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The Role of Size of Landholding and Social Participation in Shaping Farmers' Knowledge to Competence: Evidence from ATMA Beneficiaries in Sikkim

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Abstract

India's agricultural advancements have seen recent technological breakthroughs, accompanied with initiatives designed to assist farmers and implement modern technologies. Consequently, the Agricultural Technology Management Agency (ATMA) is one such initiative that has implemented technology extension services as a substitute for conventional methods of farming. The size of the landholding (especially marginal size) is an important concern in agricultural research because it impacts economic outcomes, environmental sustainability, technological adoption, resource utilisation, and productivity. The study intends to find the moderating effect of the size of marginal landholding between the Overall Information Seeking Behaviour (OISB) and Competency score (CS) of the beneficiaries, taking Overall Social Participation Behaviour (OSPB) as a mediator based on 403 Agricultural Technology Management Agency (ATMA) beneficiaries covering all the 31 blocks of 6 Districts of Sikkim. To achieve this study objective the researcher used a moderated mediation analytical framework by using the OISB as an independent variable, CS as dependent variable, and OSPB served as a mediator, while the size of marginal landholding acted as a moderator. The research indicates that OISB is more advantageous for Upper Marginal farm landholders; nevertheless, both OSPB and OISB are crucial for the development of CS on Lower Marginal farm landholders. However, the impact of OSPB on CS diminishes as the size of the landholding increases. The beneficiaries who actively seek information are more likely to demonstrate higher level of competence. Learning and competence-building may be explicitly supported by social participation (e.g., in community groups, cooperatives, or farmer associations) for Lower Marginal farm landholders. For Upper Marginal farm landowners, social participation may be more symbolic or status-driven, contributing minimally to actual competence. Thus, it is recommended that farmers' competencies can be enhanced by using metrics that are tailored to the extent of the size of their landholdings.

Keywords: Landholding size, Behaviour, Participation, Competency score.

JEL Classification: M530, Q240, Q150, Q160

Introduction

Over 50 percent of India's population depend on agriculture and are actively involved in agricultural activities for their sustenance. As time advances, the demand for rural agricultural knowledge and extension programs will undoubtedly heighten. Globally, there are challenges in regulating the swift population expansion amidst the limitation of finite arable land for agricultural purposes. The farmers must enhance their productivity and focus on their domains of competency. From the government's viewpoint, regardless of the focus on productivity, extension services remain an essential policy tool for advancing environmentally and socially sustainable agricultural practices.

The size of the landholding is a vital factor in agri-allied research as it impacts environmental sustainability, technological adoption, economic outcomes, resource use and productivity. The moderating variable of land size has both the direct and indirect outcome because of its fundamental impact on resource endowment, decision-making ability, and responsiveness to interventions among farmers (Teferra *et al*., 2018). It potentially influences the direct impact of an independent variable on the result, with the same intervention

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or resource having varying effects depending on the size of the operation.

Empirical research has demonstrated that the scale of a farm significantly influences production behavior, efficiency, and diversification outcomes. This demonstrates that the effects of various agricultural groupings are distinct (Parre *et al.,* 2024). Farmers' psychological orientation and productivity-related decisions are similarly influenced by landholding size, suggesting that its interaction with significant predictors may significantly influence result interactions (Ravi *et al.,* 2026). Land size can have significant effects on indirect (mediated) pathways because it influences how intermediary processes function. Mediation frameworks related to technology adoption, credit availability, organizational support and their efficacy depends on their land size. In accordance with the research on agricultural systems, mediators including technology adoption and growth in the operations interact with scale-related factors to alter the intensity of indirect impacts (Zhang *et al.,* 2025).

Additionally, moderated mediation frameworks have clearly included land-related or size-related factors, emphasizing their impact on both direct and indirect effects in detailed rural systems (Wei and Zhang, 2025). Thus, the theoretical evidence and empirical confirmation for the inclusion of land area as a moderator in both direct and indirect paths are confirmed. It encompasses a wide range of producers and enables a broader understanding of how the key relationships exist.

