FOOD SYSTEM RESILIENCE AMONG SMALL AND MARGINAL FARMERS IN THE SELECTED VILLAGES OF DAHOD DISTRICT, GUJARAT

APRIL, 2025

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B.Sc. (F.C.Sc.) (Dietetics)

(FOODS AND NUTRITION)

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A Dissertation submitted in partial fulfilment of
the requirement for the degree of Master of Science
(Public Health Nutrition)

BY

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CERTIFICATE

This is to certify that the research work presented in this thesis has been carried out independently by Ms. Rosemary Mondal under the guidance of Dr. Suneeta Chandorkar in pursuit of Degree of Master of Science (Family and Community Sciences) with major in Foods and Nutrition (Public Health Nutrition) and this is her original work.

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Abstract

This study investigates the resilience of food systems among small and marginal farming households in selected villages of Dahod district, Gujarat an underdeveloped tribal region in western India. Agriculture in these areas is predominantly rain-fed, vulnerable to climate shocks, and marked by low productivity and limited access to institutional support. The research adopts a holistic perspective on food system resilience, recognizing it as the capacity of agricultural households to absorb, adapt, and transform in the face of shocks and stressors while ensuring stable food security, sustainable livelihoods, and inclusive well-being. With increasing climate variability, economic volatility, and growing disparities in rural India, the urgency to assess resilience through multidimensional frameworks has never been greater.

The study employs a cross-sectional mixed-methods design, integrating both quantitative and qualitative approaches to capture a nuanced understanding of resilience. Data were collected from 24 farming households 12 small and 12 marginals across four villages in Dahod district, using structured surveys, and focus group discussions (FGDs). The analytical framework is guided by the FAO's Resilience Index Measurement and Analysis (RIMA), encompassing four key pillars: Access to Basic Services, Adaptive Capacity, Assets, and Social Safety Nets. In addition, the Food Consumption Score (FCS) and Food Insecurity Experience Scale (FIES) were used to assess dietary diversity and food access. Quantitative data were analyzed using Principal Component Analysis (PCA), Exploratory Factor Analysis (EFA), and Confirmatory Factor Analysis (CFA) to construct a Resilience Index, while qualitative data were thematically coded to extract community narratives. Findings reveal significant disparities in resilience levels between small and marginal farmers. Small farmers tended to cultivate larger landholdings, demonstrate greater crop diversity, and engage in market-oriented production. They also exhibited higher household incomes and diversified income sources, including livestock, wage labor, and small enterprises. In contrast, marginal farmers primarily relied on subsistence agriculture, cultivated smaller plots, and had fewer opportunities for income diversification. These structural constraints made them more vulnerable to shocks, including crop failures, price fluctuations, and health emergencies.

Ownership of productive assets was a key differentiator between the two groups. Small farmers were more likely to own tractors, threshers, livestock, and irrigation equipment, while marginal farmers relied on manual labor and community-shared resources. Despite these differences, both groups lacked access to proper post-harvest storage facilities and market infrastructure, resulting in losses and limited price realization. This points to a systemic weakness in agricultural value chains in tribal regions like Dahod.

Social safety nets played a variable role in enhancing resilience. While almost all households were enrolled in PM-Kisan, participation in other entitlements such as crop insurance, subsidized loans, MGNREGA, and nutritional schemes was low. Awareness levels, bureaucratic delays, and lack of proper documentation were reported as key barriers, particularly among marginal households. The study observed that small farmers were more proactive and informed in accessing entitlements, often due to stronger networks and better education levels.

The Resilience Index constructed from PCA and factor analysis identified asset ownership, income diversification, and access to social safety nets as the most significant contributors to household

resilience. Adaptive capacity measured through indicators such as education, skill diversification, mobility, and innovation in farming practices was also found to be a strong pillar, especially among younger and better-connected households. However, access to basic services such as healthcare, education, veterinary services, and market facilities remained inadequate across all groups, further compounding vulnerability.

Qualitative insights from FGDs highlighted several systemic challenges that hinder resilience-building. Farmers cited poor institutional access, low bargaining power in markets, and delays in payment for agricultural produce as major constraints. Women's roles in agriculture were found to be substantial but underrecognized; they contributed to sowing, weeding, harvesting, and even managing livestock, yet were largely excluded from decision-making and land ownership. This gendered exclusion further weakens household resilience by limiting access to schemes and financial services. In addition, young adults in many households expressed aspirations to leave agriculture due to perceived lack of returns, signaling potential future instability in food production systems.

Food utilization patterns revealed a moderately diverse diet among small farmers, with frequent consumption of grains, pulses, vegetables, and occasional protein sources. Marginal farmers exhibited lower dietary diversity and higher dependence on cereals, reflecting both economic constraints and limited market access. The FCS and FIES scores correlated with resilience levels, suggesting that food security is a reliable outcome indicator of broader household resilience.

The study concludes that resilience is a function of both structural and behavioral factors, where landholding size, access to assets, institutional linkages, and household agency play vital roles. Small farmers generally showed higher resilience due to better resource endowments and greater agency, while marginal farmers remained trapped in cycles of low investment and high vulnerability. Importantly, resilience was not only a matter of physical assets but also of social capital, awareness, and adaptive strategies.

In conclusion, this study contributes to the growing discourse on food system resilience in India by applying the RIMA framework in a micro-level context and combining it with participatory qualitative methods. The findings highlight the layered nature of vulnerability and the pressing need for equity-centered policies that not only strengthen the adaptive capacity of smallholders but also uplift the most disadvantaged farming households. As India moves toward sustainable agriculture and inclusive development, frameworks like RIMA offer robust tools to monitor resilience and guide evidence-based interventions that can future-proof the rural food system.

Introduction

Chapter 1- Introduction

1.1 Food System Resilience: Concepts, Definitions, and Implications

Resilience is a multifaceted concept that describes the ability to adapt, recover and thrive in the face of challenges or adverse situations. In general, resilience refers to the capacity to "bounce back" from setbacks while maintaining a stable trajectory of functioning. Resilience is vital for navigating adversities, as it facilitates recovery and often leads to growth and the development of enhanced coping mechanisms for future challenges. In the context of food systems, understanding resilience helps identify pathways to build sustainability and security amidst environmental, economic and social pressures.

The concept of "resilience" was initially rooted in ecology but has since been applied to food systems to capture their ability to endure and respond to shocks or stressors without jeopardizing their long-term viability (Béné, 2020). According to Tendall et al. (2015), food system resilience is defined as the ability of a food system and its components, across various levels, to consistently provide adequate, appropriate, and accessible food for all, even amidst unexpected disruptions.

In essence, resilience in food systems involves the capacity to resist, recover from, and adapt to a range of disturbances be they sudden events like natural disasters or gradual challenges such as climate change while maintaining reliable food supply and access. This concept spans several key dimensions, including governance frameworks, market dynamics, and the roles of various stakeholders.

Grasping the complexity of food system resilience is essential for policymakers aiming to craft strategies and interventions that strengthen food security. The subsequent sections delve into the core elements that shape food system resilience.

1.2 Agriculture, Food Security, and Nutrition: Pathways to a Resilient Food System for Small and Marginal Farmers in India

1.2.1 Agriculture as the Foundation of Food Security and Nutrition

Agriculture stands as the cornerstone of food security and nutrition, playing a vital role in ensuring the availability, affordability, and quality of food. As the global population continues to grow and natural resources become increasingly strained, strengthening agricultural systems through effective policies and practices is essential to meet the rising demand for safe and nutritious food (Bouxine et al., 2024).

The relationship between agriculture, food production, and food security is deeply interconnected. Food security defined as the consistent availability, accessibility, and stability of sufficient, safe,

and nutritious food for all is a critical challenge faced by nations across both the developed and developing world. Agricultural systems are central to achieving this goal, not only in terms of producing adequate quantities of food but also in maintaining its nutritional quality.

Historically, the Green Revolution demonstrated the power of technological innovation to significantly boost agricultural output. However, modern agriculture must now evolve further to address emerging issues such as malnutrition, food loss, and environmental degradation (Rana et al., 2020).

This need for transformation is even more urgent in the face of growing climate variability, economic instability, and frequent market disruptions (FAO, 2021). Agriculture shapes nutrition outcomes directly by influencing the variety and nutrient content of foods that are produced and made available. Access to diverse, healthy foods is essential for combating various forms of malnutrition (Gillespie & Bold, 2017).

Moreover, sustainable agricultural policies can improve both food access and utilization, contributing to better health and nutrition across populations (Rukhsana & Alam, 2021).

Agriculture supports food security in two key ways:

1. **Directly**, by providing food and nutrition to farming households through subsistence production.
2. **Indirectly**, by serving as a major source of income, enabling households to purchase a diverse and nutritious diet.

Together, these functions underscore the foundational role of agriculture in building resilient food systems and promoting long-term nutritional well-being.

1.2.2. Food Security and Resilience

Food security and resilience are deeply interrelated concepts that together form the foundation for sustainable nutrition and well-being. **Food security** emphasizes the consistent availability and accessibility of safe and nutritious food to meet the dietary needs of individuals and communities. In contrast, **resilience** refers to the capacity of individuals, households, and food systems to endure, recover from, and adapt to shocks—such as natural disasters, economic crises, and pandemics without jeopardizing long-term food security or overall health.

The Four Pillars of Food Security and Their Connection to Resilience

Food security is grounded in four essential pillars:

1. **Availability** – Ensuring a reliable and diverse supply of nutritious food through robust production, distribution, and trade systems.

2. **Access** – Facilitating both economic and physical access to food, especially for vulnerable populations.
3. **Utilization** – Promoting the proper use of food based on knowledge of nutrition, clean water, and healthcare, to ensure good nutritional outcomes.
4. **Stability** – Safeguarding all the above pillars over time, particularly during periods of crisis or instability.

Resilient food systems are crucial for maintaining these pillars. They enable communities and households to cope with disruptions while ensuring that food remains available, accessible, and nutritious. In particular, **the stability pillar** is directly linked to resilience; a resilient household can continue to access adequate food even under adverse conditions, which is essential for achieving sustainable food security.

1.3 Addressing Malnutrition Through Resilient Food Systems

Tackling malnutrition is a key strategy in strengthening both food security and resilience. One of the most pressing challenges in many developing countries is **hidden hunger**, a form of malnutrition caused by insufficient intake of essential micronutrients. This often results from limited access to nutrient-dense foods and disproportionately affects women and children. In India, targeted interventions have demonstrated that promoting the cultivation and consumption of micronutrient-rich crops such as fruits, vegetables, and pulses can significantly reduce hidden hunger and improve community nutrition (Bamji et al., 2022). These programs often integrate practical components such as farmer training, on-field demonstrations, and educational outreach to encourage **dietary diversification** and build long-term food system resilience.

1.4 The Significance of Agriculture and Farmers in India

Agriculture is the backbone of India's economy, serving as a primary source of food security, employment, and economic stability. Farmers play an indispensable role, not only in sustaining their livelihoods but also in fostering national growth and rural development. The agricultural sector contributes approximately 18-20% to India's Gross Domestic Product (GDP) (World Bank, 2021) and remains the largest employment provider, engaging nearly 42% of the workforce (NITI Aayog, 2022). Furthermore, around three-quarters of Indian households rely on rural incomes, with agriculture being their primary source of sustenance (Indian Economic Survey, 2020-2021). Beyond food production, agriculture generates employment across the entire value chain, including processing, distribution, and marketing. Despite industrialization, the significance of this sector remains unmatched, and continuous support through technological advancements, government policies, and sustainable practices is crucial for its future growth and resilience.

The classification of farmers is primarily based on the size of their landholdings. The Agriculture Census provides a detailed breakdown of these categories, highlighting the significant role that small and marginal farmers play in the agricultural landscape.

Table 1.1 Classification of Operational Land Holdings by Farm Size in India

Sl.No	Size-Group	Percentage of number of operational holdings to total
1	Marginal (below 1.00 ha.)	67.10
2	Small (1.00 - 2.00 ha.)	17.91
3	Semi-medium (2.00 - 4.00 ha.)	10.04
4	Medium (4.00 - 10.00 ha.)	4.25
5	Large (10.00 ha. & above)	0.70

(Ref.: Agriculture census 2010-2011)

1. Small and Marginal Farmers

This category includes farmers with landholdings less than 2 hectares. They represent a substantial majority of Indian farmers, highlighting the prevalence of small-scale farming.

Subcategories:

Marginal Farmers: Those with landholdings less than 1 hectare.

Small Farmers: Those with landholdings between 1 and 2 hectares.

2. Medium Farmers

Medium farmers possess larger landholdings, ranging from 2 to 10 hectares. This group utilizes more advanced agricultural techniques and often engages in both subsistence and commercial farming practices.

3. Large Farmers

Large farmers own landholdings exceeding 10 hectares. They are a minority but typically engage in commercial farming, employing modern agricultural practices and technologies.

1.5 Small-Scale Farmers in India

Small-scale farmers, often referred to as small and marginal farmers, form the backbone of India's agricultural sector. Nearly 86% of India's farming households are classified as small and marginal, operating on landholdings of less than two hectares. These farmers play a crucial role in food production, contributing significantly to the nation's food security and rural livelihoods.

1.5.1 Issues and Concerns of Farmers

Farmers in India face a complex array of challenges that undermine their livelihoods, productivity, and contribution to national food security. These issues are structural, economic, environmental, and institutional in nature, disproportionately affecting small and marginal farmers who form the backbone of Indian agriculture.

1. Fragmented Landholdings and Low Economies of Scale

Approximately **86% of Indian farmers are smallholders**, cultivating less than two hectares of land (Agriculture Census, 2015–16). Such fragmented landholdings limit economies of scale, reduce operational efficiency, and restrict the adoption of modern agricultural practices.

2. Limited Access to Technology and Extension Services

The adoption of modern technologies remains low among small-scale farmers due to inadequate agricultural extension services and poor awareness. Many lack exposure to advanced farming methods, which hampers productivity and sustainability. Financial constraints further limit their ability to transition to modern or climate-resilient practices (Walia & Kaur, 2023).

3. Water Scarcity and Irrigation Challenges

Agriculture consumes around **85% of India's available freshwater resources**, yet irrigation efficiency remains low, particularly in rainfed areas that constitute the majority of farmland (Pandey et al., 2020). The growing scarcity and mismanagement of water resources, combined with deteriorating water quality due to pollution, directly impact crop yields and livestock productivity (Saad et al., 2020).

4. Climate Change and Environmental Vulnerability

Climate change poses a critical threat to farming communities. Increasing incidences of droughts, floods, and erratic weather patterns have heightened risks for smallholders. Despite the need for

adaptation, the adoption of **climate-smart agriculture technologies (CSAT)** remains lowstudies indicate that 74% of farmers have low to medium awareness, and 83% show low to medium levels of adoption (Mallappa & Pathak, 2023).

5. Market Volatility and Poor Infrastructure

Unpredictable market prices and limited access to organized markets significantly affect farmers' incomes. Weak infrastructure—such as inadequate storage, cold chains, and transportation contributes to **post-harvest losses**, especially for perishable commodities (Hodges et al., 2011). During the COVID-19 pandemic, supply chain disruptions, transport restrictions, and market closures further deepened economic distress in rural areas.

6. Urban Migration and Policy Gaps

The cumulative impact of these economic and environmental challenges has led to increasing rural-to-urban migration. Many farming households perceive agriculture as economically unviable due to inconsistent policies, lack of price support, and absence of targeted rural development strategies (Ramachandran et al., 2010). This trend threatens not only the agricultural labor force but also the sustainability of food production systems.

Addressing these issues requires a comprehensive and inclusive approach focused on **resilience-building**. Empowering smallholder farmers through climate-smart practices, improved financial services, infrastructure development, and market linkages is critical. Strengthening rural institutions and aligning agricultural policies with local needs will not only safeguard farmer livelihoods but also ensure **national food security and sustainable agricultural growth**.

1.5.2 Resilience Threats

Food systems today are increasingly vulnerable to a range of resilience threats, which can be broadly categorized into **risks**, **shocks**, and **stresses**. Understanding these distinctions is essential for designing targeted interventions that can protect agricultural productivity and ensure long-term food security (PEP-CBMS Network Coordinating Team, 2011).

Risks refer to the potential for future adverse events, such as natural disasters, armed conflicts, pandemics, or economic crises, which may destabilize food systems. These risks can be mitigated through proactive measures like early warning systems (EWS), which emphasize preparedness and anticipation. Effective risk management also involves investments in forecasting technologies, the development of climate-resilient infrastructure, and educational programs that equip farmers with adaptive skills and knowledge. By anticipating these threats, communities can reduce vulnerability and minimize potential disruptions.

Shocks, in contrast, are sudden events that have already occurred and caused immediate disruptions to food availability, access, or utilization. Natural calamities, wars, and market collapses are typical examples. In such cases, emergency interventions such as food aid, temporary shelters, and livelihood restoration efforts become necessary to stabilize affected populations (PEP-CBMS Network Coordinating Team, 2011). Research highlights that even relatively minor incidents—such as illness or delayed monsoon rains—as well as major shocks like disability or successive crop failures, can severely disrupt household food security, especially among vulnerable groups in low-income countries (Dercon & Krishnan, 2000).

Stresses are persistent, long-term pressures that gradually erode the resilience of food systems. These include climate variability, soil degradation, declining groundwater levels, and prolonged conflict. Among these, climate change is particularly concerning, leading to erratic weather patterns, droughts, and heavy rainfall, all of which negatively impact agricultural output and rural livelihoods (FAO, 2016). Prolonged crises also lead to chronic undernutrition; for example, in Yemen, sustained armed conflict was linked to a 9.6% reduction in children's weight-for-height z-scores, indicating significant nutritional deterioration (Ecker et al., 2023).

Despite progress in reducing global hunger, food systems remain highly susceptible to various overlapping shocks and stressors—ranging from financial crises and weak economic growth to pandemics, natural disasters, and escalating input costs. These disruptions not only undermine food availability and access but also force difficult trade-offs between food and nutrition security, environmental sustainability, and livelihood stability. Weak rural infrastructure—such as poor storage facilities, inadequate transportation, and fragmented value chains—exacerbates these vulnerabilities by increasing post-harvest losses and limiting farmers' access to stable markets (Hodges et al., 2011). External threats such as market price volatility and the emergence of new pests and diseases, often fueled by climate change, further destabilize food production systems (Bebber et al., 2014).

Addressing these resilience threats requires a comprehensive, multi-level approach. This includes the promotion of climate-smart agricultural practices, investments in rural infrastructure, the development of robust early warning and risk management systems, and enhanced access to markets for small and marginal farmers. Only through such integrated and inclusive strategies can food systems become more adaptive, ensuring long-term food and nutrition security for all.

1.6 The Link Between SDGs and Food System Resilience

The Sustainable Development Goals (SDGs) provide a comprehensive framework for ending poverty, protecting the environment, and fostering sustainable development. Food system resilience is fundamental to achieving multiple SDGs, particularly SDG 2 (Zero Hunger), SDG 1 (No Poverty), SDG 13 (Climate Action), SDG 3 (Good Health and Well-being), and SDG 12 (Responsible Consumption and Production). Resilient food systems can withstand and recover from shocks such as climate change, economic crises, conflicts, and pandemics while ensuring consistent food security and nutrition for all (FAO, 2021). The fragility of progress toward SDG

targets is evident when food systems are disrupted, reversing development gains and exacerbating hunger and malnutrition.

Since the adoption of the 2030 Agenda, the goal of achieving Zero Hunger (SDG 2) has been challenged by climate variability, market instability, and public health emergencies such as the COVID-19 pandemic (FAO, 2021). The Food and Agriculture Organization (FAO) highlights that building resilient food systems is essential for sustainable agrifood systems, as it enhances food security and reduces vulnerability to external shocks.

Food system resilience plays a pivotal role in advancing the United Nations Sustainable Development Goals (SDGs), particularly those related to poverty, hunger, health, sustainability, and climate action.

