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Sustainable Agriculture Practice: A Case Study of Kasargod District, Kerala, India

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Abstract

Agriculture serves as the backbone of economies worldwide, supplying essential resources across all sectors. However, the increasing demand for agricultural products has pressured systems to maximize output from limited resources, leading to unsustainable practices that harm health and the environment, particularly affecting soil and water quality. In response to these challenges, sustainable agriculture has emerged as a viable solution, integrating socially responsible, environmentally friendly, and economically viable practices. This paper investigates farmers' knowledge of water and soil health management, the effectiveness of integrated nutrient use, and post-harvest techniques within Kasargod District, Kerala. Additionally, it addresses barriers to adopting sustainable practices and examines the extent to which government policies support these efforts. Data will be collected from primary and secondary sources, utilizing a structured questionnaire distributed among farmers in West Eleri and East Eleri Grama Panchayath—regions known for their diverse agricultural landscape and reliance on farming for livelihoods. A purposive sample of approximately 25 farm households will be selected to ensure a balanced representation of both male and female farmers. This study aims to provide valuable insights into the implementation of sustainable agriculture practices in Kasargod District.

Keywords: sustainable agriculture, integrated nutrients, water and soil health, post-harvest technique.

Introduction

Agriculture in India dates back more than 9,000 years and remains central to the country's socio-economic fabric. Even today, about 42 percent of the population depends directly or indirectly on agriculture for their livelihoods. Despite this, agriculture's contribution to the Gross Domestic Product (GDP) is only 14 percent, which is significantly lower compared to other sectors. Given that agriculture is often the primary source of income for many families, it has been ingrained in Indian culture as more than just an economic activity—it is considered a way of life. With an increase in population resulted in increased demand for food that created an extra pressure to produce more food to satisfy the need of society. So the agriculture sector shifts towards industrial method of production. The focus on industrial farming and chemical inputs had short-term benefits, such as increased productivity, but also long-term detrimental effects on the environment and ecosystems. Some of these environmental impacts, such as water depletion, soil degradation, and loss of biodiversity, have been difficult to ignore. Additionally, unpredictable climate patterns and extreme weather events further exacerbate the vulnerability of agriculture. Globalization has intensified these challenges by pushing farmers to produce in large quantities to meet market demands, often with heavy reliance on chemical inputs and unsustainable practices.

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As a result of these mounting challenges, there has been a growing recognition of the need for more sustainable agricultural practices. Sustainable agriculture aims to address the environmental, social, and economic issues that have emerged from the Green Revolution's industrial approach. In simple terms, sustainable agriculture is defined as "meeting the needs of the present without compromising the ability of future generations to meet their own needs." It seeks to promote practices that maintain soil health, conserve water, reduce reliance on chemical inputs, and protect biodiversity. In 2022 the world population reached 8 billion and FAO estimated that world population will reach 9.1 billion by 2050.So is the demand for food. We need to produce 60% more food as compared to the present level. To address this, a transition is needed from focusing solely on short-term productivity gains to adopting a more comprehensive approach that values ecosystems health and ensures the well-being of future generations.

Evolution of sustainable agriculture

While analyzing the origin of sustainable agriculture, long before the term “sustainability” become a buzzing word, many ancient civilization have practiced agriculture based on sustainability principles. For example Romans have practiced crop rotation ,terracing was practiced in hill areas of south America, Mayans of central America have practiced poly culture and agro forestry, hydroponic was stated in Babylonia modern Iraq and aquaponic started in south china. So practices of sustainable agriculture has not emerged from one country, entire world have contributed to the emergence of it. So, throughout human history, agriculture has evolved, transformed, and adapted to meet human demands while balancing the need to conserve natural resources.

The modern concept of sustainable agriculture evolved in late 20th century and beginning of 21st century when environmentalist questioned Norman Borlaug’s green revolutions methods of agriculture’s effect on environment. Modern practices have originated in many countries, example Australia have contributed to the development of perma culture, organic farming is promoted in India, Israel have developed many water and soil conservation methods. So the sustainable agriculture is an integration of modern and traditional practices. And modern innovations are build upon ancient knowledge while incorporating new technologies and scientific understanding to address contemporary challenges. The United Nations and many international organizations have recognized the need of sustainable agricultural practices for achieving global food security in the face of climate change. Their activities include education, partnership, research, policies and resources to improve sustainable agricultural practices globally. The United Nations' Sustainable Development Goals (SDGs) emphasize sustainable agriculture in the context, such as No Poverty (SDG 1), Zero Hunger (SDG 2), Responsible Consumption and Production (SDG 12), Climate Action (SDG 13), Life on Land (SDG 15), and Life Below Water (SDG 14). Sustainable Agriculture Initiative (SAI), define sustainable agriculture as “sustainable agriculture involves a system that is productive, competitive, and efficient, ensuring the production of safe agricultural goods while simultaneously protecting the environment and improving the social and economic conditions of local communities”. This concept is applicable to all types of crops and livestock. Building on this, the United Nations Environment Programme (UNEP) defines sustainable agriculture as “practices that safeguard natural resources, minimize pollution, and ensure food security, all while supporting the livelihoods of farmers”.Similarly, the United States Department of Agriculture (USDA) highlights organic farming, IPM, and crop rotation.The Food and Agriculture Organization (FAO) of the United Nations has been pivotal in promoting post-harvest techniques to reduce losses through improved storage, drying, and processing. Additionally involved in initiatives related to climate smart agriculture.