Agriculture has consistently progressed through innovative concepts, enhanced methodologies, and advanced technologies. Nonetheless, innovations are only beneficial when they effectively reach and grasped by farmers. Agricultural extension plays a crucial role as it serves as an intermediary between scientific research and agricultural practitioners, facilitating the acquisition and implementation of innovative technologies in their fields. Various extension initiatives have been devised and executed over time, many of which have effectively enhanced farmers' knowledge and understanding about modern agricultural practices (Kaur and Kaur, 2018).

Agricultural technology transfer is basically the transfer of important breakthroughs to farmers in a practical and understandable manner. Extension services are not merely information providers; they are also dedicated to the development of agricultural skills, the demonstration of more effective farming methods, and the encouragement of farmers to try new approaches. The knowledge and awareness levels of farmers vary and therefore these services are meant to depict ideas in a clear and accessible way. They also play an important role in persuading farmers to change and adopt more effective practices. Research indicates that successful technology transfer assists farmers in overcoming numerous agricultural issues. (Aremu *et al.,* 2015). Recognizing this importance, the Government of India introduced the Agricultural Technology Management Agency (ATMA), a district-level initiative aimed at improving the reach and effectiveness of extension services (Ahmed *et al.,* 2015; Singh and Singh, 2014).

However, the importance of land in agriculture cannot be disregarded. All agricultural practices rely on land, which is scarce. The impact of landholding size on productivity and efficiency has become the interest of academics. Several studies have looked into this connection throughout the years, with conflicting results.

According to certain researchers, the performance of farmers depends upon the size of their landholding, as they are more likely to have access to information, skilled labour, higher income, and superior resources. (Asefa and Muluken, 2024). Others noted that the division of land into smaller units diminishes efficiency although the impact may be different depending on the total land size and location. (Hu *et al.,* 2024). There are studies that confirm the effect of farm size on financial performance. For example, larger farms may benefit more from borrowed capital, improving their returns (Sulaiman and Khalid, 2024).

However, the relationship isn't always straightforward. According to certain research, there is an inverse link between farm size and efficiency, suggesting that small farms may use land more effectively (Ferreira and Feres, 2020). On the other hand, large farms tend to be more productive because they are able to invest more on inputs like fertilizers and irrigation (Nilsson, 2019). In addition, labour availability and gender roles with regard to farm size significantly impacts the application of sustainable agricultural practices. (Nigussie *et al.,* 2017).

Furthermore, the efficacy of farming is influenced by an array of interconnected factors. Education, financial support, location, farming experience, and access to extension services all play significant roles (Anang *et al.,* 2016; Mburu *et al.,* 2014). The knowledge and awareness of sustainable agricultural practices that farmers possess are also influenced by their sources of information (Veeresh and Narayana, 2012). However, despite these endeavours, there are still gaps. Many younger or millennial farmers are still lacking in the necessary knowledge to take advantage of modern technological advances and increase productivity, according to recent findings (Widiyanti *et al.,* 2025).

In this study, land size is chosen as a moderator for both the direct and indirect paths between Overall Information Seeking Behaviour (OISB) and Competency Score (CS). The rationale is that landholding size reflects resource availability, economic capacity, and social positioning among farmers. Larger landholders often have greater access to information channels and resources, which can strengthen the direct effect of OISB on CS. Conversely, smaller landholders may rely

more heavily on social participation networks to compensate for limited resources, thereby amplifying the indirect effect through Overall Social Participation Behaviour (OSPB). Thus, land size is expected to moderate both the direct and indirect pathways, providing a nuanced understanding of how resource heterogeneity shapes competency development. The study is based on the conceptual framework as below:

In this backdrop, the present study examines how the Size of Marginal Landholding (SML) moderates the relationship between Overall Information Seeking Behaviour (OISB) and Competency Score (CS), with Overall Social Participation Behaviour (OSPB) acting as a mediator. According to the Agriculture Census 2015 – 16, where the land agricultural operational holding below 1.00 ha. (i.e. 2.471 Acre) are considered as Marginal Farmers (i.e. Marginal Land Holders) and the present study stay focussed on them. Based on sample data relating to the land holding, minimum size is below 0.2 Acre and maximum is 6 Acre.