SDG 1: No Poverty recognizes the importance of agriculture as a primary source of livelihood, especially in developing countries. By strengthening the resilience of food systems, rural households are better protected from economic shocks, income instability, and seasonal distress, thus helping to reduce poverty and promote economic security (World Bank, 2021).

SDG 2: Zero Hunger is directly linked to resilient food systems that ensure reliable access to affordable, diverse, and nutritious food. Resilience-building practices—such as agroecological farming and diversified cropping—can not only boost production but also address the root causes of hunger and malnutrition in a sustainable manner (Blay-Palmer & Young, 2019).

SDG 3: Good Health and Well-being is supported through stable and secure food systems that provide safe, nutrient-rich foods. Resilience in food supply chains ensures that nutritional needs are met even during disruptions such as pandemics, conflicts, or climate-related shocks. According to the FAO (2021), resilient systems are essential to maintaining public health through nutritional stability during crises.

SDG 12: Responsible Consumption and Production aligns with resilient food systems through the reduction of food loss and waste, promotion of sustainable agricultural practices, and strengthening of supply chains. Policies aimed at sustainable resource use and climate adaptation improve overall efficiency, ensuring that food systems remain robust and equitable while minimizing environmental impact (Sapre, 2024).

SDG 13: Climate Action is especially relevant, as food systems are increasingly exposed to climate-induced challenges such as droughts, floods, and erratic weather. The agricultural sector, particularly in climate-sensitive regions, faces heightened risks that threaten food production and livelihoods. Building resilience helps food systems adapt to these climatic pressures and reduces vulnerability among affected communities (Jaba & Sharma, 2016).

In summary, fostering food system resilience supports progress across multiple SDGs by enhancing the system's capacity to absorb, adapt, and transform in response to shocks and stresses.

This ensures that food systems can sustainably provide for current populations while preserving natural resources and ecological balance for future generations, aligning with the broader vision of sustainable development.

1.7 Food System Resilience as a Solution

Food system resilience offers a strategic and sustainable solution to mitigating the adverse impacts of climate change on global food security. As climate change continues to threaten food systems through shifting weather patterns, increasing the frequency of extreme events, and disrupting agricultural productivity and supply chains, the need to build resilience has become more urgent than ever. A resilient food system possesses the capacity to absorb, adapt, and recover from such disruptions, thereby ensuring continuous and equitable access to sufficient, safe, and nutritious food.

One of the most effective approaches to strengthening resilience is the adoption of **climate-smart agriculture (CSA)** practices. Techniques such as agroforestry, crop diversification, and soil conservation improve the efficiency of resource use while reducing the vulnerability of farming systems to climate variability (Toromade et al., 2024). These practices not only enhance productivity but also ensure ecological sustainability in the long run.

In addition, **technological innovations** play a significant role in increasing food system resilience. Precision agriculture and the development of climate-resilient crop varieties allow for optimized resource management and improved tolerance to climatic stresses (Okafor & Uhuegbu, 2024). These technologies empower farmers to make informed decisions and enhance productivity under unpredictable environmental conditions.

Further resilience can be achieved through investments in sustainable infrastructure and renewable energy technologies. Innovations like agrivoltaics which combine solar energy generation with agricultural production are promising tools for creating sustainable, energy-efficient, and climate-adaptive food systems. Such integrated systems reduce dependency on fossil fuels and increase productivity while conserving land and water resources. Comprehensive climate adaptation strategies, supported by strong public-private partnerships, are also essential for fostering resilient food systems. Collaborative efforts can help mobilize resources, disseminate knowledge, and scale up successful resilience-building interventions across regions (Osawe & Ojo, 2022).

Finally, the continuous monitoring and evaluation of food system resilience at household, community, and national levels is key to informing evidence-based policymaking. Regular assessments enable timely identification of vulnerabilities and help design adaptive action plans to safeguard food security in the face of growing climate uncertainties (KC et al., 2024).

In essence, building food system resilience is not merely a response to crisis but a proactive investment in long-term food security, sustainability, and equitable development.

RATIONALE OF THE STUDY

Farmers play a vital role in food systems, particularly in rural areas where agriculture serves as the primary source of livelihood. They are highly vulnerable to both natural and human-induced shocks, such as droughts, floods, pest infestations, price volatility, and socio-political changes. These shocks disrupt food production, reduce income, and threaten food security at both household and community levels.

Building resilient food systems is essential to maintaining food availability, accessibility, and proper utilization key pillars of food security. Food system resilience aligns closely with several United Nations Sustainable Development Goals (SDGs), including:

- **Goal 2: Zero Hunger** – Enhancing food system resilience contributes to reducing hunger and ensuring food security for vulnerable populations.
- **Goal 13: Climate Action** – This study supports efforts to strengthen resilience and adaptive capacity in agriculture against climate-related hazards and natural disasters.
- **Goal 12: Responsible Consumption and Production** – Resilient food systems promote sustainable agricultural practices that ensure efficient resource use.

Agricultural communities, particularly smallholder and tribal farmers, face numerous challenges, including climate variability, market fluctuations, and resource constraints. In regions like Dahod, where a significant proportion of farmers rely on rain-fed agriculture and have limited access to modern infrastructure, building resilience is essential for sustainable livelihoods. Studying resilience in farmers will help identify key factors that enable them to adapt, recover, and thrive despite adversities. This research will contribute to designing effective interventions, policies, and support mechanisms that enhance food security, economic stability, and overall well-being in vulnerable farming communities.

Dahod, a tribal district in Gujarat, has approximately 70% of its agricultural land dependent on rainfed irrigation. This region faces a major challenge: erratic and uneven rainfall distribution, further compounded by its hilly terrain. Therefore, there is a pressing need to examine farmers' adoption of efficient agricultural practices and livelihood management strategies to address extreme weather events, market shocks, price fluctuations, and rising input costs key considerations in assessing food system resilience.

This study aims to understand the factors associated with food system resilience among small and marginal farmers and their households.

Broad Objective

Broad objective: To assess food system resilience among Selected Stakeholders of Selected villages in Dahod

Specific objective:

1. To study the impact of the availability, accessibility and utilization of government schemes, services from NGOs and agricultural extension programs on resilience among producers in the food system.

2. To study the impact of the availability, accessibility and utilization of social safety net programs among small & marginal farmer's households as consumers in the food system.

3. To assess adaptive capacity in coping with threats to resilience among farmers and their households.

Review of literature

Chapter 2: Review of literature

2.1 Food system

The food system is a complex network influenced by environmental, economic, social, and political factors. It encompasses all the processes and actors involved in feeding a population, including the production, processing, distribution, consumption, and disposal of food products. According to the Food and Agriculture Organization (FAO), a sustainable and resilient food system is essential for ensuring food security and nutrition, particularly in vulnerable populations (FAO, 2021).
A food system can be defined as "The web of actors, processes, and interactions involved in growing, processing, distributing, consuming, and disposing of food" (HLPE, 2017).

A food system is a complex network of activities, processes, and infrastructure involved in producing, processing, transporting, marketing, consuming, and disposing of food. It encompasses all stages from "farm to fork" and beyond, including the social, economic, environmental, and health dimensions that influence these activities. Food systems involve various actors such as farmers, processors, distributors, retailers, and consumers, and are influenced by factors like climate change, economic policies, and technological advancements.

2.2 Food System component

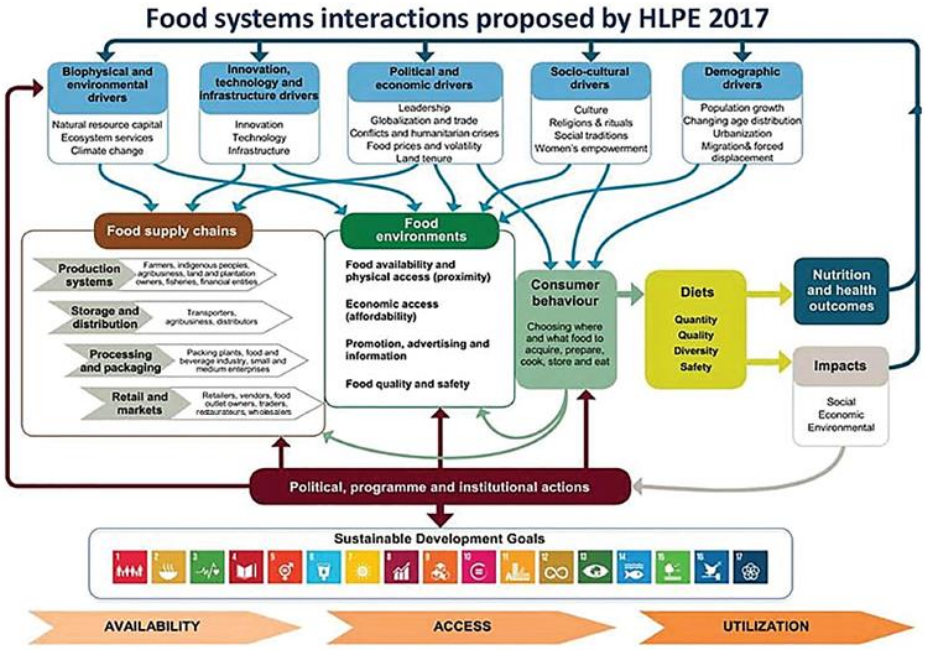

Figure 2.1: Food System interaction proposed by HLPE 2017

The food system is a complex and dynamic network influenced by multiple interacting drivers, including biophysical and environmental factors, technological advancements, economic conditions, socio-cultural aspects, and demographic shifts. These drivers shape the food supply chain, affecting food production, storage, distribution, and retail processes. The food environment determined by food availability, affordability, and safety plays a critical role in shaping consumer choices, which ultimately influence dietary patterns and health outcomes. Additionally, political and institutional actions regulate and support food systems to ensure sustainability and resilience. Achieving food security and nutrition requires integrating policies that enhance food access, affordability, and quality, aligning with the Sustainable Development Goals (SDGs). Strengthening food system resilience, particularly for marginalized communities, is essential in addressing climate change, food price volatility, and global crises that disrupt food security. (HLPE, 2017).

Key components of the framework

The framework is structured around several interacting component:

Drivers of Food Systems

Food systems are shaped by a complex interplay of various drivers that influence how food is produced, distributed, and consumed. These drivers can be broadly categorized into biophysical and environmental, innovation and technology, political and economic, socio-cultural, and demographic factors. Understanding these drivers is essential for designing effective policies and interventions aimed at improving food security, sustainability, and nutrition outcomes.

1. Biophysical and Environmental Drivers

Natural resources, ecosystem functions, and climatic conditions form the foundation of agricultural productivity. Increasingly frequent extreme weather events, land degradation, and water scarcity have emerged as major threats to food security (Vermeulen et al., 2012). Climate change, in particular, significantly affects crop yields and the availability of essential resources, thereby exacerbating food system vulnerabilities (Godfray et al., 2010). Additionally, constraints on land and water resources continue to challenge sustainable food production (Fyles & Madramootoo, 2016).

2. Innovation, Technology, and Infrastructure Drivers

Technological advancements such as precision agriculture, genetically modified crops, and digital tools in food supply chain management have revolutionized food systems by increasing efficiency and reducing post-harvest losses. Investments in infrastructure particularly in storage, transport, and market facilities are vital for minimizing food loss and improving market access (Fyles & Madramootoo, 2016). Moreover, innovations in food processing and distribution are enabling food systems to better respond to evolving consumer preferences and enhance access to nutritious food (Fanzo & Davis, 2021).

3. Political and Economic Drivers

Government policies related to land ownership, food subsidies, trade, and market regulation significantly influence food availability and affordability. Economic factors such as food prices, income levels, and global market trends determine household access to food. Additionally, political instability, armed conflicts, and humanitarian crises often disrupt food supply chains and worsen food insecurity, necessitating robust policy interventions (FAO, 2021).

4. Socio-Cultural Drivers

Cultural beliefs, dietary traditions, and social norms shape consumer behavior, food preferences, and consumption patterns. These factors also influence sustainability practices and levels of food waste within households and communities (Fritz & Schiefer, 2010). Promoting awareness and education about sustainable consumption is essential for shaping healthier and more resilient food systems.

5. Demographic Drivers

Rapid urbanization, population growth, and migration are altering global food demands and supply chain dynamics. Urban populations tend to consume more processed and convenience foods, which has implications for both health outcomes and food system sustainability (Popkin, 2017). Furthermore, demographic transitions such as aging populations also influence food preferences and nutritional needs, requiring responsive food system planning (Bendjebbar & Bricas, 2019).

2.2.2 The food supply chain

The food supply chain forms the structural backbone of food systems, encompassing all stages from agricultural production to retail. A resilient supply chain ensures that food reaches consumers in a safe, timely, and affordable manner, while also supporting food security and sustainability.

a. Agricultural Inputs and Production

This foundational stage includes key agricultural activities such as crop cultivation, livestock rearing, fisheries, and aquaculture. Food production is heavily influenced by factors like climate conditions, soil fertility, water availability, and access to modern technologies (Godfray et al., 2010). Farmers rely on inputs such as seeds, fertilizers, pesticides, irrigation systems, and machinery each of which plays a crucial role in productivity. The quality, availability, and affordability of these inputs directly impact yields. In response to growing environmental concerns, many farmers are adopting sustainable practices such as crop rotation, organic farming, and agroecological approaches to enhance soil health and reduce ecological degradation (Tittonell, 2014).

b. Storage and Distribution

Effective storage and distribution systems are vital for minimizing post-harvest losses and maintaining a steady food supply. This segment of the supply chain ensures that food is

transported from production areas to markets, often bridging vast distances between rural farms and urban consumers (Fritz & Schiefer, 2010). However, in many low-income countries, the lack of adequate rural storage infrastructure contributes significantly to food spoilage and waste (Gustavsson et al., 2011).

c. Post-Harvest Handling and Processing

Once harvested, food undergoes processing techniques such as milling, drying, fermenting, fortifying, and packaging. These processes help preserve food, enhance its nutritional value, and improve safety and shelf life (Aquino, 2024). Efficient post-harvest management is essential to maintain food quality. Unfortunately, inadequate handling often results in considerable losses. Investing in cold storage facilities, value-addition techniques, and modern processing technologies can help reduce wastage while improving food security and farmers' incomes (FAO, 2020).

d. Market Access and Distribution

Access to markets is critical for both producers and consumers. Efficient logistics, infrastructure, and supply chain systems determine how effectively food moves from farm to table. However, disparities in distribution channels especially between urban and rural areas remain a challenge (Laborde et al., 2020). Transportation costs, policy constraints, and transit losses further compromise food affordability and availability (FAO, 2021). Farmers often face difficulties in accessing reliable markets due to poor infrastructure, price instability, and limited bargaining power, all of which reduce their earnings and resilience.

Each link in the food supply chain directly impacts the availability, affordability, quality, and safety of food. Strengthening these systems is essential for building a resilient food environment that can respond to shocks and support long-term food and nutrition security.

2.2.3 Food Environments

Food environments play a pivotal role in shaping dietary behaviors, nutritional outcomes, and public health. They encompass the broader physical, social, and economic settings in which food is produced, distributed, marketed, and consumed. These environments influence what food is available, how easily it can be accessed, its affordability, and how acceptable it is to consumers based on cultural preferences and individual tastes.

A commonly used framework to understand food environments is the **4As**—**Availability, Accessibility, Affordability, and Acceptability**. These dimensions collectively determine the quality and diversity of food choices available to individuals and communities. Physical **availability** refers to the presence of food outlets or sources in the local environment, while **accessibility** considers both geographic proximity and the ability to reach these sources with ease. **Affordability** reflects the economic ability of individuals

to purchase nutritious foods, with food prices often acting as a barrier for low-income households. **Acceptability** involves cultural preferences, taste, and perceived quality of food options, which significantly influence consumer behavior.

In addition to the 4As, other key components such as **promotion and advertising** also shape food choices by influencing perceptions and preferences, often encouraging the consumption of ultra-processed foods. Furthermore, the **quality and safety** of food—ensured through hygiene standards and reduced contamination risks—remain critical for maintaining public health and preventing foodborne illnesses. Thus, transforming food environments is essential for encouraging healthy dietary patterns and achieving better nutritional and health outcomes across populations.

2.2.4 Consumer Behavior and Dietary Patterns

Consumer behavior is a key determinant of diet quality and public health outcomes, and it is shaped largely by the surrounding food environment. Factors such as food availability, affordability, marketing, safety, and access to information strongly influence what individuals choose to eat. These decisions have implications not only for individual health but also for broader societal, economic, and environmental systems.

a. Food Availability and Affordability

Economic access to food is one of the most critical factors influencing dietary diversity. Households with limited income are often forced to make trade-offs, opting for cheaper, calorie-dense foods that are typically low in nutritional value. Price volatility and food inflation further exacerbate this issue, leading to increased vulnerability among low-income groups (HLPE, 2017). Studies have shown that lower-income consumers tend to adopt less healthy dietary patterns, primarily due to affordability constraints (Clark et al., 2021). Supermarket transaction data also reveal clear disparities in food purchasing habits across socioeconomic classes, with wealthier individuals more likely to consume healthier food options. To counteract these trends, interventions such as food subsidies and social safety net programs can play a crucial role in promoting equitable access to nutritious diets (Gelli et al., 2016).

b. Promotion, Advertising, and Information

Marketing and advertising strategies significantly influence consumer food choices. The aggressive promotion of energy-dense, nutrient-poor foods especially among children and adolescents has contributed to the global rise in obesity and noncommunicable diseases (Ma et al., 2013; Hawkes, 2015). Conversely, public awareness campaigns and nutrition

education programs have the potential to positively shape dietary behaviors by encouraging healthier food choices (Cammarelle et al., 2024). Policy interventions, such as front-of-pack nutrition labeling and advertising restrictions on unhealthy foods, are increasingly being adopted to support informed consumer decisions and curb the consumption of harmful food products (WHO, 2021).

c. Food Safety and Quality

Food safety is a critical public health concern, particularly in low-resource settings where regulatory frameworks may be weak. Contaminated food remains a major cause of disease outbreaks and can severely undermine trust in food systems (FAO, 2020). Ensuring safe food handling practices, robust food safety regulations, and improved hygiene standards are essential components of building consumer confidence and reducing the burden of foodborne illnesses.

Nutrition and Health Outcomes

The relationship between food systems and nutrition is central to determining health outcomes. Malnutrition in all its forms undernutrition, micronutrient deficiencies, and obesity arises from imbalanced and unsafe diets. Health outcomes are influenced by four main dietary dimensions:

- **Quantity**: Undernutrition due to insufficient intake or obesity from overconsumption.
- **Quality**: The nutrient density and balance of macronutrients in the diet.
- **Diversity**: Access to a wide variety of food groups to meet nutritional needs.
- **Safety**: Protection from foodborne illnesses and contamination.

Encouraging the consumption of diverse, nutrient-rich, and safe foods is fundamental to improving health outcomes across populations.

Social, Economic, and Environmental Impacts

Beyond individual health, consumer behavior and food system dynamics carry broader implications for society, the economy, and the environment. Unsustainable food practices contribute significantly to environmental degradation, including deforestation, biodiversity loss, water scarcity, and greenhouse gas emissions (Tilman & Clark, 2014). Socially, food systems reflect and reinforce inequalities malnutrition, food deserts, and

public health crises are more prevalent among marginalized populations. Economically, food security, market stability, and farmer livelihoods are all tied to the integrity of the food system.

- **Social**: Disparities in access to nutritious food contribute to widespread malnutrition and health inequalities.
- **Economic**: Stable food markets and fair pricing mechanisms are essential for ensuring food access and supporting farmer incomes.
- **Environmental**: Reducing the carbon footprint, preventing land degradation, and conserving water resources are key to sustainable food systems.

2.2.7 Political and Institutional Interventions

Governments and international organizations play a pivotal role in shaping food systems through policies and programs.

Policy Frameworks and Institutional Actions

Policies targeting food security, nutrition, and climate resilience are essential for sustainable food systems. Initiatives such as the **Right to Food**, **school feeding programs**, and **agricultural subsidies** have been effective in improving food access.