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Evolution of sustainable agriculture in India

The British colonial policies have disrupted traditional farming systems and led to widespread poverty and famine. After India gained independence, the government initiated several reforms aimed at revitalizing agriculture. Among these, the Green Revolution was the most significant. This movement marked a major shift from traditional farming practices toward industrial agriculture, which utilized high-yielding variety (HYV) seeds, heavy machinery, irrigation, chemical fertilizers, and pesticides. While the Green Revolution helped India achieve food security by increasing crop yields, it also brought with it several negative consequences. The focus on industrial farming and chemical inputs had short-term benefits, such as increased productivity, but also long-term detrimental effects on the environment and ecosystems. Some of these environmental impacts, such as water depletion, soil degradation, and loss of biodiversity, have been difficult to ignore. The agricultural sector in India is facing a crisis. Farmers are confronted with numerous challenges, including stagnation in crop yields, improper use of fertilizers and pesticides, pollution of water and soil, and rising production costs. Continuous cropping cycles have led to declining soil fertility and a reduction in both surface and groundwater quality. The imbalance between pests and their natural predators, coupled with the unprofitability of farming, has only worsened the situation. Additionally, unpredictable climate patterns and extreme weather events further exacerbate the vulnerability of agriculture. Globalization has intensified these challenges by pushing farmers to produce in large quantities to meet market demands, often with heavy reliance on chemical inputs and unsustainable practices. So government has made commitments to promote sustainability in agriculture. In 2004, the Indian government launched National Project on Organic Farming (NPOF)to establish standards for organic farming. National Horticulture Mission (NHM) focus on sustainable cultivation of horticulture crops. Meanwhile, the National Mission for Sustainable Agriculture (NMSA) prioritizes Integrated Farming Systems (IFS), organic manure, and green manure. Other schemes like Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) aims to create a sustainable irrigation system, soil health hard scheme launched to understand soil health and suggest nutrients based on that., Zero Budget Natural Farming (ZBNF) aims to promote low cost farming technique. These initiatives demonstrate India's commitment to creating a resilient and sustainable agricultural ecosystem.

Diverging Paths of Sustainable Agriculture

Even though sustainable agriculture is a global concept there are some differences among the emergence of sustainable agriculture in developing and developed countries .in many developed countries, sustainable agriculture emerged as a response to the environmental degradation caused by industrialized farming. Resulted in the degradation of land, water and biodiversity. Consequently, there has been a shift toward sustainable agriculture to address these ecological impacts and to align with growing consumer demand for eco-friendly and organic products. For example Europe's green deal and farm to fork policy aim to reduce pesticide usage and restore biodiversity. In developing countries, sustainable agriculture is closely tied to the socio-economic needs of smallholder farmers, who face challenges such as food insecurity, low productivity, and limited access to resources. Here, sustainable agriculture serves as a pathway to increase crop yields, diversify income sources, and enhance resilience against climate shocks. However, this does not mean that developing countries lack environmental concerns. The impacts of environmental degradation—such as soil erosion, water scarcity, and loss of biodiversity—are often felt more acutely in these regions, where many depend directly on natural resources for their livelihoods. In essence, while sustainable agriculture in developed countries is often driven by ecological motives, in developing countries, the focus on productivity and income is equally aligned with environmental sustainability. Both approaches are

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ultimately interconnected, as sustainable productivity and environmental health reinforce one another.

Data collection

To achieve the study's goal, primary data was gathered. Each of the chosen respondents was approached personally in order to collect relevant data. Study investigates farmers' knowledge of water and soil health management, the effectiveness of integrated nutrient use, and post-harvest techniques within Kasargod District, Kerala. Additionally, it addresses barriers to adopting sustainable practices and examines the extent to which government policies support these efforts.

Results and discussion

The current study was conducted among farmers in West Eleri and East Eleri Grama Panchayath, Kasaragod District, Kerala. For the study, 25 farmers were chosen, The necessary data was gathered using a pre-planned questionnaire and Likert scale.

