Technology Adoption Survey 2023

West Central Region of Bhutan

National Centre for Organic Agriculture
in collaboration with
Department of Agriculture

Funded by AFACI, RATES Project

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FOREWORD

It is with great pleasure that I introduce this comprehensive study on agriculture technology adoption in the west central region of Bhutan. Agriculture, being the backbone of Bhutan's economy, plays a pivotal role in the livelihoods of its people. In the face of evolving challenges and opportunities, the adoption of innovative technologies becomes crucial to enhance productivity, sustainability, and overall agricultural resilience.

This study provides a detailed exploration into the demographic landscape of farmers in the region, shedding light on their age distribution, gender representation, educational backgrounds, and geographic distribution. Understanding the socio-economic context of the farming community is essential for formulating targeted strategies that resonate with their needs and aspirations.

The technology adoption rates presented in this study offer valuable insights into the acceptance levels of various agricultural technologies. From labor-saving tools and protected cultivation methods to plant protection and water efficiency technologies, each aspect is meticulously examined. The findings not only reveal the current state of technology adoption but also pave the way for informed decision-making to facilitate the wider integration of sustainable agricultural practices.

As Bhutan continues its journey towards holistic development, the role of technology in agriculture becomes increasingly pivotal. This study serves as a foundational resource for policymakers, researchers, and practitioners, guiding them in crafting interventions that align with the socio-cultural and economic fabric of the west central region. I extend my gratitude to all the participants and stakeholders who contributed to this study, and I am confident that the insights gleaned will catalyze positive transformations in Bhutan's agricultural landscape.

ACRONYMS

DoA	Department of Agriculture
AFACI	Asian Food and Agriculture Cooperation Initiative
ARID	Agriculture Research and Innovation Division
NCOA	National Centre for Organic Agriculture
RATES	Improvement of Rural Agriculture Technology Extension System in Asia
AMC	Agriculture Machinery Centre
APD	Agriculture Production Division
TRC	Technology Release Committee
VRC	Varity Release Committee
NSB	National Statistical Bureau
IPM	Integrated Pest Management
SLM	Soil fertility and land management technology
FMCL	Farm Machinery Corporation Limited

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CHAPTER ONE

INTRODUCTION

1.1 Background

Spanning from 1988 to 2023, the Department of Agriculture in Bhutan introduced a notable array of agricultural innovations. These include the release of 59 improved crop varieties, 110 enhanced fruit plant varieties, 128 upgraded vegetable varieties, 6 new plantation crops, 6 distinct spice varieties, 1 type of herb, and 31 improved forage crops. Additionally, numerous other improved field crops and fruits varieties were also introduced. In addition to expanding crop varieties, the Department of Agriculture actively promoted advanced agricultural technologies (DoA, 2023). This encompassed the adoption of protected cultivation techniques, the development of gender-friendly agricultural methods, and the introduction of various farm machinery to enhance productivity and recently the farmers were also able to explore the hydroponic farming technologies.

The importance of technology adoption is crucial for business and organization as it helps in implementing new technologies and staying competitive through informed decisions (Denning & Lewis, 2020). It is also reported that the technology adoption could also help the organization in maintaining profit and weather the recession (Arifin & Frmanzah, 2015). However, in Bhutan, besides the huge technologies being promoted by the Department of Agriculture, only few adoption studies were conducted to assess the benefits. For instance, the adoption study on the Maize cultivator was conducted using economic surplus model which concluded that almost all has adopted the technology among the study group with improvements in general household welfare than non-adopters (Shrestha & Katwal, 2003).

The Asian Food and Agriculture Cooperation Initiative (AFACI) project, in its commitment to enhancing agricultural practices and rural development in Bhutan, recognizes the paramount significance of technology adoption. Against this backdrop, this technology adoption survey embarks on a journey to investigate the technology adoption rates in four strategically selected Dzongkhags – Paro, Haa, Chhukha, and Thimphu.

1.2 Objective of the survey

The primary purpose of this research is to assess the current state of technology adoption and social indicators that plays in the technology adoption in Paro, Haa, Chhukha, and Thimphu Dzongkhags. To achieve this overarching goal, we have identified the following specific objectives:

1. ***Assessing the Types and Numbers of Technologies Adopted by the Beneficiaries****:* The research will examine the technologies that the beneficiaries have adopted.
2. ***Examining Factors Influencing Technology Adoption****:* The research will investigate the factors that influenced the adoption of technology among beneficiaries. Key aspects to consider include the usability of the technologies, adequacy of training and support provided to the beneficiaries, and the perceived benefits of adopting the technologies compared to traditional practices.

1.3 Scope of the survey

This survey focuses on evaluating technology adoption rates (Chhukha, Haa, Thimphu, and Paro) in Bhutan. The study aims to identify the types and numbers of technologies adopted by beneficiaries in these regions, investigating factors influencing the adoption such as motivation and challenges as well. The research covers a range of technologies promoted by the Department of Agriculture, including protected cultivation, labor-saving methods, plant protection, soil fertility management, improved crops, and water-efficient technologies. Utilizing a multistage sampling approach, the survey will gather data through in-person interviews, employing both quantitative and qualitative analysis methods.

CHAPTER TWO

SURVEY METHODS AND MODALITIES

2.1 Survey planning and Budgeting

The Technology Adoption Survey, initially scheduled for September, underwent coordination by the National Centre for Organic Agriculture, as appointed by the ARID (Agriculture Research and Innovation Division) of the Department of Agriculture in Bhutan. The preliminary preparations encompassed the formulation of a budget and a concept note, which were subsequently submitted for approval to the Agriculture Research and Innovation Division. Following approval, the NCOA (National Centre for Organic Agriculture) received confirmation of the budget and acceptance of the concept note. Funding for the survey is secured through the AFACI-funded project RATES (Improvement of Rural Agriculture Technology Extension System in Asia).

In October, the survey approach was delineated through a technical consultative meeting, and by mid-October, the development of the survey questionnaire was successfully concluded. The survey itself was executed from the end of October to the first week of November, marking a significant milestone in advancing agricultural technology adoption in the region.

2.2 Stakeholder Engagement

To guarantee effective coordination and the seamless execution of the survey, the National Centre for Organic Agriculture (NCOA), with the backing of the Agriculture Research and Innovation Division (ARID), actively engaged key technical divisions and sections within the Department of Agriculture. This collaborative effort involved the organization of two significant workshops and consultative meetings, where participation and input were sought from pivotal entities such as the Agriculture Machinery Centre (AMC) and the Agriculture Production Division (APD). These interactions aimed to secure essential support and technical assistance, fostering a unified approach to ensure the success of the survey. The involvement of multiple technical divisions underscores the comprehensive nature of the survey and highlights the commitment to a well-coordinated and thorough implementation process.

2.3 Questionnaire Manuals

The Technology Adoption Survey marked a significant milestone as the inaugural study of its kind in Bhutan, focusing specifically on the west-central region. Notably, while there have been reports on commodity adoption rates, this survey introduced a pioneering approach to comprehensively understand various technologies adoption rates. The development of the questionnaire was in line with the well-established Rogers innovation attributes. However, given the unique context of Bhutan and the novelty of the survey, it was acknowledged that not all innovation attributes outlined by Rogers could be fully considered in this initial study.

Rogers' innovation attributes, also known as the "diffusion of innovations" theory, are characteristics that influence the adoption and diffusion of new innovations or technologies among individuals and groups. Developed by Everett Rogers, these attributes provide insights into how and why innovations are adopted by people at different rates. A study conducted to assess the Bhutanese Agriculture Research Practice Gaps was observed using this method in analyzing the technology adoption rate (Dorji, Miller, & Wu, 2022). Further, it is recommended in the review of Rogers' innovation attributes as one of the widely used theoretical frameworks in technology diffusion and adoption (SAHIN, 2006).

The survey questionnaire consists of following modules:

- **Module I (Demographic Variable):** This module consists of questions that identifies the demographic variable such as gender, age, education level, decision maker, road connectivity and income and other information.
- **Module II (Technology Adoption Dynamics):** This model provides information on the important factors (awareness, access and source) considered in the adoption of technology.
- **Module III (Acceptance Dynamics).** This module provides information on the motivational factors and challenges in adopting the technologies.
- **Module IV (Non adoption).** This module provides compressive understanding of the why technologies are not being adopted.
- **Module V (Aspirations):** This module provides information on the future aspects of technology adoption desired by the farmers.

2.4 Selection of the technologies to be evaluated.

In the process of selecting technologies for examination in this social study, we have carefully considered a range of indicators to ensure that our research is both relevant and impactful. These indicators include:

- **Alignment with TRC and VRC Promotions:** We give priority to technologies that have received endorsements or support from the Technology Release Committee (TRC) and the Varity Release Committee (VRC).
- **Farmer Preferences and Needs:** We have also considered the technologies that resonate with the desires and requirements of our local farmers. This involves gathering input and feedback directly from the farming community to understand their specific needs and challenges.
- **Investment Requirements:** We acknowledge that some technologies have significant financial investments made by the Department and Projects. Therefore, we considered some of the technologies based on the investment.
- **Localization and Adaptation:** We prioritize technologies that have been customized and adapted to suit the unique characteristics and conditions of our locality. This ensures that the solutions we investigate are practical and effective in our specific context.

2.5 Preparation of Frames

The listing process was initiated in October, utilizing data obtained from the National Statistical Bureau (NSB) to compile household lists for Chhukha, Haa, Thimphu, and Paro Dzongkhags. This initial list was then refined to identify households engaged in agriculture farming. To ensure accuracy and completeness, the household list underwent a finalization process in consultation with the Geog Agriculture Extension officers of Chhukha, Haa, Thimphu, and Paro Dzongkhags.

2.6 Sampling Design

To guarantee a representative sample, all Dzongkhags in the west-central regions were incorporated into the study. A multistage sampling procedure was implemented to select the gewogs and chiwogs for the survey, maintaining a 50% sampling intensity. This approach was chosen to strike a balance between the statistical robustness of the study and the practicality of data collection.

2.7 Determination of sample size

The selection of respondents followed a random sampling approach from the chiwogs within each selected gewog. In this process, a total of 789 samples were randomly chosen from the entire population of 2,630. This sampling procedure maintained at a 30% sampling intensity.

Table 1: Sample size

Dzo	Gewog	Chewog	THH	30% sample size
Chhukhag	Doongna	Chhulakha_Mangdokha	17	5.1
		Doongna_Pagsel-Lakha	95	28.5
		Drukdingsa_Khori	33	9.9
		Dzedokha	49	14.7
	Loggchina	Chagdokha_Damchhekha	80	24
		Mongna_Lha-sarp	90	27
		Uekha	23	6.9
	Maedtabkha	Jozhingkha_Maedtab-Toed	38	11.4
		Pangu	28	8.4
		Darga_Tshebji	12	3.6
	Sampheling	Pekerling	50	15
		Khenpithangsonamthang	55	16
		Gongbogang_pangna	109	32
	Phuentshogling	Pachhu	149	44.7
		Deling_Marpji	109	32.7
Haa	sangbhaykha	Mochhu	69	20.7
		Sangbay Ama	54	16.2
		Anakha_Shepji	22	6.6
		Tshaphel_Tsiloongkha	26	7.8
	Esue	Betso_Doomchhog	38	11.4
		Geyruna_Karnag	49	14.7
		Bali_Mombitshokha	16	4.8
	Katsho	Ingo_Pharikha	49	14.7
		Wangtsa	21	6.3
Paro	Dopshari	Jangsa_Jooka	50	15
		Kempa-Kuduphu	54	16.2
		Rinchhending_Shar-ri	82	24.6
		Rangzhin-Gang_Tshebji	68	20.4
		Jazhina_Tsoen-Goen	96	28.8
	Naja	Wanakha-Tokhab-Zusuna	19	5.7
		Jieu_Woochhu	78	23.4
		Baangdey	43	12.9
	lunii	Nemjo	73	21.9
		Dawakha_Tshongkha	99	29.7
		Tenchhekha_Tsiphu	15	4.5
	dogar	Mendrel_Uesun	75	22.5
	tsento	Nyechhu_Shar-Ri	89	26.7

		Mitshig_Shana	77	23.1
		Chhungjey_Zamsar	98	29.4
Thimphu	Mewong	Khasadrupchhu	139	41.7
		Jiminang	129	38.7
	Chang	Lhoongtsho_Tashigang	33	9.9
		Yoeselpang	32	9.6

2.8 Data collection Technology

The KoboToolbox software played a pivotal role in crafting questionnaires, while the Kobocollect application, hosted on Android operating systems, facilitated seamless data collection. Recognized globally, KoboToolbox serves as a comprehensive system for data collection, management, and visualization, particularly in research and social impact initiatives. Utilizing the Kobo humanitarian response system, which is a cost-free application, our survey incorporated validation, logic, and skip functions within the questionnaire. These features were instrumental in enhancing data quality by minimizing errors and preventing incorrect entries during data collection. Each question was accompanied by specific instructions, aiding enumerators and respondents in addressing queries. Upon completion of data collection, the gathered information was exported from KoboToolbox for subsequent analysis.

2.9 Data processing, validation, and editing

Following the culmination of field data collection, the information was transferred from KoboToolbox to MS Excel 365 for a meticulous process of cleaning and validation. To ensure accuracy and reliability for subsequent analysis and reporting, a dedicated five-day write shop was conducted in Phuntsholing. During this session, the data underwent thorough validation and cleaning procedures, refining it to meet the highest standards for precision and coherence.

2.10 Response rate

Nonresponse is an anticipated factor in surveys, as recognized in the agriculture survey (NSB, 2021). In the technology adoption survey, we achieved a commendably high response rate, with nearly 77.5 out of 789 samples. The observed nonresponse rate was attributed to the survey timeline coinciding with the harvesting season in the study area, impacting participant availability and engagement.

2.11 Technology Adoption Rate Calculation

The adoption rate is calculated as the percentage of the total population that has embraced a particular product, technology, or practice. The formula for calculating the adoption rate is:

$$Adoption\ Rate = \left(\frac{\text{Number of adopters}}{\text{Total Population}}\right) 100$$

In this formula, the 'Number of Adopters' represents the count of individuals or entities that have adopted the innovation, and the 'Total Population' is the overall number of potential adopters. Multiplying the result by 100 expresses the adoption rate as a percentage. This metric provides valuable insights into the extent of acceptance and utilization within the given population, aiding in the assessment of the innovation's impact or market penetration."

CHAPTER THREE

DEMOGRAPHIC VARIABLES OF STUDY POPULATION

3.1 Overview

Table 1 presents a demographic overview of respondents in a agriculture technology adoption study among farmers in the west central region of Bhutan. The age distribution reflects a majority (87.4%) in the productive age range of 20-64, with a minimal representation below 18 (0%) and a notable 12.6% above 65. Gender-wise, the study includes a balanced participation, with 48.4% males and 51.6% females. Geographically, participants are distributed across various Dzongkhags, with Chhukha being the most represented (41.3%), followed by Paro (34.3%), Haa (14.1%), and Thimphu (10.3%). In terms of educational qualifications, a substantial portion of participants have no formal education (56.5%), while 30.4% have completed non-formal primary education, 11.6% have attained high school to higher secondary education, and a modest 1.5% possess university-level qualifications.

Table 2: Demographic overview of respondents

		%
Age	Below 18	0
	20-64	87.4
	Above 65	12.6
Gender	Male	48.4
	Female	51.6
Dzongkhag	Thimphu	10.3
	Chhukha	41.3
	Haa	14.1
	Paro	34.3
Qualification	None	56.5
	Nonformal - Primary level	30.4
	High School - Higher Secondary	11.6
	University level	1.5

3.2 Land size and income source of the study population.

The data presented in this section outlines the distribution of farmers based on the size of their land holdings in different categories—Dry Land, Wet Land, Orchard, and Leased Land (Table 2). For Dry Land, most farmers (69.8%) possess land ranging from 0 to 2 acres, with diminishing percentages for larger categories such as 3-5 acres (24.9%) and 6-8 acres (5.4%). Interestingly, there are no participants with land sizes falling within the 9-10 acres category. In the case of Wet Land, an overwhelming 98.0% of farmers own plots within the 0-2 acres range, while only a small fraction own land in the 3-5 acres (1.6%) and 6-8 acres (0.3%) categories. No participants reported having wetlands sized 9-10 acres. Similarly, for Orchard, the majority (98.2%) have land holdings in the 0-2 acres category, with marginal representation in the 3-5 acres (1.8%) category, and none in the 6-8 acres or 9-10 acres categories. Lastly, in the Leased Land category, a significant 99.3% of farmers hold leases for land sizes between 0 to 2 acres, with minimal representation in the 3-5 acres (0.5%) and 6-8 acres (0.2%) categories. Notably, no participants reported leasing land in the 9-10 acres category. This detailed breakdown provides insights into the land distribution patterns among farmers participating in the study, essential for understanding the context of technology adoption in diverse agricultural settings.

Table 3: Distribution of farmers based on the size of their land holdings in different categories.

		%
Dry Land	0-2	69.8%
	3-5	24.9%
	6-8	5.4%
wet land	0-2	98.0%
	3-5	1.6%
	6-8	0.3%
Orchard	0-2	98.2%
	3-5	1.8%
leased land	0-2	99.3%
	3-5	0.5%
	6-8	0.2%

The income distribution among farmers in this study reveals that the majority (69.9%) derive their income predominantly from farming. Remittances contribute to the income of a smaller subset (1.9%). A significant portion of farmers (20.3generate income from off-farm activities or business ventures. Additionally (7.8%) rely on employed family members for income (Table 3).

Table 4: Income Details of the respondents

		Responses
Income Source of Farm[a]	Farming	69.9%
	Remittances	1.9%
	Off farm/Business	20.3%
	Employed family member	7.8%
Total		100.0%

a. Dichotomy group tabulated at value 1.

3.3 Technology information source of the respondents

Agriculture extension services emerge as the predominant source with 57.5% of responses. Social media is reported by 18.8% of responses, constituting 28.0% of responses. Word of mouth is mentioned by 21.0% of responses. Publications and study tours are less frequently mentioned, at 1.6% and 1.1%, respectively. Most respondents rely on agriculture extension services, highlighting their significance in disseminating knowledge and information.

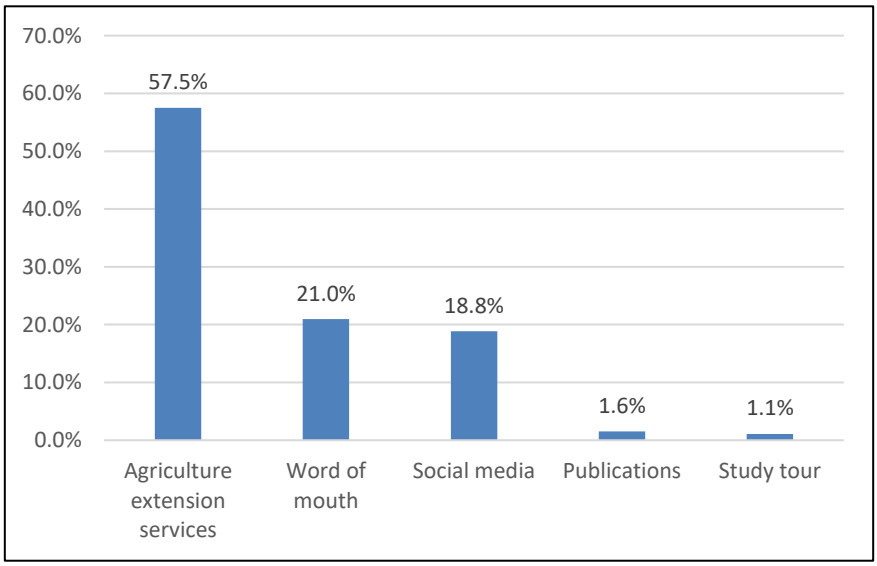

Figure 1: Technology information source

OVERALL TECHNOLOGY ADOPTION RATE

Table 5: Technology adoption rate

Category	Technology	adoption rate	Overall adoption rate
Protected cultivation technology	Greenhouse	22.05%	22.05%
labor-saving technologies	Power tillers	29.07%	16.28%.
	Mini tiller	11.11%	
	Combine harvester	1.96%	
	Thresher machines	18.13%	
	Grass cutter	21.15%	
Plant Protection Technologies	Integrated Pest Management (IPM)	15.35%	16.16%
	Sprayers	10.45%	
	Rangzhin Buupmen	4.70%	
	Electric fencing	27.60%	
	Plastic mulch	22.70%	
Soil fertility and land management technology	Biochar	0.81%	14.62%
	Composting	8.90%	
	Green manure	4.20%	
	SLM	9.60%	
	Fertilizers	49.60%	
Improved crops	Potato Yusi Maap	26.60%	11.80%
	Quinoa	4.90%	
	Citrus canopy management	3.90%	
Water efficiency Technologies	Drip irrigation system	2.70%	10.67%
	Sprinkler irrigation system	28.70%	
	Rainwater harvesting technologies	0.60%	

PROTECTED CULTIVATION TECHNOLOGY

8.1 Greenhouse

8.1.1 Accessibility, ownership, source of technology and adoption

Table 6 presents that most respondents, comprising 89.5% (548 individuals), are aware of greenhouses, while 10.5% (64 individuals) lack awareness. In terms of greenhouse ownership, 24.6% (135 individuals) possess a greenhouse, whereas 75.4% (413 individuals) do not own one. This highlights a considerable level of awareness about greenhouses, although actual ownership remains less prevalent among the surveyed population.