Therefore, the Landholding size is classified into three ordinal categories based on percentile distribution for Lower Marginal: < 0.8 acre (below 33rd percentile) Landholding (LML), Middle Marginal: 0.8 – 1.5 acres (33rd–66th percentile) Landholding (MML), and Upper Marginal: > 1.5 acres (above 66th percentile) Landholding (UML). Thus, this study aims to examine the mediating-moderating role of the Size of Marginal Landholding (SML) on Overall Information-Seeking Behaviour (OISB), and Competency Score (CS) with Overall Social Participation Behaviour (OSPB) as a mediating factor.

The following hypothesis, sub-hypotheses was used for the analysis.

Interaction Effect

$H_{1.1(a)}$: A significant interaction effect of SML exists between OISB and OSPB

$H_{1.1(b)}$: A significant interaction effect of SML exists between OSPB and CS

$H_{1.1(c)}$: A significant interaction effect of SML exists between OISB and CS

Direct Effect

$H_{1.2A\,(1)}$: A positive link exists between OISB and CS for the LML

$H_{1.2A\,(2)}$: A positive link exists between OISB and CS for the MML

$H_{1.2A\,(3)}$: A positive link exists between OISB and CS for the UML

Indirect Effect

$H_{1.3A\,(1)}$: A positive link exists between OISB→OSPB→CS for the LML

$H_{1.3A\,(2)}$: A positive link exists between OISB→OSPB→CS for the MML

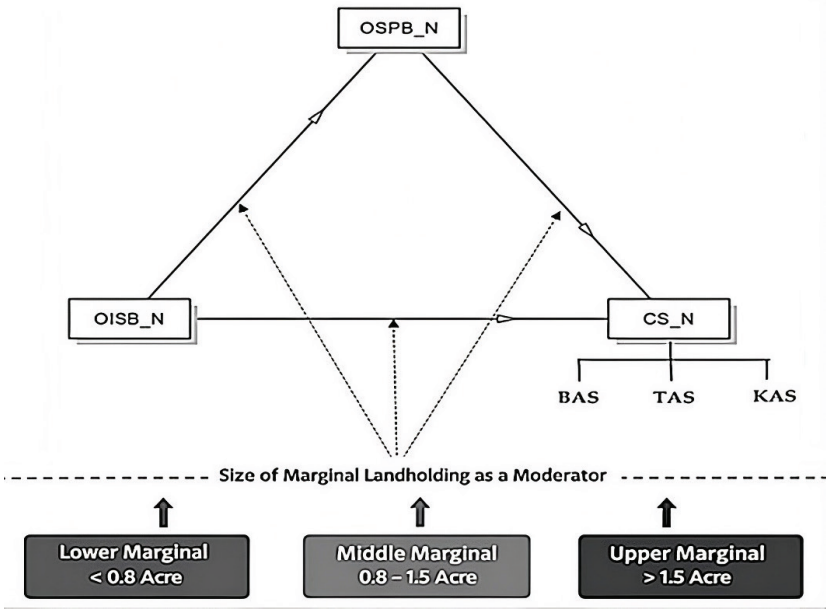

Figure 1. Conceptual Model of Med-Mod mode of the study

Source: Model developed by the researcher

NOTE: Direct Path: → ; Indirect Path: →

BAS: Beneficiary Awareness Score; TAS: Technology Adoption Score; KAS: Knowledge Acquired Score OISB_N: Overall Information Seeking Behaviour; OSPB_N: Overall Social Participation Behaviour; CS_N: Competency Score.

$H_{1.3A\,(3)}$: A positive link exists between OISB→OSPB→CS for the UML

Data Sources and Methodology

The study consists of both the primary and secondary data. The researcher has obtained secondary data i.e., the beneficiary information specific to district and activity, from the State Agricultural Management and Extension Training Institute (SAMETI) in Sikkim. The population comprises of all ATMA beneficiaries who participated in various categories of ATMA activities between 2020 and 2025. This data is a sample frame for the purpose of determining the sampling unit from the population. The Rao-soft sample size calculator suggests that a sample size of 371 is required to guarantee a 95% confidence level for a population of 10,108. 403 ATMA beneficiaries are included in the study. Using the Block Wise Equal Proportionate Ratified Random Sampling Technique, a probability sampling method, the study includes 13 beneficiaries from each of the 31 blocks in all the six districts of Sikkim.