Soil related problems in farm

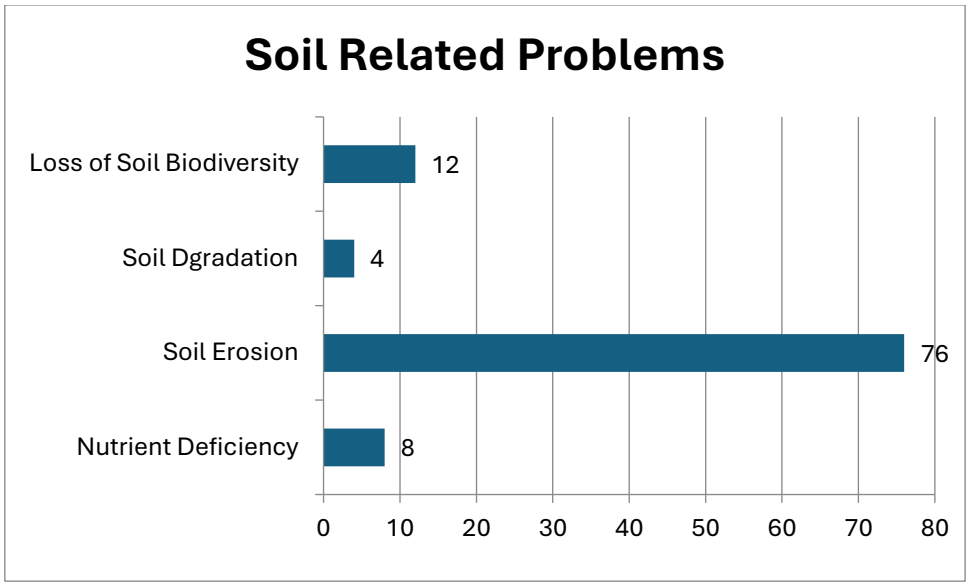

Fig 1: Soil related problems

Figure 1 depicts key soil-related problems affecting sustainable agriculture. Among 25 respondents, soil erosion emerged as the most significant issue, with 76% of farmers reporting it. Loss of soil biodiversity and nutrient deficiency were also noted, but to a lesser extent, at 12% and 8% respectively. Only 4% identified soil degradation as a problem.

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Methods for Soil Health Management