Table 6: Greenhouse access, and utilization

Greenhouse awareness?		Own a Greenhouse?	
Yes	**No**	**Yes**	**No**
89.5% (548)	10.5% (64)	24.6% (135)	75.4% (413)

The greenhouse technology sources among respondents, treated as a multi-response variable, indicates that the predominant method of technology acquisition is through cost-sharing arrangements, reported by 73.9% of participants. Self-procurement is chosen by 12.0% of respondents, while 14.1% obtain technology free of cost from sources like government, NGOs, or family members (Table 5).

Table 7: Source of greenhouse technology

		Percent
Source of Technology[a]	Self-procured	12.0%
	Cost sharing	73.9%
	Free of cost (government, NGO, family member)	14.1%
Total		100.0%

Therefore, the adoption rate for greenhouse technology is 22.05%, where it is calculated by the number of people who owns it to the total number of populations.

8.1.2 Motivational factors and challenges in adopting greenhouse.

As presented in figure 2, the most prominent factor, identified by 31.4% of responses, is the efficiency in agricultural management attributed to greenhouses, encompassing aspects such as ease of crop management, labor-saving, and being female friendly. Financial sustainability and support, including government incentives and income generation, are reported by 21.3% of responses as motivating factors. Additionally, 28.0% of responses are motivated by the year-round production resilience provided by greenhouses, allowing for multiple cropping, lean season production, and the ability to grow crops in any season. Furthermore, 19.2% of responses highlight the importance of greenhouses in protecting crops from extreme weather conditions. These findings emphasize the multifaceted motivations driving the adoption of greenhouse technologies.

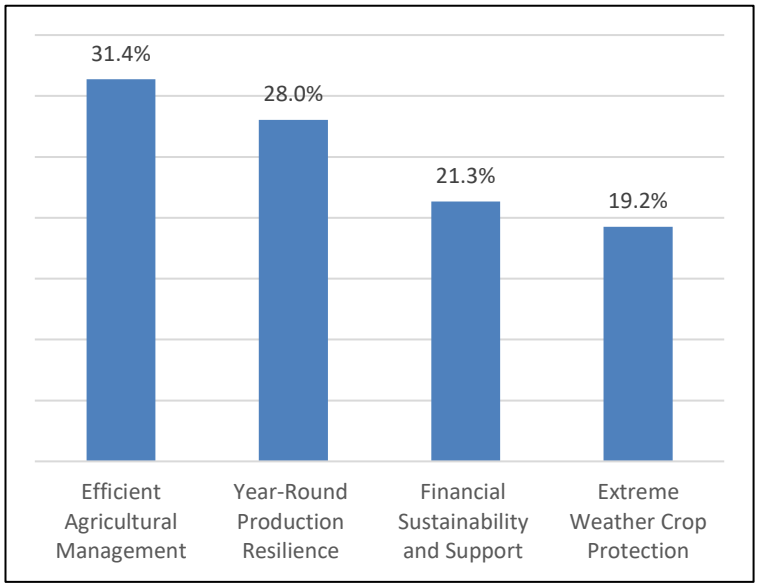

Figure 2: Motivational factor

As presented in figure 3, the most prevalent challenge, cited with 36.6% of responses, relates to structural and environmental issues. These include concerns such as maintenance problems, susceptibility to wind damage, vulnerability to snow damage, and the perceived thin quality of greenhouse plastic. Seasonal limitations emerge as another significant challenge, as noted by 20.1% of responses. This includes restrictions on winter use and concerns about the impact of heat on operational efficiency. Sustainability and feasibility concerns are expressed by 6.7% of responses, indicating a subset of respondents questioning the long-term viability of greenhouse

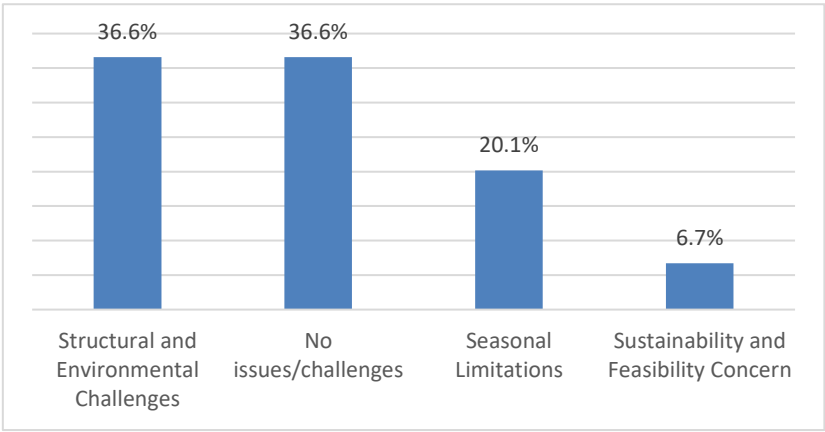

Figure 3:Challanges

practices. Interestingly, 36.6% of responses claim to face no issues with greenhouse use, suggesting a positive experience for this group.

8.2 Reasons for not adopting (not owning) greenhouse technology by 75.4%(n=413)

As presented in figure 4, economic and resource constraints emerge as the primary hurdle for non-adoption of greenhouse with 56.7% of responses. This category encompasses factors such as the perceived unaffordability of greenhouse setups, limitations in available land, and considerations of feasibility. Knowledge and interest issues contribute to nonadopting with 7.5% of responses, reflecting challenges related to technical know-how and a lack of interest in greenhouse practices. Environmental and accessibility challenges are cited at 13.1% of responses, involving concerns about environmental impact, lack of accessibility, and instances where greenhouse adoption is denied due to limited land availability. Operational difficulties, including labor shortages and situations where greenhouses are deemed unusable consists of 22.6% of responses. This comprehensive exploration of nonadopting reasons underscores the multifaceted barriers that influence the decision-making process regarding greenhouse technologies.

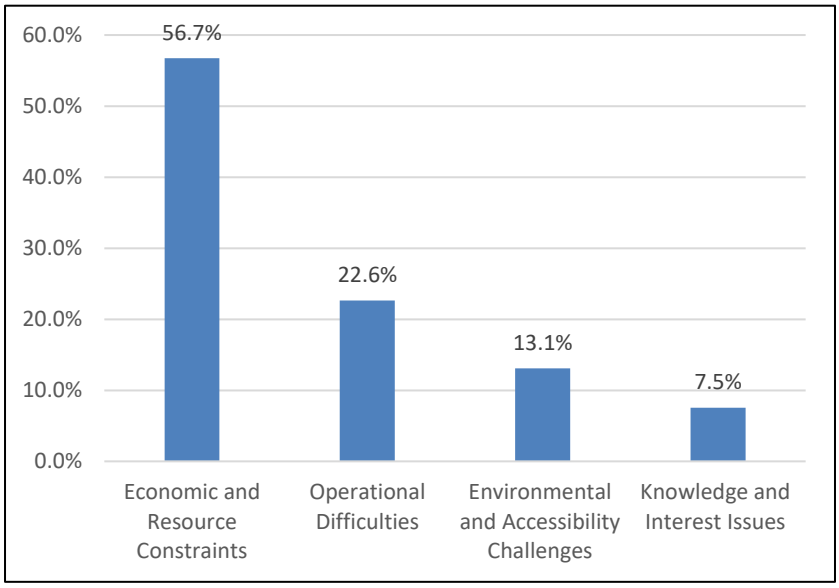

Figure 4:Reasons for not adopting greenhouses.

LABOR SAVING TECHNOLOGIES






9.1 Power Tiller

9.1.1 Accessibility of power tiller, usage and adoption

The data in table 8 indicates that 43.1% of respondents have access to a power tiller, while 56.9% do not. Among those with access, 68.9% reported using the power tiller, while 31.1% did not utilize this agricultural equipment. This information highlights the prevalence of power tillers among the respondents and the varying degrees of utilization among those who have access to this technology.

Table 8: Power tiller access and use

Do you have access to power tiller?		**Do you use it?**	
Yes	**No**	**Yes**	**No**
43.1% (264)	56.9% (348)	68.9% (182)	31.1% (82)

Therefore, the adoption rate for power tiller technology is 29.07%, where it is calculated by number of people who owns it to the total number of populations.

9.1.2 Usage, motivational factors, and challenges in adopting power tillers.

Out of 235 responses, a substantial 76.6% indicate "Field preparation" as the primary purpose, underscoring the critical role of power tillers in agricultural activities. "Transportation" is another significant application, accounting for 18.7%, highlighting the versatility of power tillers in facilitating the movement of goods. The utilization of power tillers as a "Power Generator (energy source)" is less common, reported by 4.7% (table 8).

Table 9: Power tiller utilization

		Responses	
		N	**Percent**
Power tiller utilization	Field preparation	180	76.6%
	Power Generator (energy source)	11	4.7%
	Transportation	44	18.7%
Total		235	100.0%

Figure 4 presents diverse motivational factors influencing the adoption of power tillers among respondents. The predominant factor, reported with 75.2% of responses, centers around affordability and resource management, encompassing aspects such as affordable hiring charges and labor-saving attributes. Support and encouragement, including government incentives and peer influence, are identified as another motivational factors with 5.0% of responses. Moreover, 12.6% of responses indicate that the presence of a large land size serves as a motivation for power tiller adoption, while 7.1% highlight the potential for income generation through hiring as a contributing factor. These findings underscore the multifaceted motivations driving the adoption of power tillers in agricultural practices.

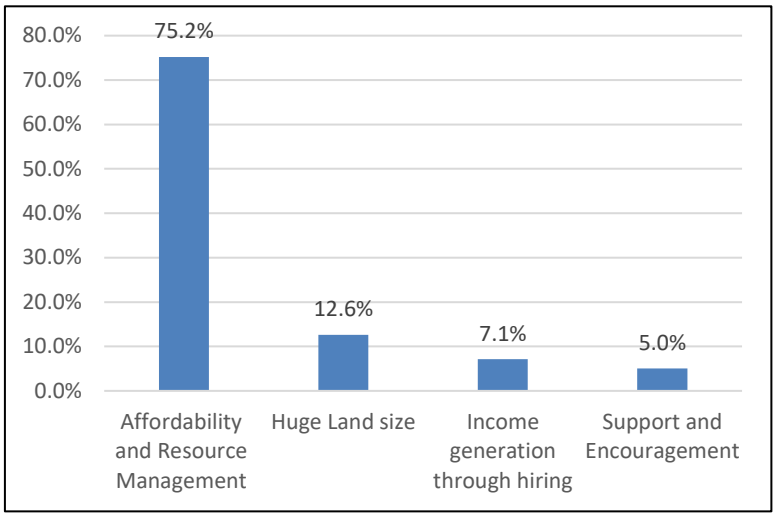

Figure 5: Motivational factors

Figure 5 presents various challenges associated with the use of power tillers among respondents. The most prevalent challenge, identified with 47.3% of responses, pertains to maintenance issues, including problems with maintenance, expensive spare parts, the unavailability of operators, and topography-related challenges. Operational challenges, such as higher hiring charges, fuel shortages, and occasional unavailability of hiring services, are indicated with 25.4% of responses. Additionally, 6.3% of responses highlight gender disparities, particularly operational challenges faced by women. However, 21.0% of responses indicate no specific issues with power tiller use. These findings underscore the multifaceted challenges encountered in the adoption and utilization of power tillers in agriculture.

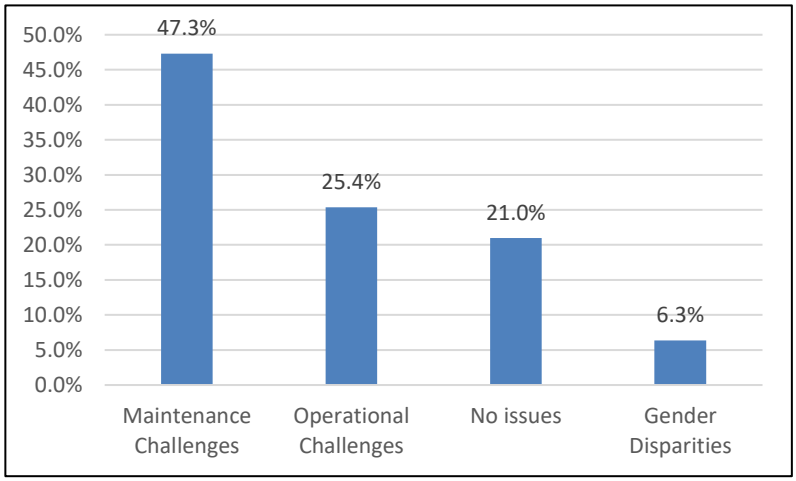

Figure 6: Challenges

9.1.3 Reasons for not adopting the power tiller technology.

Figure 6 reveals various reasons for the non-adoption of power tillers among respondents. Financial and economic constraints, particularly unaffordability, are cited with 36.4% of responses as a significant barrier to adoption. Operational and skill-related challenges, such as the lack of operators, limited land, and accessibility issues, are reported with 39.4% of responses as key hindrances. Knowledge and interest issues, including limited awareness, lack of interest, and the perception of power tillers as a relatively new technology, contribute to nonadaptation with 9.1% of responses. Additionally, feasibility concerns are indicated with 15.2% of responses. These findings shed light on the multifaceted factors influencing the decision not to adopt power tillers in agricultural practices.

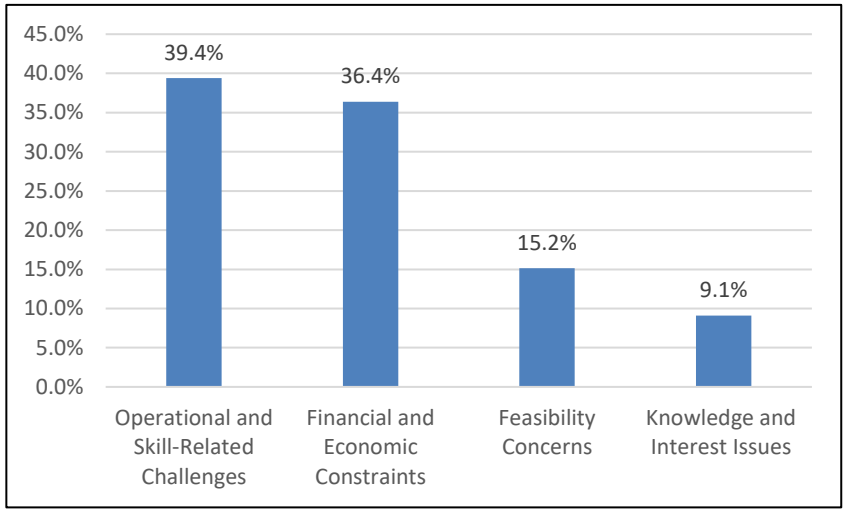

Figure 7: Reasons for not adopting the technology.

9.2 Mini tillers

9.2.1 Accessibility of mini tiller, usage and adoption

As presented in table 10, the data indicates that 19.9% of respondents have access to a power tiller, while 80.1% do not. Among those with access, 55.7% use the power tiller, while 44.3% do not utilize it.

Table 10: Accessibility of mini tiller.

Do you have access to mini tiller?		Do you use it?	
Yes	**No**	**Yes**	**No**
19.9% (122)	80.1% (490)	55.7% (68)	44.3% (54)

Therefore, the adoption rate for mini tiller technology is 11.11%, where it is calculated by number of people who own it to the total number of populations.

9.2.2 Motivational factors and challenges in adopting mini tillers.

Figure 7 presents the motivational factors for mini-tiller adoption among responses. The predominant factor, identified with 84.0% of responses, is the efficiency and labor management associated with mini-tillers, emphasizing their labor-saving and small, efficient design. Additionally, 9.9% of responses indicated that the gender-inclusive and friendly nature of mini-tillers. A smaller proportion, 4.9% of responses, cite government support and incentives, including income generation through hiring, as motivating factors. This underscores the significance of efficiency and user-friendly features in driving the adoption of mini-tillers.

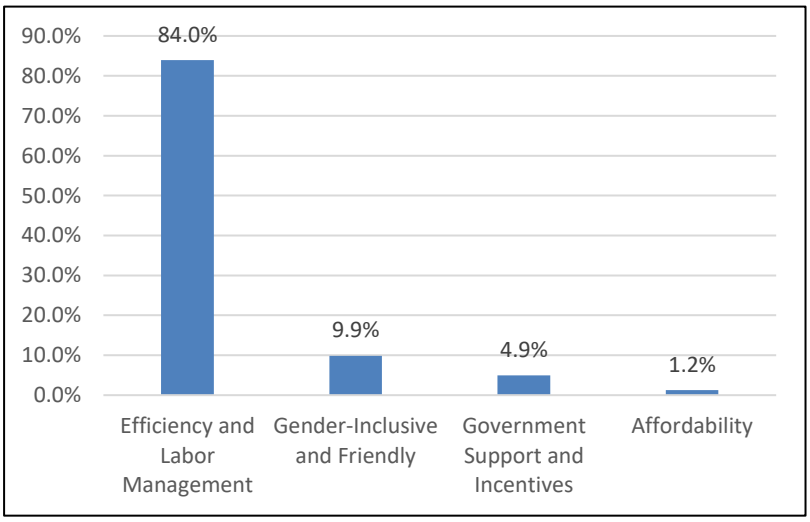

Figure 8: Motivational factors for mini tiller adoption

The challenges associated with the use of mini tillers are diverse, presented in figure 8. A significant proportion, comprising 40.6% of responses, highlighted maintenance, and spare parts challenges, including the absence of maintenance services, unavailability of spare parts, and the high cost of spare parts. Operational knowledge and efficiency were identified as challenges by 21.7% of responses, with concerns about a lack of operational knowledge and the limited efficiency of mini tillers on larger lands. Additionally, 5.8% of responses pointed out the distance of fuel depots as a challenge. On a positive note, 31.9% of responses reported no issues, suggesting that a substantial portion of users did not encounter challenges with mini-tiller usage.

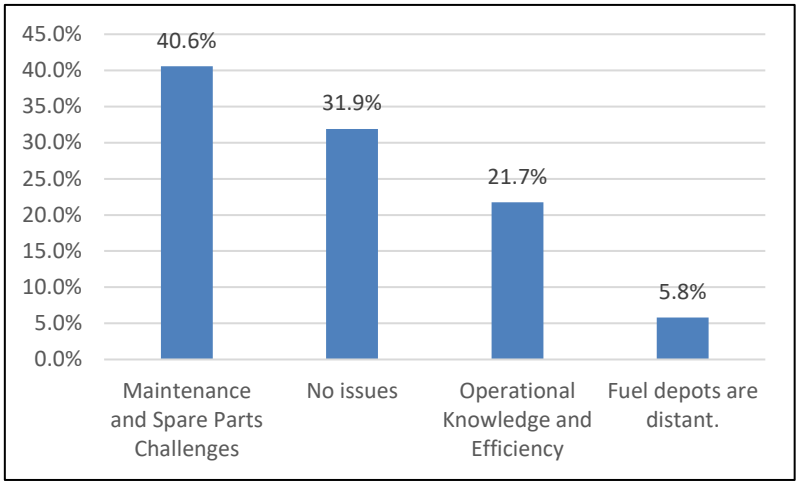

Figure 9: Challenges in using mini tiller.

9.2.3 Reasons for not adopting the mini tiller technology.

The reasons for the non-adoption of mini tillers are diverse, as highlighted in figure 9. Feasibility concerns, encompassing issues related to feasibility and limited land, were indicated with 30.4% of responses, indicating that some individuals find mini-tillers impractical or unsuitable for their specific circumstances. Economic constraints, particularly the unaffordability of mini tillers, were reported with 23.2% of responses. Operational knowledge and maintenance challenges, such as a lack of operational knowledge and limited availability of maintenance services, constituted reasons for non-adoption with 21.4% of responses. Equipment possession, specifically owning a larger power tiller, was indicated by 25.0% of responses.

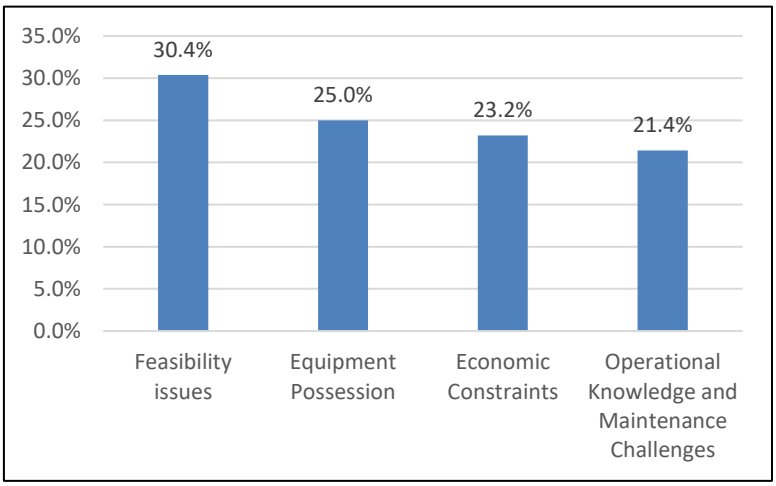

Figure 10: Reasons for non-adopting mini tillers

9.3 Combine Harvester

9.3.1 Accessibility of combine harvester, usage, and adoption.

Out of 612 respondents for the combine harvester adoption study, 98% confirmed having no access to combine harvester while only 2% confirmed that they have access to combine harvester. It is also observed that all the 2% respondents who have access to combine harvester use it as well.