A. Food security programs (subsidies, food rations)

B. Agricultural policies (sustainable farming incentives)

C. Public health campaigns (nutrition awareness)

D. Trade regulations (tariffs, import/export controls)

2.2.8 Sustainable Development Goals (SDGs) and Food Systems

The **Sustainable Development Goals (SDGs)** emphasize the need for sustainable food systems to achieve global food security. SDG 2 (Zero Hunger) directly addresses food availability, while SDGs 3 (Good Health), 12 (Responsible Consumption), and 13 (Climate Action) are interlinked with food system sustainability (UN, 2015).

A. **Availability:** Sustainable food production (SDG 2 - Zero Hunger)

B. **Access:** Equitable food distribution (SDG 1 - No Poverty)

C. **Utilization:** Safe, nutritious diets (SDG 3 - Good Health and Well-being)

Scientific Significance of the Framework

This model provides a holistic approach to understanding food security, integrating agriculture, economics, health, and sustainability. It highlights:

A. Interdisciplinary nature of food systems (linking environment, technology, and policy)

B. Role of governance in shaping nutrition and health outcomes

C. Need for resilience-building in food supply chains (climate adaptation, market stability)

D. Consumer behavior as a critical determinant of food system sustainability

2.3 Food system resilience: **Linking Resilience, Food Security, and Food Systems**

For decades, researchers have studied how seasonal and unexpected shocks affect food security, particularly for vulnerable communities in low-income countries. Studies show that even small disruptions such as delays in monsoon rains or illness within a household can lead to severe consequences, sometimes with irreversible effects (Dercon& Krishnan, 2000). More extreme events, such as consecutive crop failures or disability, can push families into chronic poverty and malnutrition. Research has found that women who experience food shortages during pregnancy are more likely to give birth to smaller babies, which can impact their long-term health and development (Rayco-Solon et al., 2002). Similarly, studies show that children's height gain fluctuates with seasonal hunger cycles, reinforcing the lasting impact of food insecurity on physical development (Maleta et al., 2003).

Beyond economic and environmental shocks, armed conflicts also play a devastating role in food insecurity. People living in conflict zones are up to three times more likely to be food insecure compared to those in stable regions. Globally, 60% of the 815 million undernourished individuals and 79% of the 155 million stunted children live in conflict-affected countries (FAO et al., 2017). Given these realities, ensuring that households can withstand and recover from such shocks is crucial to achieving long-term food security.

This is where the concept of **Resilience** becomes essential. **Food system resilience** refers to the ability of a food system to anticipate, prepare for, absorb, adapt to, and recover from shocks and stresses while maintaining its essential functions. These shocks can include natural disasters, climate change, economic crises, pandemics, or conflicts. A **resilient food system** ensures food security, nutrition, and livelihoods even in the face of disruptions. It does not just **bounce back** but adapts and transforms to become stronger and more sustainable over time.

2.3.1 Framework to Assess Resilience of Farming Systems

Farming has always been a way of life, deeply connected to nature and the well-being of communities. However, farmers today face an unpredictable world climate change, economic ups and downs, and shifting market demands constantly test their ability to sustain their livelihoods. In this context, resilience has become a key focus, not just for individual farmers but for entire agricultural systems. Ensuring that farming remains viable and sustainable is essential for food security and the future of rural communities (Folke et al., 2010).

But resilience isn’t just about holding on, it's about adapting and evolving. A truly resilient farming system doesn’t just survive challenges; it learns, adjusts, and sometimes even reinvents itself to stay strong in the face of change. To understand and measure this ability, researchers have developed a framework that focuses on three essential qualities:

- **Robustness** – The strength to endure shocks, like extreme weather or economic downturns, without major disruptions.
- **Adaptability** – The flexibility to tweak farming methods, diversify crops, or shift strategies to cope with new conditions.
- **Transformability** – The courage and capacity to make fundamental changes when the old ways no longer work such as transitioning to regenerative farming or adopting entirely new agricultural models (Walker et al., 2004).

Originally, these ideas were explored in the broader field of social-ecological systems, where they helped explain how societies interact with their environment. Today, they are widely used in agriculture to guide farmers, policymakers, and researchers in building stronger, more future-proof farming systems (Folke et al., 2010).

To systematically evaluate how well farming systems can withstand and adapt to challenges, researchers have developed a five-step framework that breaks resilience down into key components.

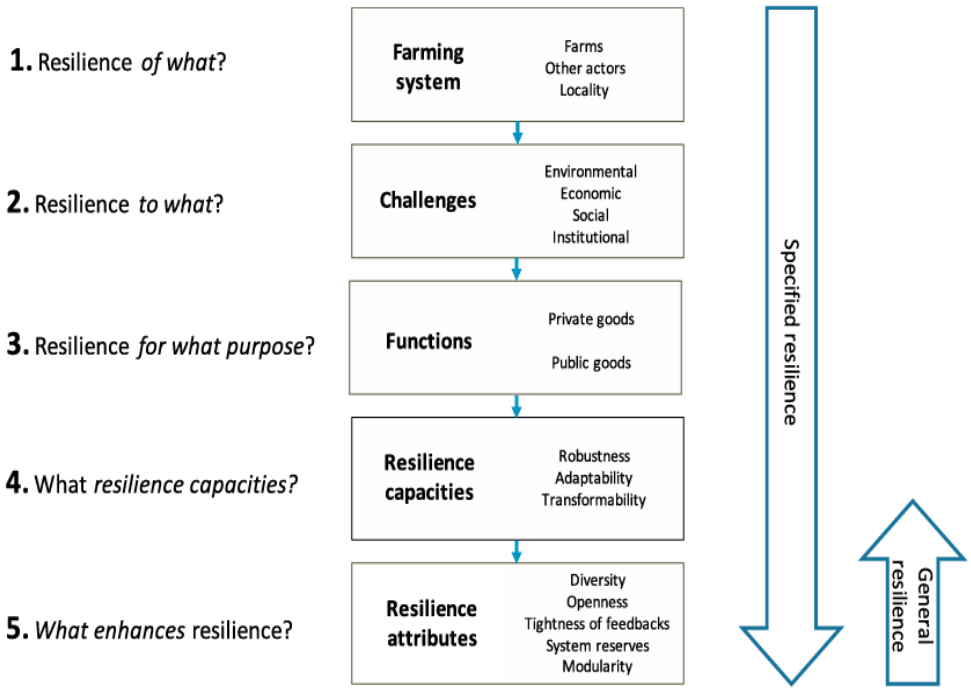

Figure 2.2 Framework to assess resilience of farming systems.

The first step in this process is asking the fundamental question: Resilience of what? This step involves identifying and characterizing the farming system under study. Since farming systems vary widely based on geography, crops, and socio-economic conditions, it is essential to define their scope clearly. For instance, potato farming in the Veenkoloniën region of the Netherlands operates within its own distinct economic and environmental context, making it a unique farming system with specific resilience challenges (Cumming & Peterson, 2017).

A farming system is more than just farms; it is a network of interconnected actors. At its core, there are the farmers who cultivate crops and produce food. Surrounding them are farming system actors, such as suppliers, processors, and traders, who directly shape agricultural production. Beyond these, there are context actors, including government agencies, NGOs, and policymakers, who influence farming through policies, regulations, and broader economic conditions. Farming systems do not function in isolation; they interact with economic markets, social structures, and environmental factors, making them dynamic and constantly evolving. Understanding these interconnections is crucial for

building resilience, as it helps pinpoint where interventions and improvements can be made to ensure long-term sustainability.

The second step in assessing resilience asks the question: Resilience to what? Farming systems are constantly exposed to a variety of challenges, which can be broadly categorized as short-term shocks and long-term stresses. Shocks are sudden, unpredictable events that can disrupt agricultural activities; these include extreme weather events like floods and droughts, pest outbreaks that devastate crops, and economic crises such as global market price crashes. On the other hand, long-term stresses develop gradually over time, silently weakening the foundation of farming systems. These include soil degradation from years of intensive farming, dwindling water resources, an aging rural workforce with fewer young farmers entering agriculture, and shifting consumer preferences that demand different types of food production.

Without resilience, these pressures can push farming systems to the brink, leading to reduced productivity, financial instability, and even abandonment of agricultural lands. However, a resilient farming system does not merely survive these disruptions it adapts, innovates, and finds ways to continue functioning efficiently despite challenges. Whether through improved soil management, better water conservation techniques, or diversification of crops and income sources, resilience ensures that farming remains sustainable and productive for future generations.

The third step in assessing resilience asks: Resilience for what purpose? Farming is not just about growing crops, it plays a much broader role in society by providing both private and public goods.Private goods are the direct benefits that farming generates, such as food production, income for farmers, and stable market supply. These are essential for the economic well-being of farming families and the communities that depend on agriculture for their livelihoods.

Beyond this, farming systems also contribute to public goods, which benefit society as a whole. These include soil conservation, biodiversity preservation, rural employment opportunities, and sustainable land management practices that help maintain the health of ecosystems. However, balancing these different priorities is not always easy. Farmers may prioritize higher yields and profitability, while policymakers and environmentalists might advocate for conservation and sustainable practices. Similarly, consumers may demand both affordable food and environmentally friendly production methods.

The resilience framework must take these trade-offs and synergies into account, ensuring that agricultural development remains balanced. Instead of focusing on just one aspect such as maximizing production at the cost of environmental degradation the framework

encourages a holistic approach that supports long-term agricultural sustainability while meeting the needs of different stakeholders.

The fourth step in assessing resilience focuses on what resilience capacities a farming system needs to sustain itself in the face of challenges. Resilience is not just about enduring hardships it is about responding effectively to different levels of stress and uncertainty. This response can be categorized into three key capacities: robustness, adaptability, and transformability.

Robustness refers to the ability of a farming system to withstand shocks without major changes to its existing structures. For example, a well-irrigated farm with efficient water management can endure a short-term drought without significantly affecting crop yields. Robust systems rely on strong infrastructure, financial reserves, and efficient resource use to absorb disturbances and continue functioning.

Adaptability, on the other hand, is the ability to make gradual adjustments in response to ongoing changes. Instead of simply resisting stress, adaptable farming systems modify their practices to maintain productivity. This could involve crop diversification, adopting climate-smart agriculture, or finding alternative income sources such as agritourism or livestock integration. Adaptability helps farmers adjust to new realities without completely overhauling their way of life.

However, when conditions become unsustainable, minor adjustments may not be enough, and transformability becomes necessary. This involves a fundamental restructuring of the farming system to ensure long-term viability. For instance, if groundwater depletion makes rice farming impossible in a region, farmers might transition to drought-resistant crops, agroforestry, or even completely new livelihood strategies (Walker et al., 2004). Transformability requires bold decisions, investments in new knowledge, and support from policies and institutions to make large-scale shifts successful.

The final step in assessing resilience involves identifying what factors enhance a farming system’s ability to withstand, adapt to, and transform in response to challenges. Several key attributes contribute to resilience, ensuring that farmers can navigate uncertainties and sustain their livelihoods over time.

Diversity plays a crucial role in resilience. Farming systems that rely on a variety of crops, income sources, and farming techniques are better equipped to handle shocks. For instance, a farmer who cultivates multiple crops instead of depending on a single one is less vulnerable to a sudden pest outbreak or price fluctuations. Similarly, having alternative income sources such as livestock, agro-tourism, or value-added products provides a safety net during tough times. This diversity directly contributes to asset

accumulation, ensuring that farmers have different forms of capital, natural, financial, and human to fall back on in times of crisis.

Modularity refers to reducing overdependence on a single supply chain, input source, or market. When a farming system is too tightly linked to a single buyer or supplier, disruptions in that connection can lead to significant instability. A resilient system ensures multiple market linkages, decentralized supply chains, and regional self-sufficiency, reducing the risk of collapse if one part of the system fails. This aligns with access to basic needs, ensuring that farmers have consistent access to food, inputs, and services despite external shocks.

Openness highlights the importance of connections between farmers, markets, and support networks. A well-connected farming community benefits from shared knowledge, access to new technologies, and financial resources. For example, farmers who are part of cooperatives or digital platforms can learn from one another, access better prices, and collectively advocate for supportive policies. This aligns with the social safety net pillar, as government programs, cooperatives, and non-profit initiatives help farmers manage risks by providing financial aid, insurance, and subsidies during crises.

Tightness of feedback ensures quick responses to changing conditions. When farming systems have efficient decision-making mechanisms such as farmer organizations, government support, and community-based networks they can rapidly adapt to environmental and economic shifts. Timely responses to issues like climate change, pest outbreaks, or policy changes can prevent long-term damage and help farmers stay ahead of challenges. This principle is closely linked to adaptive capacity, as it involves the ability to anticipate, plan for, and respond effectively to change.

System reserves serve as a critical buffer during crises. A resilient farming system maintains sufficient financial, natural, and human capital to absorb shocks and sustain itself during difficult periods. This includes savings, fertile soils, access to water, strong social networks, and skilled labor. When unexpected hardships arise such as a drought or market crash these reserves provide the stability needed to recover and rebuild without collapsing. These reserves contribute to both asset accumulation and social safety nets, as they provide both financial stability and access to essential resources.

By integrating these resilience-enhancing attributes, farming systems can become more adaptable, sustainable, and capable of thriving in an unpredictable world.

2.4 Interconnections Between Household Production, Nutrition, and Income in Agriculture

Despite India's economic advancements and improvements in food security, malnutrition remains a pressing public health challenge. While various policies and programs have targeted nutrition-specific interventions, a critical gap persists in understanding how broader economic and agricultural factors influence malnutrition. Nutrition outcomes are shaped not only by direct interventions, such as supplementation and dietary diversification programs, but also by household income levels, agricultural productivity, and access to essential services like healthcare, education, and sanitation.

Recent research has examined the intricate linkages between nutrition, household incomes, and agricultural production, offering valuable insights into how these factors interact to shape nutritional outcomes. Using data from the 2004-05 India Human Development Survey (IHDS 2005), studies have sought to explore the role of economic and agricultural variables in determining nutrition status at the household level. These findings highlight the need for an integrated approach to malnutrition reduction one that considers economic growth, agricultural development, and improvements in social infrastructure.

2.4.1 Household Income and Its Relationship with Nutrition

Household income significantly influences nutrition by affecting both food affordability and quality. Generally, higher household income is associated with better dietary quality and increased consumption of essential nutrients. For instance, a study in rural Mexico found that as household income increased, so did calorie consumption, although the rate of increase diminished at higher income levels, suggesting that while additional income enables greater food consumption, its impact on caloric intake lessens beyond a certain point (Skoufias et al., 2009). Similarly, research among Malaysian women indicated that higher income and better nutrition knowledge were associated with improved diet quality, highlighting the importance of education alongside economic factors in promoting healthier eating habits (Chong et al., 2019).

However, in India, the relationship between income and undernutrition appears relatively weak. Despite economic growth improving overall food availability, translating income gains into better nutritional outcomes remains uneven. Several factors contribute to this disconnect. These findings suggest that while income is important, it is not a standalone solution. Without complementary improvements in public health, education, and infrastructure, economic growth alone is insufficient to comprehensively address malnutrition.

2.4.2 Agricultural and Its Relationship with Nutrition

Agricultural production forms the foundation of nutrition and food security, extending beyond the provision of calories to encompass the availability, accessibility, diversity, and quality of foods essential for a balanced diet rich in macro- and micronutrients. A robust and well-functioning agricultural system is vital not only for enhancing food availability but also for ensuring that food remains nutritious, affordable, and equitably accessible to all segments of the population. Globally, smallholder farmers play a pivotal role in food production—approximately 500 million smallholder farms support the livelihoods of nearly 2 billion people and account for about 80% of food produced in regions like sub-Saharan Africa and parts of Asia. Despite their contribution, many smallholders suffer from chronic food and nutrition insecurity due to factors such as low agricultural productivity, poor market access, and increased vulnerability to climate shocks. Addressing these issues requires targeted efforts to improve productivity, reduce post-harvest losses, and strengthen local food systems so that farming communities themselves can benefit from the food they produce.

A holistic, food-systems approach is essential to ensure that agriculture supports both food security and nutritional well-being (Hawkes et al., 2007). While technological advances and increased agricultural output can enhance food availability, a narrow focus on yield and productivity may inadvertently reduce food diversity and contribute to diet-related chronic diseases (Welch et al., 2005). Thus, a balanced approach that values both quantity and quality is crucial. Initiatives such as farmers' markets and community-supported agriculture can enhance access to nutritious foods, especially in underserved, low-income areas, and promote healthier dietary habits (McCullum, 2004).

Agriculture also plays a significant role in improving food accessibility by reducing the costs of nutrient-dense foods through more efficient production, waste reduction, and stronger supply chains. Furthermore, sustainable practices like family farming and agroecology support long-term food and nutrition security by fostering crop diversification, preserving soil and water resources, and minimizing environmental degradation. These practices not only sustain the ecosystem but also promote dietary diversity, which is essential for combating malnutrition in all its forms.

To fully realize agriculture’s potential in improving nutrition, it is vital to implement nutrition-sensitive strategies. These include promoting crop diversification to ensure a wide array of nutrient-rich foods, empowering women to enhance household food security and nutrition-related decisions, and integrating nutrition education to translate increased food availability into improved dietary practices (Gillespie & van den Bold, 2017). Embedding such strategies into agricultural policies and programs can help build a food system that not only meets caloric needs but also supports health, resilience, and well-being for current and future generations.

2.5 The Role of Assets in Strengthening Farmer Resilience

Assets play a significant role in enhancing farmers' resilience to environmental and economic challenges. The relationship between asset ownership and farmers' resilience is widely studied in agricultural and development literature, as assets significantly shape a farmer's ability to withstand, recover from, and adapt to shocks such as climate change, economic instability, and market fluctuations.

Resilience is built on multiple types of assets, including natural, physical, financial, human, and social capital, which collectively determine a household's adaptive capacity. These assets function as buffers against shocks and as enablers of adaptation and transformation within agricultural systems.

Natural assets, including land, water resources, and soil fertility, form the backbone of agricultural productivity. Access to fertile land and reliable water sources allows farmers to maintain and improve crop yields, even under adverse environmental conditions (Cambridge University Press, 2024). Secure land tenure is particularly crucial, as it provides farmers with the confidence to invest in long-term improvements such as soil conservation and agroforestry practices, thereby enhancing sustainability.

Physical assets, including farm machinery, irrigation infrastructure, storage facilities, and transportation networks, enhance agricultural efficiency and minimize post-harvest losses. These assets allow farmers to mechanize labor-intensive tasks, improve irrigation efficiency, and reduce post-harvest spoilage, all of which contribute to increased resilience in times of uncertainty (Emerald Publishing, 2017). Farmers with better access to physical assets can respond more effectively to climate variability and market fluctuations.

Financial assets, such as savings, access to credit, and agricultural insurance, play a crucial role in buffering farmers against economic shocks. The availability of financial capital enables farmers to invest in climate-resilient technologies, diversify income sources, and reduce dependency on single crops or volatile markets (Reuters, 2025). Financial inclusion through microfinance and cooperative banking further enhances small and marginal farmers' resilience by providing access to resources needed for adaptation and growth. Meanwhile, human capital, which includes knowledge, skills, and health of farmers determine their capacity to adopt innovative and sustainable agricultural practices. Education, extension services, and access to agricultural training equip farmers with the ability to make informed decisions regarding input usage, crop diversification, and climate adaptation strategies (Arxiv, 2021). Moreover, good health ensures that farmers can engage in labor-intensive agricultural activities without disruptions, further strengthening resilience.

Farm assets play a crucial role in enhancing farmers' resilience by improving productivity, reducing vulnerability to climate shocks, and ensuring long-term sustainability. Kaur (2017) analyzed the composition of farm assets among farmers in Punjab, highlighting that large and medium farmer possess significantly more assets than small and marginal farmers. The study found that tractors, electric tubewells, reapers, and combines constitute the largest proportion of farm assets, which directly influence agricultural resilience through mechanization and efficiency gains. However, small and marginal farmers face significant challenges in acquiring such assets, leading to lower resilience and increased financial dependence (Kaur, 2017).