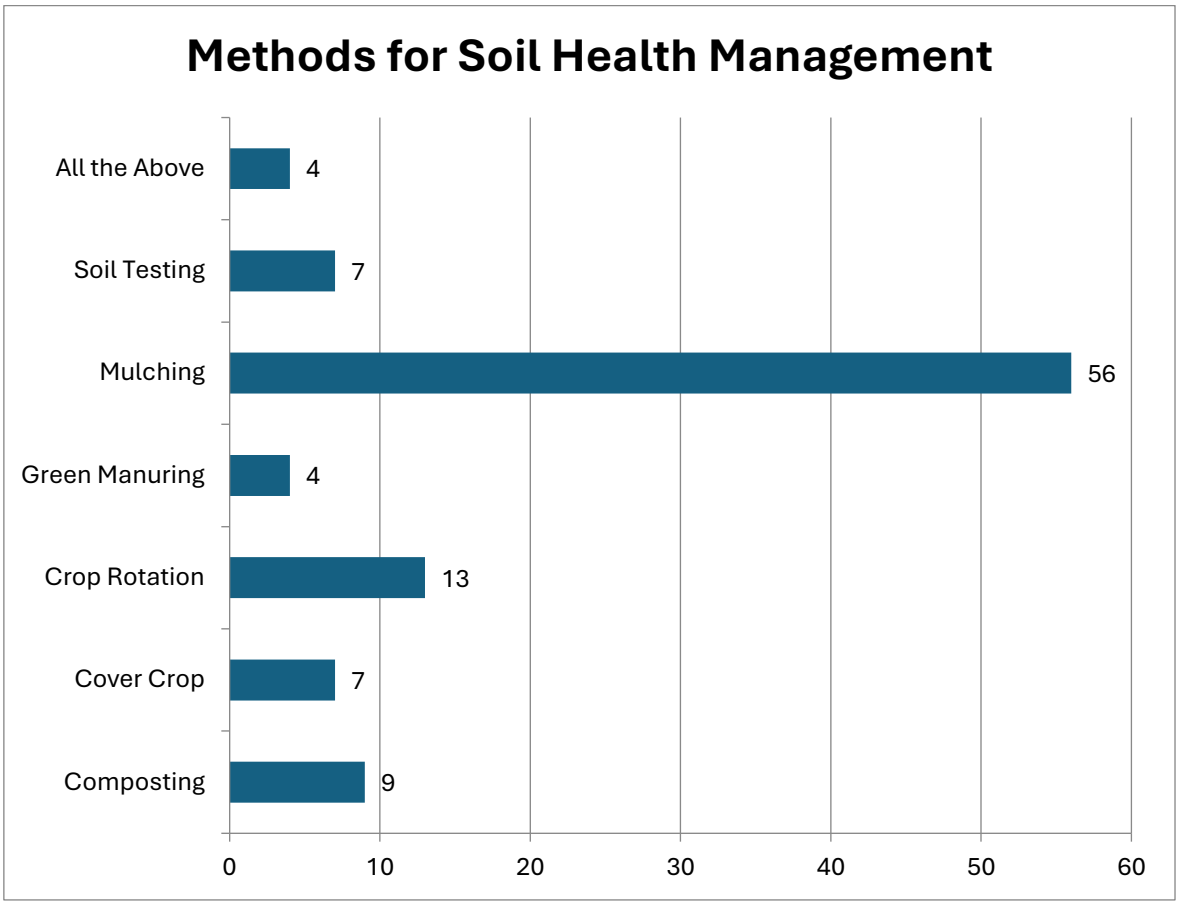

Fig 2: Methods for soil health management

Figure 2 provides information about various soil management methods and their adoption rates. Mulching is the most widely used method, with 56% of farmers opting for it, indicating its popularity in preserving soil moisture and reducing erosion. Crop rotation, employed by 13%, ranks second, showcasing its effectiveness in enhancing soil fertility. Composting, at 9%, suggests moderate usage, likely for improving organic matter. Cover crops, green manuring and soil testing are less common, each at 7%, 4% and 7% respectively reflecting limited awareness or resource constraints. The chart underscores mulching's dominance, possibly due to its simplicity and immediate benefits in soil conservation.

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Methods for water management

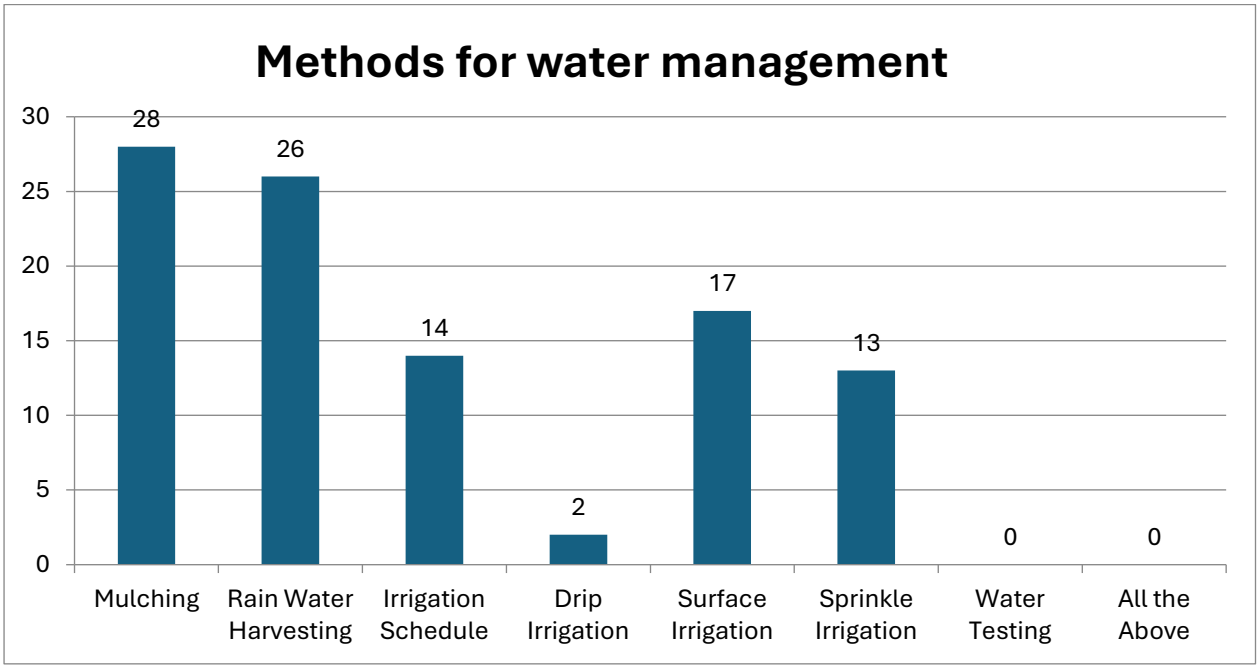

Fig 3: Methods for water management

Figure 3 provides information different water management methods in sustainable agriculture and their usage rates. Mulching is the most popular method at 28%, likely due to its ability to conserve soil moisture and reduce evaporation. Rainwater harvesting follows at 26%, reflecting its importance in restoring soil, water bodies and collecting water for irrigation. It also highlights a growing awareness among farmers to manage water resources efficiently. Irrigation scheduling, utilized by 14% of farmers, suggests a shift towards more efficient water management practices. In contrast, drip irrigation and sprinkle irrigation show lower adoption rates at 2% and 13%, respectively, which indicate barriers such as initial costs. Surface irrigation remains relatively common at 17%, reflecting traditional methods still in use. Lastly, the absence of water testing indicates a significant gap in practice, underscoring the need for education on the importance of water quality management in sustainable agriculture.