Table 11: Accessibility of combine harvester.

Do you have access to Combine harvester?		**Do you use it?**	
Yes	**No**	**Yes**	**No**
2% (12)	98% (600)	100% (12)	0% (0)

Therefore, the adoption rate for combine harvester is 1.96%, where it is calculated by number of people who own it to the total number of populations.

9.3.2 Motivational factors and challenges in adopting combine harvesters.

Labor saving stands out as the predominant motivator with the response of 54.5%, underscoring the significance of efficiency and reduced manual labor in the decision to adopt combination tools. "Less crop loss" is another notable factor (40.9% responses), highlighting the potential impact on crop preservation as a motivational factor. "Government incentives" constitutes of 4.5% responses, showcasing the role of policy support in influencing adoption decisions.

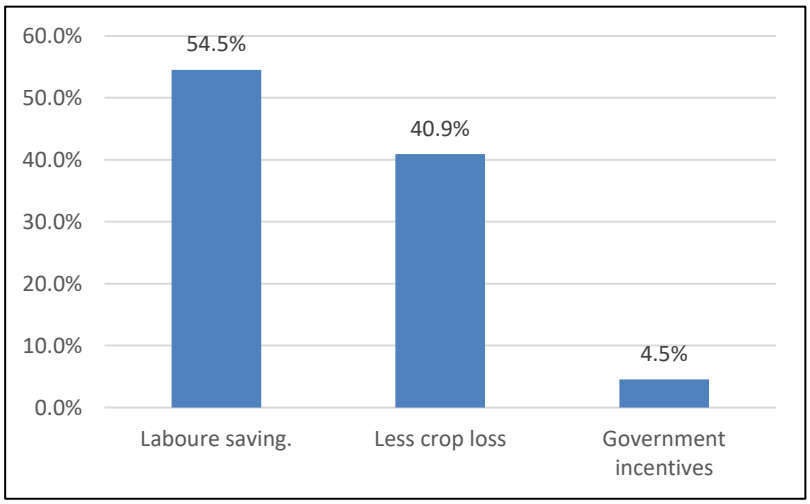

Figure 11: Motivational factors in adopting combine harvesters.

The analysis of challenges faced in the use of combine harvesters revealed issues as presented in figure 11. "Hiring agent occasionally unavailable" stands out as the predominant challenge (42.9%), highlighting logistical difficulties in accessing combine harvester services. "Unaffordable hiring charges" and "No issues" constitutes the response rate of 21.4%, indicating financial concerns and a segment of users experiencing minimal challenges. "Expensive machine" and "Lack of operators" contribute to challenges, each at 7.1%, emphasizing cost and the need for skilled personnel as potential barriers.

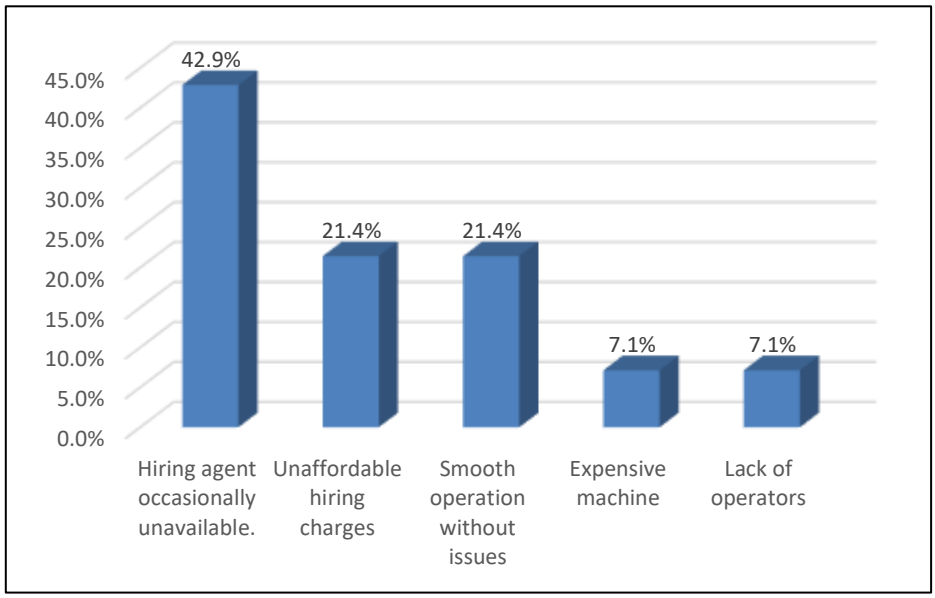

Figure 12: Challenges in using combine harvester.

9.4 Thresher machines

9.4.1 Accessibility of combine harvester, usage, and adoption.

As presented in table 12, it is observed that out of 612 respondents, 23.2% have access to thresher machines where 78.2% of the respondents who have access to thresher use it.

Table 12: Thresher machine access, use and source.

Do you have access to Threshers?		Do you use it?	
Yes	**No**	**Yes**	**No**
23.2% (142)	23.2% (142)	78.2% (111)	21.8% (31)

Therefore, the adoption rate for thrashers is 18.13%, where it is calculated by number of people who own it to the total number of populations.

9.4.2 Motivational factors and challenges in adopting threshers.

The motivation behind the adoption of threshers is driven by various factors, as presented in figure 12. A significant 94.6% of responses highlighted economic and labor-related benefits, including income generation through hiring, labor-saving features, and improved efficiency leading to less crop loss. Additionally, 3.6% of responses indicated support and encouragement factors, such as government incentives and peer influence, while 1.8% of responses considered affordable hiring charges as a motivating factor. These findings underscore the predominant role of economic advantages and efficiency in influencing the adoption of thresher technologies.

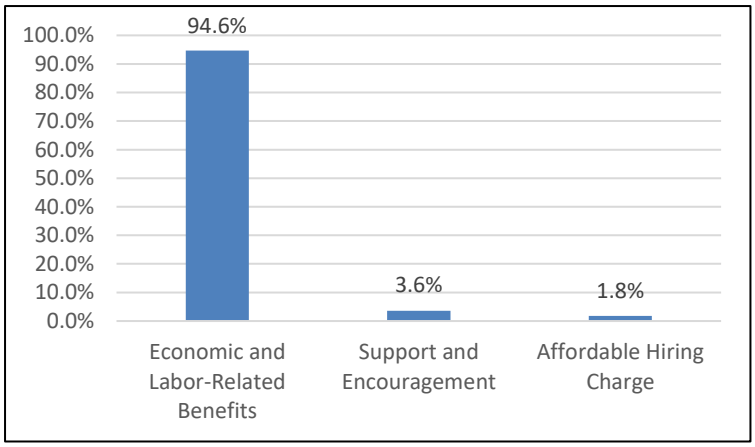

Figure 13: Motivational factors for use of threshers

As presented in figure 13, the utilization of threshers faces various challenges, as reported by respondents. Notably, 82.3% of responses indicated that threshers are used without significant issues, suggesting a generally smooth operation. However, 12.4% of responses highlighted maintenance and operational challenges, including a lack of maintenance services, a shortage of operators, and the use of manual threshers. Affordability and availability issues, such as unaffordable hiring charges and occasional unavailability of hiring agents or neighbors, were mentioned with 5.3% of responses. While most respondents reported smooth operations, addressing the identified challenges could further enhance the efficiency and accessibility of thresher use.

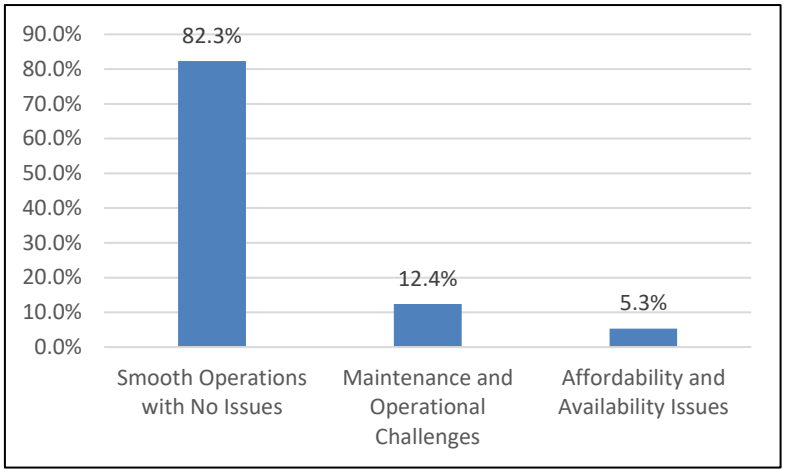

Figure 14: Challenges in using threshers.

9.4.3 Reasons for not adopting the threshers.

The non-adoption of threshers is driven by a combination of economic constraints, operational challenges, and interest/feasibility issues as presented in figure 14. Economic constraints, encompassing the perceived expense of the machine and unaffordable hiring charges, account for 21.6% of responses. Operational challenges, such as the lack of maintenance services, limited land, and inaccessibility, contribute to 27.0% of responses. However, the predominant factor, cited by 51.4% of responses, revolves around interest and feasibility issues. This category includes the lack of interest in adopting threshers, considering them a relatively new technology, and finding them not feasible within the current farming practices. These insights emphasize the multifaceted

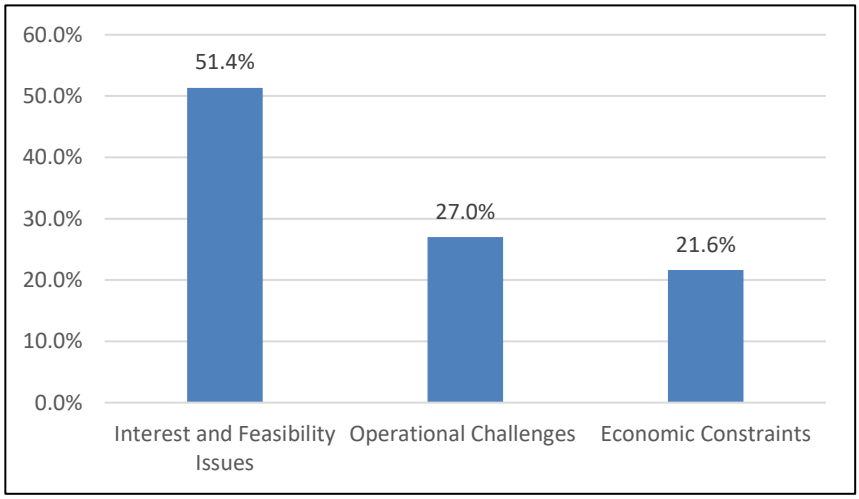

Figure 15: Reasons for not adopting the threshers.

nature of barriers to thresher adoption, highlighting the importance of addressing economic, operational, and attitudinal aspects to promote their uptake.

9.5 Grass Cutter Machine

9.5.1 Accessibility of grass cutter, usage and adoption.

Table 13 presents that 30.4% of respondents have access to grasscutters, while 69.6% do not. Among those with access, 71.0% use grasscutters, and 29.0% do not utilize them. These findings suggest that a significant portion of the respondents have access to grasscutters and most of them actively engage in using these animals, potentially for various purposes such as meat production or other economic activities.

Table 13: Accessibility of grass cutter & usage

Do you have access to grasscutter?		**Do you use it?**	
Yes	**No**	**Yes**	**No**
30.4% (186)	69.6% (426)	71.0% (132)	29.0% (54)

Therefore, the adoption rate for grass cutter is 21.15%, where it is calculated by number of people who own it to the total number of populations.

9.5.2 Motivational factors and challenges in adopting grass cutter.

Figure15 presents motivational factors for grasscutter adoption among respondents. Economic benefits emerge as a prominent factor, with 51.9% of responses citing income generation through hiring and labor-saving as motivators. Operational efficiency is also significant, as 38.1% of responses indicate that grasscutters are considered efficient compared to sickles, with easy operational costs. Additionally, 10.0% of responses attribute grasscutter adoption to support and encouragement factors, including government incentives and peer influence. These findings underscore the multifaceted motivations driving the adoption of grasscutters, combining economic considerations and operational efficiency with external support and encouragement.

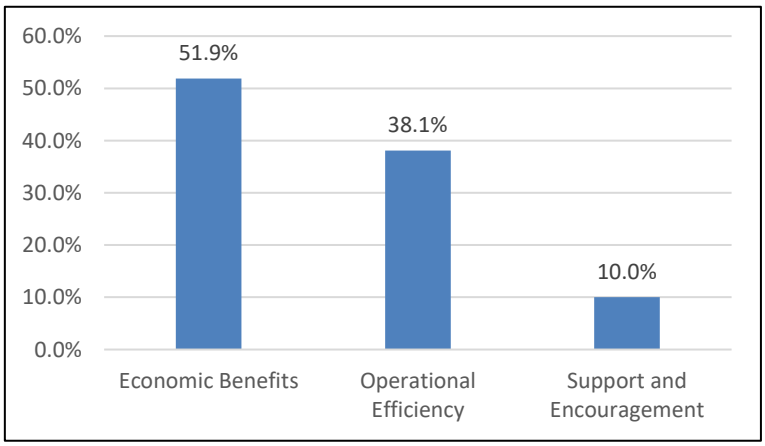

Figure 16: Motivational factors for using grass cutter.

The challenges associated with using grasscutters are diverse, as presented in figure 16. Operational challenges account for 30.1% of responses, encompassing issues such as the lack of maintenance services, insufficient operational knowledge, and occasional unavailability of hiring agents. Economic constraints, including the perceived expense of the machine and unaffordable hiring charges, contribute to 11.6% of responses. Another 12.3% of responses mention operational breakdowns, indicating that grasscutters often experience technical issues. However, a significant portion (45.9%) of respondents reported smooth operations without encountering any issues. This underscores the varied experiences and considerations surrounding the use of grasscutters in agriculture.

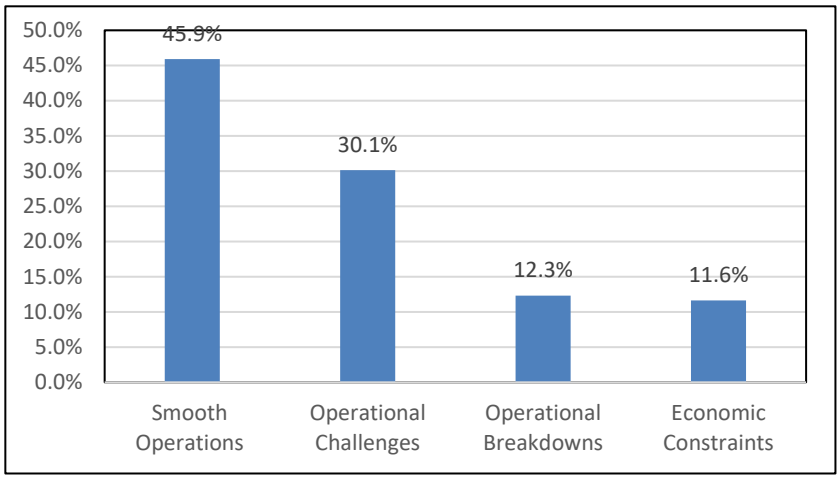

Figure 17: Challenges in using grass cutters.

9.5.3 Reasons for not adopting the grass cutter.

The reasons for not adopting grasscutters as presented in figure 17. Economic constraints, specifically the perceived expense of the machine and unaffordable hiring charges, constitute the primary factor, as indicated by 37.1% of responses. Operational challenges and knowledge gaps, such as the lack of maintenance services and awareness about the operation, contribute significantly, accounting for 30.6% of responses. Additionally, accessibility and feasibility issues, including concerns about accessibility and feasibility due to limited land, labor, and farming practices, are reported with 32.3% of responses. These findings highlight the various barriers that individuals face when deciding not to adopt grasscutters in their agricultural practices.

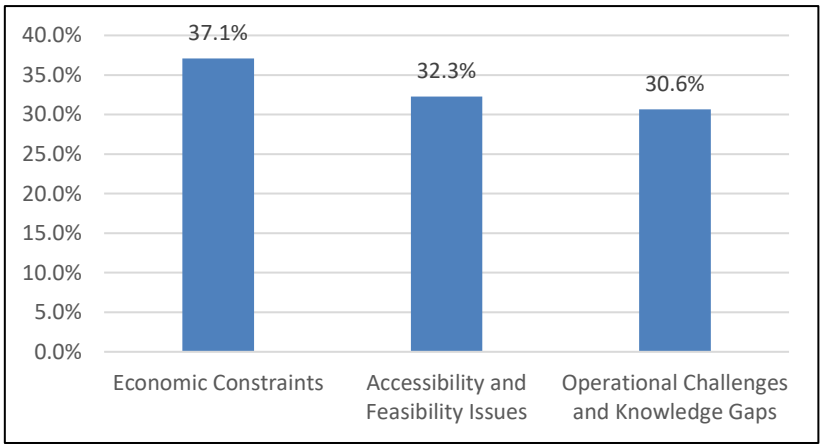

Figure 18: Reasons for not adopting the grass cutters.

PLANT PROTECTION TECHNOLOGIES

10.1 Integrated Pest Management

10.1.1 Awareness and adoption of the IPM technologies

The survey data on Integrated Pest Management (IPM) awareness and practice among 612 respondents reveals that 27.1% are familiar with IPM, while 72.9% lack awareness of this approach. Among those aware of IPM, 56.6% actively practice it, indicating a positive adoption trend, while 43.4% do not engage in IPM practices (Table 14).

Table 14: Awareness and practice of IPM

Are you aware of IPM?		Do you use it?	
Yes	**No**	**Yes**	**No**
27.1% (166)	72.9% (446)	56.6% (94)	43.4% (72)

Therefore, the adoption rate for IPM technologies is 15.35%, where it is calculated by number of people who are practicing it to the total number of populations.

10.1.2 Motivational factors and challenges in adopting IPM.

The motivations for adopting Integrated Pest Management (IPM) practices are diverse and encompass social, economic, and environmental considerations as presented in figure 20. Economic and environmental benefits emerge as the primary motivators, with 59.3% of responses emphasizing the cost-effectiveness, environmental friendliness, and sustainability associated with IPM practices. Agricultural productivity is another significant factor, accounting for 23.3% of responses, where farmers are motivated by increased yield, safer consumption of harvested crops, and a reduction in pest and disease occurrences. Social and cultural factors, including peer influence and religious beliefs, contribute to the motivation for IPM practices, representing 9.3% of responses. Additionally, 8.1% of responses attribute IPM adoption to the

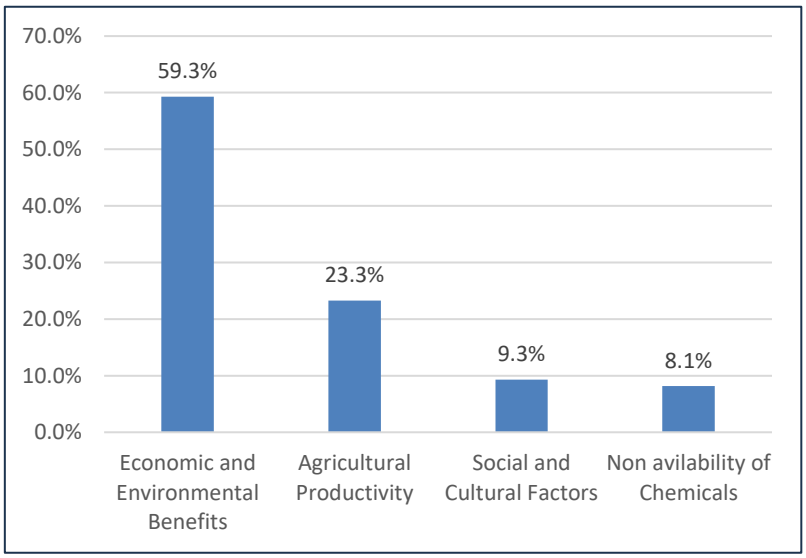

Figure 19: Motivational factors in adopting IPM.

non-availability of chemicals, showcasing the practical considerations influencing farmers' choices in pest management strategies.

The challenges associated with adopting Integrated Pest Management (IPM) practices are diverse, as highlighted in figure 21. Approximately 14.5% of responses identified challenges related to "Knowledge and Awareness," including limited awareness and information, as well as concerns about limited technical capacity. Another 15.5% mentioned "Labor and Community Challenges," indicating issues with labor intensity and a lack of community cooperation. The majority, constituting 60% of responses, pointed to "Agricultural Productivity Challenges," encompassing difficulties in reducing diseases and pests and concerns about poor yield. However, 10% of respondents reported "Smooth Operations with No Issues," suggesting that a portion of farmers may not encounter significant challenges in implementing IPM practices. These findings underscore the multifaceted nature of challenges in adopting IPM and the need for targeted interventions to address knowledge gaps, labor issues, and productivity concerns.