Punia (2020) further emphasized the role of livelihood assets in securing farmers' resilience, particularly in Haryana, India. The study revealed that over 50% of farm households depend on communal water sources for irrigation, while 65% rely on community land for livestock grazing, making them highly vulnerable to external shocks. Farmers with greater access to financial, physical, and social assets were found to be more resilient, whereas those with limited asset ownership struggled with economic security and adaptation (Punia, 2020).

Climate change is a major challenge for agricultural resilience, making access to assets even more critical. Wang et al. (2014) found that financial, physical, and social assets significantly enhance farmers' resilience by enabling adaptation measures such as improved irrigation infrastructure. Aguilar et al. (2022) examined smallholder farmers' resilience to water scarcity, emphasizing that physical and natural capital, such as irrigation infrastructure and water access, were the most critical assets in coping with water-related stress. Households with better access to human capital ie farming experience and social networks were more likely to implement adaptation strategies, reinforcing the role of multi-dimensional asset accumulation in resilience enhancement

The study underscores that land availability, mechanization, and livestock ownership serve as key indicators of resilience, as they determine a household's capacity to maintain production and recover from disruptions. The results suggest that farmers with better access to these assets are more likely to sustain agricultural productivity and secure food availability even in the face of shocks (Andreea-Ion et al. 2021)

However, small and marginal farmers often face limited access to critical farm assets, which restricts their ability to invest in mechanization and modern farming techniques. This asset disparity creates a vulnerability gap, making smaller farmers more susceptible to external shocks such as droughts, erratic rainfall, and economic downturns.

2.6 Farmer Literacy as a Pathway to Agricultural Resilience

Farmer literacy plays a crucial role in promoting agricultural sustainability by enhancing their ability to adopt eco-friendly farming techniques, manage resources efficiently, and make informed decisions. Research has shown that environmental literacy significantly impacts farmers' adoption of green production practices, as it improves their understanding of ecological processes and sustainable agricultural behaviors (Li et al., 2022). Moreover, digital literacy is emerging as a critical factor in sustainable farming, as it enables farmers to access real-time information, use precision agriculture tools, and adopt environmentally friendly practices. Studies indicate that digital literacy not only facilitates access to crucial agricultural information but also enhances farmers' ecological cognition, leading to more sustainable production behaviors (Zhou et al., 2023).

Additionally, the adoption of agricultural green production technologies is closely linked to farmers' literacy levels, as educated farmers are more likely to embrace sustainable techniques and innovations (Chen et al., 2023). Literacy also contributes to food security by improving farmers' knowledge of efficient farming methods, market dynamics, and climate resilience strategies, thereby reducing production risks and enhancing agricultural output (Ahmed et al., 2021). A review of two decades of agricultural literacy research further highlights that education fosters better decision-making among farmers, leading to improved agricultural productivity and long-term sustainability (Frick et al., 1995).

Farmers with greater exposure to education, training programs, and digital resources are better equipped to adapt to climate change. Experienced farmers often rely on traditional knowledge, whereas younger farmers are more inclined to adopt modern adaptation techniques. However, limited literacy and financial constraints hinder adaptation efforts, particularly for small-scale farmers. (Nor Diana et al., 2022) Anabaraonye et al. (2020), educating farmers in rural areas is crucial for enhancing climate resilience and ensuring sustainable agricultural practices. Access to **agricultural training, climate-related information, and non-formal education** significantly boosts farming efficiency (Zahra, 2018). Dang et al. (2019), educated farmers are more likely to adopt climate-smart practices, access agricultural extension services, and utilize modern technologies. Limited literacy acts as a barrier, restricting access to climate-related information and financial resources needed for adaptation.

2.7 Role of Adaptive Capacity in building Resilience

2.7.1 Strengthening Farmer Resilience: The Impact of Marginal Work

A worker is any individual engaged in economically productive work, either through physical or mental activity (Census of India, 1971). The Census of India classifies workers

into two categories: main workers, who have worked for 183 days or more in a year, and marginal workers, who have worked for less than 183 days in a year (Census of India, 1961). Marginal workers often engage in seasonal or irregular employment, contributing to household income but lacking long-term stability.

Marginal workers play a crucial role in shaping the resilience of farming communities, particularly in regions vulnerable to climate change. In areas where recurrent droughts and erratic rainfall patterns threaten agricultural productivity, marginal work can serve as both a coping mechanism and a potential pathway to resilience. However, the effectiveness of marginal work in enhancing resilience depends on income stability, diversification opportunities, and the presence of social safety nets.

Marginal work significantly enhances the resilience of small and marginal farmers by diversifying income sources, reducing distress migration, empowering women, and fostering skill development. Engaging in alternative income-generating activities such as construction, small-scale trade, and wage labor helps farmers create financial buffers against climate-induced agricultural losses like droughts, floods, and crop failures. Government initiatives such as the Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) in India provide temporary employment, offering financial stability without forcing permanent relocation. Vocational training and microfinance programs further enable workers to transition to more sustainable livelihoods. Additionally, marginal work strengthens the economic participation of women, particularly in female-headed households. Women involved in handicrafts, food processing, and poultry farming contribute to household income, ensuring food security.

2.7.2 Animal Husbandry

Animal husbandry sector is considered to be one of the major activities for providing subsidiary income to small and marginal farming families. The ability to raise livestock such as cattle, goats, poultry, and sheep offers farmers an additional source of income, nutrition, and economic stability during periods of crop failure, drought, or market instability.

By integrating livestock into their farming systems, farmers can reduce their dependency on seasonal crops and generate continuous income through dairy, meat, eggs, and wool production (FAO, 2020). Livestock assets act as financial buffers, allowing farmers to sell animals during economic distress or agricultural losses due to climate variability (Thornton et al., 2019). Additionally, animal products contribute to nutritional security by providing essential proteins, vitamins, and minerals, which are particularly critical during food shortages caused by droughts or crop failures (Herrero et al., 2021). Furthermore,

manure from livestock enhances soil fertility and supports sustainable crop production, improving long-term agricultural resilience (Rao et al., 2018).

2.7.3 Rainwater harvesting

Rainwater harvesting (RWH) serves as a crucial adaptive strategy to enhance farmers' resilience against unpredictable weather patterns. By capturing and storing rainwater, farmers can mitigate the risks associated with droughts and erratic rainfall, ensuring a more stable water supply for irrigation and livestock needs (Rockström et al., 2010). Furthermore, RWH contributes to groundwater recharge, reducing dependency on depleting water sources and enhancing long-term sustainability. RWH techniques, such as rooftop harvesting, farm ponds, check dams, and percolation pits, help capture and store rainwater for agricultural and domestic use, ensuring water availability during dry periods. This practice not only mitigates water scarcity but also enhances soil moisture, reducing crop failure risks and improving overall farm productivity.

2.8 The Role of Women in Agriculture

Women are integral to agricultural production and rural economies across the developing world. They contribute significantly to food production, livestock management, and agro-processing, often juggling multiple roles within households and farming systems. Their participation in agriculture varies by region, farm type, and socio-economic conditions.

Women make up an estimated 43% of the agricultural workforce in developing countries, with regional variations ranging from 20% in Latin America to 50% in Eastern Asia and Sub-Saharan Africa. In South Asia and India, over 60% of women workers are engaged in agriculture (FAO, 2010-11). Despite their crucial role, women often have limited access to productive resources such as land, credit, inputs, and agricultural training. If women had equal access to these resources as men, they could increase farm yields by 20-30%, raising overall agricultural output in developing countries by 2.5-4%. This increase could reduce the number of hungry people globally by 12-17%, significantly enhancing food security and economic development (FAO, 2011).

Women engage in various agricultural activities, including crop and livestock production, fisheries, agro-processing, and value-added food production. They work as farmers on their own land, unpaid family laborers, and wage workers in agricultural enterprises. Their contributions extend beyond traditional farming, encompassing household food security through kitchen gardens, small-scale poultry farming, and homestead plots, which are often unrecognized in formal agricultural statistics but play a vital role in dietary diversity.

2.8.1 Women in Livestock Farming

Livestock farming is a critical sector where women play a pivotal role in sustaining rural households. Women constitute about two-thirds of the world's 600 million poor livestock keepers, amounting to approximately 400 million women (Thornton et al., 2002). Their responsibilities include raising poultry, managing dairy animals, and caring for small livestock within the homestead. These activities provide not only nutritional benefits but also a steady source of income, which is often under women's direct control. Women dominate poultry farming in many regions and are extensively involved in dairy farming (FAO, 1998; Guèye, 2000; Tung, 2005).

Despite their vital role in agriculture, women face systemic barriers that limit their productivity and economic opportunities. Limited land rights prevent long-term farm investments, while financial exclusion restricts access to credit and essential inputs like quality seeds and fertilizers. Women are also overrepresented in low-paying, part-time, and seasonal jobs, earning less than men for the same work. Additionally, they bear a heavy unpaid labor burden, managing household chores, child-rearing, and food preparation, which consumes 85-90% of their time in many countries (Fontana & Natalia, 2008). These challenges hinder their ability to fully participate in and benefit from agricultural economies.

2.9 The Role of Social safety net programs in Strengthening Farmer Resilience

Social safety net programs in India form a comprehensive framework aimed at safeguarding economically disadvantaged groups, particularly small and marginal farmers, from climate shocks, market volatility, and rural poverty. These programs include direct income support, food security initiatives, rural employment schemes, crop insurance, credit facilitation, and health and nutritional services. By addressing these key areas, social safety nets play a crucial role in fostering sustainable agricultural livelihoods and overall rural development.

These programs are designed to reduce poverty, enhance livelihood resilience, and promote human capital development (World Bank, 2018). Specifically, in the agricultural sector, social safety nets act as risk mitigation mechanisms, shielding small and marginal farmers from income fluctuations, climate-related shocks, and unpredictable market conditions, thereby strengthening resilience and food security (Alderman & Yemtsov, 2014).

In Gujarat, farmers benefit from a wide range of social safety net programs that aim to improve their livelihoods, ensure food security, and promote sustainable agricultural practices. These initiatives are implemented through central and state government schemes, often in collaboration with non-governmental organizations (NGOs). By bridging economic disparities and enhancing household resilience, these programs contribute significantly to sustainable rural development.

The Public Distribution System (PDS) is one of India's most significant food security programs, designed to provide essential commodities at subsidized prices to economically weaker households. Initially introduced to manage food scarcity, PDS has evolved into a cornerstone of India's food security framework.

Structure and Functioning of PDS:

- The **Central Government** oversees food procurement, storage, transportation, and bulk allocation through the Food Corporation of India (FCI).
- **State Governments** manage internal distribution, including identifying eligible households, issuing ration cards, and ensuring fair allocation to Fair Price Shops (FPSs).
- **Essential Commodities Distributed:** Wheat, rice, sugar (at highly subsidized prices), kerosene (for cooking and lighting), and additional items such as pulses, edible oils, iodized salt, and spices (varies by state).

Despite its significance, PDS faces several challenges, including leakage and diversion of supplies, misidentification of beneficiaries, and limited nutritional diversity. To enhance its efficiency, technology-driven reforms like Aadhaar-based biometric authentication, end-to-end digitization, and initiatives such as **One Nation One Ration Card (ONORC)** have been introduced to make PDS more accessible, particularly for migrant workers and the urban poor.

Central Government Schemes Supporting Farmers

Pradhan Mantri Fasal Bima Yojana (PMFBY)

Launched in 2016, PMFBY is a flagship crop insurance scheme aimed at providing financial protection to farmers against agricultural risks. It covers crop loss due to droughts, floods, cyclones, hailstorms, landslides, pests, and diseases.

Key Features:

- Affordable Premium Rates: Farmers pay only 2% for Kharif crops, 1.5% for Rabi crops, and 5% for commercial/horticultural crops, with the rest subsidized by the government.

- Comprehensive Risk Coverage: Covers sowing to post-harvest losses, including localized risks and unseasonal rains.

- Technology-Driven Assessment: Utilizes remote sensing, drones, and GPS-enabled mobile apps for accurate loss assessment, ensuring timely claim settlements.

- Impact: Annually benefits over 3.8 crore farmers, with ₹1.4 lakh crore worth of claims disbursed since its inception, thereby enhancing financial security and agricultural resilience.

Kisan Credit Card (KCC) Scheme

Introduced in 1998, the KCC scheme provides farmers with short-term, low-interest loans for agricultural and allied activities, ensuring timely access to institutional credit and reducing dependency on informal moneylenders.

Key Features:

- Flexible Credit: Covers expenses for seeds, fertilizers, pesticides, post-harvest needs, marketing, and allied activities like animal husbandry and fisheries.

- Low-Interest Rates with Subsidies: Interest rates start as low as 4% per annum, with government subsidies for timely repayments.

- Hassle-Free Loan Process: Minimal paperwork, a one-time application, and a revolving credit structure enable easy fund access.

Integrated Child Development Services (ICDS)

The Integrated Child Development Services (ICDS) program has been a crucial support system for rural families, particularly those dependent on farming for their livelihood. Since its inception in 1975, it has focused on ensuring that children under six years, along with pregnant and lactating mothers, receive adequate nutrition and healthcare. In farming communities, where long working hours in the fields often lead to inadequate nutritional intake, ICDS bridges the gap by providing free meals, health check-ups, and essential supplements through Anganwadi Centers (AWCs). This helps combat malnutrition, anemia, and other prevalent health issues.

Beyond nutrition, ICDS plays a key role in early childhood education, offering pre-school programs that help children from farming families develop cognitive and social skills, preparing them for formal schooling and reducing dropout rates. The program also empowers rural women by educating them on maternal health, breastfeeding, hygiene, and childcare, enabling them to balance both farm work and family responsibilities more effectively.

ICDS is closely integrated with other food security initiatives such as the Public Distribution System (PDS) and the Mid-Day Meal Scheme (MDMS) to ensure comprehensive nutrition coverage for farming households. Additionally, it aligns with Poshan Abhiyaan and Mission Saksham Anganwadi &Poshan 2.0, which focus on improving dietary habits and promoting sustainable food practices in rural communities.

Though ICDS is not a direct financial support program, it plays a crucial role in strengthening agricultural households by improving the health and resilience of women and children. By investing in the well-being of farming families, the program indirectly contributes to a more sustainable and productive agricultural sector, ensuring a healthier future for India’s rural workforce.

Methodology

CHAPTER 3: METHODS AND MATERIALS

The present study **"Food System Resilience among small and marginal farmers in the selected villages of Dahod district, Gujarat"** is planned with the following objectives.

Broad Objective:

Broad objective: To assess food system resilience among Selected Stakeholders of Selected villages in Dahod

Specific objective:

1. To study the impact of the availability, accessibility and utilization of government schemes, services from NGOs and agricultural extension programs on resilience among producers in the food system.

2. To study the impact of the availability, accessibility and utilization of social safety net programs among small & marginal farmer's households as consumers in the food system.

3. To assess adaptive capacity in coping with threats to resilience among farmers and their households.

Ethical Considerations

The study entitled **"Food System Resilience among small and marginal farmers in the selected villages of Dahod district, Gujarat"** conducted under the Department of Foods and Nutrition, has received ethical approval from the Institutional Ethics Committee for Human Research (IECHR) at the Faculty of Family and Community Science, The Maharaja Sayajirao University of Baroda. The study, allotted the ethical approval number IECHR/FCSC/M.Sc./10/2024/37.

Permission and consent obtained- Informed consent was obtained from all participants, ensuring confidentiality and voluntary participation.

Study Area:

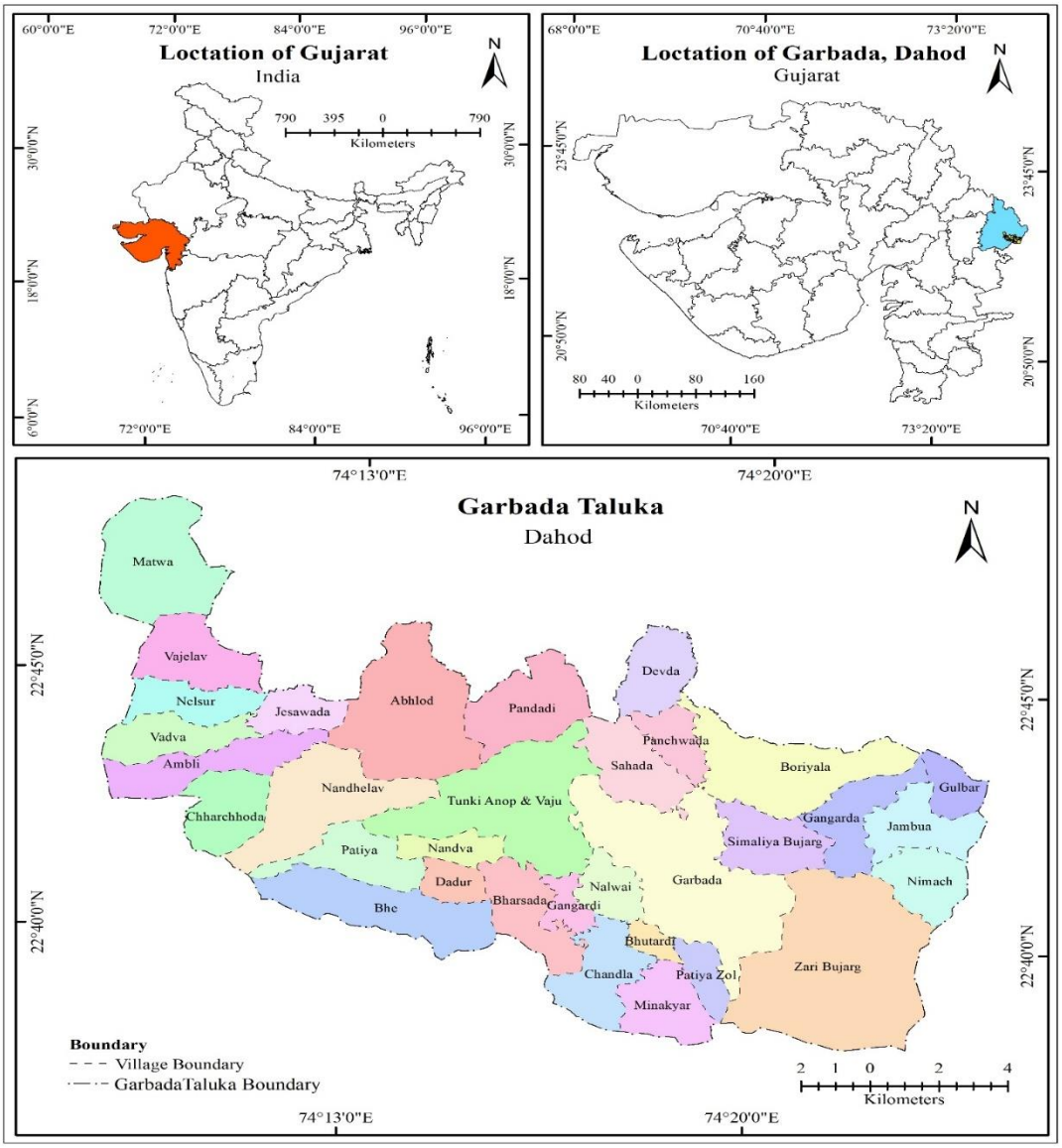

Figure 3.1- Location Map of Study Area: Ablod and Dadur village of Garbada Taluka, Dahod District, Gujarat, India

This study was conducted in Dahod district, located in the **eastern part of Gujarat, India**, and shares its borders with **Madhya Pradesh to the east and Rajasthan to the north** making it a crucial region for interstate migration, trade, and rural development. It lies

between **22.5° to 23.5° North latitude and 73.0° to 74.5° East longitude**. The district is part of the **eastern tribal belt of Gujarat** and has a largely hilly and undulating terrain, with several rivers, including the **Mahi and Anas rivers**, flowing through the region. The district has a significant Scheduled Tribe (ST) population, including Bhil, Rathwa, and Nayaka communities, who primarily depend on agriculture for their livelihoods.