The study evaluates the Beneficiary Awareness, Technology Adoption, and Knowledge Acquired by examining agricultural, horticultural, and animal husbandry practices. The detailed process of the computation of scores is exhibited in Figure 2.

The data is collected using a pre-tested, standardized, and structured interview schedule. An interview schedule containing closed-ended, dichotomous, and multinomial questions determines the beneficiary's demographic, socioeconomic, information seeking, and social participation behaviour. The data is encoded to calculate the aggregate scores for Beneficiaries' Awareness (BA), Technology Adoption (TA), and Knowledge Acquired (KA). The Competency Score (CS) is the aggregate of these three scores. Subsequently, a Med-Mod Analysis is conducted to examine the influence of Land Size on the relationship between Overall

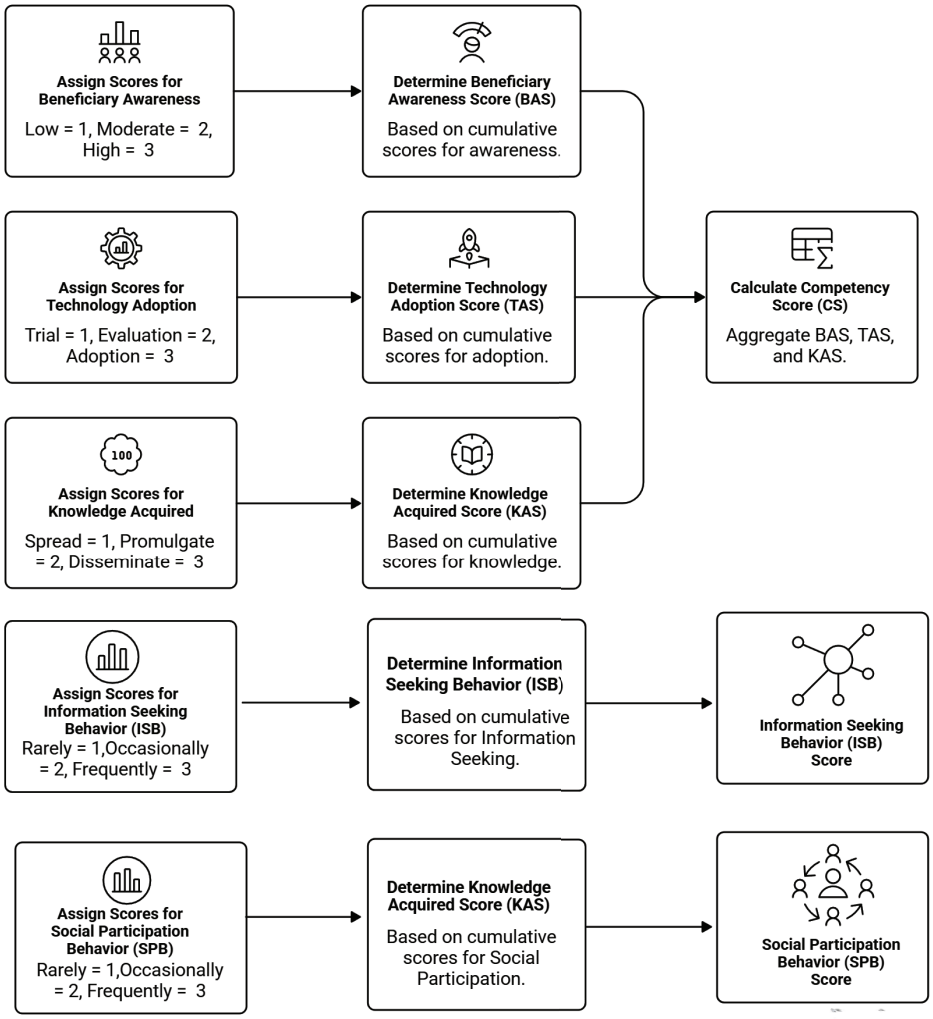

Figure 2. Computation of Information Seeking Behaviour, Social Participation Behaviour & Overall Competency Score
Source: Created by the author

Information-Seeking Behavior and Competency Score.