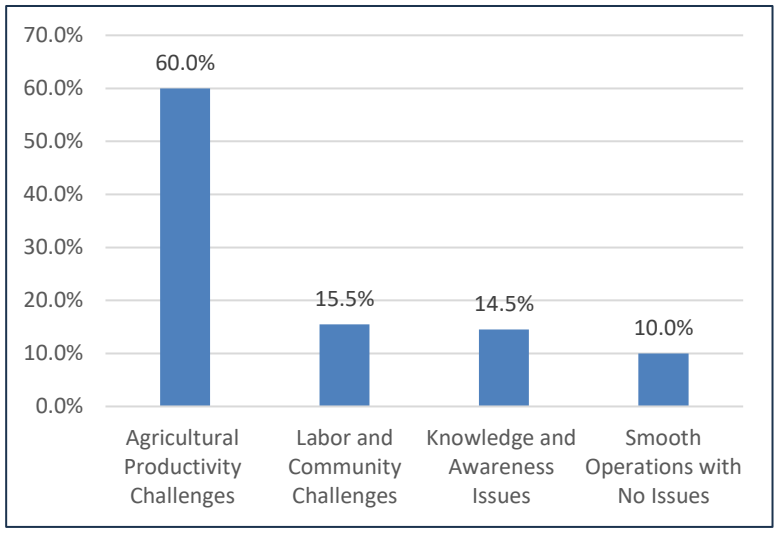

Figure 20: Challenges while using IPM.

10.1.3 Reasons for non-adoption of IPM practices

The non-adoption of Integrated Pest Management (IPM) practices is attributed to various factors, as indicated in figure 22. Knowledge and interest issues, including a lack of awareness and information, were reported at 22.8%. Labor and community challenges, such as labor-intensive

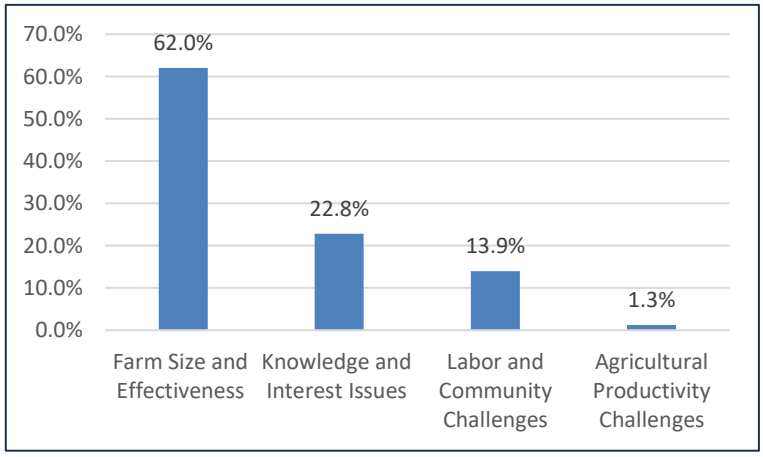

Figure 21: Reasons for non-adoption of IPM

practices and a lack of community cooperation, accounted for 13.9% of responses. The most prevalent reason, highlighted by 62% of respondents, is related to farm size and effectiveness, with concerns about small-sized farming and perceived ineffectiveness of IPM. Additionally, a minimal percentage (1.3%) cited agricultural productivity challenges, specifically poor yield, as a factor influencing non-adoption. These findings emphasize the need for targeted strategies to address knowledge gaps, labor issues, and the perceived effectiveness of IPM, particularly in smaller farms.

10.2 Sprayer Machines

10.2.1 Access and usage of sprayers

The data reveals that 52.6% of respondents have access to sprayers, while 47.4% do not. Among those with access, 82.0% reported using sprayers, whereas 18% chose not to utilize them (table 16).

Table 15: Access, and usage of sprayers machine

Do you have access to sprayers?		Do you use it?	
Yes	**No**	**Yes**	**No**
52.6% (322)	47.4% (290)	82.0% (64)	18% (58)

Therefore, the adoption rate for sprayers machine is 10.45%, where it is calculated by number of people who are using it to the total number of populations.

10.2.2 Motivational Factors and challenges in using sprayers.

The analysis of responses on the motivation for using sprayers indicates that economic benefits play a significant role, with 51.6% of responses highlighting income generation through hiring and labor-saving as motivating factors. Safety and environmental benefits are also crucial, as reported with 42.2% of responses, emphasizing the importance of safe handling, reduced chemical losses, and improved efficiency in pest control. Additionally, a smaller proportion, 4.3%, mentioned enhanced overall profitability as a motivating factor. This suggests that economic considerations and safety concerns are key drivers for the adoption of chemical sprayers among the surveyed participants.

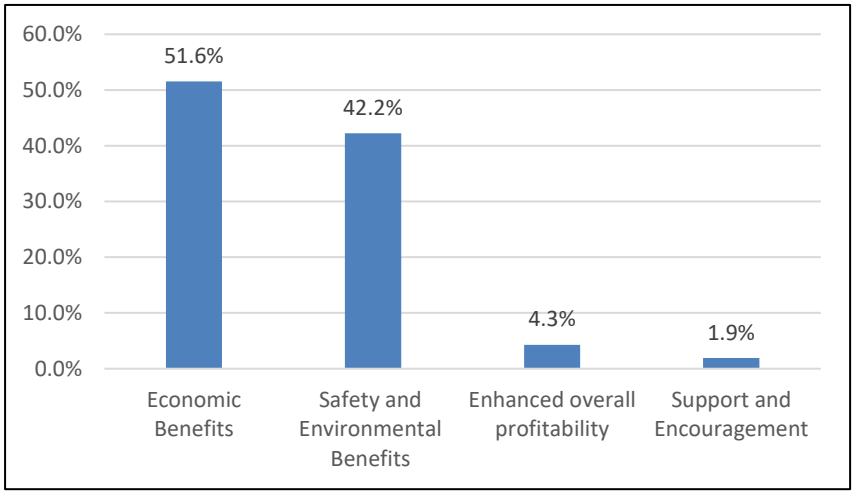

Figure 22: Motivational factors

Figure 24 presents the challenges related to the use of sprayers. Economic constraints, reported with 8.1% of responses, encompass both the affordability of purchasing and hiring sprayers. Operational and maintenance challenges, highlighted by 22.3% of responses, include issues such as the lack of spare parts, maintenance services, and the need for regular maintenance. Knowledge and environmental concerns, raised with 6.2% of respondents, involve limited awareness and information, environmental concerns, and inefficiencies in operation. On a positive note, most responses (63.4%) reported smooth operations with no identified issues, suggesting a generally satisfactory experience with sprayer usage.

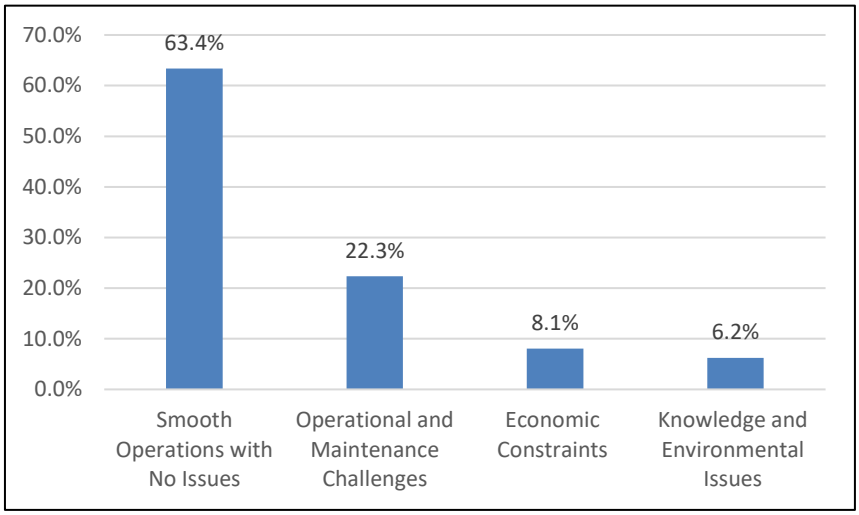

Figure 23: Challenges in using sprayers.

10.2.3 Reasons for the non-adoption of sprayers

The non-adoption reasons for sprayers provide valuable insights as presented in figure 25. Economic constraints emerge as a significant factor, with unaffordability reported at a response rate of 41.9%. Operational challenges, including the lack of spare parts, maintenance services, and perceived inefficiencies, are reported with 6.5% of responses. Knowledge and awareness issues, such as limited information and the perception of sprayers as a relatively new technology, contribute to non-adoption with 12.9% of responses. Land and accessibility concerns, along with the choice to avoid chemical use, are reported at response rates of 21.0% and 17.7%, respectively. These findings highlight diverse factors influencing the non-adoption of sprayers among the surveyed population.

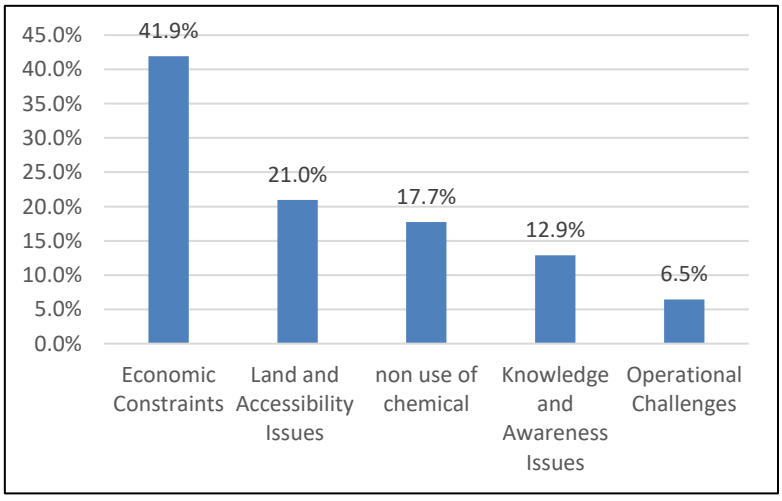

Figure 24: Reasons for not adopting the technology.

10.3 Rangzhin Buupmeen

10.3.1 Awareness and usage

It is observed that the awareness and practice of Rangzhin Buupmen among 612 respondents indicates a notable awareness gap, with 87.4% (535) stating that they are not aware of it. In terms of practical implementation, 62.3% (48) of those aware reported practicing it, while 37.3% (29) did not adopt despite being aware of it.

Table 16: Awareness and usage

Are you aware of Rangzhin Buupmen?		**Do you use it?**	
Yes	**No**	**Yes**	**No**
12.6% (77)	87.4% (535)	37.3% (29)	62.3% (48)

Therefore, the adoption rate for of Rangzhin Buupmen is 4.7 %, where it is calculated by number of people who are using it to the total number of populations.

10.3.2 Motivational factors and challenges in using Rangzhin Buupmeen

As presented in figure 26, economic and environmental benefits are the primary motivators, with 46.8% of responses citing factors such as economic viability, environmental friendliness, and sustainability. Additionally, 42.6% of responses indicated that they are motivated by the potential impact on agricultural productivity and safety, emphasizing the desire for increased yields and the assurance of safe and sound agricultural practices. Social and cultural factors, including peer influence and religious beliefs, also play a role, as indicated by 8.5% of responses. Land conservation, specifically the prevention of land degradation, is a less commonly cited but still significant motivator, indicated with 2.1% of responses. These findings underscore the diverse motivations that drive the adoption of Rangzhin Bupmeens practices among the surveyed population.

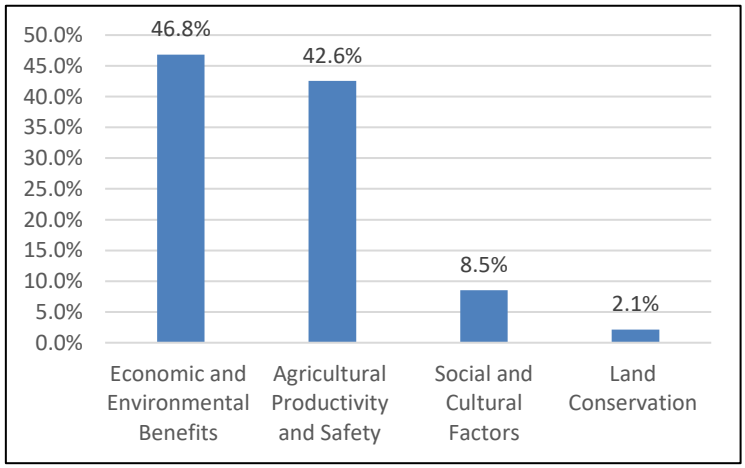

Figure 25: Motivational factors in adoption

The challenges associated with the adoption of Rangzhin Bupmeen practices, as reported in figure 27, encompass various dimensions. Knowledge and awareness issues emerge as the most prevalent challenges, accounting for 34.4% of responses. These challenges include a lack of awareness and information, limited technical capacity, and the perception of the technology as relatively new. Accessibility and community challenges contribute to 15.6% of responses, with issues related to raw material accessibility and labor-intensive practices. Technological and agricultural challenges, such as inefficiency, disease and pest incidence, and poor yield, are reported by 18.8% of responses. Notably, 31.3% of responses indicate a smooth operation with no reported issues. These findings highlight the multifaceted challenges that individuals face in adopting Rangzhin Bupmeen practices, emphasizing the importance of addressing knowledge gaps, accessibility issues, and agricultural concerns to enhance adoption rates.

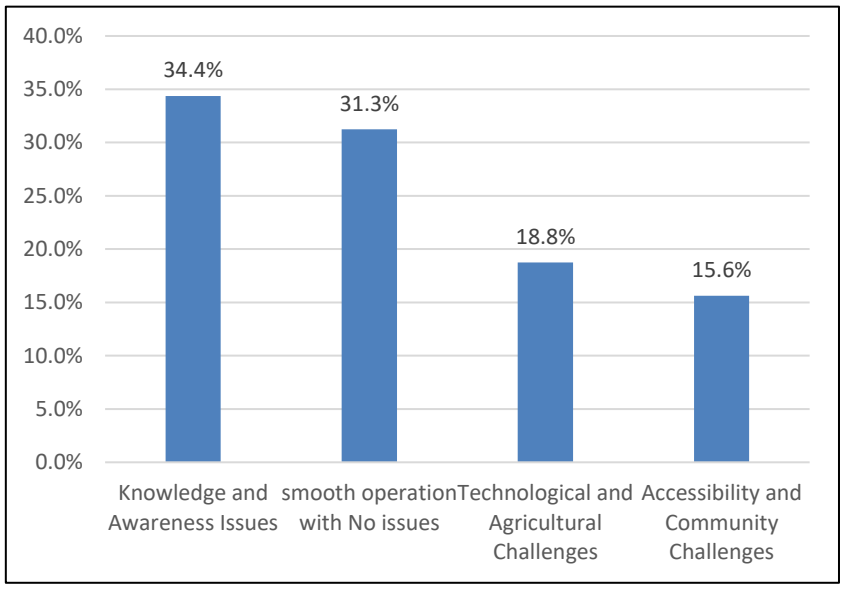

Figure 26: Challenges while using Rangzhin Bupmeen

10.3.3 Reasons for non-adoption of the Rangzhin Bupmeen

The non-adoption reasons for Rangzhin Buupmeen practices, as reported in figure 28, highlights a range of factors contributing to the decision not to adopt. Knowledge and interest issues constitute a significant portion, with 34.9% of responses citing a lack of awareness and information, lack of interest, and perceptions of the technology as relatively new. Accessibility and community challenges account for 24.1%

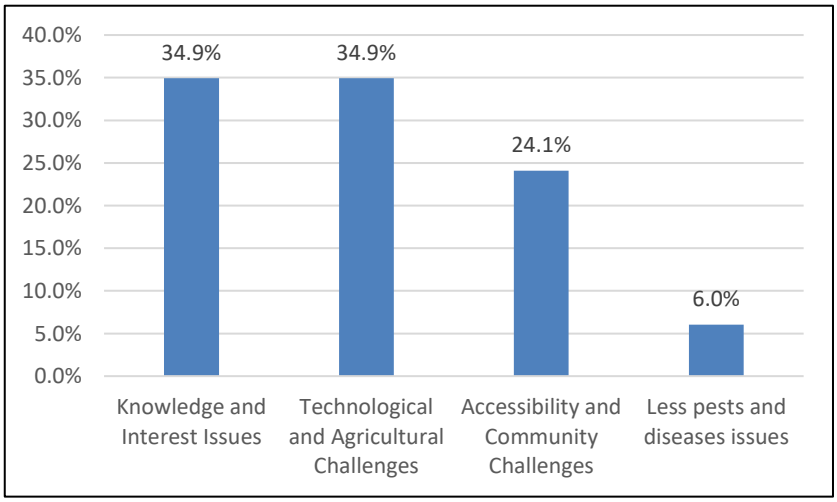

Figure 27: Reasons for not adopting the technology.

of responses, encompassing issues related to raw material accessibility, labor-intensive practices, limited technical capacity, and a lack of community cooperation. Technological and agricultural challenges, including inefficiency, difficulties in managing diseases and pests, and concerns about yield loss, are reported by another 34.9% of responses. Additionally, 6.0% of responses mention the perception of facing fewer issues related to pests and diseases as a reason for non-adoption. These findings underscore the diverse and interconnected barriers that individuals encounter when considering the adoption of Rangzhin Buupmeen practices. Addressing these challenges could contribute to fostering greater adoption rates and promoting sustainable agricultural practices.

10.4 Electric Fencing

10.4.1 Awareness and usage

It is observed that awareness and practice of a certain technology among 612 respondents reveals that 58.8% are aware of it, while 41.2% are not. Among those aware, 46.9% practice it, while 53.1% do not (Table 16).

Table 17:Awareness and use

Are you aware of electric fencing?		Do you use it?	
Yes	**No**	**Yes**	**No**
58.8% (360)	41.2% (252)	46.9% (169)	53.1% (191)

Therefore, the adoption rate for electric fence is 27.6 %, where it is calculated by number of people who are using it to the total number of populations.

10.4.2 Motivation and Challenges in adopting electric fencing technology.

Figure 29 presents data on motivations for adopting electric fences, with 309 responses categorized into different factors. The primary motivation is Agricultural Productivity and Protection, constituting 40.8% of responses, including considerations such as crop protection, high yield, and reduced crop loss. Support and Encouragement factors, encompassing government incentives and peer influence, account for 25.6% of responses. Convenience and Security, highlighting the advantage of not having to guard crops, make up 30.4% of responses. Economic Benefit, specifically increased income, is cited by 3.2% of respondents. In summary, the data underscores the significance of agricultural productivity and protection as the primary driver for electric fence adoption, followed by support and encouragement, convenience, and security, while economic benefits play a comparatively smaller role in motivating respondents.

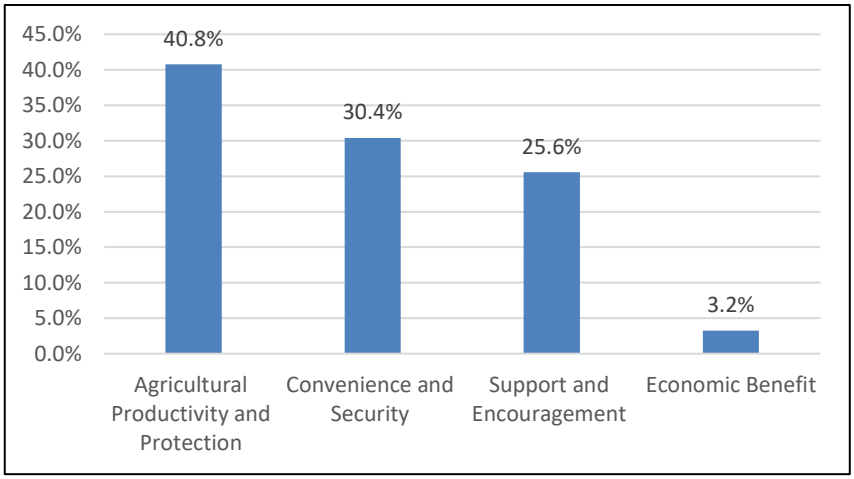

Figure 28: Motivational Factors

Figure 30 provides insights into challenges related to electric fencing, with 226 responses categorized into distinct factors. The most prevalent challenge is Maintenance and Operational Challenges, encompassing issues such as the absence of maintenance service providers, the need for external energy, unavailability of spare parts, and the requirement for regular jungle clearing, constituting 61.9% of responses. Efficiency issues, including dependence on sunshine for effectiveness and ineffectiveness against monkeys, wild boar and elephants account for 21.7% of responses. Knowledge and Labor Intensity challenges, reflecting limited knowledge, make up 9.7% of responses. Respondents indicating Smooth Operations with No Issues represent 6.6% of responses.