Physical Features and Climate of Dahod

Dahod district is part of the eastern tribal belt of Gujarat and features a predominantly hilly and undulating terrain. The region is influenced by the Vindhya Mountain range, resulting in low to moderate elevation hills and rugged landscapes. The district is intersected by several rivers, including the Mahi, Anas, and Panam, which serve as crucial water sources for irrigation and drinking purposes. However, due to seasonal variability, water scarcity remains a concern, particularly in non-monsoon months. The soil in Dahod primarily consists of black cotton soil and sandy loam, which are well-suited for growing crops like maize, wheat, and pulses. The district also has dry deciduous forests, which provide livelihood opportunities for local tribal communities through minor forest produce collection.

Dahod experiences a tropical monsoon climate, characterized by hot summers, moderate to heavy rainfall during the monsoon, and mild winters. During summer (March to June), temperatures can rise above 40°C, making it one of the hotter regions of Gujarat. The monsoon season (June to September) brings moderate to heavy rainfall, with an annual average of 800–1000 mm, although rainfall distribution is often uneven, leading to periods of drought in some areas. Winters (November to February) are relatively mild, with temperatures ranging between 10°C and 25°C. The combination of variable rainfall, hilly terrain, and soil conditions influences the district's agricultural productivity and overall resilience, making access to water and sustainable land use critical factors for farmers in the region.

Dahod district has a total of 7 talukas, among which Garbada has been selected as an Aspirational Block under the Aspirational Block Programme (ABP) launched by the Government of India to accelerate development in backward areas. The programme focuses on improving key development indicators such as health, education, nutrition, agriculture, and financial inclusion.

Garbada consists of 34 villages, and for this study, two villages were purposively chosen:

1**.** Abhlod

2. Dadur

Sampling Technique

This study employed a **non-probability purposive sampling technique** to select small and marginal farmers in the selected villages of **Dahod district, Gujarat**. Farmers who were **available and willing to participate** during the data collection period were included in the study. This approach was chosen due to practical constraints, including **limited time, accessibility issues, and farmers' seasonal availability**.

Inclusion Criteria:

1. Individuals who own and actively cultivate agricultural land
2. Must be actively engaged in farming activities.
3. Residing in the selected Villages.

Exclusion Criteria:

1. Farmland Owned by Non-Residents
2. Non-Consenting Individuals

Methodology

Study Design

A cross-sectional, mixed-methods study design was employed to assess the food system resilience of small and marginal farmers. The study incorporated both qualitative and quantitative approaches to provide a comprehensive understanding of resilience dynamics.

Data Collection Methods

To assess food system resilience among small and marginal farmers in Dahod district, Gujarat, data was collected from both farmers and their households using interview method.

Primary Data Collection

Primary data was collected through a structured **questionnaire.**

Farmer Interviews:

- Individual interviews with 24 farmers were conducted to understand:
    - Farming practices and crop selection.
    - Access to agricultural inputs and credit facilities.
    - Market access and price fluctuations.
    - Climate resilience strategies
- **Household Surveys:**

  A structured questionnaire was administered to 24 farming households to gather data on:
    - Demographic details (age, gender, education, family size).
    - Household income and expenditure (farming and non-farming sources).
    - Access to food, markets, and government schemes (including social safety nets like MDM, PDS, etc.).
    - Shocks and coping mechanisms.

Focus Group Discussions (FGDs):

- FGDs were held with groups of farmers and their household members to capture:
    - Shared challenges in farming and livelihood.
    - Collective coping mechanisms and adaptive strategies.
    - Perceptions of food system resilience and sustainability.

Tools and Indicators for Assessment

1. Interviews with Farmers through pretested questionnaire:

Principle: Interview provides in-depth insights into farmers' perspectives, experiences, and practices related to agriculture.

Method: A structured questionnaire was used to interview 24 farmers, covering topics such as cropping patterns, water management practices, input utilization, and challenges faced in agricultural production.

Study Outcomes: Interview helped identify common agricultural practices, access to basic services, assets, social safety nets and adaptive capacity.

2. Focus Group Discussions (FGDs) with Farmers:

Principle: FGDs facilitate group interaction and discussion to explore shared experiences, perceptions, and opinions on agricultural practices.

Method: 3 FGD was conducted involving a diverse group of farmers about 4-6 farmers at a time. A checklist guided the discussion, covering topics such as crop diversity, food habit, adaptation strategies and social interactions

Study Outcomes: FGDs provided collective insights into community-level agricultural practices, local knowledge, and adaptation strategies employed by farmers in response to threats.

Indicators and data processing

Resilience Index Measurement and Analysis (RIMA)

Data processing

1. **Data Cleaning and Preparation**
   The dataset was carefully examined for missing values, outliers, and inconsistencies. Missing values, if any, were addressed using appropriate imputation techniques to maintain data integrity. Outliers were identified and treated based on statistical thresholds to prevent distortion in the analysis.

2. **Method of Data Analysis**

   This study adopts the **Resilience Index Measurement and Analysis (RIMA)** framework developed by the **Food and Agriculture Organization (FAO)**. RIMA treats resilience as a **latent variable** that cannot be directly observed but can be inferred from measurable indicators grouped under four main **pillars**:

1. **Access to Basic Services (ABS)**
2. **Adaptive Capacity (AC)**
3. **Assets (ASS)**
4. **Social Safety Nets (SSN)**

   The resilience analysis was carried out in **R Studio**, an open-source statistical computing environment chosen for its flexibility in handling both data management and advanced modeling.

Step 1: Principal Component Analysis (PCA) PCA was first conducted to reduce the dimensionality of the dataset and to identify the most relevant indicators for each resilience pillar. This step helped in eliminating redundant variables and improving the

parsimony of the model. PCA results guided the selection of variables with higher communalities and factor loadings for the subsequent EFA.

Step 2:Exploratory Factor Analysis (EFA)

EFA was used to extract latent constructs representing each of the four RIMA pillars. This technique allowed for the grouping of observed variables into coherent factors based on their underlying structure.

Step 3: The final step involved building a structural measurement model using Confirmatory Factor Analysis (CFA) to validate the factor structure obtained in EFA and estimate the Household Resilience Capacity Index (RCI).

After deriving standardized pillar scores through Principal Component Analysis (PCA) for the four dimensions Asset (AST), Access to Basic Services (ABS), Adaptive Capacity (AC), and Social Safety Nets (SSN) a composite Resilience Index was constructed. This was achieved by calculating the simple arithmetic mean of the four PCA-based scores for each household. The formula used was:

Resilience Index as the average of the four PCA scores:

Resilience index = (Asset score + ABS score + AC score + SSN score)/ 4

Qualitative Data Analysis

Qualitative data from **Focus Group Discussions (FGDs)** were analyzed using thematic analysis.

Data Analysis Tools Used

Quantitative data analysis was performed using Jamovi and R Studio. Descriptive statistics, bivariate analyses (e.g., t-tests, chi-square tests), and regression models were conducted using Jamovi. For multivariate analysis, particularly the construction and validation of the Resilience Index, techniques such as Principal Component Analysis (PCA), Exploratory Factor Analysis (EFA), and Confirmatory Factor Analysis (CFA) were performed using R Studio. Data visualization (scatter plots, loading plots) was also done in R. Qualitative data from interviews and FGDs were analyzed using manual thematic analysis, following an inductive approach to identify recurring patterns related to adaptation, resilience, and livelihood strategies in R studio.

Results and Discussion

Chapter 4: Result and Discussion

The Results and Discussion chapter presents the findings of this study on food system resilience among small and marginal farmers in the selected villages of Dahod district, Gujarat. This chapter systematically analyses the data collected through structured interviews, household surveys, and focus group discussions. The results are interpreted in the context of the study objectives, which focus on the impact of government schemes, social safety net programs, and adaptive capacity on farmers' resilience.

The findings provide insights into farmers' access to agricultural resources, market linkages, and coping mechanisms in response to shocks and vulnerabilities. Using both quantitative and qualitative approaches, this chapter explores key factors influencing resilience, such as availability and utilization of support programs, livelihood diversification, and socio-economic conditions. The discussion integrates these results with existing literature to highlight challenges, trends, and policy implications for enhancing food system resilience in the region.

By linking empirical evidence with theoretical frameworks such as the Resilience Index Measurement and Analysis (RIMA-II), this chapter offers a comprehensive understanding of the absorptive, adaptive, and transformative capacities of small and marginal farmers. The interpretations aim to inform policy recommendations and strategies that strengthen sustainable agricultural practices and rural development in Dahod district.

The results of the study are presented under seven thematic areas to provide a comprehensive understanding.

These include:

(1) Socio-demographic profile,

(2) Crop diversity and cropping patterns,

(3) Sale of agriculture produce,

(4) Income livelihood resources,

(5) Assets and livelihood resources,

(6) Availability and Utilization of Social Safety Net program

(7) Government schemes for agriculture

(8) Household food consumption patterns,

(9) Resilience index analysis (RIMA),

(10) Qualitative findings.

4.1 Socio-demographic Profile of Farmer and their Households

Small and marginal farmers form the foundation of India's agricultural economy, yet they remain among the most vulnerable groups due to limited landholding, financial constraints, and climate variability. Present data on the socioeconomic characteristics and farming practices of 12 small farmers and 12 marginal farmers their household who participated in the study. The analysis highlights the key differences and similarities between these two groups.

Table 4.1.1 Comparative Analysis of the Socio-Demographic Profile of Small and Marginal Farmers

Description	Small Farmers (N-12)	Marginal farmers (N-12)
Variable	Mean ± SD	Mean ± SD
Land holding size(acre)	3.13 ± 0.48	1.63 ± 0.48
Experience in farming	22.50 ± 6.91 (10-40)	21.42 ± 7.17 (10-40)
Number of Kharif crops (Yearly)	3.92 ± 0.79	2.83± 0.94
Number of Kharif crops (Yeraly)	3.92 ± 0.79	2.83± 0.94

The average landholding size for small farmers was 3.13 ± 0.48 acres (ranging from 2.5 to 5 acres), whereas marginal farmers had an average of 1.63 ± 0.48 acres (≤2.5 acres). Despite differences in landholding, both groups had a comparable average farming experience approximately 22.50 years for small farmers and 21.42 years for marginal farmers. This indicates that both groups possess substantial agricultural experience, which may positively influence their adaptive capacity and resilience in farming.

Experience plays a critical role in shaping farmers' adaptation strategies to climate change. A study conducted on 410 rainfed smallholder households in rural Ghana found that farmers relied heavily on their lived experiences to guide a variety of adaptation practices. These included improved farm and crop management, soil and water conservation, conservation agriculture, smart-farming techniques, livelihood diversification, and the application of indigenous knowledge (Yeleliere, Antwi-Agyei, & Guodaar, 2023).

A study conducted in Assam's Cachar district between December 2022 and July 2023 highlighted the influence of farming experience on adaptive capacity. The findings revealed that more experienced farmers were significantly more likely to adopt a broader range of coping strategies in response to climate-related stress compared to less experienced farmers. This suggests that accumulated knowledge and familiarity with local climatic patterns enhance farmers' ability to respond effectively to environmental challenges (Ahmed, Saha, & Majhi, 2024).

Together, these studies underscore the vital role of experiential learning in informing and strengthening climate adaptation strategies among smallholder farmers.

Table 4.1.2 Proportion of Rainfed and Irrigated Land by Farmer Type

Type of land	Small farmer (N-12) (%)	Marginal farmer (N-12) (%)
Rainfed	16.67	66.67
Irrigated	83.34	33.34

Among small farmers, the majority (83.34%) cultivate irrigated land, while only 16.67% are engaged in rainfed farming. In contrast, a large proportion of marginal farmers (66.67%) rely on rainfed land, whereas only 33.34% have access to irrigated land.

This indicates a significant difference in access to irrigation between small and marginal farmers, with small farmers having relatively better access to irrigated land.

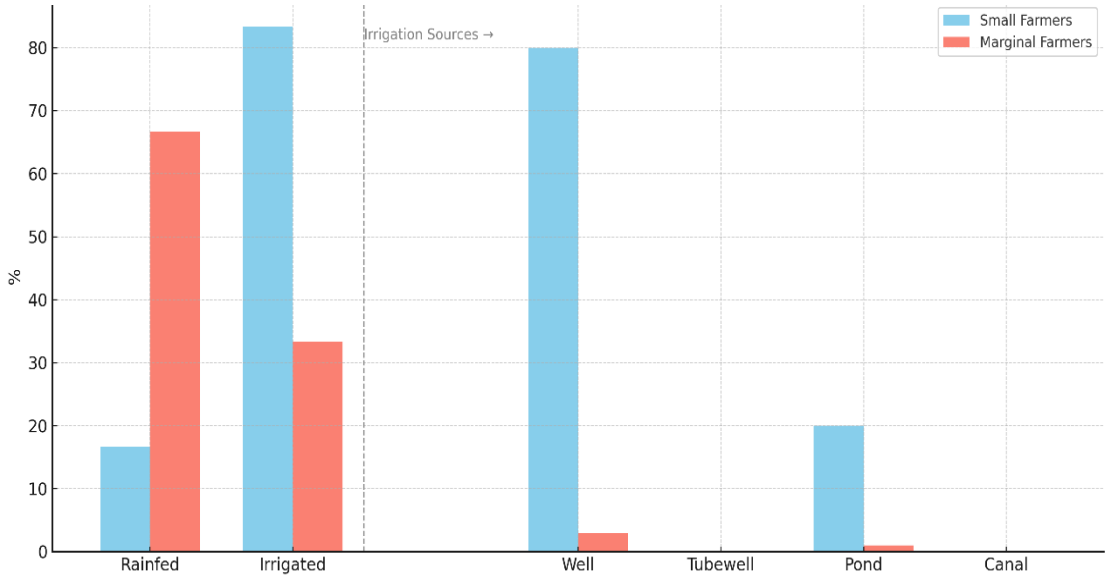

Figure: 4.1.1 Percentage of Farmers having Access to Irrigation and Sources of Irrigation

Given that approximately 70% of the district's agricultural area is rainfed, these farmers are particularly vulnerable to climatic uncertainties. The district's heavy reliance on the south-west monsoon with the majority of rainfall occurring between June and October, and peaking in July and August further compounds this vulnerability.

When comparing rainfed and irrigated agriculture, notable differences emerge in terms of efficiency and productivity. Study examined the performance of irrigated versus rainfed farming and found that irrigated agriculture generally tends to be more efficient, particularly in water use and economic returns. The study emphasized that large-scale irrigation schemes outperformed small-scale ones, offering higher efficiency and improved outcomes. These findings underscore the potential of irrigation especially at scale to enhance agricultural productivity and build resilience in regions prone to climate variability Tilahun et al. (2011).

Image 4.1 Well in the middle of farm for irrigation

Image 4.2 Water store for household use

Educational Status of Farmers

The educational level among the farmers in the study ranged from no formal education to 12 years of schooling**.**

Table 4.1.3 Educational Status of Farmers

Years of Education	Percentage (%) (n=24)
0 (No education)	20.8%
1–5 years	7%
6–10 years	29.2%
12 years	33.3

This suggests that while a portion of farmers have completed schooling, a significant number still lack formal education, which could influence their ability to access information, adopt improved farming technologies, or diversify livelihoods.

Table 4.1.4 Comparison of Secondary Income Among Small and Marginal Farmers

Secondary source of income	Small Farmers (N-12)	Marginal Farmers (N-12)
Yes	58.33%	66.66%
No	41.66%	33.33%

Among small farmers, 58% reported having a secondary source of income, whereas 67% of marginal farmers had additional income sources. This suggests that marginal farmers are more dependent on non-farm income, possibly due to smaller landholdings and productivity constraints. This observation aligns with existing literature, which consistently shows that marginal farmers often rely on alternative livelihood sources to sustain their households.

Secondary Occupation

The figure 4.1.2 shows secondary sources of income among small and marginal farmers reveals distinct patterns in livelihood strategies. Small farmers primarily depend on dairy and self-employment, with approximately 43% of them engaged in each of these activities. This indicates a relatively diversified and potentially more stable income base. In contrast, marginal farmers show a heavy reliance on daily wage labor, with 50% reporting it as their secondary source of income. This suggests a higher level of economic vulnerability and limited access to alternative livelihood options. While self-employment

is also a source of income for around 25% of marginal farmers, their participation in dairy-related activities remains low, at just 12%.

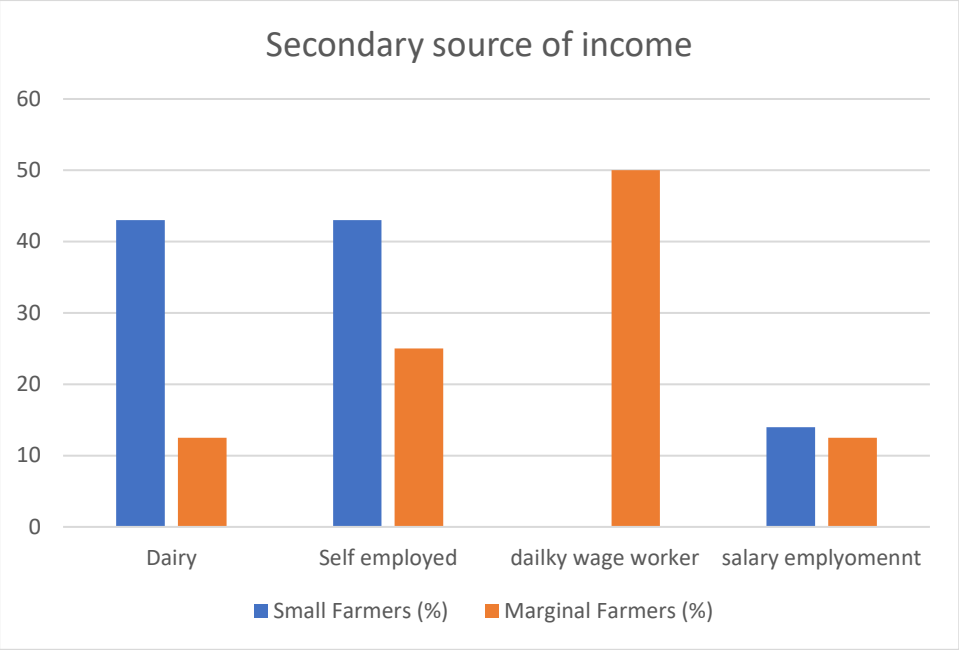

Figure: 4.1.2 Secondary source of income

Both small and marginal farmers have a relatively low presence in salaried employment, accounting for 14% and 12% respectively, highlighting limited formal employment opportunities in rural settings. Overall, the data suggests that small farmers tend to have more diversified and self-driven sources of income, whereas marginal farmers are more dependent on labor-intensive, less secure forms of work.

Study done on marginal farmers investigated the reasons behind the growing shift of marginal farmers toward secondary livelihoods. Their study revealed that over 40% of farmers were dissatisfied with farming due to low profitability, high risks, and poor social recognition. Despite these challenges, many farmers remained in agriculture due to a lack of viable alternatives. Those expressing a preference to exit farming typically had small landholdings, weak irrigation infrastructure, limited productive assets, and poor access to credit, insurance, information, and social networks (Birthal, Roy, Khan, & Negi, 2015).

4.1.4 Sociodemographic data of households

Table 4.1.5 captures key characteristics of the households surveyed, including family size, age distribution, education levels, landholding categories of small and marginal farmers.

