moderate knowledge. In disease control methods, knowledge of farmers regarding physical control was relatively higher in Thoubal (43.75%) and Imphal East (37.50%), with Senapati (28.75%) and Churachandpur (36.25%) showing lower levels. For biological control, farmers of Imphal East (46.25%) had the highest knowledge, followed by Thoubal (36.25%), while farmers of Senapati (6.25%) and Churachandpur (12.50%) had very low levels. In cultural control, farmers of Imphal East (35.00%) had the highest knowledge, though still below-moderate, followed by farmers of Thoubal (30.00%), Churachandpur (18.75%), and Senapati (16.25%) districts. In recycle management, farmers of Thoubal (78.75%) and Imphal East (76.25%) demonstrated high knowledge of field waste management, while farmers in Senapati (41.25%) and Churachandpur (37.50%) had lower knowledge levels. For animal waste management, farmers of Thoubal (36.25%) and Senapati (35.00%) had below-moderate knowledge, while farmers of Imphal East (18.75%) and Churachandpur (30.00%) had very low knowledge. In plant waste recycling, farmers of Thoubal (62.50%) and Senapati (61.25%) showed strong knowledge, followed by Imphal East (57.50%), while farmers of Churachandpur (40.00%) exhibited lower knowledge. Overall, farmers of Thoubal and Imphal East districts demonstrated higher knowledge levels. In contrast, farmers of Senapati and Churachandpur had relatively lower knowledge levels in areas such as water harvesting, pest control, and nutrient management.

Table 2 revealed that the mean farmer's knowledge index was higher for the valley district (45.07) compared to the hill district (30.76), indicating that farmers in the valley district have greater knowledge of sustainable agricultural practices. The t-values (29.973 for the valley district and 24.842 for the hill district) suggest a significant difference between the two groups' knowledge indices. Overall, it is indicated that the difference in the knowledge level of the farmers have resulted significant variation in adopting the SAP dimensions in selected districts with the valley district farmers exhibiting a higher level of knowledge. The data pertaining to ranking of different dimensions affecting the sustainable agricultural practices (SAP) revealed that distinct differences in performance across various dimensions in valley and hill districts (Table 3). Comparatively, valley districts generally outperformed hill districts in most dimensions of SAP, with higher mean scores and knowledge index (KI) percentages. Among the different dimensions, agronomic practice was the top-ranked dimension in both districts, with valley districts achieving a mean (1.74) and KI (57.92%), while hill districts scored slightly lower with a mean (1.53) and KI (51.25%).

In terms of soil and water conservation, valley districts showed significantly stronger performance, scoring a mean (1.39) and KI (46.46%), ranking III, compared to hill districts, which scored much lower with a mean (0.79) and KI 26.46%, ranking IV. Similarly, for

Table 2. Comparative knowledge of farmers between valley and hill districts on the sustainable agricultural practices (SAP)

Districts	Mean	Std. Deviation	Knowledge index	t value	P value
Valley district	13.812	4.122	45.07	29.973	0.001
Hill district	9.625	3.465	30.76	24.842	0.001

Table 3. Ranking of the dimension of sustainable agricultural practices (SAP) based on the mean knowledge level of the respondents

S.No.	Dimensions of SAP	Valley districts			Hill districts		
		Mean	KI %	Ranking	Mean	KI %	Ranking
1.	Agronomic practice	1.74	57.92	I	1.53	51.25	I
2.	Soil and water conservation	1.39	46.46	III	0.79	26.46	IV
3.	Nutrient Management	1.19	39.80	IV	0.92	30.84	III
4.	Pest control method	0.99	33.13	VI	0.46	15.42	VI
5.	Diseases control method	1.44	38.13	V	0.59	19.79	V
6.	Recycle management	1.65	55.00	II	1.22	40.84	II

Maximum mean value = 3 and Minimum mean value = 0

Table 4. Socio-economic determinants of farmers' knowledge on sustainable agricultural practices (SAP)