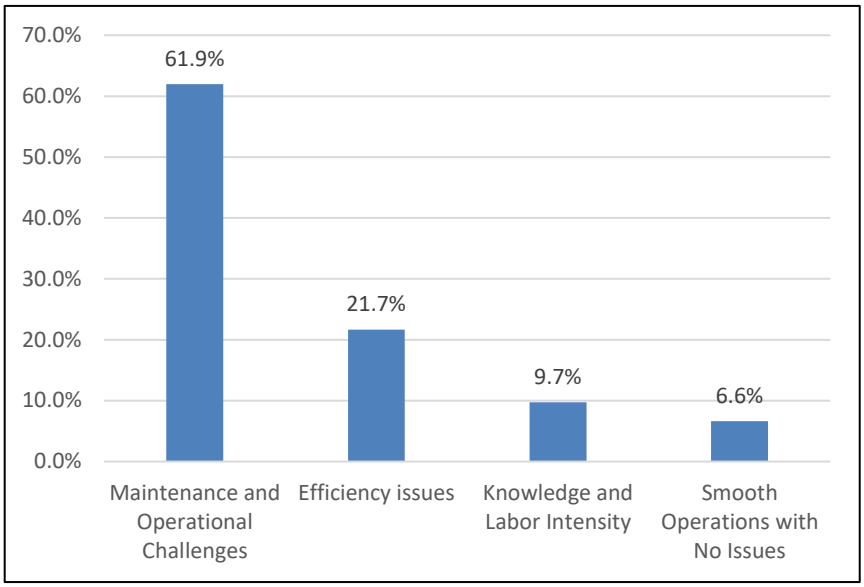

Figure 29: Challenges in electric fencing

10.4.3 Factors for not adopting electric fencing technology.

Figure 31 presents insights into reasons for the non-adoption of electric fencing, with 215 responses categorized into distinct factors. Economic Constraints, such as unaffordability and small land size, constitute 37.7% of responses. Knowledge and Interest Issues, including limited awareness, information, and lack of interest, account for 16.3% of responses. Accessibility and Community Challenges, encompassing issues like land located between settlements, inaccessibility (scattered settlements, unavailability in gewog), absence of human-wildlife conflict, and lack of community cooperation, make up 37.2% of responses. In summary, the data highlights Economic Constraints as a major reason for non-adoption, followed by Accessibility and Community Challenges, and Knowledge and Interest Issues.

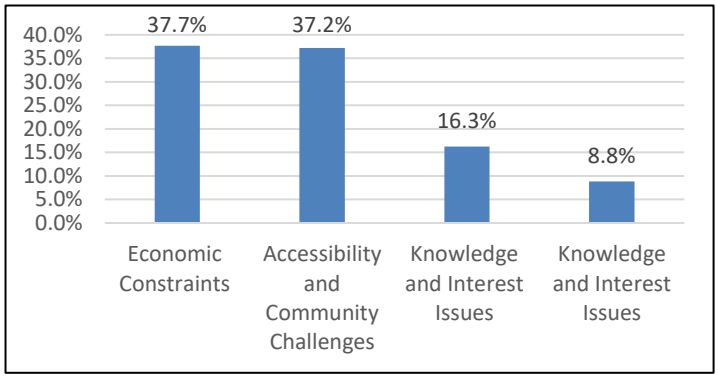

Figure 30:Non adoption factors for electric fencing

10.5 Plastic Mulch

10.5.1 Awareness and usage of plastic mulch.

The data indicates that 52.3% of respondents are aware of the technology, with 43.4% practicing it.

Table 18: Awareness and usage

Are you aware of plastic mulch?		Do you use it?	
Yes	**No**	**Yes**	**No**
52.3% (320)	47.7% (292)	43.4% (139)	56.6% (181)

Therefore, the adoption rate for plastic mulch is 22.7 %, where it is calculated by number of people who are using it to the total number of populations.

10.5.2 Motivation and challenges in using plastic mulch.

Figure 32 presents the insights into motivational factors driving the use of plastic mulch, with 379 responses categorized into different factors. Weed Control emerges as a significant motivation, accounting for 34.3% of responses. Labor and Yield Benefits, encompassing less labor, high yield, and better crop growth, constitute 25.1% of responses. Similarly, Soil Health and Moisture Conservation factors, such as improved soil temperature, soil moisture conservation, and prevention of nutrient leaching, also account for 25.1% of responses. Peer influence is cited as a motivation by 15.6% of respondents.

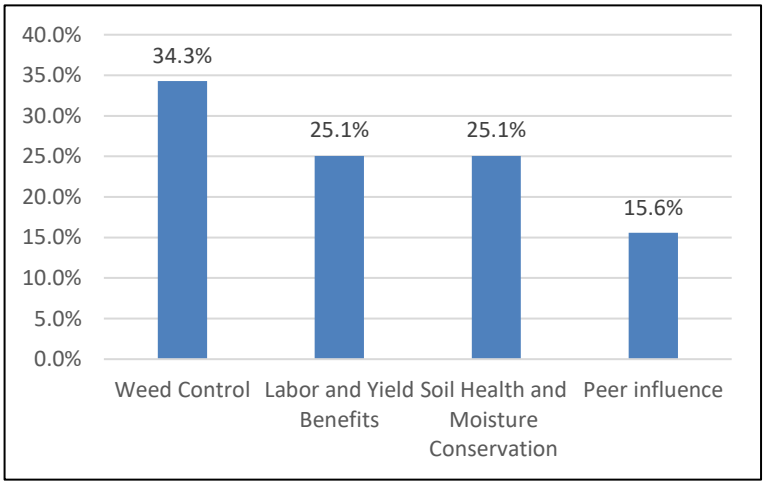

Figure 31: Motivational factors

Figure 33 presents challenges associated with the use of plastic mulch, with 53 responses categorized into various factors. Limited knowledge is identified as a challenge by 11.3% of respondents. Economic and Cost-Related Constraints, such as the expense of the material, constitute a challenge for 24.5% of responses. Environmental Concerns and Effectiveness, including environmental concerns, perceived ineffectiveness, and sustainability issues, are reported as challenges by 24.5% of respondents. Operational Challenges, specifically hole-making and irrigation issues, are mentioned by 1.9% of respondents. On a positive note, 37.7% of respondents report having no issues.

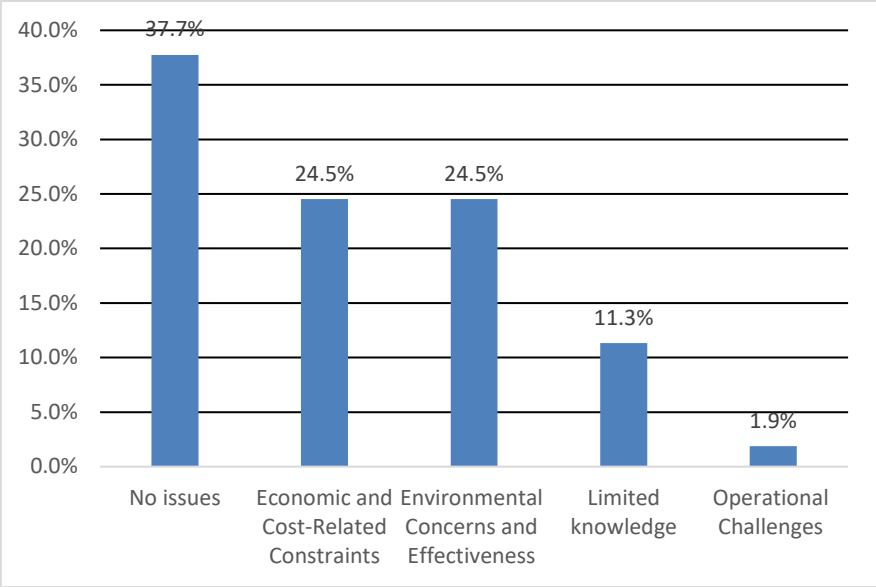

Figure 32: Challenges while using plastic mulch.

10.5.3 Non adoption factors for plastic mulch

Figure 34 provides insights into reasons for the non-adoption of plastic mulch, with 225 responses categorized into various factors. Economic Constraints, specifically the unaffordability of plastic mulch, constitute 25.8% of responses. Knowledge and Interest Issues, encompassing limited awareness, information, and lack of interest, account for 28.9% of responses. Land and Community Challenges, including limited land and concerns about neighbours' experiences, make up 15.6% of responses.

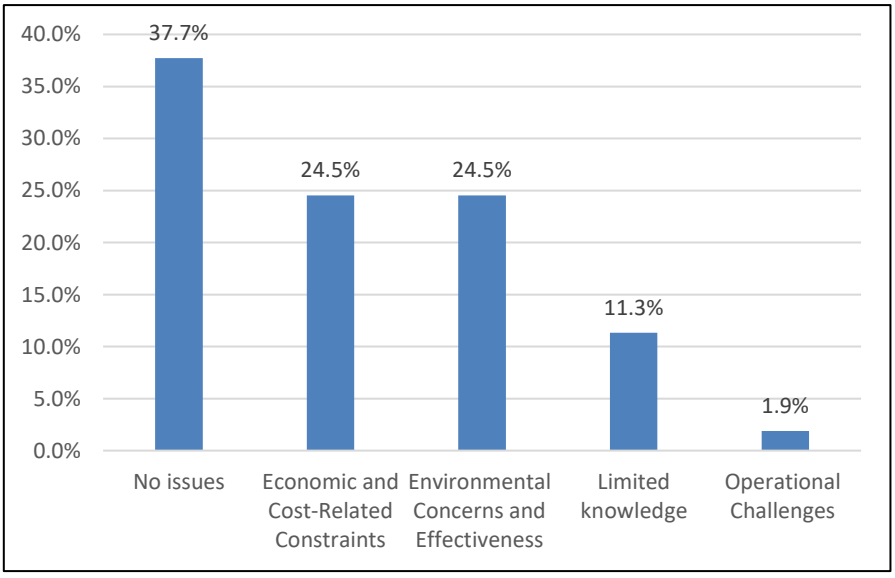

Figure 33: Reasons for not adopting plastic mulch.

Feasibility and Operational Issues, such as labor shortage, small-scale farming, unavailability, ineffectiveness, and incompatibility with current farming practices, constitute 29.8% of responses.

SOIL FERTILITY AND LAND MANAGEMENT TECHNOLOGY

11.1 Biochar

11.1.1 Access, source of technology and usage

The awareness and adoption of the practice in question appear to be limited, with only 2.0% of respondents indicating awareness and 41.7% of those practicing it. However, a significant majority of 98% are not aware of the practice, and among those aware, only a small fraction (5 individuals) is actively practicing it (table 18).

Table 19: Awareness and usage of Biochar.

Are you aware of Biochar?		Do you use it?	
Yes	**No**	**Yes**	**No**
2.0% (12)	98% (600)	41.7% (5)	58.3% (7)

Therefore, the adoption rate for Biochar is 0.81 %, where it is calculated by number of people who are using it to the total number of populations.

11.1.2 Motivational factors and challenges while using Biochar.

The motivational factors for adopting biochar are presented, with respondents citing various reasons. The majority (50.0%) emphasized its potential to improve soil conditions, while 37.5% highlighted its role in enhancing plant growth.

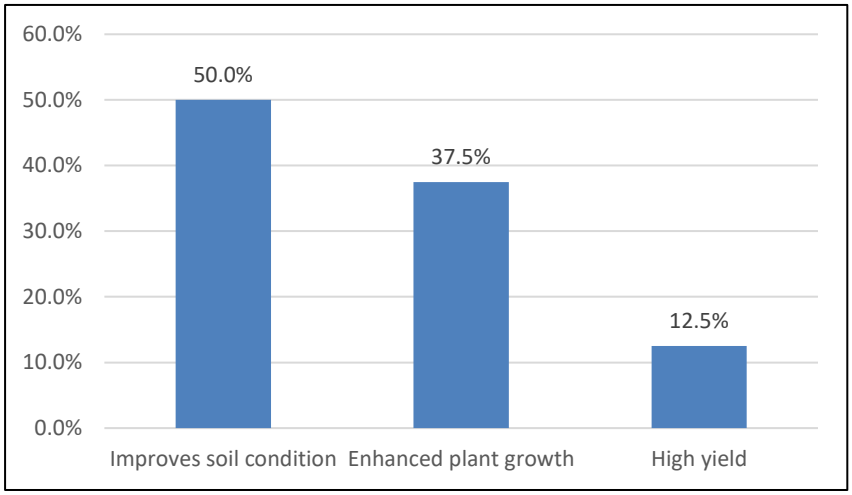

Figure 34: Motivational factors for Biochar

A smaller proportion (12.5%) identified the motivational factor of achieving high yields using biochar.

The challenges associated with the use of biochar are identified, with respondents highlighting specific issues. The primary challenge, as indicated by 83.3% of the responses, is the requirement of a substantial amount of firewood for the biochar production process. This finding suggests that the resource demand, specifically the need for large quantities of firewood, poses a significant obstacle to the adoption of biochar among the surveyed individuals. Additionally, a smaller proportion (16.7%) cited limited knowledge as a challenge, emphasizing the importance of awareness and information dissemination to address barriers to biochar adoption.

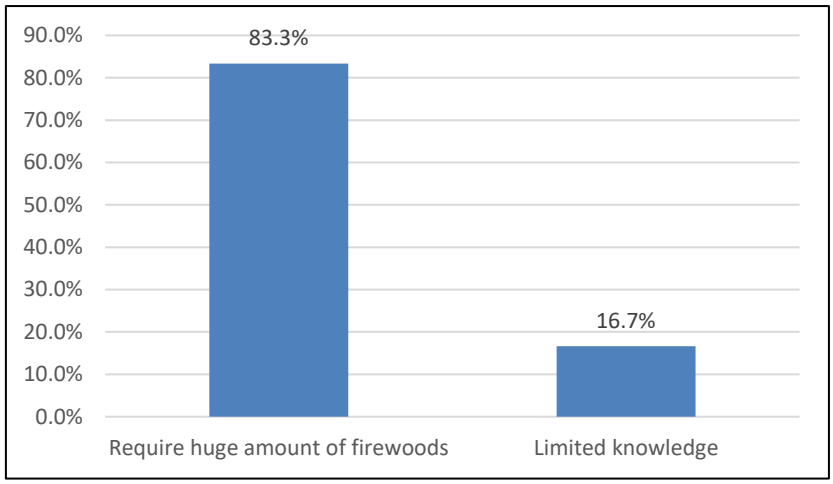

Figure 35: Challenges inn using Biochar.

11.1.3 Reasons for not adopting the Biochar.

For the non-adoption of biochar, respondents cited various reasons (Figure 37). Lack of interest emerged as the predominant factor, with 57.1% of the responses indicating this as a barrier. Limited awareness and information were also significant, accounting for 28.6% of the responses, emphasizing the need for increased education and outreach efforts. Additionally, a smaller proportion (14.3%) mentioned unaffordability as a reason for not adopting biochar.

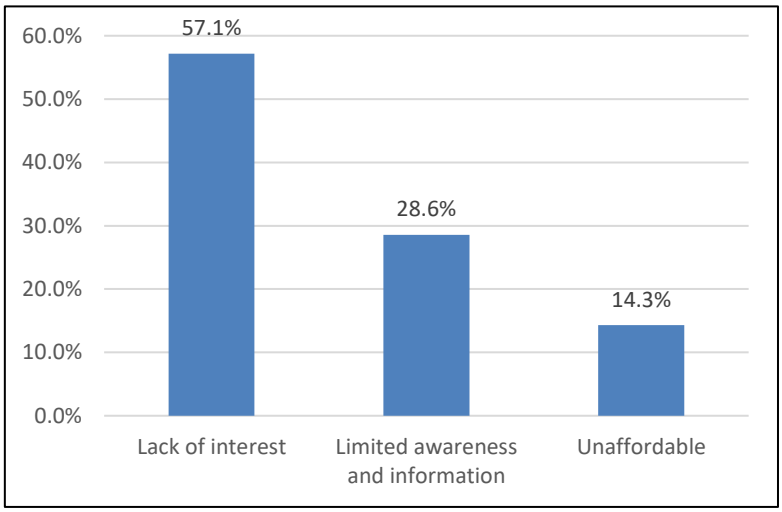

Figure 36: Reason for non-adoption of technology

11.2 Composting Technology

11.2.1 Awareness, use and source of technology.

Among the respondents, 43.3% were aware of composting technologies, while 56.7% were not. However, only 20.8% of those aware practiced composting, indicating a gap between awareness and adoption (Table 19).

Table 20: Awareness and usage.

Are you aware of composting?		Do you use it?	
Yes	**No**	**Yes**	**No**
43.3% (265)	56.7% (347)	20.8% (55)	79.2% (210)

Therefore, the adoption rate for composting is 8.9 %, where it is calculated by number of people who are using it to the total number of populations.

11.2.2 Motivation and challenges

The motivations for adopting composting practices were diverse among the respondents (Figure 38). The majority, 78.2%, were driven by the desire to improve soil condition, emphasizing the importance of soil health in agricultural practices.

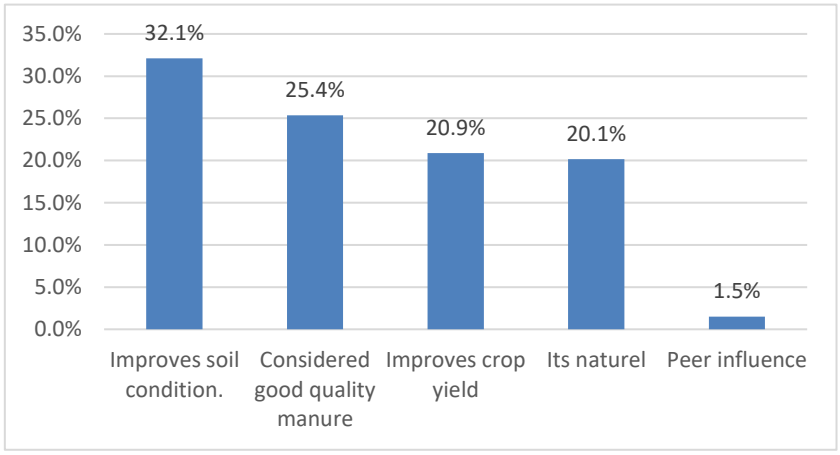

Figure 37: Motivational factors

Additionally, 61.8% highlighted the appeal of compost as a good manure source, showcasing its significance as an organic fertilizer. About 50.9% of respondents were motivated by the belief that composting enhances crop yield, reinforcing the positive impact on overall agricultural productivity. The natural nature of compost was cited by 49.1%, indicating an inclination towards environmentally friendly and sustainable farming practices. Peer influence played a smaller role at 3.6%.

Figure 39 provides insights into challenges associated with composting, with 75 responses categorized into various factors. Knowledge and Resource Constraints, including limited knowledge, material unavailability, and the requirement for large amounts, constitute 36.0% of responses. Effectiveness and Pest Issues, such as perceived ineffectiveness and problems with pests and rodents, account for 10.7% of responses. Operational Challenges, particularly the time-consuming nature of the process, are mentioned with 29.3% of responses. On a positive note, 24.0% of respondents report smooth operations with no identified issues.

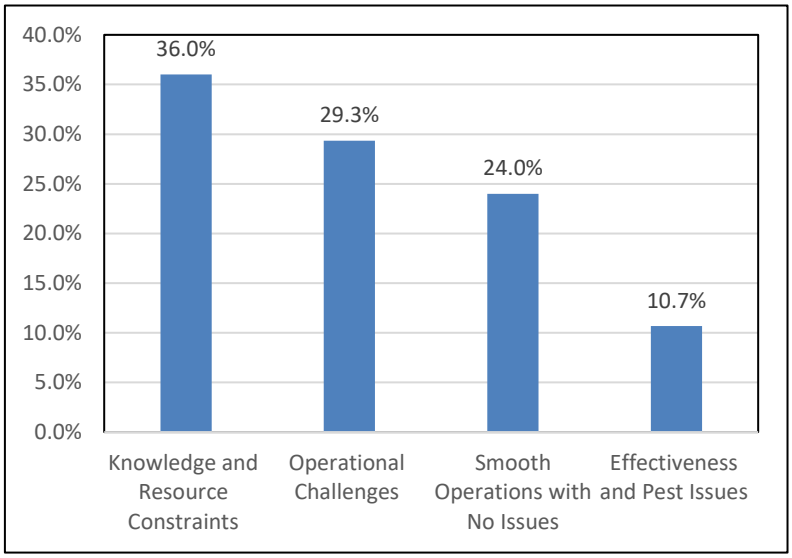

Figure 38: Challenges in using composting.

11.2.3 Reasons for not adopting composting.

Figure 40 provides insights into reasons for the non-adoption of composting, with 222 responses categorized into various factors. Knowledge and Economic Constraints, encompassing unaffordability due to labor shortage, limited awareness, lack of interest, and neighbours not adopting, constitute 15.3% of responses. Land and Agricultural Effectiveness issues, including limited land and perceived ineffectiveness compared to chemical manure, account for 6.3% of responses. Availability and Preference for Cattle Manure emerge as the primary reason for non-adoption, constituting 72.5% of responses. Alternative Manure Options, such as using horse dung, poultry manure, and exchanging straw with compost, make up 5.9% of responses.