Table 4.1.5 Comparative analysis of Sociodemographic data of households

Variables	Small farmer	Marginal farmer
1. Family size		
Family size 1-4	20%	33.33%
Family size 5-7	70%	58.33%
More than 8:	10%	8.3%
2. Type of House		
Pakka	50%	Nil
Semi pakka	50%	66.66%
Kacha	Nil	33.33%
3. Source of water		
Well	66.66%	50%
Bore	33.33%	25%
Government hand pump	-	25%
4. Number of vehicles		
No vehicle	16.66%	58.33%
1	66.66%	41.66%
2	16.66%	0
More	0	0
5. Toilet facility		
Yes	100%	83.33%
No	Nil	16.66%

Family size

The figure 4.1.3 reveals that 70% of small farm households have a family size of 5–7 members, while 20% have 1–4 members and only 10% have more than 8 members. As family size increases, the number of working members also rises: households with 1–4 members have about 1 working members, those with 5–7 members have around 2, and households with more than 8 members have approximately 4 working members. This indicates a strong positive correlation between family size and number of working members in small farm households. The figure 4.1.4 shows that the majority (58%) of marginal farm households have a family size of 5–7 members, followed by 33% with 1–4 members. Only 9% of households have more than 8 members. The number of working family members increases with family size: households with 1–4 members have about 1 working members, those with 5–7 members have approximately 2, and households with more than 8 members have around 4 working members. This suggests a positive

correlation between family size and the number of working members in marginal farm households. The average family size among small and marginal farmers displays notable variations in household composition. Most families consist of 5 to 7 members, with nine small farmer households and seven marginal farmer households falling within this range.

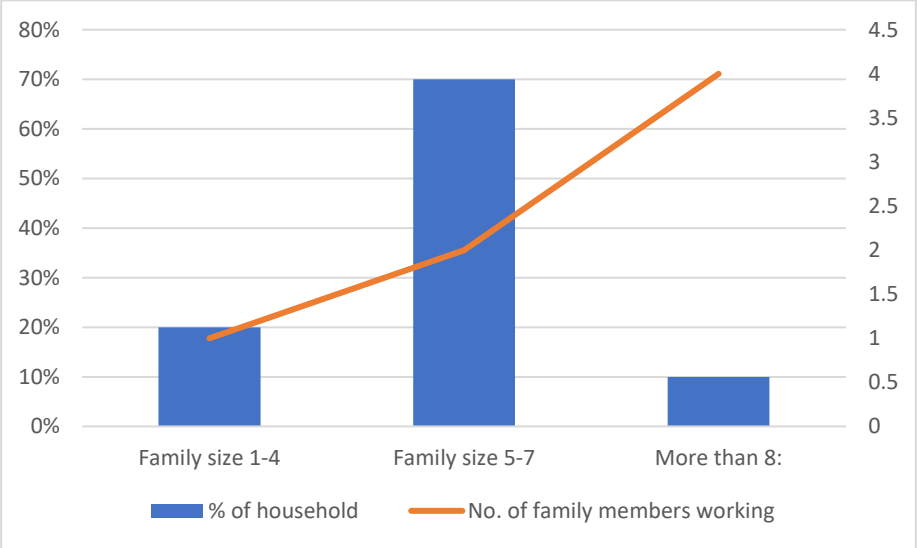

Figure 4.1.3 Distribution of Family Size and Working Members in Small Farm Households

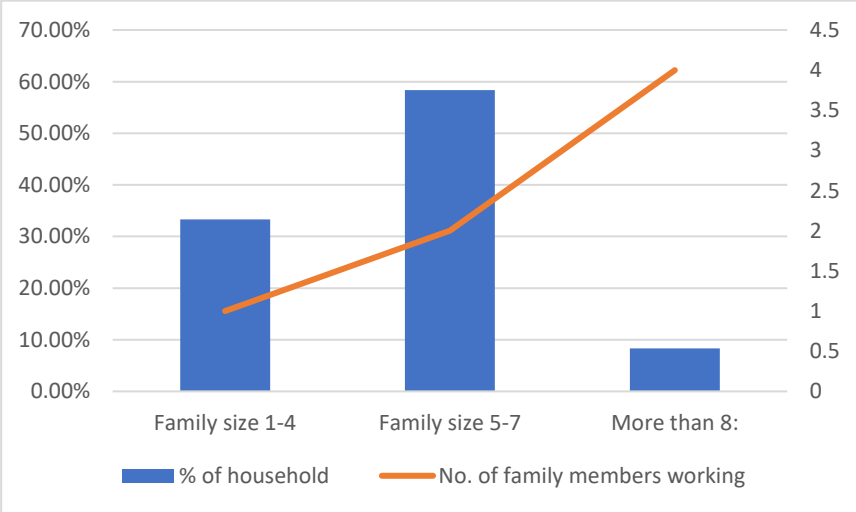

Figure 4.1.4 Distribution of Family Size and Working Members in Marginal Farm Households

This suggests the prevalence of extended family systems, which likely contribute to shared agricultural labor and domestic responsibilities. Smaller households with 1 to 4 members are more common among marginal farmers (four households) than among small farmers (two households), potentially reflecting economic challenges, limited landholding, or the impact of migration. In contrast, families with more than eight

members are rare, with only one occurrence in each group. Family size plays a critical role in shaping household economic outcomes by influencing income distribution, consumption levels, and the capacity to save.

Supporting evidence from broader research aligns with these findings. One study found that larger households in agricultural communities face a heightened risk of food insecurity due to increased consumption needs and limited resources. Female-headed households and those solely reliant on agriculture or led by less-educated individuals were found to be particularly vulnerable. The study recommended farm size expansion and targeted social support as key mitigation strategies (Kadir & Prasetyo, 2023).

Similarly, an analysis of 35 family farms in Vojvodina revealed that larger farms significantly increased both labor engagement and income, with earnings up to 3.6 times higher than those from smaller farms. This highlights the inefficiency and underemployment commonly associated with small-scale farming and emphasizes the need for state intervention (Munćan & Božić, 2017). Another study found that households with at least two full-time workers enjoy greater economic stability and are significantly less likely to fall below the poverty line, reinforcing the critical link between employment intensity and financial resilience in rural households (Filandri, Pasqua, & Struffolino, 2020).

Amenities

a. Housing Condition

Among small farmers, **50%** had semi-pakka houses, **50%** had pakka houses, and none had kacha houses. In contrast, marginal farmers had **66.67%** semi-pakka houses and *33.33% kacha houses, with no pakka houses. This suggests that small farmers generally have better housing conditions, reflecting relatively better economic stability.

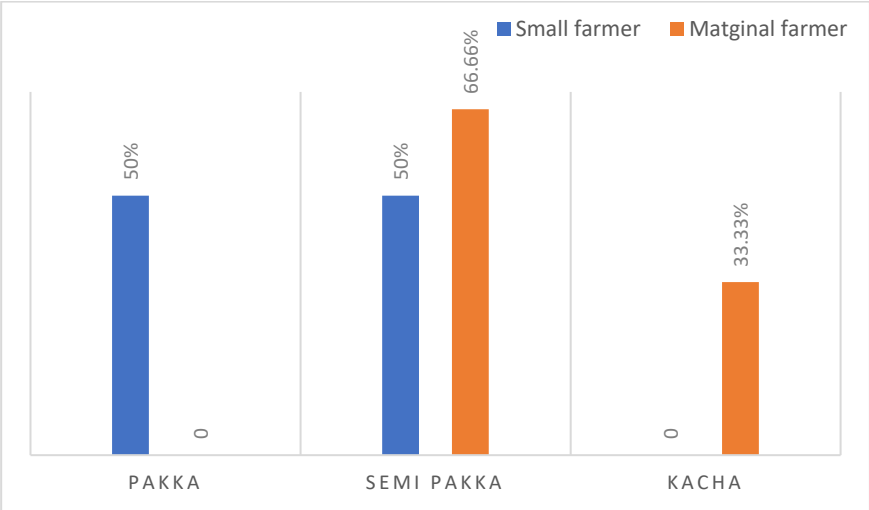

Figure 4.1.5: Housing condition of farmers

Water source and sanitation

Water source availability and sanitation access are interconnected, as access to clean water directly influences hygiene and overall health. The data reveals that small farmers have better access to private water sources (wells and borewells) and 100% sanitation coverage, whereas marginal farmers have greater dependence on government hand pumps and a lower sanitation facility rate (83.33%).

Small farmers primarily rely on wells (66.67%) and borewells (33.33%), ensuring a more reliable water supply, whereas marginal farmers depend more on government hand pumps (25%), which may lead to inconsistent water availability for hygiene and sanitation. This disparity affects sanitation access, as small farmers enjoy 100% toilet coverage, benefiting from sufficient water for hygiene maintenance, while 16.67% of marginal farmers lack toilets, possibly due to water scarcity. The absence of sanitation facilities among marginal farmers increases their vulnerability to health risks, including waterborne diseases, exacerbated by unreliable water sources. In contrast, better water access among small farmers supports improved sanitation, hygiene, and overall living standards, reducing health risks.

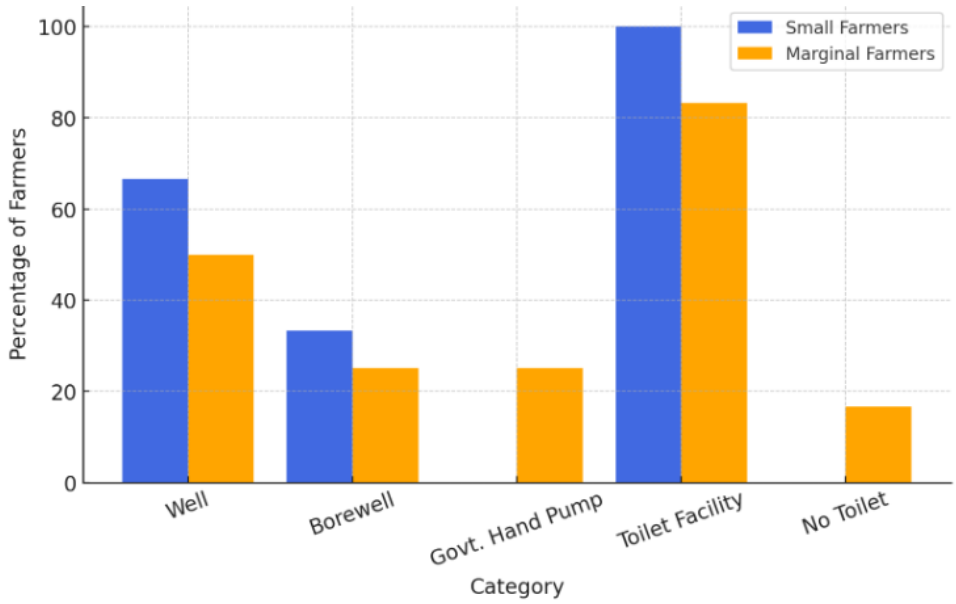

Figure 4.1.6 Relationship between water source and sanitation

4.2 Major Crops Grown & Shifts in the Cropping Pattern

4.2.1 Crops diversity among farmers

Crop diversification refers to the practice of cultivating more than one crop within a given area. This can be achieved through the introduction of new crop species or varieties, or by altering the existing cropping system. Typically, it involves the inclusion of additional crops within an established rotation. Diversification may also aim to replace low-value crops with higher-value commodities, such as vegetables and fruits. Furthermore, it can encompass the integration of crop and livestock production, commonly known as mixed farming. Crop diversity includes several dimensions, such as species diversity, varietal diversity within crop species, and genetic diversity within species. It is widely acknowledged as one of the most effective, cost-efficient, and sustainable approaches to building resilient agricultural systems.

Agricultural producers are already adopting crop diversification strategies to address challenges in crop production, such as high land prices, rising input costs, unpredictable weather conditions, and increasing demand for new products. These challenges have created barriers to generating higher revenue per acre from traditional crops like alfalfa (Northern Nevada Business Weekly Report, 2008). As a result, concerns about sustainability have driven greater interest in crop diversification among farmers globally.

The average number of Kharif crops grown by small farmers was 3.92 (± 0.79), while marginal farmers grew an average of 2.83 (± 0.94) crops per year. Similarly, small farmers reported a higher average number of Rabi crops per year (3.83 ± 0.72) compared to marginal farmers (2.83 ± 0.94). The most common crops grown in the Kharif season by both groups included rice, maize, and cotton, whereas wheat and pulses dominated the Rabi season.

In figure 4.2.1 Small farmers showed significantly greater crop diversity compared to marginal farmers, likely due to their larger landholdings, which provide more flexibility in diversifying crops. Additionally, the higher crop diversity among small farmers may enhance their resilience to climatic and economic shocks. In contrast, marginal farmers, with fewer resources, tend to focus on a smaller number of crops, making them more vulnerable to market and environmental fluctuations. Cultivating a diverse range of crops enables farmers to sell their produce in the market, generating income that can be used

to purchase a wider variety of foods, thereby enhancing household dietary diversity (Njeru 2013).

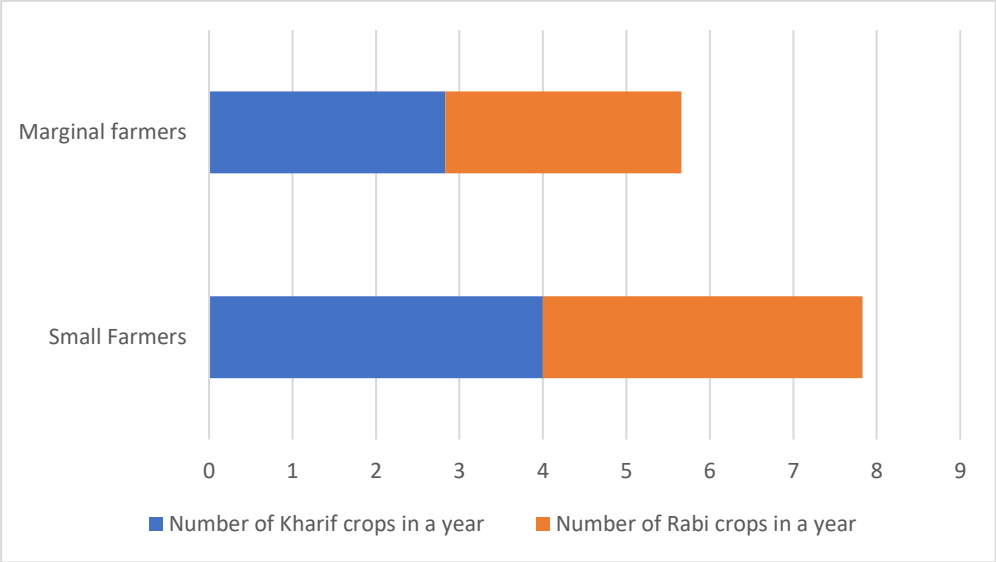

Figure 4.2.1: Crop diversity among farmers

Higher crop diversity may provide farmer households with access to a wider range of food items produced on their own farm, as well as opportunities to cultivate cash crops, which may indirectly influence dietary diversity through increased income. Although increasing incomes have been shown to improve dietary diversity (Dillon et al. 2014).

4.2.2 Crop Cultivation Patterns

Kharif Crops Grown by Farmers

The data on Kharif crops reveal notable differences between small and marginal farmers in terms of crop diversity:

Table 4.2.1 Kharif Crops Grown by Farmers

Kharif crops grown by farmers	Small Farmers (%) (n-12)	Marginal Farmers (%)(n-12)
Oryza sativa (Paddy)	92	58
Zea mays (Maize)	100	100
Arachis hypogaea (Groundnut)	33	0
Glycine max (Soybean)	58	0

- **Paddy (Oryza sativa):** Cultivated by **11 out of 12 small farmers (92%)** and **7 out of 12 marginal farmers (58%)**, indicating that paddy is more commonly grown by small farmers.
- **Maize (Zea mays):** Cultivated by **all farmers (100%)**, suggesting it is a staple Kharif crop across both categories.
- **Groundnut (Arachis hypogaea):** Grown exclusively by **4 out of 12 small farmers (33%)**, whereas no marginal farmers cultivated groundnut. This suggests that small farmers have greater flexibility in crop choices due to more land.
- **Soybean (Glycine max):** Similar to groundnut, **7 out of 12 small farmers (58%)** cultivated soybean, while marginal farmers did not.

Rabi Crops Grown by Farmers

Table 4.2.2 Rabi Crops Grown by Farmers

Rabi crops grown by farmers	Small Farmers (%)	Marginal Farmers (%)
Triticum aestivum (Wheat)	100	100
Cicer arietinum (Chana)	92	92
Cajanus cajan (Pigeon pea)	83	50

The Rabi cropping pattern indicates more similarities between the two groups:

- **Wheat (Triticum aestivum):** Universally grown by **all small and marginal farmers (100%)**, confirming its staple status.
- **Chana (Cicer arietinum):** Cultivated by **11 out of 12 farmers (92%)** in both groups, showing its importance as a Rabi crop.
- **Pigeon Pea (Cajanus cajan):** More commonly grown by small farmers (**10 out of 12, or 83%**) compared to marginal farmers (**6 out of 12, or 50%**), suggesting that small farmers engage in more diverse Rabi cropping patterns due to more land.

Table 4.2.1 Crops grown during summer

Summer crops grown	Small farmer	Marginal farmers
Yes	66.66	33.33
No	33.33	66.66

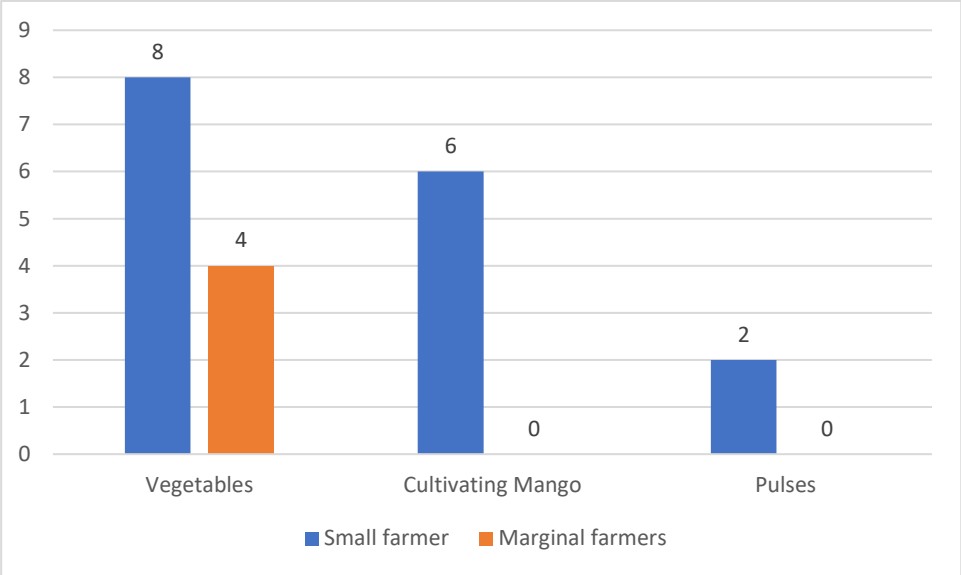

Figure 4.2.4 Crops grown during summer

During the summer season, small and marginal farmers cultivate a variety of crops. Small farmers primarily grow vegetables, with a significant portion also engaged in cultivating mangoes. Additionally, they grow pulses such as Mung and Tuver, although to a lesser extent. Marginal farmers, on the other hand, focus mainly on vegetable cultivation but do not appear to be involved in growing mangoes or pulses during this period. This highlights the broader crop diversity managed by small farmers compared to marginal farmers in the summer.

Rabi Crops: Growth Conditions and Agronomic Practices

Rabi crops, sown during the winter season and harvested in spring, require specific climatic and soil conditions to achieve optimal growth and yield. These crops flourish in cooler temperatures during their vegetative phase, with wheat (*Triticum aestivum*) growing best at temperatures ranging from 10°C to 25°C during growth and 20°C to 25°C during maturation. Excessive rainfall can be detrimental, leading to fungal diseases and root rot, making regions with minimal rainfall during the growing season ideal for Rabi crops.