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Source for Nutrients for Plants

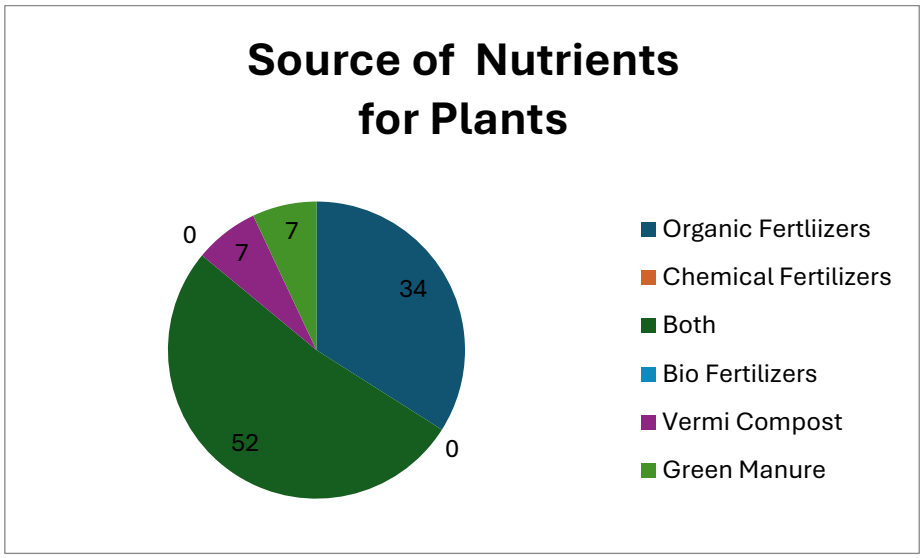

Fig 4: Source of Nutrients for Plants

This pie chart illustrates the sources of nutrients adoption rate by farmers for plant growth. The majority i.e., 52% use both organic and chemical fertilizers, indicating a preference for integrated nutrient management. Organic fertilizers alone account for 34% of the nutrient sources, showing significant reliance on sustainable, eco-friendly methods. However, no respondents reported using chemical fertilizers alone, which suggests a move away from purely chemical inputs. Vermi compost and green manure are each used by 7% of the respondents, reflecting limited adoption. Bio fertilizers have no usage (0%), indicating a lack of awareness or availability. This chart highlights the dominance of combined organic and chemical fertilizer usage in sustainable agriculture practices.

Adopted Post-Harvest Techniques

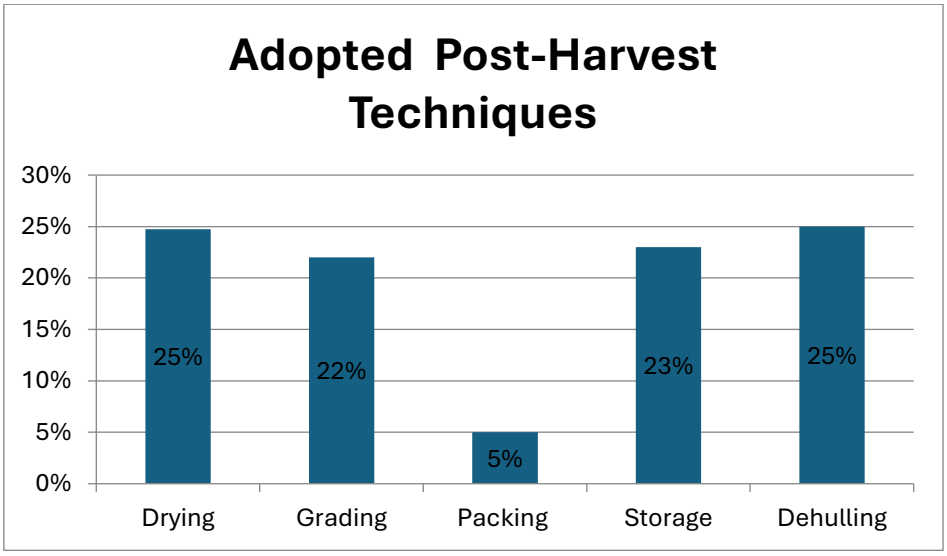

Fig 5: Adopted Post-Harvest Techniques

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Figure 5 illustrates the adoption rates of various post-harvest techniques by respondents. Among the techniques, drying and dehulling are the most widely practiced, both with a 25% adoption rate. Storage follows closely, being adopted by 23% of respondents. Grading is used by 22%, while packing is the least adopted, with only 5% using it. This suggests that farmers prioritize methods such as drying, dehulling, and storage to maintain crop quality post-harvest.