Model	Valley districts				Hill districts			
	Unstandardized Coefficients		t	p	Unstandardized Coefficients		t	p
	B	Std. Error			B	Std. Error		
Constant	1.016	1.742	.583	.561	.800	2.351	.340	.734
Age (X_1)	.064	.031	2.029	.044*	.002	.039	.060	.952
Education (X_2)	-.036	.065	-.553	.581	.065	.067	.972	.333
Family size (X_3)	-.040	.143	-.278	.781	-.066	.773	-.086	.932
Family type (X_4)	.140	.465	.302	.763	.598	.247	2.422	.014*
Experience in agriculture (X_5)	.134	.039	3.408	.001**	-.015	.038	-.408	.684
Total land holding (X_6)	.053	.221	.240	.810	-1.031	.000	-1.287	.200
Annual income (X_7)	-7.006	.000	-.718	.474	.600	.301	2.107	.037*
Extension contact (X_8)	.179	.165	1.086	.279	.099	.197	.504	.615
Informal information sources (X_9)	.557	.125	4.449	.000**	-.042	.177	-.239	.811
Mass media information sources (X_{10})	.282	.148	1.908	.058	.216	.184	1.176	.242
Social media information sources (X_{11})	.709	.149	4.744	.000**	.323	.166	2.664	.009**
Market orientation (X_{12})	.133	.061	2.177	.031*	-.013	.054	-.243	.808

Valley districts: R Square = 0.644; Adjusted R square = 0.572; F value = 5.628; P value = 0.01
Hill districts: R Square = 0.532; Adjusted R square = 0.457; F value = 2.071; P value = .019

nutrient management, valley districts registered a mean (1.19) and KI (39.80%), ranked IV, while hill districts ranked III with a mean (0.92) and KI (30.84%). Though both districts showed progress, valley districts demonstrated more effective nutrient management practices. In pest control methods, valley districts scored a mean (0.99) and KI (33.13%), ranking VI, while hill districts showed lower mean (0.46) and KI (15.42%), also ranking VI. Similarly, in disease control, valley districts had higher mean (1.44) and KI (38.13%), ranked V, while hill districts scored lower, mean (0.59) and KI (19.79%), also ranking V. While both districts ranked similarly, valley districts showed a much stronger approach to disease control. Finally, in recycle management, both districts performed well, with valley districts achieving a mean (1.65) and a KI (55.00%), ranked II, and hill districts scoring a mean (1.22) and KI (40.84%), also ranked II. Despite the same ranking, the valley districts demonstrated a higher level of recycling practices and knowledge.

From Table 4 it was found that in case of the valley districts, the variables, Age (t = 2.029, p = 0.044), experience in agriculture (t = 3.408, p = 0.001), informal information sources (t = 4.449, p = 0.000), Social media information sources (t = 4.744, p = 0.000) and market orientation (t = 2.177, p = 0.031) had a significant relationship with the knowledge of farmers on SAP. Further R-squared value of 0.644 for the valley districts indicating 64.4% of the variability in farmers' knowledge of sustainable farming systems is represented by independents variable used in the model. In contrast, in case of the hill districts, the variables Family type (t = 2.422, p = 0.014), annual income (t = 2.107, p = 0.037) and social media information sources (t = 2.664, p= 0.009) had a significant relationship with the knowledge of farmers on SAP. The model for the hilly area has a lower explanatory power, with an R-squared value of 0.532, which accounted for 53.2% of the variability in farmers' knowledge of sustainable farming systems.

DISCUSSION

The findings of this study underscore the significant disparities of farmers of valley and hill districts on the knowledge of sustainable agricultural practices as well as socio-economic factors, highlighting key areas for targeted intervention and capacity building. In the study it was evident that farmers in the valley districts (Thoubal and Imphal East) exhibited a higher overall knowledge of sustainable farming practices compared to their counterparts in the hilly districts (Senapati & Churachandpur). Liao et al., (2022) reported that over half of the farmers had good levels of knowledge on sustainable agriculture.

The valley districts acquired better knowledge of SAP, such as crop rotation, water harvesting, and recycle management. These findings are consistent with the assumption that valley areas may have better access to resources, extension services, and infrastructure, all of which can enhance farmers' understanding that help to increase the knowledge of SAP. In contrast, the hilly district, with more challenging terrain and limited access to modern farming technologies and information channels, displayed lower knowledge levels among farmers in several SAP, particularly water harvesting, pest control method, and nutrient management. This disparity in knowledge levels between valley and hilly districts emphasizes the need for context-specific interventions that account for the unique challenges faced by farmers in hilly regions. Framers have lower knowledge level in diseases and pest management as compared with other practices such as agronomic practices, soil management practice, and nutrient and recycle management. Our findings were consistent with the previous studies of Sarma et al., (2022); Podikunju & Arathy (2022); Pawar & Channaveer (2021) where it was found that majority of the farmers were unaware or lack of knowledge on pest and disease control. However, findings of Kumar & Jahanara (2021) emphasized that farmer's knowledge related to disease and pest control increases due to impart trainings and other capacity building programmes. The role of information sources had significant impact in both valley and hilly areas. In this context, Swami, (2022) found that there was significant association of information seeking behaviour of the farmers with their knowledge level.