Soil conditions play a crucial role in Rabi crop productivity. Well-drained loamy or clayey soils with moderate organic matter provide an optimal balance of water retention and nutrient availability. For instance, wheat performs best in loamy soils, whereas chickpeas (Cicer arietinum) can tolerate slightly saline or alkaline conditions. The ideal soil pH range for Rabi crops is between 6.0 and 7.5, ensuring efficient nutrient absorption and microbial activity.

Several Rabi crops, such as gram (chickpea) and lentils (Lens culinaris), exhibit resistance to frost and drought. These crops have adaptive mechanisms, including deep root systems and low transpiration rates, which allow them to survive in conditions with minimal water availability. Adequate soil moisture at the time of sowing is critical for seed germination and establishment, as dry soils hinder germination, while waterlogged conditions increase the risk of root diseases.

Timely sowing, typically from October to December, ensures optimal plant establishment, as delayed sowing exposes crops to higher temperatures, reducing yields. The use of high-quality, disease-resistant seed varieties improves productivity. Since Rabi crops are less dependent on monsoon rains, efficient irrigation management is necessary to maintain adequate soil moisture. Many Rabi crops exhibit long-day photoperiod sensitivity, meaning they require extended daylight hours for proper flowering and grain development. Wheat, for example, requires longer daylight exposure during its reproductive phase to maximize yield potential.

Balanced fertilization, including nitrogen, phosphorus, and potassium, supports healthy crop development, while organic matter such as compost or farmyard manure enhances soil fertility. Weed and pest management play a crucial role in maintaining productivity. Integrated pest and disease management strategies, such as crop rotation, intercropping, and timely application of herbicides or pesticides, help control weeds and pests, ensuring stable yields.

Understanding and implementing these optimal growing conditions and agronomic practices contribute significantly to food security and the agricultural economy.

Kharif Crops: Growth Conditions and Agronomic Practices

Kharif crops, also known as monsoon crops, are sown at the onset of the rainy season, typically in June or July, and harvested in the post-monsoon period between September and October. These crops are highly dependent on rainfall and thrive in warm and humid climatic conditions. The optimum temperature for germination and early growth varies among crops, with rice (Oryza sativa) and maize (Zea mays) requiring temperatures between 25°C and 35°C. Kharif crops require high soil moisture for proper development. Rice, for instance, needs between 1000 and 1500 mm of rainfall, while maize and pulses

can thrive with 500 to 800 mm. However, excess rainfall can cause waterlogging and crop damage, particularly in poorly drained soils.

Soil conditions also play a vital role in Kharif crop cultivation. Rice prefers clayey and loamy soils with high water retention capacity, whereas maize grows best in well-drained alluvial and sandy loam soils. Many Kharif crops, such as soybean, are short-day plants, meaning they require longer nights for proper flowering and fruiting.

Warm and humid conditions during the Kharif season make these crops highly vulnerable to pest infestations and diseases. Rice is particularly susceptible to stem borers (*Chilo suppressalis*) and fungal diseases such as blast (*Magnaporthe oryzae*), while maize faces threats from fall armyworm (*Spodopterafrugiperda*). The success of Kharif crops is closely linked to monsoon variability, as unpredictable rainfall patterns can lead to drought stress or waterlogging, both of which significantly impact yields.

To ensure sustainable production, adaptive strategies such as the use of drought-resistant crop varieties, improved water management techniques, and soil nutrient management are essential. Given the increasing unpredictability of climatic conditions, the promotion of resilient cropping systems is crucial for stabilizing yields and ensuring the long-term sustainability of Kharif crop production.

The cultivation patterns of crops are influenced by a multitude of factors that vary significantly across regions, making their understanding vital for enhancing agricultural productivity and ensuring sustainability. Among the most critical are climatic factors, which directly affect the types of crops that can be grown and their potential yields. Changes in temperature and rainfall patterns, for instance, have led to declining wheat productivity in some areas, as highlighted by Din et al. (2019). Furthermore, regional agro-climatic zones shape what crops are suitable for cultivation; for example, in Karnataka, rainfall variability has played a key role in shifting cropping patterns. Socio-economic factors also exert a strong influence on farmers' cropping decisions. Access to markets and the potential for higher profitability encourage farmers to transition from traditional to commercial crops, as observed in Nepal (Shrestha, 2010). Additionally, higher rural literacy rates have been associated with the adoption of more productive cropping systems, as educated farmers are generally more receptive to technological innovations (Halagundegowda et al., 2015). In this context, technological advancements have become a major driver of change in agricultural practices. The adoption of improved technologies such as high-yielding varieties, mechanization, and efficient irrigation systems has enabled farmers to improve yields and modify cropping systems accordingly (Shrestha, 2010). Moreover, modeling tools like system dynamics and land-use simulations offer predictive insights into future cropping trends by integrating climatic and socio-economic variables (Mesgari & Jabalameli, 2018). However, while these changes have largely improved productivity, they are not without consequences. Rapid agricultural expansion, if poorly managed, can lead to land fragmentation and environmental degradation, thereby threatening the long-term resilience of farming systems (Wang et al., 2024). Therefore, a balanced and context-specific approach is

essential to optimize crop cultivation patterns while safeguarding environmental and socio-economic sustainability.

Table 4.2.4. Soil-site suitability criteria (crop requirements) for wheat

Soil-site characteristics	Unit	Highly suitable (S1)	Moderately suitable (S2)	Marginally suitable (S3)	Not suitable (N)
Climatic regime	Mean temperature in growing season (°C)	20–25	26–28	29–34	<14; >34
Land quality	Land characteristics				
Moisture availability	Length of growing period (days)	>150	120–150	90–120	<90
	AWC (mm/m)				
Oxygen availability to roots	Soil drainage (class)	Well drained to moderately well drained	Imperfectly drained	Poorly drained	Very poorly drained; excessively drained
Nutrient availability	Texture (class)	cl, sil, sicl	sc, sic, c, ls, sicl, sl	c++ (45–60%)	s, c++ (>60%)
	pH (1:2.5)	6.5–7.5	7.6–8.5; 5.5–6.4	8.6–10.4; 4.5–5.4	<4.5; >10
	OC (%)	0.6–0.7	0.5–0.6	0.3–0.5	<0.3
Rooting conditions	Effective soil depth (cm)	65–100	65–50	50–25	<25
	Stoniness (%)	<15	15–35		
Soil toxicity	Salinity (EC saturation extract, dS/m)	<4.0	4.0–6.0	>6.0	
	Sodicity (ESP, %)	<15	15–30	30–40	>40
Erosion hazard	Slope (%)	<3	3–<5	5–10	>10

National Bureau of Soil Survey and Land Use Planning (2006).

Note: c++ = Clay (45–60%), C++ = Clay >60%

Cl = Chloride.

Table 4.2.5. Soil-site suitability criteria (crop requirements) for rice

Soil-site characteristics	Unit	Highly suitable (S1)	Moderately suitable (S2)	Marginally suitable (S3)	Not suitable (N)
Climatic regime	Mean temperature in growing season (°C)	30-34	35-38	39-40	>40
	Total rainfall (mm)	1110-1250	900-1110	750-900	<750
Land quality	Land characteristics				
Oxygen availability to roots	Soil drainage (Class)	Imperfectly drained	Moderately well drained	Well drained; somewhat excessively drained	Excessively drained
	Free from flooding (duration in months)	>4	3-4	2–3	<2
	Depth of water (cm)	<10	10–20	20–40	>40
Nutrient availability	Texture*	c, sic, cl, sicl, sc	sc, sil, l	sl, ls	s
	pH	5.5-6.5	6.4-7.5 4.5-5.4	7.6-8.5	>8.5 <4.5
	$CaCO_3$ in root zone (%)	<15	15 to 25	25 to 30	>30
Rooting conditions	Effective soil depth (cm)	>75	51 to 75	25 to 50	<25
Soil toxicity	Salinity (EC saturation extract, dS/m)	<3	3 to 6	6 to 10	>10
	Sodicity (ESP, %)	<15	15 to 40	40 to 50	>50
Erosion hazard	Slope (%)	0 to 1	1-3	3-5	>5

National Bureau of Soil Survey and Land Use Planning (2006).

Table 4.2.6. Soil-site suitability criteria (crop requirements) for Maize

Soil-site characteristics	Unit	Highly suitable S1	Moderately suitable S2	Marginally suitable S3	Not suitable N
Climatic regime	Mean temperature in growing season (°C)	21-32	33-38	39-40	>40
	Total rainfall (mm)	900-1000	750-900	500-750	<500
Land quality	Land characteristics				
Moisture availability	Length of growing period (Days)	>100	100-80	60-80	<60
Oxygen availability to roots	Soil drainage (Class)	Well drained	Mod. to imperfectly	Poorly/Excessively	V. Poorly
Nutrient availability	Texture (Class)	l, cl, **scl, sil**	sl, sicl, c(n-s)	c (s-s), ls	s
	pH (1:2.5)	5.5-7.5	7.6-8.5 5.0-5.4	8.6-9.0 <5.0	>9.0
	CEC (C mol (p+)/kg)	>20	15-20	10-15	<10
	OC (%)	High	Medium	Low	<0.25
Rooting conditions	Effective soil depth (cm)	>75	50-75	25-50	<25
	Stoniness (%)	Non gravelly	15-35	35-50	>50
Soil toxicity	Salinity (EC saturation extract, dS/m)	Non Saline	1.0-2.0	2.0-4.0	>4.0
	Sodicity (ESP, %)	Non Sodic	10-15	>15	
Erosion hazard	Slope (%)	<3	3-5	5-8	>8

National Bureau of Soil Survey and Land Use Planning (2006).

Image 4.2.1 Maize Field

Image 4.2.2 Maize cob

Image 4.2.3 Tomato Cultivation for consumption

Image 4.2.4 Mixed cropping

Image 4.2.5: Mango cultivation

Image 4.2.6: Wheat Field

Image 4.2.7 On-Field Observation of Smallholder Mixed Farming

4.3 Sale of Agricultural Produce

4.3.1 Selling Agricultural Produce vs. Self-Consumption

Evaluating the underlying objectives of crop cultivation is essential for understanding agricultural production dynamics and its implications for household food security and economic sustainability. This study categorizes farmers based on whether they primarily grow crops for subsistence, commercial sale, or a combination of both.

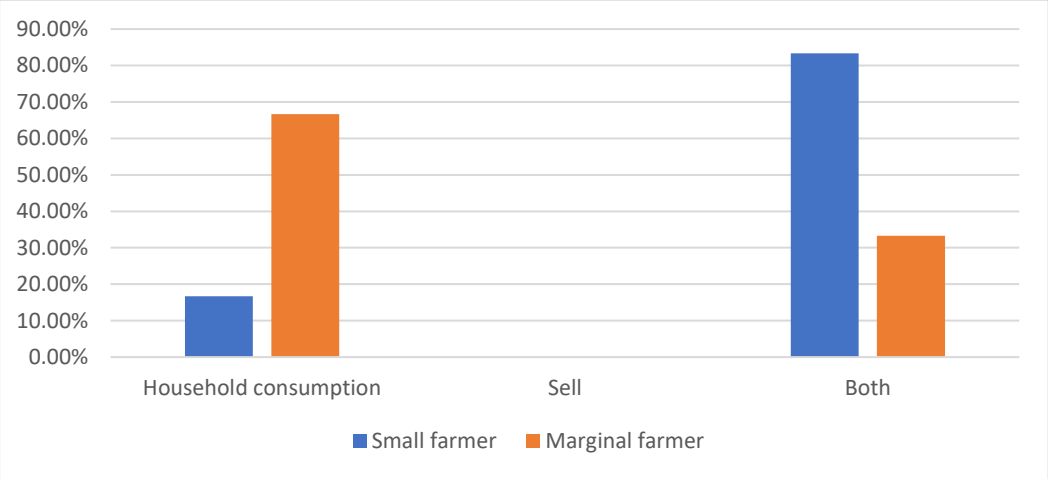

Figure 4.3.1 Crop Utilization Patterns Among Small and Marginal Farmers

Figure 4.3.1 illustrates the distribution of crop cultivation objectives among small and marginal farmers in the selected villages of Dahod district. Among small farmers, a substantial majority (83.33%) reported cultivating crops for both household consumption and sale, while only 16.66% grew crops exclusively for subsistence purposes. In contrast, marginal farmers displayed a more balanced distribution, with 66.66% focusing primarily on household consumption and only 33.33% engaging in commercial cultivation.

These findings suggest a clear distinction in cultivation objectives based on landholding size. Small farmers, having relatively greater access to cultivable land, are better positioned to grow sufficient quantities of crops to meet both household needs and market demands. Conversely, marginal farmers constrained by smaller landholdings and limited resources prioritize subsistence farming to ensure household food security.

The observed variation between small and marginal farmers in their approach to crop cultivation reflects broader themes in rural agrarian economies, particularly regarding food system resilience. The preference of small farmers for a mixed strategy (consumption and sale) aligns with global research emphasizing the economic benefits of market-oriented production. As Minot and Hill (2007) demonstrate, smallholder farmers who engage in markets and specialize in profitable crops tend to earn higher

incomes and achieve improved livelihoods. In the Dahod context, this is evident in the majority of small farmers opting to sell surplus produce, which supplements their income and supports their families' broader welfare.

Moreover, market integration offers an avenue for increased economic mobility. Households connected to local traders or mandis reported more consistent income flows and greater access to goods and services. However, market participation also presents challenges. Field observations and respondent narratives revealed that many farmers face unstable pricing, delayed payments, and dependency on middlemen, which often diminishes the profitability of crop sales. These challenges are particularly acute for marginal farmers, who may not have sufficient produce to negotiate better prices or absorb financial shocks.

On the other hand, the emphasis on subsistence cultivation among marginal farmers underscores the importance of household food security as a resilience strategy. For these households, retaining produce especially staple grains is critical for survival, particularly during lean seasons or periods of market disruption. Study noted that while commercialization can enhance dietary diversity, self-consumption ensures basic nutritional adequacy when market access is unreliable or insufficient Ogutu et al. (2017).

The importance of adopting a dual strategy cultivating for both household needs and market sale also emerged as a key insight from the study. Such a mixed approach enables smallholders to diversify risk, stabilize incomes, and strengthen food system resilience. This finding is reinforced by Bui et al. (2021), who advocate for short supply chains and localized food systems as mechanisms to protect farmers from external shocks and improve livelihood sustainability.

National-level data further contextualize these findings. The 2023 survey by the Development Intelligence Unit, covering over 6,000 marginal farmers across India, revealed that 68.65% had sold crops or agricultural by-products, with average annual sales reaching Rs. 60,510 and median sales at Rs. 40,000. This indicates both participation in markets and variability in income levels among marginal farmers. These figures highlight that while many marginal farmers do engage in sales, the income generated is often modest and uneven, pointing to the need for targeted support in infrastructure, pricing mechanisms, and farmer capacity-building.

In summary, the differences in crop cultivation objectives between small and marginal farmers reflect the interplay of land access, resource availability, and risk management strategies.

4.4 Primary Farming Income and Total Household Income

Primary **Farming Income** is the **net income** a household earns from agricultural activities after deducting farming costs.

$$\text{Primary Farming Income} = \text{Total Farming Revenue} - \text{Total Farming Costs}$$

Total income is derived by adding **primary farming income**, **secondary income**, and **income from other household members**. The calculation of total income provides insights into the financial health of farming households and their reliance on various sources of income.

Total income= Primary Farming Income + secondary income + another household income

The results show a distinct difference in the total income of small and marginal farmers:

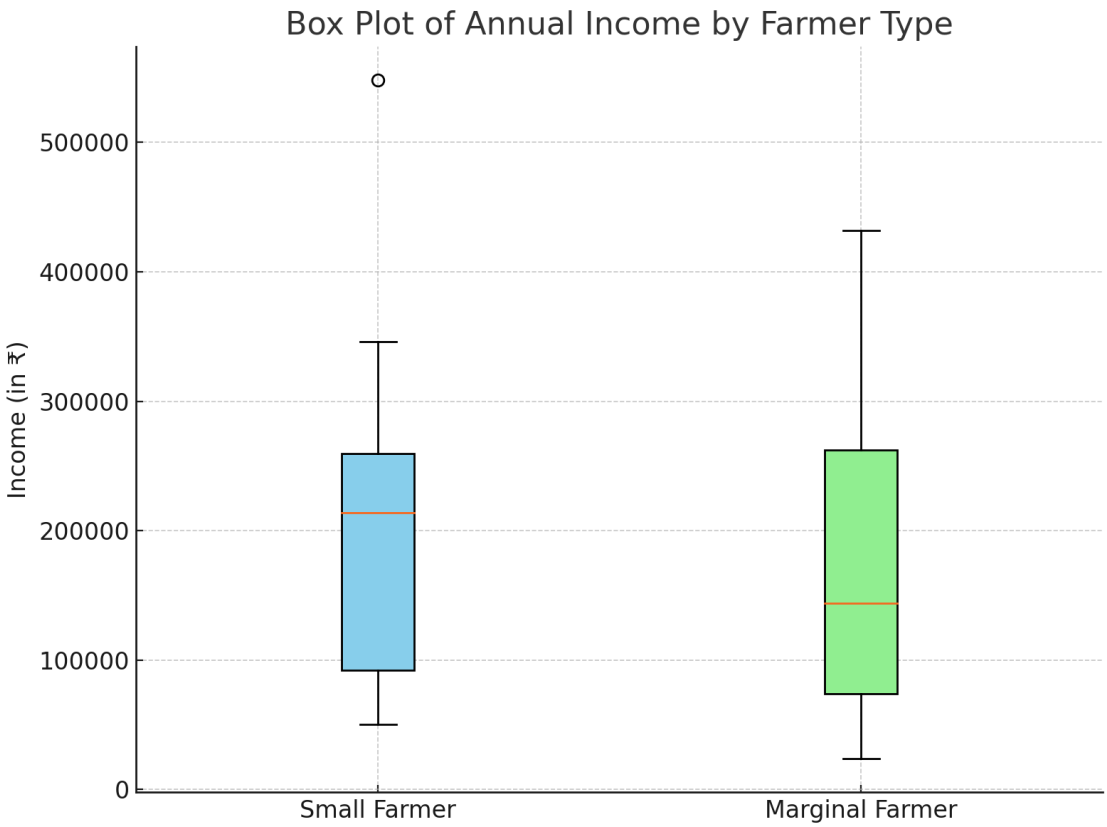

Figure: 4.4.1 Comparison of Annual Income Distribution Between Small and Marginal Farmers

The box plot displays the distribution of annual income for small and marginal farmers. For small farmers, the median income is visibly higher than that of marginal farmers, indicating a central tendency toward higher earnings. The interquartile range (IQR), represented by the width of the box, is also larger for small farmers, suggesting more variability in income within this group. The whiskers extend from the lower to the upper adjacent values, showing the range within 1.5 times the IQR. In the case of small farmers, the whiskers are longer, indicating a wider spread of data points. The marginal farmers show a more compact box with shorter whiskers, reflecting more consistency but lower

income levels. Outliers, if any, appear as individual points beyond the whiskers and represent extremely high or low incomes. Overall, the box plot suggests that small farmers not only tend to earn more annually than marginal farmers but also experience greater income variability.
The box plot compares annual incomes of small and marginal farmers. For small farmers, the median income is ₹2,14,000, which is higher than that of marginal farmers, whose median income is ₹1,44,000. The interquartile range (IQR) for small farmers extends from ₹92,400 (Q1) to ₹2,59,450 (Q3), showing a wide spread in income. This indicates that 50% of small farmers earn between ₹92,400 and ₹2,59,450 annually. In contrast, marginal farmers have an IQR from ₹73,750 to ₹2,62,500, which also shows variability but with a slightly lower central tendency.

The minimum income among small farmers is ₹50,000, and the maximum is ₹5,48,000, indicating a broad range of income levels. For marginal farmers, the minimum income is ₹24,000, and the maximum is ₹4,32,000. The whiskers in the box plot extend from the lower to upper adjacent values within 1.5 times the IQR, capturing most of the income data. Outliers, if present, lie beyond these whiskers and may indicate unusually high- or low-income cases.