The moderated mediation study was somewhat exploratory due to the limited historical research on the subject, as it was challenging to identify the appropriate pathways (Wilski, 2024). Moderation analysis was conducted on all paths in the mediation model. It is challenging to predict the magnitude of impact, particularly the effect sizes of mediation at each level of moderation. Typically, Social Science results are considered reliable when a minimum of 15 individuals responded to each predictor. Mediation and moderation models are founded on regression analysis. Thus, the sample size of 403 beneficiaries in our study is adequate for this type of research, considering the number of variables and effects in the estimated model.

The independent variable is Overall Information-Seeking Behavior (OISB), the dependent variable is Competency Score (CS), and Overall Social Participation Behaviour (OSPB) is taken as a mediator while the Size of Marginal Landholding is a moderating factor. The Free Open-Source Software (FOSS) Statistical analysis software namely i.e. JAMOVI (Version 2.3.13) by using the percentile bootstrap method of 1000 samples and a 95% confidence interval, assesses the significance of moderating and mediating pathways and effects. The effect was statistically significant if the confidence interval excludes zero.

Results and Discussion

Understanding heterogeneity in agricultural practices and responses to policies by analysing size of marginal landholding has the potential to yield agricultural interventions and guidelines that are more efficient and customised, thereby facilitating the development of more precise policies. Thus, the study assesses that the Overall Social Participation Behaviour (OSBP) mediates the relationship between Overall Information Seeking Behaviour (OISB) → Competency Score (CS): and Size of Marginal Landholding (SML) being a Moderator. Further, the Size of Marginal Landholding (SML) is classified into three ordinal levels such as, Lower Marginal [< 0.8 Acre] below 33 percentiles of the sample; Middle Marginal [0.8 – 1.5 Acre] 33 – 66 percentiles of the sample, and Upper Marginal [> 1.5 Acre] above 66 percentiles of the sample based on the 33 percentiles classification of the overall sample.

Direct effect with interaction (size of marginal landholding * OISB → CS)

The study examines whether the effect of Overall Information Seeking Behaviour (OISB) on Competency Score (CS) varies across different categories of marginal landholding, an interaction term was introduced. Specifically, the moderating role of landholding size was tested by including the product term (Size of Marginal Landholding × OISB) in the model. This specification allows us to assess whether the strength and direction of the OISB → CS relationship differ for lower, middle, and upper marginal farmers.

The analysis results are revealed in Table 1. a statistically significant interaction between Overall Information Seeking Behaviour (OISB) and Size of Marginal Landholding (SML) on Competency Score (CS) ($\beta = 0.11$, $t = 80.17$, $p < .001$). The results suggest that the direct effects of Overall Information Seeking Behaviour (OISB) on Competency Score (CS) are significant across all marginal size of Landholding categories i.e. Lower, Middle and Upper Marginal Landholding. This confirms Hypothesis H1.1(c). The effect of OISB on CS was stronger among farmers with Upper Marginal Landholdings compared to those with Middle or Lower Marginal Landholdings. The OISB has a significant positive effect on CS, for those with Lower Marginal Landholding and Middle Marginal Landholdings. Direct path estimates further demonstrated significant positive effects of OISB on CS across all categories: $H_{1.2A\,(1)}$ Lower Marginal ($\beta = 0.77$, $p < .001$), $H_{1.2A\,(2)}$ Middle Marginal ($\beta = 0.77$, $p < .001$), and $H_{1.2A\,(3)}$ Upper Marginal ($\beta = 0.84$, $p < .001$). The CS of these individuals are generally higher when they are more actively involved in the OISB. The beneficiaries with Upper Marginal landholdings have an even greater positive impact on their CS than those with Lower Marginal or Middle Marginal Landholdings because of their OISB.