Effect of Post Harvest Techniques on Income

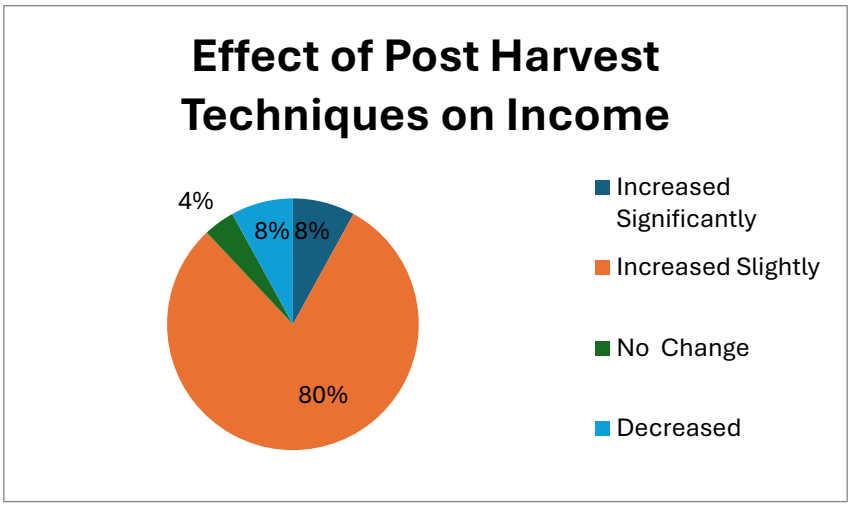

Fig 6: Effect of Post Harvest Techniques on Income

Figure 6 provides the impact of post-harvest techniques on farmers' income. A significant 80% of farmers experienced a slight increase in their income, reflecting the widespread positive but modest effects of these techniques. A smaller portion, 8%, saw a significant rise in income, indicating that while some farmers benefit greatly, the majority see only incremental improvements. Meanwhile, 4% of farmers reported no change in their income, suggesting that for a few, post-harvest techniques did not make a noticeable impact. Lastly, 8% of farmers experienced a decline in income, because the prices of commodities have fallen after few months. And farmers have to sell it for lesser price.

Benefits from Government

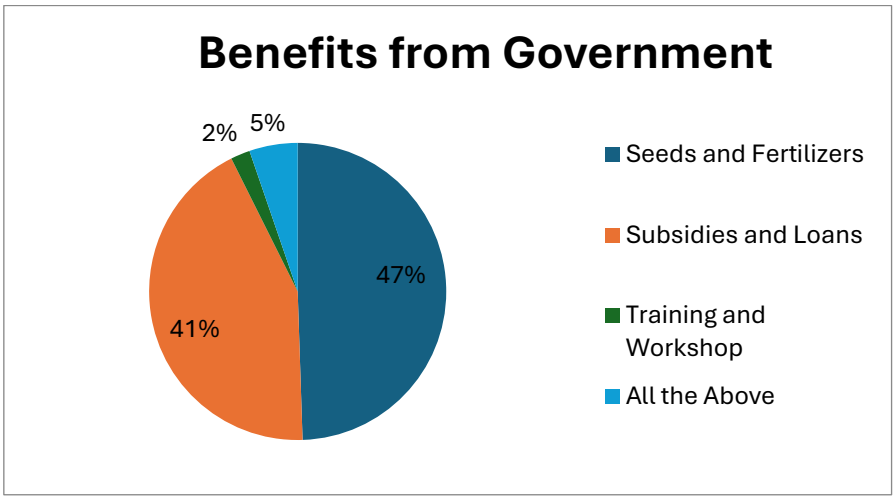

Fig 7: Benefits from Government

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The chart illustrates the benefits that farmers receive from government policies and programs. Notably, seeds and fertilizers emerge as the most common support, with 47% of farmers citing them as the most commonly received benefits. Following this, subsidies and loans constitute 41%, reflecting the critical financial assistance that enables farmers to invest in sustainable methods. Additionally, only 2% of farmers have participated in training and workshops focused on sustainable agriculture, indicating a need for greater educational outreach. Finally, 5% of farmers benefit from a combination of seeds, fertilizers, subsidies, loans, and training, highlighting the value of a comprehensive approach to capacity development.