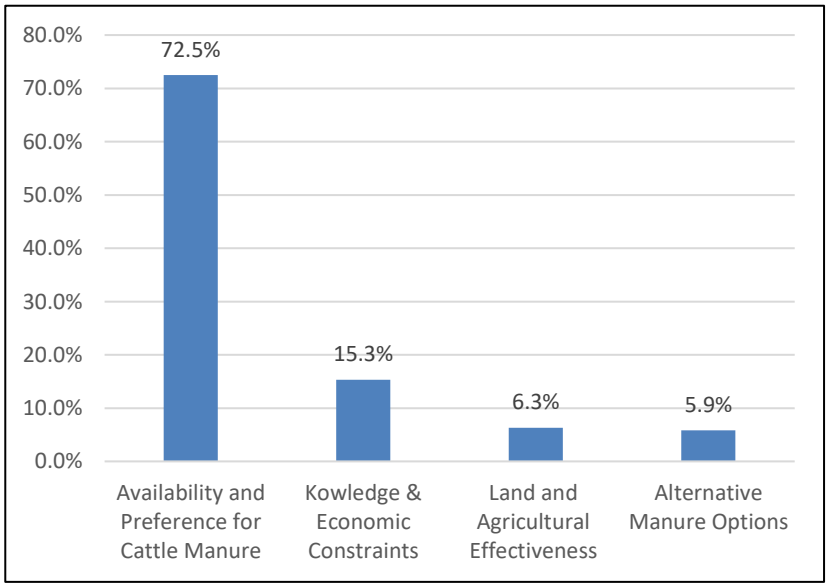

Figure 39: Non adoption reasons

11.3 Green manure cultivation

11.3.1 Awareness and cultivation practices of green manure

Approximately 7.7% of respondents indicated awareness of green manure, while the majority (92.3%) reported a lack of awareness. Among those aware, a significant portion (55.3%) claimed to actively cultivate green manure. This suggests that although awareness is limited, a noteworthy proportion of those familiar with green manure incorporate it into their cultivation practices.

Table 21: Awareness and cultivation practice of green manure

Are you aware of green manure cultivation?		Do you cultivate it?	
Yes	**No**	**Yes**	**No**
7.7% (47)	92.3% (565)	55.3% (26)	44.7% (21)

Therefore, the adoption rate for green manure cultivation is 4.2 %, where it is calculated by number of people who are cultivating it to the total number of populations.

11.3.2 Motivations and challenges in green manure cultivation

Among those cultivating green manure, various motivational factors were identified (Figure 41). The most prominent motivation (38.6%) was the impact of green manure cultivation of improvement of soil fertility. Additionally, easy access to planting materials (15.9%), peer influence (9.1%), income generation through selling (20.5%), and the potential to use as cattle feed (15.9%) were cited as motivations.

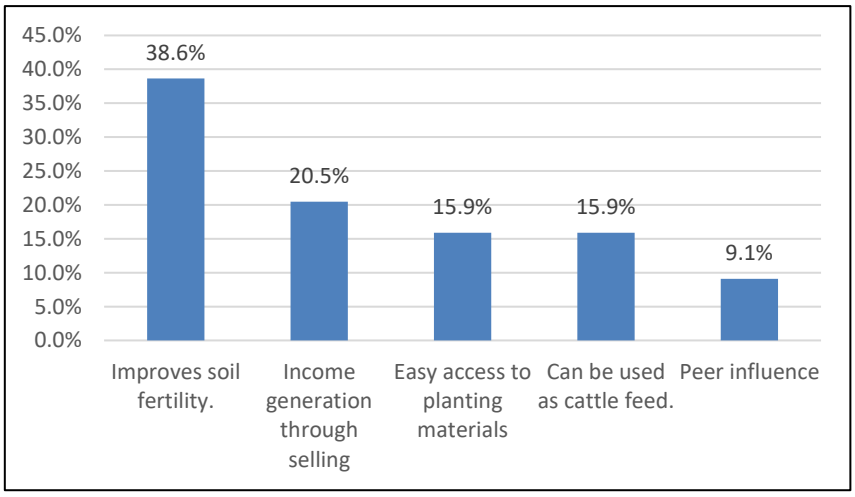

Figure 40: Motivational Factors

Among those involved in green manure cultivation, several challenges were identified (figure 42). The most common response of 38.7% was the perceived absence of no issues in the cultivation process. Other challenges included limited awareness and information (12.9%), labor shortages (35.5%), unavailability of planting materials (6.5%), and pest and disease issues (6.5%).

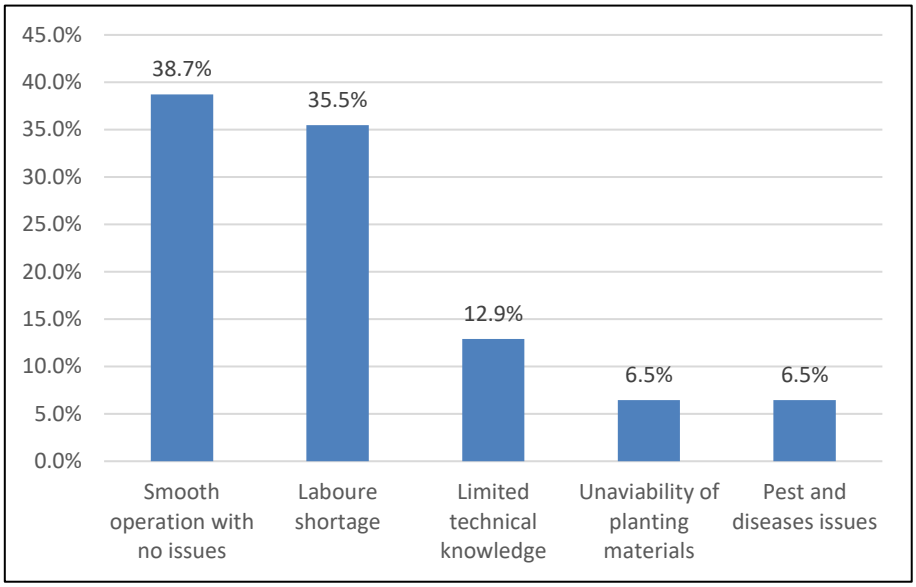

Figure 41: Challenges in green manure cultivation

11.3.3 Reasons for not adopting green manure cultivation.

For those not adopting green manure cultivation, various reasons were identified (Figure 43). Limited awareness and information and lack of interest has the same response of 20.7%. Labor shortages were a significant factor (34.5%), highlighting the importance of addressing workforce constraints in promoting green manure cultivation. Additionally, 10.3% responses were for the lack of input materials, and 13.8% were for limited land as a hindrance to adopting green manure cultivation practices.

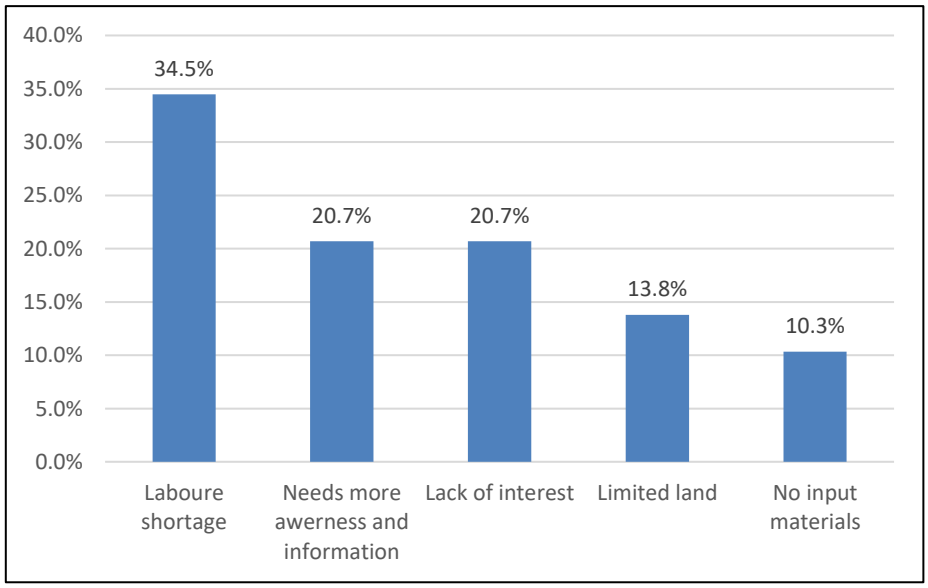

Figure 42: Reasons for non-adoption of green manure cultivation

11.4 Soil & Land Management Technologies

11.4.1 Awareness, practices, type of technologies and the funding source of technology

It is observed that 19.4% out of 612 respondents confirmed their awareness on the soil and land management technologies (Table 22). Only 49.5% of respondents who are aware of the technology uses it. The stone bund is the most (39.20) practice technology while check dame remains the least (8.9%) practiced technology.

Table 22: Access, usage, and types of technologies

Are you aware SLM practices?		Do you practice it?		SLM technologies practiced in field	
Yes	No	Yes	No		
19.4% (119)	80.6% (493)	49.6% (59)	50.4% (60)	Hedge row	34.20%
				Check Dame	8.90%
				Stone bund	39.20%
				Terracing	17.70%

Therefore, the adoption rate for SLM technology is 9.6 %, where it is calculated by number of people who are practicing it to the total number of populations.

11.4.2 Motivation and challenges in adopting SLM technologies.

Figure 44 presents motivations for adopting Sustainable Land Management (SLM) practices, with 81 responses categorized into different factors. Improved Agricultural Operations, emphasizing easy farming and stable land, constitute the primary motivation, accounting for 53.1% of responses. Government Incentives through cost-sharing is identified as a motivation by 24.7% of respondents. Soil Improvement and Cattle Feed, including the enhancement of soil fertility and providing a source of cattle feed, are

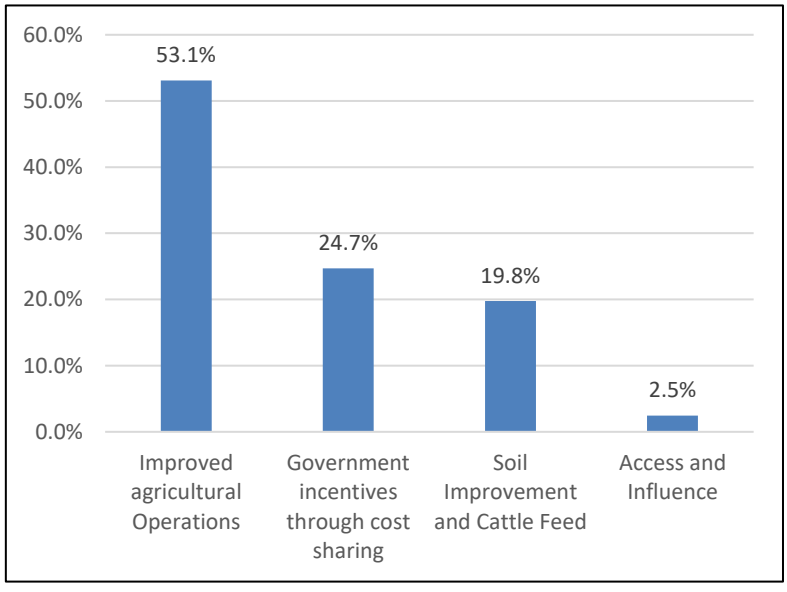

Figure 43: Motivational factors

mentioned with 19.8% of responses. Access and Influence, such as easy access to raw materials and peer influence, play a smaller role, accounting for 2.5% of responses.

Figure 45 provides insights into challenges associated with Sustainable Land Management (SLM) practices, with 62 responses categorized into various factors. Operational Challenges, including labor shortage and lack of input materials, constitute a significant challenge, accounting for 41.9% of responses. Smooth Operations with No Issues is reported by 45.2% of respondents. Knowledge and Awareness Issues are mentioned by 3.2% of respondents, Financial Constraints by 1.6%, and Land Limitation and Soil Conditions by 8.1%.

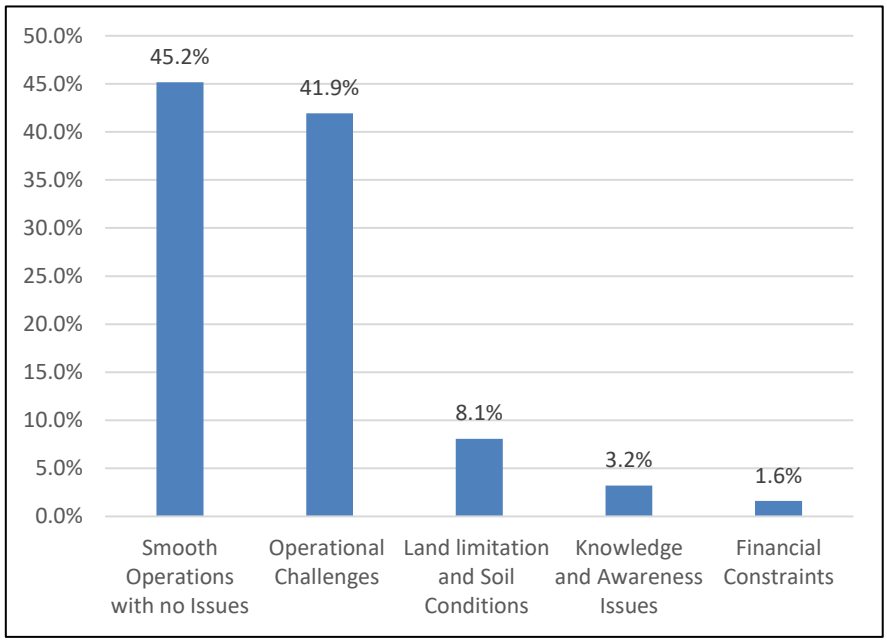

Figure 44: Challenges in SLMP technology

11.4.3 Reasons for non-adoption of the technology

Figure 46 presents the reasons for the non-adoption of Sustainable Land Management (SLM) practices, with 73 responses categorized into various factors. Knowledge and Interest Issues, encompassing limited awareness and information, as well as a lack of interest, constitute 27.4% of responses. Operational Challenges, including labor shortage, lack of input materials,

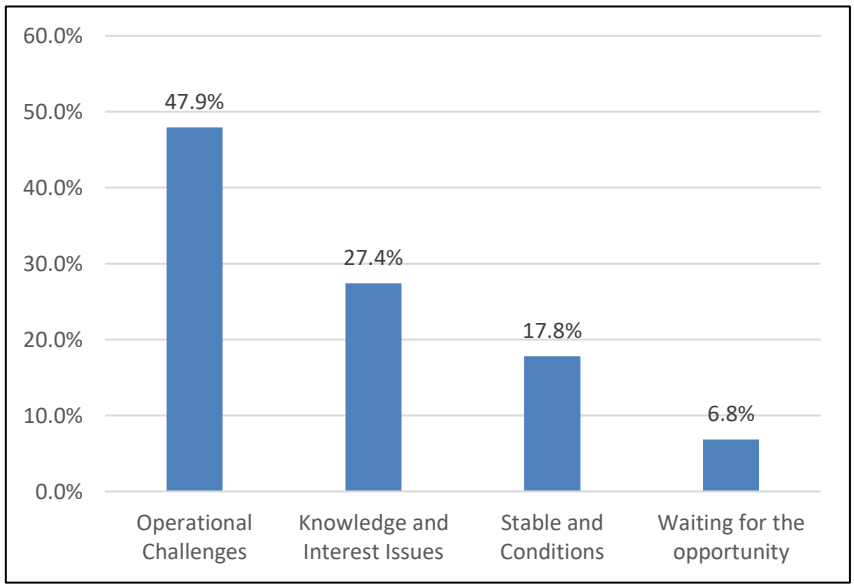

Figure 45: Reasons for not adopting technologies.

and limited land, are identified as the primary reasons for non-adoption, accounting for 47.9% of responses. Stable Conditions are mentioned by 17.8% of respondents, while Waiting for the opportunity is cited with 6.8% of responses.

11.5 Fertilizer

11.5.1 Awareness, use and source of fertilizer.

It is observed that out of 612 respondents, 88.4% of respondents are aware of the use of fertilizer in their farming practices (table 24). Further 56.9% of the respondents who are aware of fertilizer confirmed using it.It is confirmed that many fertilizer users buy it from the commission agents (98.7%).

Table 23: Fertilizer awareness, source, and usage.

Are you aware of fertilizers?		Do you use it?		From where you buy it?	
Yes	**No**	**Yes**	**No**		
88.4% (541)	11.6% (71)	56.9% (308)	43.1% (233)	Commission Agent	98.7% (304)
				Buy from Border town	1.3% (4)

Therefore, the adoption rate for fertilizer is 49.6 %, where it is calculated by number of people who are using it to the total number of populations.

11.5.2 Motivation and challenges in fertilizer uses.

Figure 47 provides insights into motivations for the use of fertilizers, with 544 responses categorized into different factors. Agricultural Productivity emerges as the predominant motivation, constituting 53.5% of responses. Convenience and Access, emphasizing easy access and farming management, account for 25.2% of responses. Effective compared to natural fertilizers is mentioned by 13.8% of respondents, while Soil Improvement and Compelled reasons, such as improving soil fertility and feeling compelled due to soil degradation, make up 7.5% of responses.

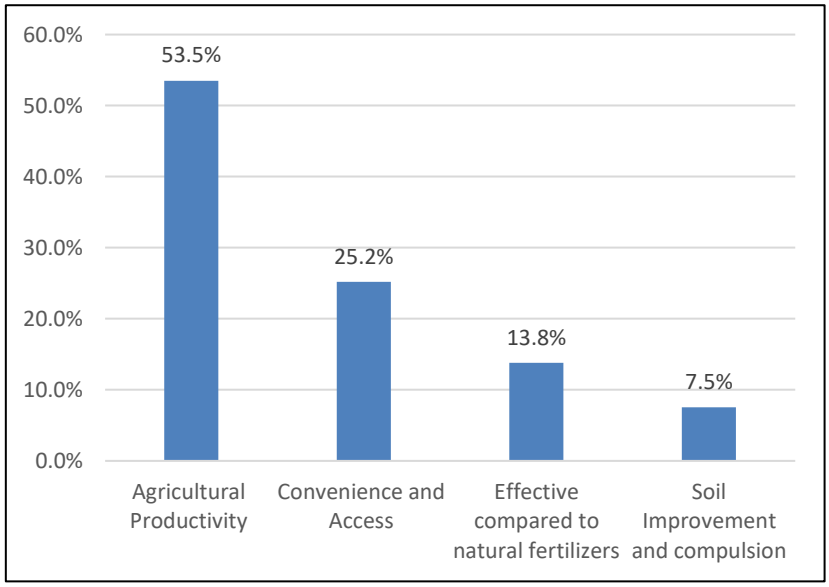

Figure 46: Motivational factors

Figure 48 presents challenges associated with the use of fertilizers, with 470 responses categorized into various factors. Economic Factors, including high prices and occasional unavailability, constitute a significant challenge, accounting for 53.2% of responses. Safety Concerns related to harmful handling and environmental damages are reported by 13.8% of respondents. Land Degradation is identified as a challenge accounted by 27.9% of responses. On a positive note, 5.1% of respondents report smooth operations with no identified issues.

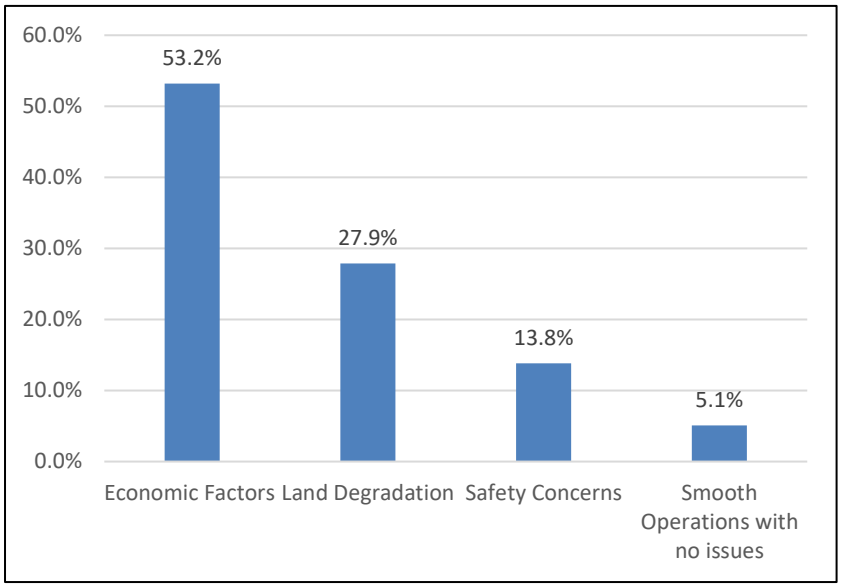

Figure 47: Challenges of fertilizers

11.5.3 Reasons for not adopting fertilizer use.

Figure 49, outlines reasons for the non-adoption of fertilizers, with 312 responses categorized into various factors. Knowledge and Interest Issues, encompassing limited awareness and information, as well as a lack of interest, constitute 7.7% of responses. Availability and Sustainability Concerns, such as occasional unavailability and concerns about sustainability, are reported with 19.6% of responses. Environmental and Safety Concerns, including degradation of lands, harmful handling, and environmental concerns, are cited at 28.8% of responses. Organic Farming and Alternatives, such as being an organic farmer, the high price of fertilizers, and the preference for using cattle manure or FYM, are the primary reasons for non-adoption, constituting 43.9% of responses.