Indirect effect with interaction (size of marginal landholding * OISB → OSPB) and (size of marginal landholding * OSPB → CS)

To assess whether the indirect effect of Overall Information Seeking Behaviour (OISB) on Competency Score (CS) via Overall Social Participation Behaviour (OSPB) is contingent upon landholding size, interaction terms were specified. The moderating role of Size of Marginal Landholding (SML) was tested both in the OISB → OSPB path and in the OSPB → CS path, thereby evaluating a moderated mediation framework.

The analysis results are revealed Table 1. The interaction between OISB and OSPB was not significant ($\beta = 0.001$, $p = .82$), rejecting Hypothesis H1.1(a). However, the interaction between OSPB and CS was significant ($\beta = -0.53$, $t = -80.21$, $p < .001$), supporting Hypothesis H1.1(b). This indicates that the positive impact of OSPB on CS diminishes as landholding size increases. Indirect effects of OSPB on CS were significant for Lower ($\beta = 0.23$), Middle ($\beta = 0.23$), and Upper Marginal ($\beta = 0.16$) farmers, with stronger effects observed in smaller landholdings. The mediation pathway (OISB → OSPB → CS) was significant across all categories, though weaker for Upper Marginal farmers.

Total effects (OISB→CS)

The total effect of Overall Information Seeking Behaviour (OISB) on Competency Score (CS) was estimated by summing the direct effect and the indirect effect mediated

Table 1: Results of Med-Mod Analysis of OSPB Mediates the Relationship Between OISB → CS:: Size of Marginal Landholding (SML) as a Moderator

Moderation Effects (Interactions)

Moderator	H_0	Interaction	Estimate	SE	Lower	Upper	β	z	p
Size of Land (L)	$H_{1.1(a)}$	SML*OISB → OSPB	9.47e-4	0.00431	-0.00750	0.00939	0.00135	0.220	0.826
	$H_{1.1(c)}$	SML*OISB → CS	1.10	0.01368	1.06955	1.12315	0.10594	80.169	<.001
	$H_{1.1(b)}$	SML*OSPB → CS	-1.04	0.01298	-1.06669	-1.01580	-0.53001	-80.210	<.001

Conditional Mediation

Moderator Level: Age Group	H_0	Type	Effect	Estimate	SE	β	z	p
Lower Marginal Size of Landholding (LML) *[< 0.8 Acre] Below 33 percentiles of the sample*	$H_{1.3A(1)}$	Indirect	OISB→OSPB → CS	3.59	0.02409	0.227	149	<.001
		Path(s)	OISB → OSPB	1.06	0.00701	0.992	152	<.001
			OSPB→ CS	3.38	0.00403	0.228	839	<.001
	$H_{1.2A(1)}$	Direct	OISB→ CS	12.26	0.00432	0.774	2839	<.001
		Total	OISB→ CS	**15.84**	**0.01643**	**1.000**	**964**	**<.001**
Middle Marginal Size of Landholding (MML) *[0.8 – 1.5 Acre] 33 – 66 percentiles of the sample*	$H_{1.3A(2)}$	Indirect	OISB→ OSPB → CS	3.59	0.02409	0.227	149	<.001
		Path(s)	OISB→ OSPB	1.06	0.00701	0.992	152	<.001
			OSPB→CS	3.38	0.00403	0.228	839	<.001
	$H_{1.2A(2)}$	Direct	OISB→CS	12.26	0.00432	0.774	2839	<.001
		Total	OISB→CS	**15.84**	**0.01643**	**1.000**	**964**	**<.001**
Upper Marginal Size of Landholding (UML) *[> 1.5 Acre] above 66 percentiles of the sample*	$H_{1.3A(3)}$	Indirect	OISB→OSPB→ CS	2.49	0.01611	0.157	154	<.001
		Path(s)	OISB→ OSPB	1.06	0.00664	0.993	160	<.001
			OSPB→ CS	2.34	0.00403	0.158	581	<.001
	$H_{1.2A(3)}$	Direct	OISB→ CS	13.35	0.00432	0.843	3093	<.001
		Total	OISB→ CS	15.84	0.01556	1.000	1018	<.001

Source: Computed and Compiled by the Researcher | Note. Confidence intervals computed with method: Standard (Delta method); Betas are completely standardized effect sizes.