Effectiveness of government support

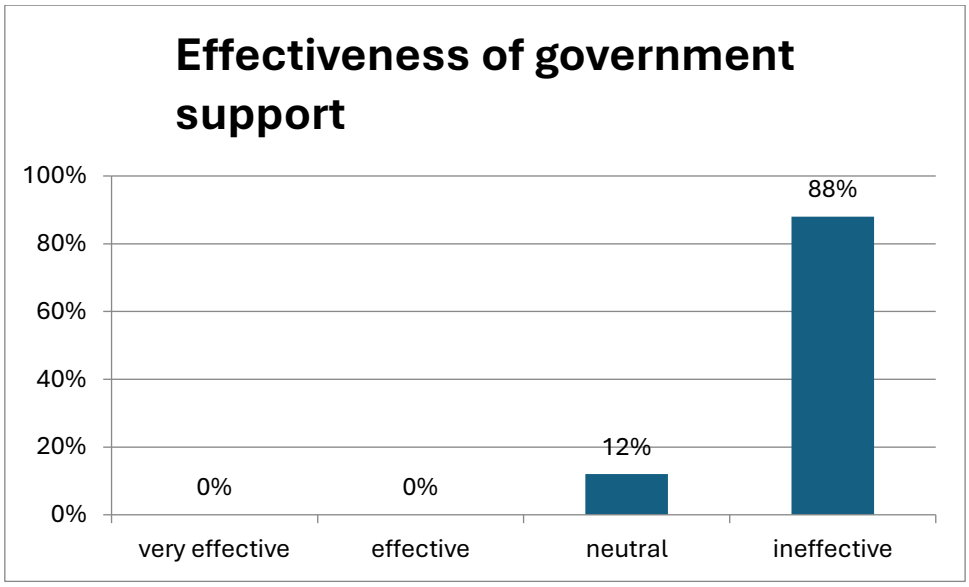

Fig 8: Effectiveness of government support

The figure indicates farmer's opinion about the efficiency of government support to farmers, reveals a concerning trend with 88% of respondents deeming these policies ineffective in their practical lives. This overwhelming dissatisfaction indicates significant barriers to accessing and utilizing government assistance. Only 12% of farmers consider the support to be neutral, acknowledging some benefits but finding them insufficient to positively impact their operations. Notably, there are no assessments classifying the support as very effective or effective, highlighting a critical gap in program efficacy. The cause of dissatisfaction is although farmers receive seeds from the government, they often face low germination rates and inconsistent plant quality, leading to unsatisfactory yields. Additionally, government fertilizers frequently arrive late and lack adequate quantity and quality. While central government policies are delivered more timely than state subsidies, delays still occur, and some benefits remain undeceived. The process for obtaining agricultural loans without collateral is lengthy and cumbersome, further complicating access to financial support. Many farmers also forgo training and workshops due to the demands of managing their farms.

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Table 1: Barriers to Sustainable Agriculture

Barriers	Non-Barrier (%)	Minor Barrier (%)	Moderate Barrier (%)	Major Barrier (%)	Severe Barrier (%)	Total Responses	Percentage of Total (%)
Lack of Awareness	12%	24%	28%	32%	8%	25	100%
High Cost of Production	0%	0%	36%	40%	24%	25	100%
Lack of Technical Knowledge	16%	38%	30%	12%	4%	25	100%
Climate Change	0%	0%	4%	29%	67%	25	100%
Insufficient Government Support	0%	0%	12%	67%	21%	25	100%
Market Related Issues	0%	0%	4%	71%	25%	25	100%

The table 1 illustrates the barriers farmers face in practicing sustainable agriculture, highlighting varying perceptions of severity. Lack of Awareness is perceived as a moderate to major barrier, with 32% of respondents identifying it as a major challenge, indicating a need for better education and outreach programs. The High Cost of Production significantly affects farmers, with 36% marking it as a moderate barrier and 40% labeling it as major, underscoring financial constraints in adopting sustainable practices. Lack of Technical Knowledge shows a diverse response; with majority consider it as a non barrier to moderate barrier and small portion consider it as a major to severe barrier. Climate Change poses a severe challenge, with 67% viewing it as a severe barrier, reflecting the urgent need for adaptive strategies. Similarly, Insufficient Government Support is seen as a major barrier by 67%, indicating that policy enhancements are necessary. Lastly, Market Related Issues also present significant challenges, with 71% identifying it as a major barrier. Overall, these insights can guide targeted interventions to support farmers in overcoming these barriers.