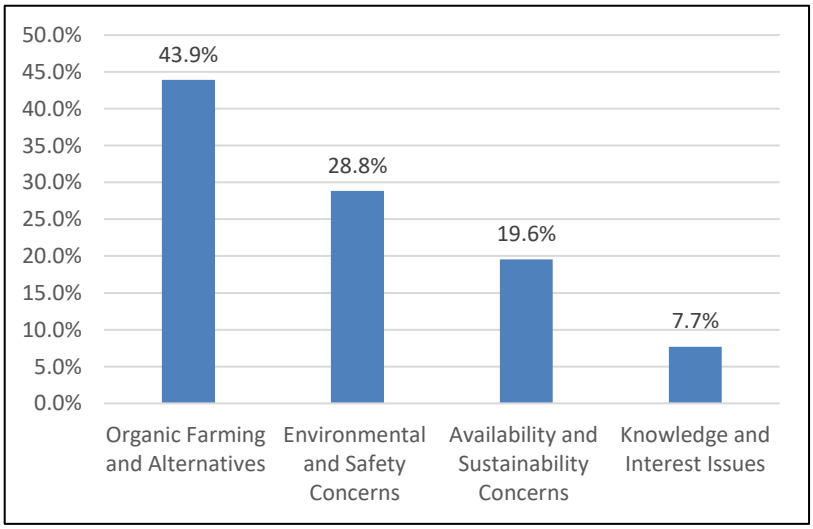

Figure 48: Reasons for not adopting fertilizers.

IMPROVED CROPS

11.6 Yusi Maap (Potato)

11.6.1 Awareness, cultivation practices and source of technology

It is reported that 41.0% of the respondents are aware of the newly released potato Yusi Maap. 64.9% of the respondents who are aware of it confirmed cultivating it. The cultivator's major source of seeds is sought from the peer farmers (47.20%) and the least (9.80%) maintains their own seeds (Table 27).

Table 24: Awareness, cultivation practices and source of technology

Are you aware of potato Yusimaap?		Do you cultivate it?		Seed source	
Yes	**No**	**Yes**	**No**		
41.0% (251)	59.0% (361)	64.9% (163)	35.1% (88)	Procured from NSC	17.30%
				Maintain own seeds	9.80%
				Government incentives through cost sharing/free distribution	30.70%
				Peer Farmers	47.20%

Therefore, the adoption rate for Ysuimaap cultivation is 26.6 %, where it is calculated by the number of people who are cultivating it to the total number of populations.

11.6.2 Motivational and Challenges in Yusi Maap cultivation

As presented in figure 48, economic and quality Factors, including better price, bigger tuber size, and high yield, constitute the primary motivation, followed by Tasty and Nutritious attributes mentioned with 29.6% of responses. Additionally, Resistant to diseases and pests is cited as a motivation by 17.4% of responses. Support and Encouragement, encompassing government incentives and peer influence, play a smaller role in motivating respondents.

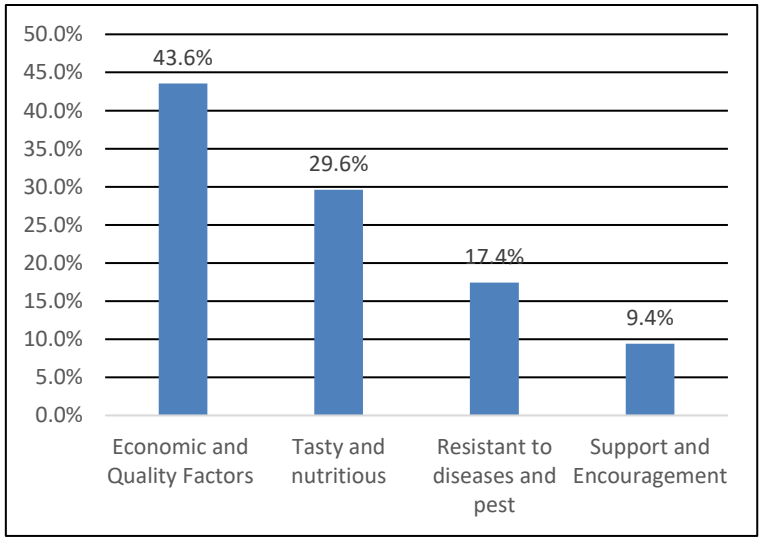

Figure 49: Motivational Factors

As presented in figure 49, market and accessibility challenges, including market issues, limited land, and inaccessibility of seed potatoes, constitute a significant challenge, accounting for 46.0% of responses. Storage and Health Concerns, such as storage facilities, injuries leading to decay, costly seed, rapid aging, and red ant issues, are reported with 26.8% of responses. Knowledge and Awareness Issues are mentioned at 1.0% of responses, while 26.3% of responses indicated smooth operations with no identified issues.

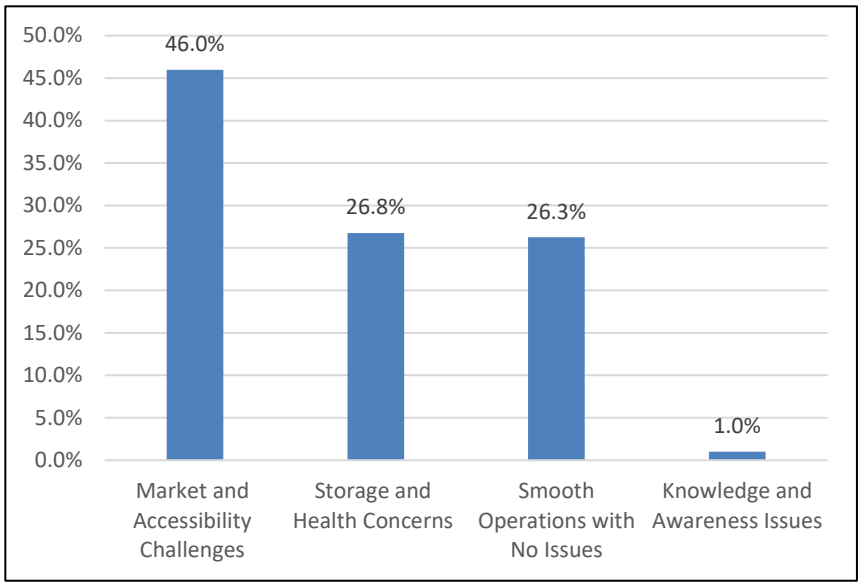

Figure 50: Challenges in adopting Yusimaap

11.6.3 Reasons for not adopting Yusimaap

As presented in figure 50, knowledge and interest issues, encompassing limited awareness and information, as well as a lack of interest, constitute 18.6% of responses. Land and Agricultural Inputs issues, including limited land and a lack of fertilizer and seeds, account for 24.7% of responses. Quality and Yield Concerns, such as poor quality and low yield, are mentioned by 10.3% of respondents. Feasibility and Operational Challenges, including market issues, extensive handling and care required, and suitability concerns, are identified as the primary reasons for non-adoption, constituting 46.4% of responses.

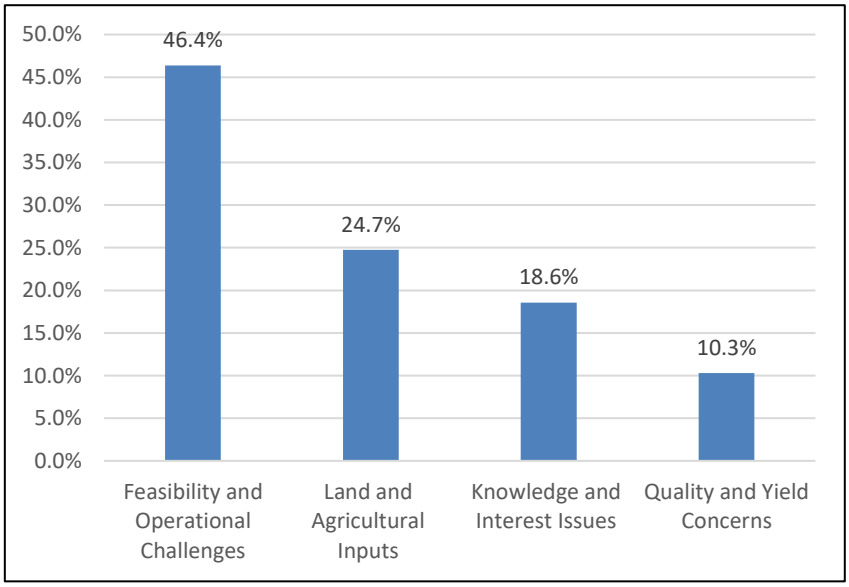

Figure 51: Non adoption factors

11.7 Quinoa

11.7.1 Awareness, cultivation practices and source of seed materials

Quinoa awareness rate stands at 25% out of 612 respondents. Further it is observed that only 19.6% of the respondents who are aware cultivates the quinoa. Those who cultivate quinoa access their seeds mainly through government incentives (71.90%) (Table 25).

Table 25: Quinoa awareness, practices, and source of seeds

Are you aware of Quinoa?		Do you cultivate it?		Seed source	
Yes	**No**	**Yes**	**No**		
				Maintain own seeds	6.30%
25% (153)	7.0% (459)	19.6% (30)	80.4% (123)	Government incentives	71.90%
				Peer Farmers	21.90%

Therefore, the adoption rate for Quinoa cultivation is 4.9 %, where it is calculated by the number of people who are cultivating it to the total number of populations.

11.7.2 Motivation and challenges in Quinoa cultivation

Figure 51 provides insights into motivations for quinoa cultivation, with 42 responses categorized into different factors. Nutritional Value, emphasizing quinoa's contribution to household nutrition, constitutes the primary motivation. Support and Encouragement, including government incentives and peer influence, as well as Agricultural Productivity and Quality, such as high yield and taste preference, are highlighted with 19.0% of responses each. Economic Benefits, specifically income generation, are indicated with 2.4% of responses.

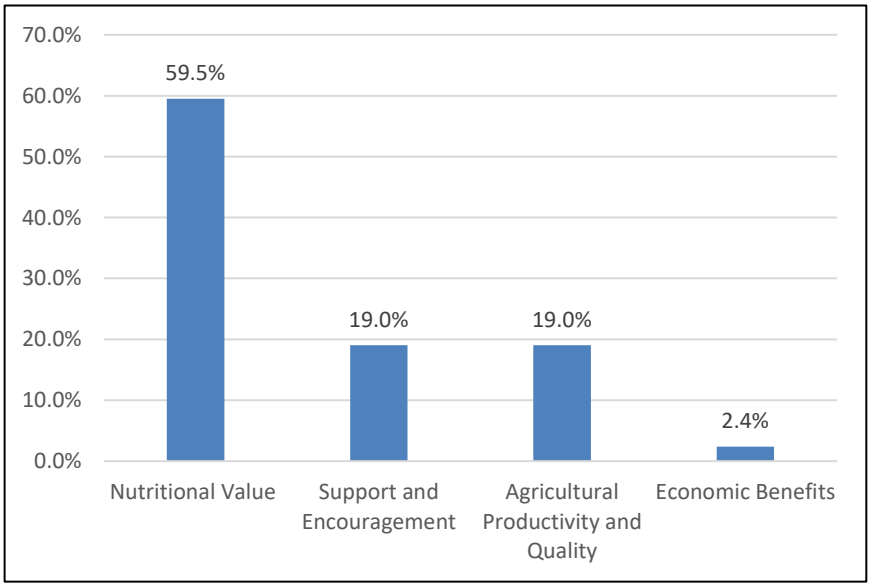

Figure 52: Quinoa motivational factors

Agricultural Practices, including nutrient-exhaustive, labor-intensive, and unsuitability concerns, constitute a significant challenge, accounting for 35.3% of responses. Market and Knowledge Constraints, such as the absence of a market and limited knowledge on utilization, are reported by 17.6% of respondents. Seed Quality Issues are mentioned by 14.7% of respondents. On a positive note, 32.4% of respondents report smooth operations with no identified issues (Figure 52).

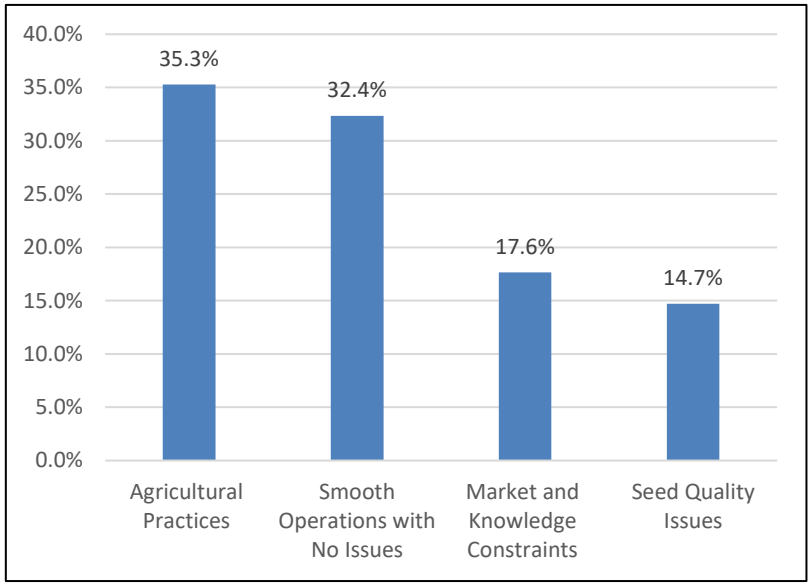

Figure 53: Challenges in quinoa cultivation

11.7.3 Non adoption factors for quinoa cultivation

Interest and Knowledge Issues, encompassing lack of interest and limited awareness and information, constitute 32.2% of responses. Land and Agricultural Inputs issues, including limited land, nutrient exhaustiveness, and unavailability of seeds, account for 34.9% of responses. Market and Storage Challenges, such as market issues and lack of storage facilities, are reported by 16.1% of responses. Feasibility and Community Factors, including neighbours not doing well and suitability concerns, are identified as reasons for non-adoption, constituting 16.8% of responses (figure 53).

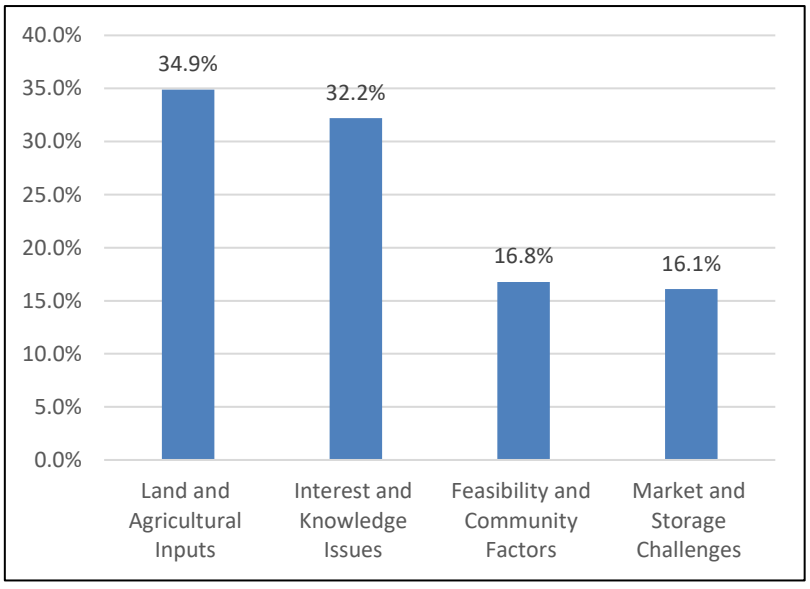

Figure 54: Non adoption reasons for quinoa

11.8 Citrus canopy management

11.8.1 Awareness, practices, and intervention source

It is observed that 8.8% of the respondents out of 612 are aware of citrus canopy management practices. However, only 44.4% of the respondents who are aware of the citrus canopy management practices practice in their orchard. Their intervention source is mostly through government incentives as indicated by 61% of the response for the factor.

Table 26: Awareness, practices, and intervention source

Are you aware of citrus canopy management?		Do you practice it?		Intervention source	
Yes	**No**	**Yes**	**No**		
8.8% (54)	91.2% (558)	44.4% (24)	55.6% (30)	Government incentives	61%
				With peer Farmers	9.70%
				Did it on my own	29.90%

Therefore, the adoption rate for citrus canopy management practices is 3.9 %, where it is calculated by the number of people who are practicing it to the total number of study populations.

11.8.2 Motivational factors and challenges for the adoption of citrus canopy management practices

Agricultural Productivity and Orchard Health, including high yield, less incidence of diseases and pests, and a healthy orchard, constitute the primary motivation, accounting for 54.1% of responses. Support and Encouragement, encompassing government incentives and peer influence, is mentioned with 21.6% of responses. Economic Benefits related to increased income are cited by 24.3% of responses (Figure 54).

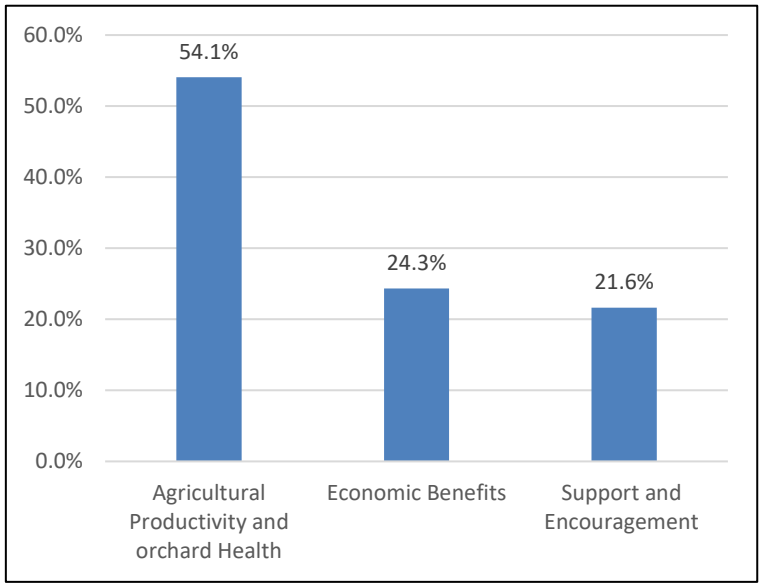

Figure 55: Motivational factors

Operational Challenges, including labor-intensive tasks and a lack of proper tools, constitute a significant challenge, accounting for 59.4% of responses. Knowledge and Awareness Issues is indicated by 12.5% of responses. Community Factors, such as a lack of community cooperation, are reported with 3.1% of responses. On a positive note, 25.0% of respondents report smooth operations with no identified issues.

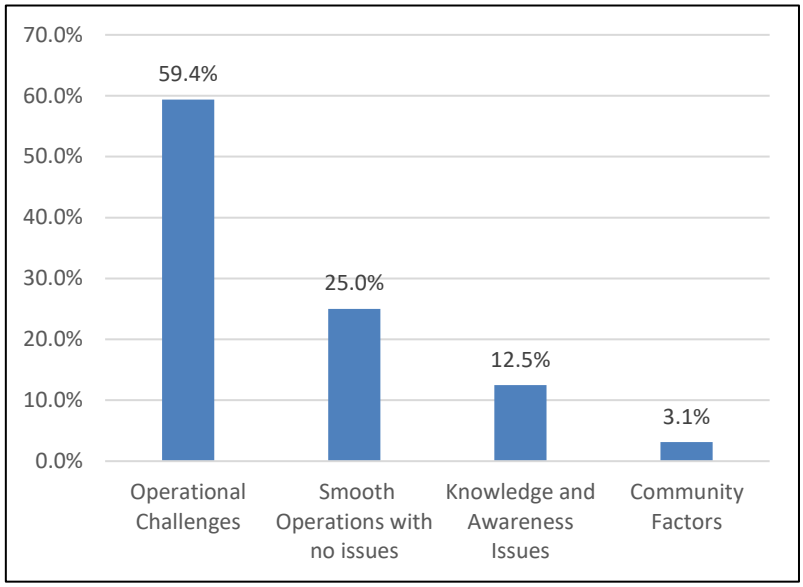

Figure 56: Challenges for citrus canopy management

11.8.3 Non adoption factors for citrus canopy management practices

Orchard Characteristics, including having few trees in the orchard and the orchard being new or old, constitute the primary non-adoption factor, accounting for 68.6% of responses. Knowledge and Interest Issues, encompassing limited awareness and information and a lack of interest, are mentioned with 22.9% of responses. Effectiveness and Community Factors, such as perceived ineffectiveness due to neighbours not practicing it, contribute to non-adoption, constituting 8.6% of responses.