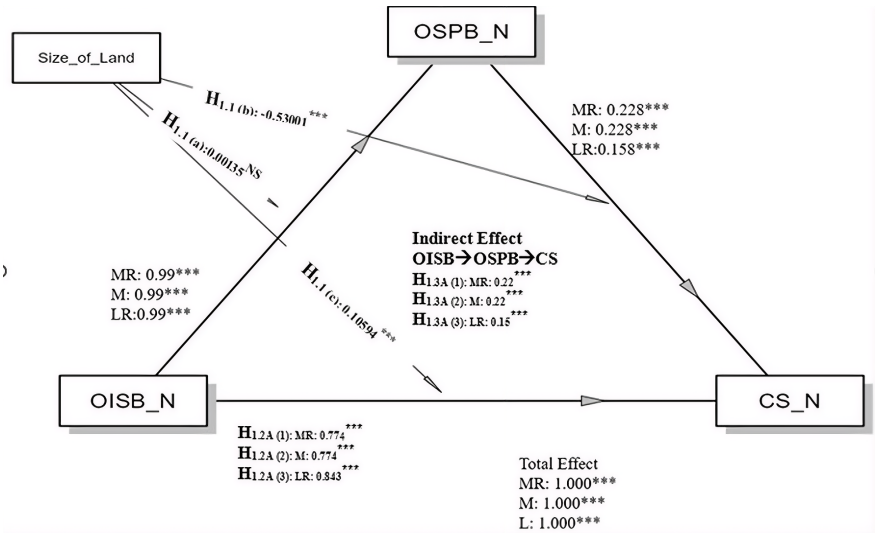

Figure 3. Results of Med-Mod Analysis of OSPB Mediates the Relationship Between OISB → CS: Size of Marginal Landholding (SML) as a Moderator

Source: Model Tested by the Researcher through Primary Data

*Note:MR: Lower Marginal [< 0.8 Acre] below 33 percentiles of the sample; M: Middle Marginal [0.8 – 1.5 Acre] 33 – 66 percentiles of the sample, and LR: Upper Marginal [> 1.5 Acre] above 66 percentiles of the sample of size of marginal landholding. | ***: Significance at 1%*

through Overall Social Participation Behaviour (OSPB). This approach provides a comprehensive measure of the net influence of OISB on CS. The results are exhibited in the Table 1 & Figure 3 and revels that, the total effect of OISB on CS was robust and nearly uniform across landholding sizes ($\beta \approx 1.00$, $p < .001$), underscoring the central role of information seeking in competence development. This illustrates a robust, positive and virtually uniform relationship between OISB and CS in a variety of settings, indicating that individuals who are proactive in their pursuit of information are more likely to demonstrate higher levels of competence.

Mediation effect

The results in the Table 1 confirmed that both the direct effects (DE) and indirect effects (IDE) of Overall Information Seeking Behaviour (OISB) on Competency Score (CS) are statistically significant across all categories of marginal landholding. In case of Lower Marginal Landholders (< 0.8 acres), the indirect effect through Overall Social Participation Behaviour (OSPB) was significant ($\beta = 0.277$, $t = 149$, $p < .001$), in case of Middle Marginal Landholders (0.8–1.5 acres), the direct effect remained consistent ($\beta = 0.774$, $t = 2839$, $p < .001$), with a slightly lower indirect effect (β

Table 2: Result of Moderating and Mediation Effects of Size of Marginal Landholding on the OISB→CS with OSPB as Mediator

Hypothesis	**Moderating Effects**			**Results**	
$H_{1.1}$	(a). SML * OISB→ OSPB			Not Supported	
	(b). SML * OSPB→ CS			Supported	
	(c). SML * OISB→ CS			Supported	
Hypothesis	Mediation Effect	Moderating Factors	Category	Effects	Results
$H_{1.3}$ $H_{1.2}$	OISB→OSPB→CS OISB→CS	Size of Marginal Landholding (SML)	(1). Lower (2). Middle (3). Upper	Indirect Effect & Direct Effect	Both Supported

Source: Computed and Compiled by the Researcher

Note: Lower Marginal [< 0.8 Acre] below 33 percentiles of the sample; Middle Marginal [0.8 – 1.5 Acre] 33 – 66 percentiles of the sample, and Upper Marginal [> 1.5 Acre] above 66 percentiles of the sample of size of marginal landholding.