In the valley districts, informal information sources, mass media information sources and social media emerged as key facilitators of knowledge about SAP, reinforcing the importance of non-traditional information channels. Farmers in the valley districts were more likely to rely on informal information sources in disseminating SAP. In contrast, in the hilly districts, social media also had a significant positive effect on knowledge of farmers, but other information sources, like mass media, have not produced a significant impact on farmer knowledge. Overall, it is suggested that social media platforms might serve as critical tools for bridging knowledge gaps in hill regions where access to formal education and extension services is limited. Socio-economic factors have influenced on farmer's knowledge, though the patterns differed between the valley and hilly district were observed. Age of the farmers was an important explanatory variable in line with the findings of Kumar et al., (2020); Musafifiri et al., (2020) & Serebrennikov et al., (2020). In the valley districts variables viz., age, experience in agriculture, and market orientation were positively associated with higher knowledge levels of sustainable farming systems. Older farmers with more years of experience in agriculture might have developed a deeper understanding of traditional farming practices and were likely better positioned to integrate these with newer sustainable methods. Asmara et al., (2023) stated that farmer's knowledge increased considering their long experience of farming which eventually helps farmers in achieving high income and increase knowledge on sustainable agriculture.

Additionally, education and extension contact were found insignificant it might be due to respondents were not contacted with the extension agent and this finding is contrast with the results of Mishra et al., (2024) where education, extension participation, were positively and significantly related to the knowledge index of farmers. Moreover, farmers with stronger market orientation may be more attuned to the economic benefits of adopting sustainable practices, such as increased yield, cost reduction, and market demand for eco-friendly products. Interestingly, family size and land holding area did not produced significant impact on knowledge levels in the valley, suggesting that other factors, such as access to information and community support, play a more critical role. In hill districts variables, family type, annual income, and social media usage had a significant and positive association with knowledge. It is possible that farmers in larger or more diversified family set-ups might have greater collective knowledge, with multiple family members contributing to the farming process.

Similarly, higher annual income could enable farmers to invest more in sustainable technologies, training, or information sources that improve their knowledge. However, experience in agriculture, age, and extension contacts did not significantly affect knowledge levels in the hilly regions, which could be due to the limited presence and effectiveness of formal extension services in these more remote areas. The lack of impact of extension contact in the hilly areas further underscores the need for innovative and locally adapted extension models that better cater to the specific needs of these regions. The lower explanatory power of the model for the hilly areas (R Sq: 0.532) compared to the valley areas (R Sq: 0.644) suggests that other unaccounted factors may influence knowledge in the hilly regions. These could include environmental conditions, access to markets, and local cultural practices, which may not be fully captured by the socio-economic variables examined in this study. The lower R-square value in the hilly areas also points to the need for a more understanding of the local context and potentially the incorporation of additional variables, such as environmental constraints and farming practices that could better explain knowledge variations in these regions.

Overall, the study highlights the need for tailored educational programs and extension services that consider the specific socio-economic and environmental contexts of different regions. In valley areas, where knowledge levels are higher, efforts could focus on reinforcing the use of modern technologies and practices, as well as improving market access. In contrast, hilly areas, where knowledge levels were lower, could benefit from targeted interventions that emphasize water conservation techniques, pest management, and nutrient management, along with enhanced access to information through social media and informal networks. Creating awareness programme on sustainable agricultural practices may increase the farmer's knowledge. Gebska et al., (2020) reported that awareness programme resulted in higher knowledge and better implementation of sustainable practices among farmers. Additionally, integrating sustainable farming practices in the state agricultural policies and developing stronger linkages between formal extension services and local community networks could help bridge knowledge gaps in sustainable farming practices across both valley and hilly areas of Manipur.

CONCLUSION

The farmers in the valley districts generally possess higher levels of knowledge compared to their counterparts in the hilly districts. In valley districts, informal information networks, mass media, and social media were pivotal in disseminating knowledge on sustainable practices, whereas in hilly districts, social media played a particularly important role in bridging knowledge gaps. Variables such as age, experience, informal and social media information sources as well as market orientation positively influenced the knowledge levels of farmers in valley areas, while family type, income, and social media usage emerged as key drivers in the hilly areas. Targeted interventions are needed, particularly in hill areas such as water conservation, pest management, and nutrient management, alongside enhancing information access through social media and informal networks. Creating awareness programs and integrating sustainable farming practices into agricultural policies will be crucial in bridging knowledge gaps and promoting the sustainable agricultural practices across Manipur.

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