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Additional Support to Overcome Barriers

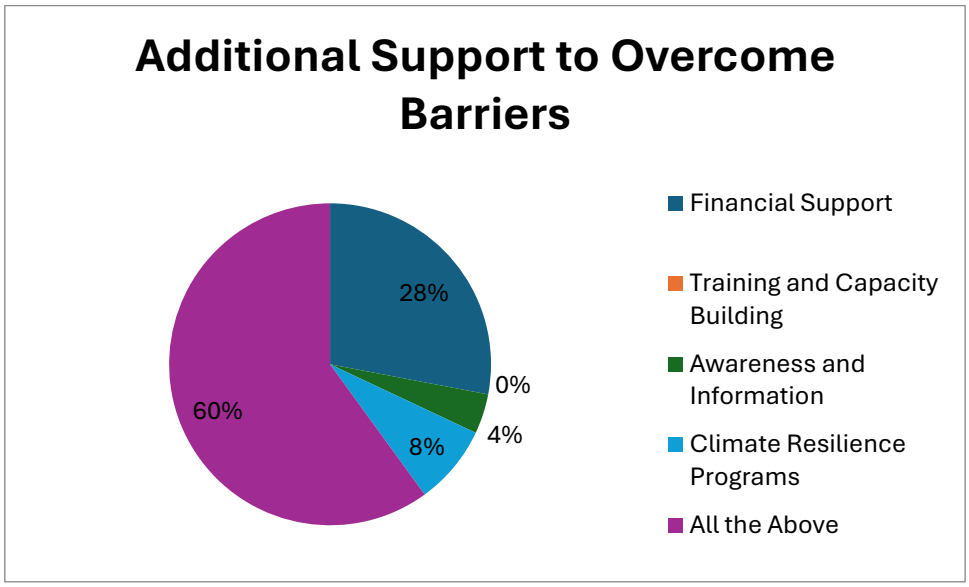

Fig 9: Additional Support to Overcome Barriers

The pie chart highlights the distribution of support needed by farmers. The largest portion, representing 60%, indicates that the majority of respondents selected "All of the above," suggesting a comprehensive need for financial support, training, awareness, and climate resilience programs. Financial support alone accounts for 28%, showing a significant demand for monetary aid. Training and capacity building “received no response separately, while climate resilience programs take up 8% "Awareness and Information" received 4%. This chart emphasizes the importance of holistic solutions to overcome sustainable farming barriers.

Summary and conclusion

In soil and water management, mulching is the most commonly used practice due to its effectiveness in preserving soil moisture, preventing erosion, and its affordability. Farmers predominantly rely on traditional methods like mulching, cover crops, crop rotation, and rainwater harvesting. However, there is limited adoption of modern techniques such as sprinkle irrigation, drip irrigation, and an absence of water testing and farmers still using surface irrigation, which shows other than traditional technique leads to poor water management. But farmers who use drip and sprinkler irrigation mostly practice irrigation schedule which is a modern technique. For nutrient management, farmers use a combination of organic and chemical fertilizers, represent an integrated nutrient approach, and explain the reason for very less nutrient deficiency and loss of soil bio diversity. There is, however, a lack of awareness about bio-fertilizers. More attention is needed in this area. While farmers engage in value addition practices like grading, drying, dehulling, and storing, these techniques have not significantly improved income for most of them. Despite receiving government benefits such as loans, seeds, fertilizers, and subsidies, many farmers express dissatisfaction due to low-quality seeds, delayed fertilizers, and lengthy processes for obtaining loans and subsidies. Farmers see lack of awareness and technical knowledge as moderate to major barriers, while the high cost of production is viewed as a severe barrier. This explains their reluctance to adopt modern water and soil conservation measures despite being aware of them. Farmers view climate change as a severe challenge that effect agriculture productivity. Insufficient government support is also a major to severe barrier, which underscores why

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many farmers find current government policies ineffective in supporting them. Farmers consider market related issue as constrain, this explain why even though farmers adopt post harvest techniques, but sill they are not able significantly increase their income. Due to lack of market stability and price fluctuation.

Suggestions

Efforts should be intensified to promote modern water-saving technologies like drip and sprinkler irrigation, alongside proper water testing, to enhance efficiency and reduce wastage. This can be supported by more accessible government subsidies for these technologies.

Greater awareness needs to be raised among farmers about soil testing to help them make informed decisions based on soil quality.

Educational programs should be introduced to increase awareness about the benefits of bio-fertilizers among farmers.

Improving the quality and timely delivery of seeds and fertilizers through government programs would boost farmer satisfaction and productivity. Simplifying loan processes and offering capacity-building workshops for farmers would help address technical knowledge gaps and financial challenges.

Addressing market instability through stronger market linkages, price stabilization mechanisms, and better access to market information can help farmers increase their income from value-added post-harvest activities.

To fully benefit from post-harvest techniques, farmers should adopt a more entrepreneurial mindset and view farming as a profession rather than just a cultural activity. Local self-governments and NGOs should take the lead in promoting entrepreneurship skills among farmers.

Greater efforts should be made to combat climate change by developing more resilient crops and mitigating crop losses. The government should provide timely and adequate financial assistance during periods of distress.

Agricultural officers are needed more in the field, working directly with farmers, rather than being confined to office duties at the Krishi Bhavan. Their expertise and support are crucial on the ground, where their guidance can have a direct impact. Therefore, more frequent visits by agricultural officers to farmers' fields are expected to provide better assistance and address agricultural challenges effectively.

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