= 0.227, t = 149, p < .001) and in case of Upper Marginal Landholders (>1.5 acres), the direct effect was comparatively stronger (β = 0.843, t = 3093, p < .001), while the indirect effect was weaker (β = 0.157, t = 154, p < .001).

These results indicate partial mediation across all landholding categories. OISB directly enhances CS, but also exerts an indirect influence through OSPB. The mediating role of OSPB is more pronounced among Lower and Middle Marginal Farmers, suggesting that social participation provides an important pathway for competence development in Smaller Landholdings. In contrast, for Upper Marginal Far mers, the direct effect of OISB dominates, reflecting their greater reliance on individual information seeking rather than social participation networks.

The findings highlight the heterogeneity of agricultural practices and responses to policy interventions based on landholding size. Three key insights emerge: Firstly, the Information Seeking acting as a Universal Driver of Competence - OISB consistently predicts higher CS across all landholding sizes, confirming its critical role in agricultural knowledge acquisition and skill development. Larger Landholders benefit more strongly, due to greater resource access and capacity to act on information. Secondly, the Social Participation acting as a Conditional Mediator - OSPB mediates the OISB → CS relationship more effectively among Lower and Middle Marginal Farmers. For these groups, social networks provide essential channels for knowledge exchange and collective problem-solving. However, its effect diminishes for upper marginal farmers, where reliance on individual information seeking outweighs social participation. Thirdly, the Policy Implications- For small farmers, interventions should strengthen social participation platforms (e.g., farmer cooperatives, peer learning groups) to amplify competence gains. For large farmers, policies should prioritize direct access to information (e.g., digital advisory services, targeted extension programs), as their competence is more strongly driven by individual information seeking.

Thus, the overall study underscores the need for customized agricultural policies that account for landholding heterogeneity. By tailoring interventions to farmer categories, policymakers can enhance efficiency, equity, and precision in agricultural development strategies.

Conclusions and Policy Implications

The research indicates that farmers who actively seek information (OISB) generally exhibit elevated competency levels (CS), irrespective of their size of marginal landholding. This beneficial effect is more pronounced among farmers with upper marginal landholdings. Conversely, social participation (OSPB) does not exert a uniformly beneficial effect on all farmers. The effect fluctuates based on size of marginal landholding and may diminish competitiveness for Upper Marginal Landholding. Overall, findings indicate that information seeking consistently enhances competence, while social participation mediates this effect more strongly among Smaller Landholders.

The results further validate that social participation partially illustrates the manner in which information-seeking behavior enhances competency (partial mediation). Additionally, size of marginal landholding significantly influences the formation of these interactions. This indicates that a uniform strategy will be ineffective. Farmers with Lower & Middle Marginal Landholding derive greater advantages from collective activities, collaborative learning, and community engagement, as these facilitate knowledge acquisition and skill enhancement. Conversely, Upper Marginal Landholders derive greater advantages from targeted, specialized training and experiential learning than from broad social participation.

Policy implications suggest tailoring agricultural interventions by landholding size: strengthening social networks for smaller farmers and prioritizing direct information access for larger farmers. Consequently, policies and extension initiatives, such as ATMA, must be tailored to the distinct needs of various farmer demographics. Increased emphasis should be placed on collaborative learning for Lower and Middle Marginal Farmers, while Upper Marginal Farmers should receive help through advanced training, expert consultation, and skill development programs. This focused strategy can enhance the overall efficacy of competency development among farmers.

Limitation of the study

The study has been limited to Sikkim, increasing the geographical coverage can help in understanding the agricultural dynamics in different regions and identifying region-specific insights and trends leading to more holistic strategies for improvement. The variables such as Information Seeking Behaviour, Social Participation Behaviour and Size of Marginal Landholding have been used in this research. Future research might also include other variables like gender, education, access to credit which are known to influence competency and adoption. Including them could enrich the model.

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