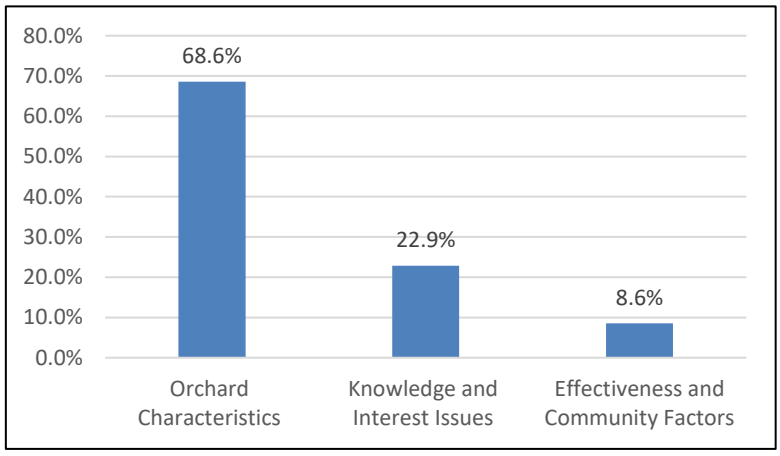

Figure 57: Reasons for not adopting citrus canopy management practices.

WATER EFFICIENCY TECHNOLOGIES

12.1 Drip irrigation system

12.1.1 Awareness, practices, and source of intervention

It is observing the out 612 respondents, 8.2% confirmed on the awareness of the drip irrigation system. Further, only 34% said they use the drip irrigation system out of those that are aware of it. The majority (94.10%) has accessed the technology through government incentives.

Table 27: awareness, uses and source of technology.

Are you aware of drip irrigation system?		Do you use it?		Intervention source	
Yes	**No**	**Yes**	**No**		
				Government incentives	94.10%
8.2% (50)	91.8% (562)	34% (17)	66.0% (33)	Personal fund	5.90%

Therefore, the adoption rate for drip irrigation system is 2.7 %, where it is calculated by the number of people who are using it to the total number of study populations.

12.1.2 Motivations and challenges in adopting drip irrigation system.

Drip irrigation adoption is primarily motivated by its efficiency in irrigation, as indicated by 56.7% of responses. Farmers recognize the benefits of efficient water usage and precise irrigation, contributing to the widespread adoption of drip irrigation. Additionally, 16.7% of responses indicated high yield as one of the motivations, emphasizing the positive impact on crop productivity. The improvement of soil conditions was cited with 10.0% of responses, reflecting the awareness of the broader benefits associated with drip irrigation. Another aspect highlighted by 16.7% of responses was the resolution of irrigation issues, further underlining the practical advantages that motivate farmers to adopt drip irrigation practices (Figure 59).

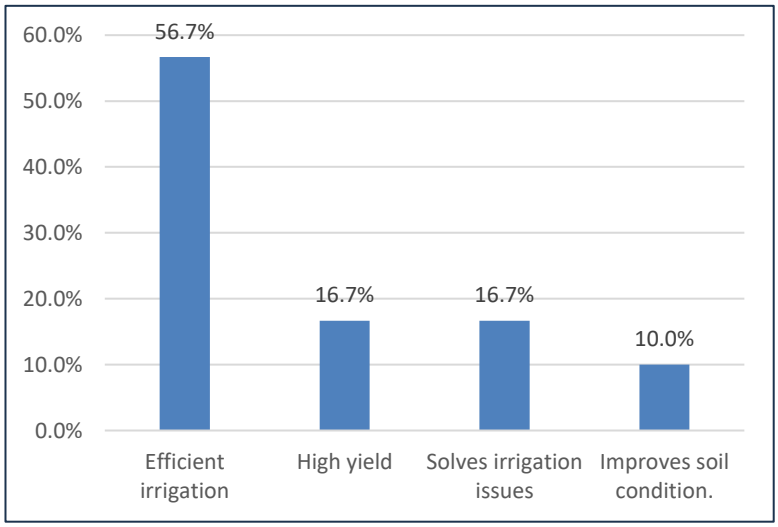

Figure 58: Motivational factors

The adoption of drip irrigation faces various challenges, as reported by respondents. The cost factor is identified as a challenge by 12.5% of responses, emphasizing the perceived expense associated with implementing drip irrigation systems.

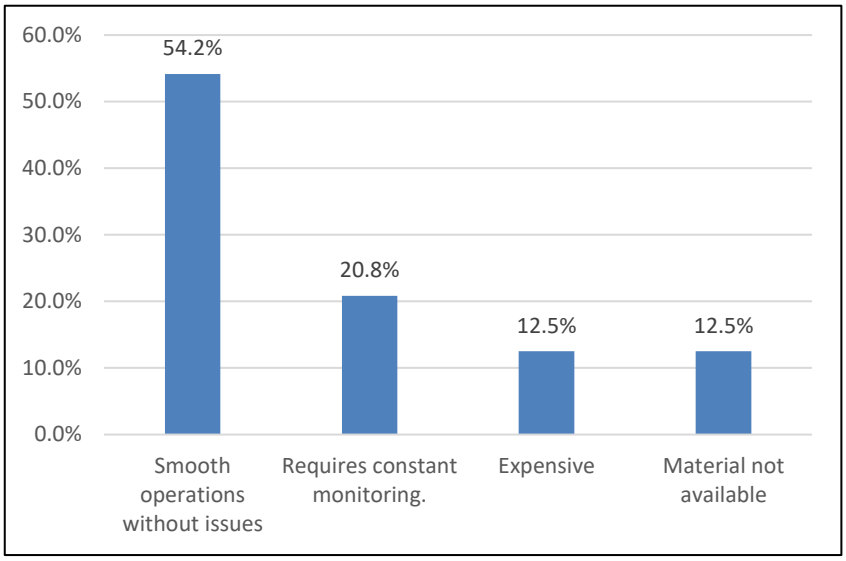

Figure 59: Challenges in adoption of drip irrigation system

Additionally, 12.5% of responses indicated a challenge related to the availability of materials required for drip irrigation. Another highlighted challenge, mentioned by 20.8% of responses, is the need for constant monitoring of the system, reflecting concerns about the maintenance and attention required. On a positive note, 54.2% of respondents reported no issues, suggesting that most farmers did not encounter significant obstacles in adopting drip irrigation practices (Figure 60).

12.1.3 Reasons for not adopting drip irrigation system.

The non-adoption of drip irrigation systems is influenced by various factors, as reported by respondents. A significant proportion of responses, 41.2%, indicated that the primary reason for non-adoption is the perceived unaffordability of implementing drip irrigation systems. Lack of interest was cited with 2.0% of responses, while 25.5% of responses highlighted the absence of water scarcity as a reason for not adopting drip irrigation. Lack of technical capacity was identified as a barrier by 23.5% of responses,

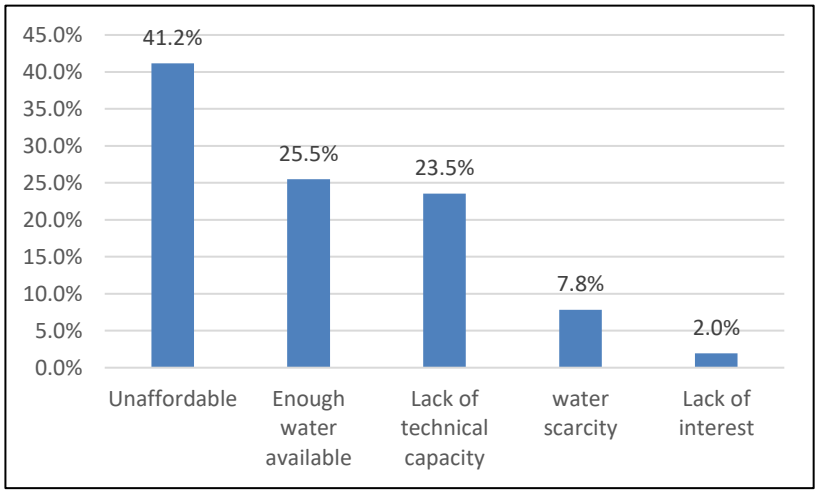

Figure 60: Reasons for not adopting the technology.

reflecting concerns about the knowledge and skills required for managing drip irrigation systems. Additionally, 7.8% of responses indicated that water scarcity is a factor influencing the decision not to adopt drip irrigation (Figure 61).

12.2 Sprinkler irrigation system

12.2.1 Awareness, usage, and funding source of the technology

Out of 612 respondents, 65% of the respondents are aware of the technology. 44.2% of the respondents who are aware of the technology uses it. They access the technology mostly through their personal funds (Table 29).

Table 28: Awareness, usage, and funding source.

Are you aware of sprinkler irrigation system?		Do you use it?		Intervention source	
Yes	**No**	**Yes**	**No**		
				Government incentives	2.80%
65% (398)	35% (214	44.2% (176)	55.8% (222)	Personal fund	97.20%

Therefore, the adoption rate for sprinkler irrigation system is 28.7 %, where it is calculated by the number of people who are using it to the total number of study populations.

12.2.2 Motivations and challenges in adopting sprinkler irrigation systems.

Irrigation Efficiency, encompassing efficient irrigation and ease of use, constitutes the primary motivation, accounting for 64.4% of responses. Resource Conservation and Soil Improvement, including water conservation and improved soil condition, are mentioned with 23.8% of responses. Agricultural Productivity, specifically the expectation of high yield, is cited as a motivation with 10.7% of responses. Social and Influential Factors, such as peer influence, contribute to motivation, albeit to a lesser extent, with 1.1% of responses.

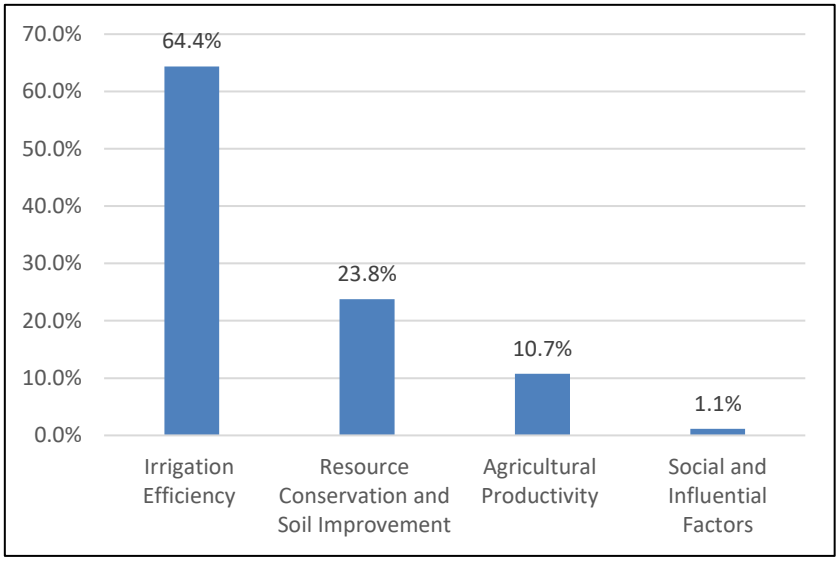

Figure 61: Motivational factors

Figure 61 presents challenges associated with Sprinkler Irrigation, comprising 197 responses categorized into various factors. Knowledge and Resource Constraints, encompassing limited knowledge, high expenses, and unavailability of materials, as indicated by 7.6% of responses. Operational Challenges, including the need for constant monitoring, ineffectiveness, promotion of leaf damages, and substandard sprinklers, are mentioned with 22.3% of responses. Water Supply Issues, such as water scarcity, the requirement for high-pressure water supply, and the need for a clean water source, constitute a significant challenge, accounting for 38.6% of responses. Smooth Operations with No Issues are cited with 31.5% of responses.

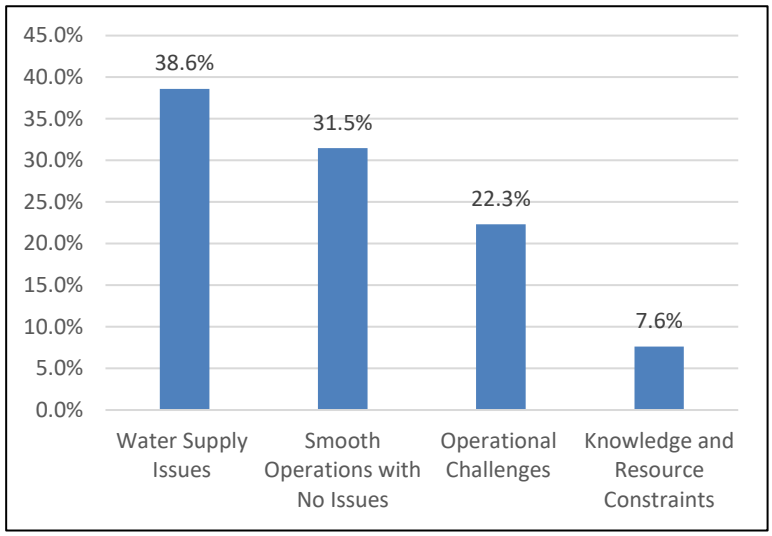

Figure 62: Challenges

12.2.3 Reasons for not adopting sprinklers.

Figure 62 outlines non-adoption reasons for Sprinkler Irrigation, with 213 responses categorized into different factors. Economic Constraints, including unaffordability, are reported with 24.9% of responses. "Knowledge and Interest Issues, encompassing limited awareness and information, a lack of interest, and insufficient technical capacity, are mentioned with 22.5% of responses. Water a bundantly available is reported as a non-adoption reason by 1.9% of responses. Effectiveness and Water Supply Challenges, such as ineffectiveness, water scarcity, and the requirement for high-pressure water supply, constitute a significant non-adoption reason, accounting for 50.7% of responses.

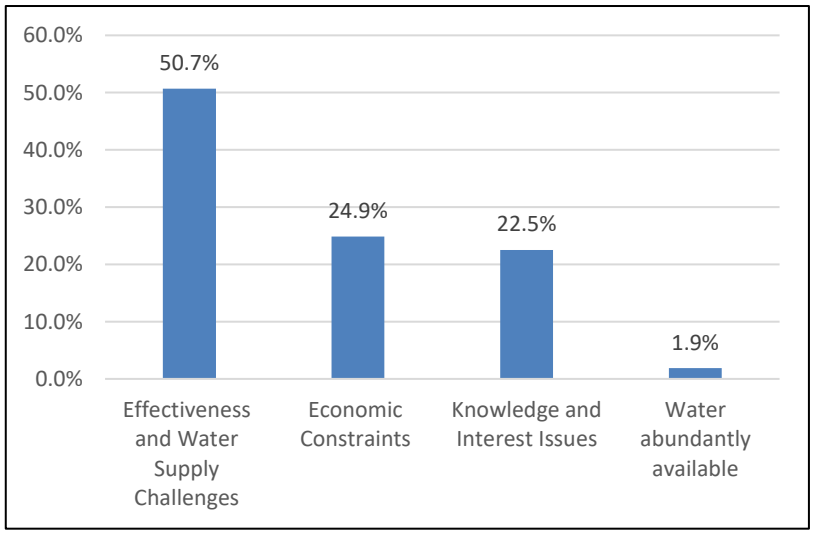

Figure 63: Non-adoption factors for sprinklers

12.3 Rainwater harvesting technologies.

12.3.1 Awareness and usage of rainwater harvesting technologies.

The data reveals that 2.8% of respondents are aware of rainwater harvesting technologies, with 23.5% among them actively using these technologies. Conversely, most respondents, constituting 97.2%, reported no awareness of rainwater harvesting technologies.

Table 29: Awareness and usage of rainwater harvesting technologies.

Awareness		Use	
Yes	**No**	**Yes**	**No**
2.8% (17)	97.2% (595)	23.5% (4)	76.5% (13)

Therefore, the adoption rate for sprinkler irrigation system is 0.6 %, where it is calculated by the number of people who are using it to the total number of study populations.

12.3.2 Reasons for not adopting rainwater harvesting technology.

For the non-adoption of rainwater harvesting technology, unaffordability is cited with 25.0% of responses. Limited knowledge is indicated by 31.3% of responses. No water scarcity is mentioned by another 31.3% of responses. Not being feasible is stated by 12.5% of responses (Figure 63). In summary, the data illustrates that limited knowledge and the absence of water scarcity are prominent reasons for non-adoption of Rainwater Harvesting, followed by unaffordability and feasibility concerns.

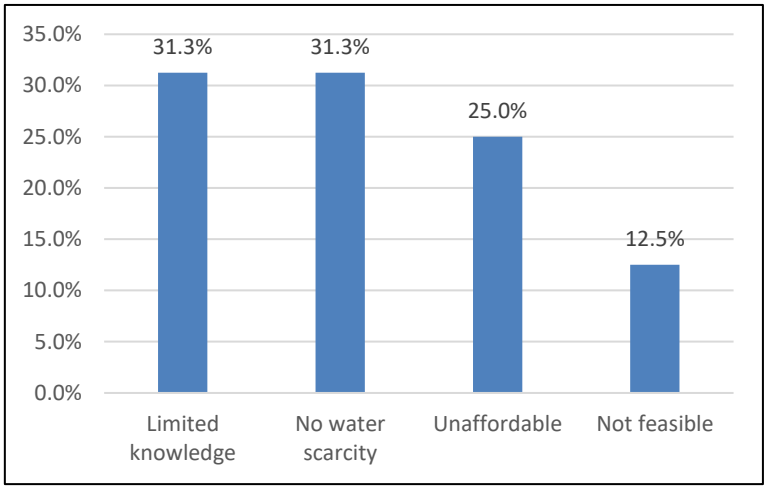

Figure 64: Reasons for non-adoption

FUTURE ASPIRATION ON THE FARMING TECHNOLOGIES

13.1 Need of technologies in future

According to the responses, 74.8% of participants reported planning to adopt new agricultural technologies soon, while 25.2% indicated that they do not have plans for adoption as presented in figure 65. This suggests a notable interest and willingness among most respondents to embrace innovative agricultural technologies soon, potentially contributing to advancements and improvements in agricultural practices.

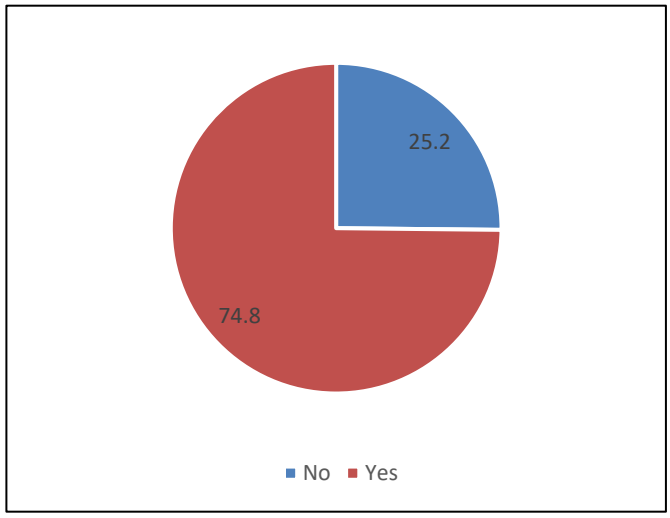

Figure 65: Requirements of technology

13.2 Types of technology required.

As presented in table 30, the farm machinery holds the highest priority with 42%, reflecting the significant demand for advanced equipment to enhance efficiency and productivity in agricultural practices. Seeds and seedlings technologies closely follow at 49%, indicating a strong emphasis on innovations related to crop genetics and early-stage cultivation. Irrigation and water management technologies are also prominent, garnering 44% of the respondents' preferences, emphasizing the importance of efficient water utilization in farming. Training and education technologies, crop cultivation technologies, environment-friendly technologies, and others are also acknowledged, each contributing to the overall vision of a technologically advanced and sustainable future for agriculture.

Table 30: Technologies required in future.

#	Technologies	Precent
1 2	Seeds and Seedlings Technologies	49%
3 4	Irrigation and Water Management Technologies	44%
5 6	Farm Machineries	42%
7 8	Environment-Friendly Technologies	37%
9 10	Crop Cultivation Technologies	35%
11 12	Training and Education Technologies	16%

CONCLUSION

The demographic overview of respondents in the agriculture technology adoption study in the west central region of Bhutan provides a comprehensive understanding of the participant profile. The majority fall within the productive age range of 20-64, indicating a workforce capable of engaging with and benefiting from advanced agricultural technologies. Gender parity is observed, with a balanced participation of males and females. Geographically, Chhukha emerges as the most represented Dzongkhag, highlighting the regional diversity of respondents. The educational background is diverse, with a significant portion having no formal education.

In terms of technology adoption rates, the study indicates varying degrees of acceptance across different agricultural technologies. Notably, labor-saving technologies such as power tillers and thresher machines exhibit higher adoption rates compared to protected cultivation technologies like greenhouses. Plant protection technologies, including integrated pest management and electric fencing, show moderate adoption rates. Soil fertility and land management technologies, such as fertilizers and sustainable land management practices, have higher adoption rates. Improved crop varieties, particularly Potato Yusi Maap, demonstrate substantial acceptance. Water efficiency technologies like sprinkler irrigation systems are more widely adopted compared to drip irrigation systems.

In conclusion, the study highlights the nuanced landscape of technology adoption in Bhutan's west central region. It underscores the importance of tailoring adoption strategies to the specific needs and preferences of farmers, considering factors such as geographic location, education levels, and the nature of the technology in question. This insight can inform targeted interventions and policies to enhance the overall adoption of sustainable and efficient agricultural practices in the region.

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