Overall, the plot suggests that while both groups show income variability, small farmers tend to earn more annually and have a wider range of income compared to marginal farmers. These differences suggest that while small farmers generally earn more, their income is also more variable. This is due to diversified income strategies, engagement in higher-value crops. Marginal farmers, on the other hand, operate within narrower financial margins, due to limited land, fewer productive assets.

This pattern reflects broader rural income dynamics. In Zambia, crop income continues to dominate rural household earnings (Mofya-Mukuka & Hichaambwa, 2018). However, over-reliance on farming as a sole income source can increase vulnerability due to its exposure to environmental shocks, market volatility, and seasonal changes. Multiple studies affirm that income diversification can significantly reduce poverty vulnerability. In Indonesia, income diversification showed a strong negative correlation with poverty vulnerability, with a correlation coefficient of −0.60 (Polimango et al., 2025). In Ghana, households engaged in both farm and non-farm activities reported higher consumption expenditure and per capita income compared to those relying solely on agriculture (Senadza et al., 2018). These findings support the idea that while small farmers may have higher income potential, both groups benefit from diverse livelihood strategies to enhance financial resilience.

4.5 Asset

The data for small and marginal farmers was analysed based on three key variables: number of farm machinery, livestock count, and the presence of storage facilities.

Table 4.5 Distribution of Farm Machinery, Livestock, and Storage Facilities by Farmer Type

Type of farmer	Number farm machinery	Livestock Count	Storing facility
Small farmer	0.67 ± 0.78	4.75 ± 1.76	0
Marginal farmer	0.25 ± 0.45	2.332.42	0

a. Farm Machinery

The analysis of farm machinery ownership among small and marginal farmers revealed notable disparities and low levels of mechanization. The mean number of farm machinery owned by small farmers was 0.67 ± 0.78, indicating that, on average, small farmers possess less than one unit of machinery. The relatively high standard deviation suggests a wide variation among respondents: while some farmers may own multiple machines, others own none at all.

In contrast, marginal farmers reported a mean ownership of only 0.25 ± 0.45, underscoring a very limited access to mechanized tools. Once again, the high standard deviation indicates variability, but the overall low mean demonstrates that the majority of marginal farmers rely either on shared machinery, rental services, or manual labor.

Comparatively, small farmers own more machinery than marginal farmers, but both categories fall short of the levels required for meaningful mechanization of agricultural processes. The limited access to machinery can significantly affect labour efficiency, timeliness of agricultural operations, and overall productivity. During peak seasons such as sowing or harvesting, these limitations may exacerbate labor shortages and increase operational costs.

Farm assets, particularly machinery and equipment, are instrumental in improving the efficiency and sustainability of agricultural practices. Empirical evidence supports that mechanization enhances productivity and profitability. For instance, Ma et al. (2018) found that the use of agricultural machinery in China not only increased maize yields but also reduced input costs, especially in agrochemical usage. Similarly, Mohanty et al. (2024) emphasized the role of mechanization in resource conservation, including the efficient use of water and fertilizers, contributing to sustainable agricultural development.

However, for small and marginal farmers, the adoption of modern machinery is constrained by several factors, including high upfront costs, limited access to credit, lack of awareness or training, and landholding fragmentation. Without intervention, these constraints can further widen productivity gaps between mechanized and non-mechanized farmers.

b. Livestock count

The analysis revealed a notable difference in livestock ownership between small and marginal farmers. The mean livestock count for small farmers was 4.75 ± 1.76, suggesting that on average, small farmers own approximately five animals. The relatively moderate standard deviation indicates some variation in ownership levels, with a few farmers owning more or fewer animals than the mean.

In contrast, marginal farmers reported a mean livestock count of 2.33 ± 2.42, which is significantly lower than that of small farmers. The high standard deviation among marginal farmers suggests a wider disparity, with some farmers owning no livestock at all, while others manage a few animals. This disparity may reflect differences in access to resources such as land, capital, fodder, and labor.

These findings indicate that small farmers own significantly more livestock than marginal farmers, and that livestock ownership may be closely tied to landholding size and financial capacity. Livestock serves not only as a supplementary income source but also as an essential resilience asset in rural agrarian livelihoods. Particularly in times of crop failure or seasonal unemployment, livestock can act as a buffer, offering alternative income through milk production, manure, draught power, or sale of animals.

The variability in livestock ownership also underlines the inequality in agricultural resource distribution. Marginal farmers, with limited assets, may find it difficult to invest in animal husbandry due to constraints such as lack of shelter space, feed, veterinary care, or financial support.

According to Baird and Little (2002), effective livestock management directly influences a farm's productivity and financial performance, as it enhances both production efficiency and market competitiveness. Livestock is not only a productive asset but also a crucial part of comprehensive farm management strategies that can stabilize income and build resilience against shocks.

c. Storage facility

None of the small or marginal farmers in the sample had access to a storing facility. This indicates a lack of infrastructure for the storage of harvested crops or livestock, which could lead to post-harvest losses or difficulties in managing produce effectively.

The absence of storing facilities for both small and marginal farmers is a significant concern. Without proper storage infrastructure, farmers are at risk of losing a portion of

their harvested produce due to spoilage, pests, or inadequate storage conditions. This issue may exacerbate food insecurity, especially for farmers who rely on their harvest for both consumption and sale. The lack of storage facilities also limits farmers' ability to sell their produce at the optimal time, potentially reducing income and making them more vulnerable to price fluctuations. Investing in simple storage solutions could mitigate some of these challenges and help improve food security and farmers' resilience.

Implications for Agricultural Resilience:

The findings suggest that both small and marginal farmers face significant challenges in terms of infrastructure, machinery, and storage. These limitations can directly affect their ability to manage risks and improve productivity. While small farmers appear to have more assets and livestock on average, they still lack access to essential farm infrastructure that could improve their resilience to external shocks such as climate change, market volatility, or financial crises.

The lack of storing facilities is a particularly concerning issue, as it prevents farmers from maximizing their income and reduces their ability to respond to seasonal market fluctuations. Access to affordable storage, as well as farm machinery, could significantly enhance productivity, reduce post-harvest losses, and contribute to more sustainable livelihoods.

4.6 Availability and Utilization of Social Safety Net program

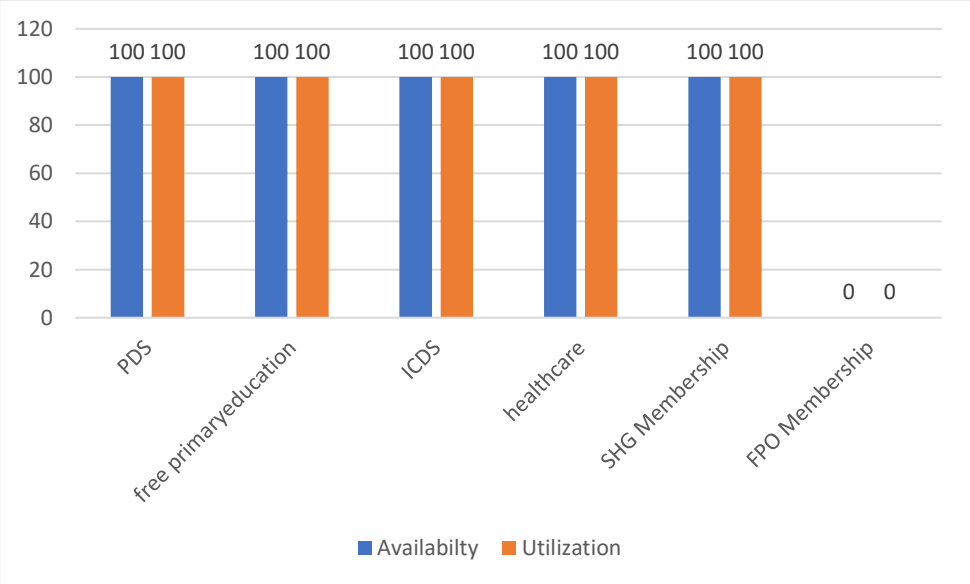

Figure 4.6 Availability and Utilization of SSN program

Figure 4.6 explored the availability and utilization of Social Safety Net (SSN) programs among 24 small and marginal farming households in Dahod district. The analysis reveals full availability (100%) and high utilization of key public welfare services such as:

- Public Distribution System (PDS)
- Free primary education
- Integrated Child Development Services (ICDS)
- Basic healthcare access
- Self-Help Group (SHG) membership

Interestingly, Farmer Producer Organization (FPO) membership showed 0% availability, indicating either a lack of functioning FPOs in the area or low awareness and mobilization.

Despite all listed programs being fully available to the respondents (except FPO), their utilization rates, although high, were slightly lower than availability, suggesting minor gaps. These could stem from factors like procedural hurdles, social barriers, or limited information dissemination.

The importance of social safety nets in enhancing resilience among smallholder farmers is well established. Programs like the PDS, ICDS, and education services have proven to buffer shocks related to food insecurity and income gaps (World Bank, 2014; FAO, 2018). Self-help groups (SHGs), such as *Sakhi Mandals*, play a dual role by offering both financial services and social empowerment (Banerjee et al., 2015).

However, access alone is insufficient. Studies show that utilization often depends on factors such as proximity, caste/gender dynamics, and service quality (Khera, 2011; Devereux & Sabates-Wheeler, 2004).

Farmer Producer Organizations (**FPOs)** are collective institutions formed by farmers to enhance **market access, bargaining power, input procurement, and income generation**. Figure 4.6 none of the respondents reported FPO membership, indicating a complete lack of availability and access to such institutions in the study area. This absence points to a missed opportunity in leveraging collective action for market access, input procurement, and enhanced farm incomes—particularly for small and marginal farmers.

Existing research strongly underscores the benefits of FPO membership. For instance, Gurung et al. (2023) found that FPO members in Northeast India earned ₹7,254–₹8,133 more in annual net returns compared to non-members, alongside improvements in return on investment and profit margins. Similarly, the Sahyadri Farmers Producer Company Ltd in Maharashtra illustrates how robust FPO structures can build social capital, lower transaction costs, and enhance sustainable livelihoods (Lalitha et al., 2022).

Moreover, FPOs serve not just as economic institutions but as platforms for social empowerment. They provide farmers with a collective voice to negotiate better prices,

access subsidies, and influence procurement policies. This is especially impactful for female-headed households and larger marginal farms, where vulnerabilities are often amplified (Gurung et al., 2023).

Given this, the absence of FPO access in the study villages may reflect institutional gaps, lack of awareness, or logistical barriers, and represents a critical area for policy intervention. Strengthening FPO promotion and farmer engagement could significantly contribute to building resilience, improving livelihood security, and enhancing bargaining power among vulnerable farming households.

4.7 Government Support related to agriculture

Government schemes play a critical role in enhancing agricultural resilience by offering financial assistance, credit support, risk mitigation tools, and infrastructural development. This study assessed farmer participation in major agricultural schemes such as PM-Kisan, Kisan Credit Card (KCC), PM Fasal Bima Yojana (PMFBY), Agriculture Infrastructure Fund (AIF), Soil Health Card, Pradhan Mantri Krishi Sinchayi Yojana (PMKSY), and Paramparagat Krishi Vikas Yojana (PKVY). The findings underscore key disparities in awareness, accessibility, and utilization across schemes and between farmer categories.

4.7.1 Awareness and Utilization of Government Support related to agriculture

As illustrated in the accompanying figure, PM-Kisan emerged as the most recognized and widely utilized scheme, with nearly 90% awareness and over 80% actual participation among the respondents. This reflects the scheme's strong institutional outreach and user-friendly implementation, particularly its direct benefit transfer mechanism and minimal eligibility constraints.

In contrast, schemes like the Kisan Credit Card (KCC), Soil Health Card, and PM Fasal Bima Yojana (PMFBY) revealed moderate levels of awareness (approximately 20%) but much lower utilization rates. This gap between knowledge and participation suggests systemic issues such as bureaucratic hurdles, inadequate field-level guidance, or limited perceived benefits by the farmers.

Schemes such as the Agriculture Infrastructure Fund (AIF), PMKSY, and PKVY showed both low awareness and negligible enrollment, indicating either weak outreach mechanisms or limited applicability to the needs of small and marginal farmers. This underlines a pressing need for more targeted communication and simplification of procedural norms.

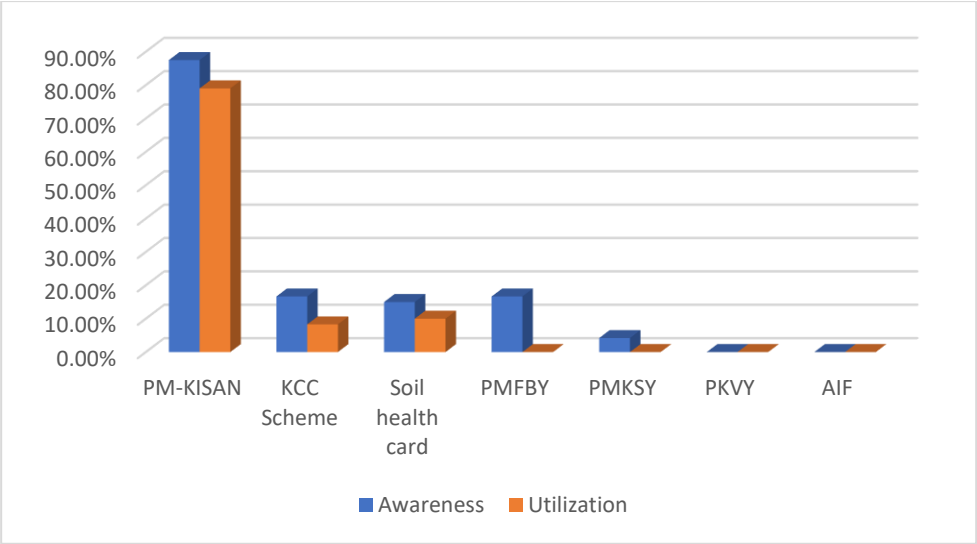

Figure 4.7.1: Awareness and Utilization of Government Schemes among Farmers

4.7.2 Utilization of Government schemes

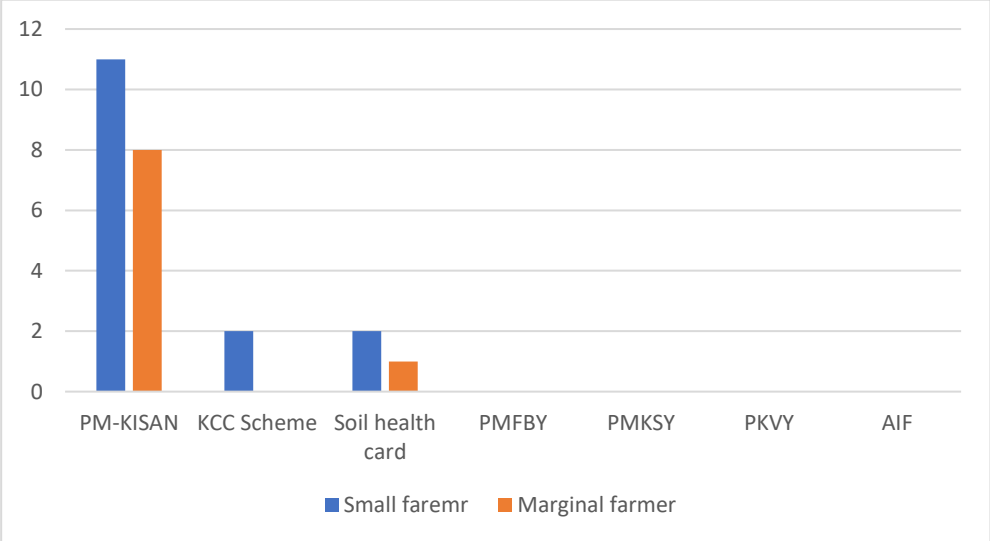

Figure 4.7.2 Utilization of Government schemes by farmers

A comparison between small and marginal farmers reveals notable disparities in the participation levels across government agricultural schemes. Among the programs assessed, PM-Kisan exhibited the highest enrollment, with 11 small farmers and 8 marginal farmers benefitting from the scheme. This indicates that PM-Kisan is relatively more accessible and widely adopted due to its direct benefit transfer mechanism and minimal eligibility constraints. In contrast, participation in the Kisan Credit Card (KCC) scheme was minimal, with only 2 small farmers enrolled and no marginal farmers participating. This could be attributed to procedural complexities, lack of awareness, or challenges faced by marginal farmers in accessing formal credit institutions. Alarmingly,

no farmers from either category were enrolled in schemes such as the PM Fasal Bima Yojana (PMFBY), Agriculture Infrastructure Fund (AIF), Pradhan Mantri Krishi Sinchayi Yojana (PMKSY), Paramparagat Krishi Vikas Yojana (PKVY), or PM-KMY, indicating a major shortfall in outreach and relevance at the grassroots level.

These trends suggest that small farmers may have slightly better access to institutional mechanisms, possibly due to comparatively larger landholdings or better integration with local agricultural networks. Marginal farmers, despite their greater vulnerability due to limited land and financial constraints, remain significantly underserved. This reflects a serious gap in policy reach and effectiveness, particularly in addressing the needs of those most at risk.

4.7.3 Challenges faced by Farmers

Several barriers contribute to the low participation in these schemes, especially in credit and insurance-based programs. Complex application procedures often deter farmers from applying, while low financial literacy especially among marginal farmers hinders their ability to understand and navigate the process. Delays in disbursement and inadequate follow-up from implementing agencies further discourage participation. Moreover, the lack of trust in schemes like possibly due to delayed or denied claims in previous cycles, undermines farmer confidence and engagement. These challenges have led many farmers to continue relying on informal mechanisms, thereby limiting the transformative potential of formal government support programs.

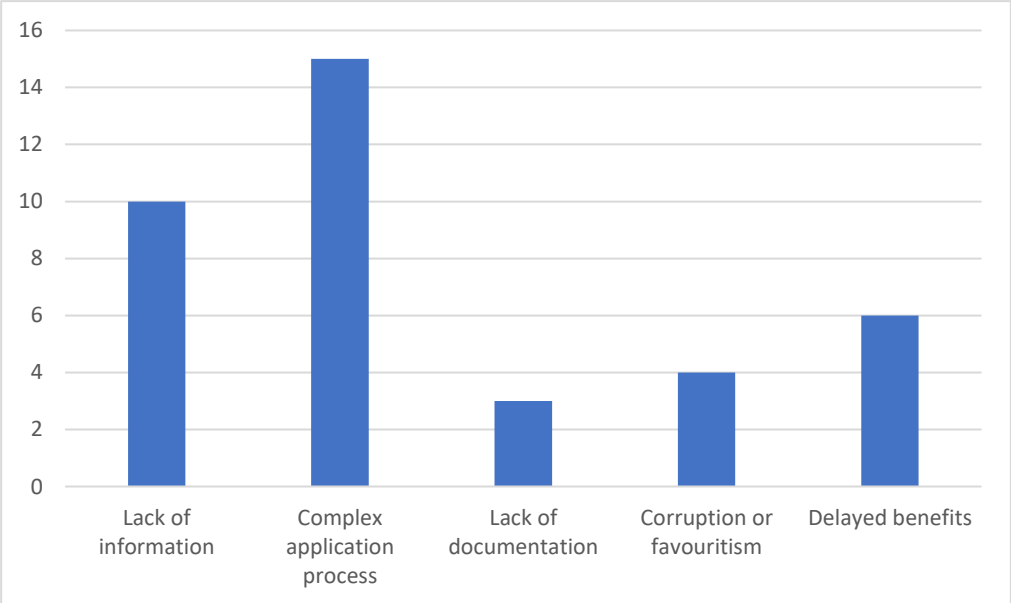

Figure 4.7.3 Challenges faced by Farmers to avail government scheme

Despite these participation challenges, government schemes have demonstrated a positive influence on the rural economy and agricultural sustainability when accessed effectively. The PM-Kisan scheme, by providing predictable and unconditional financial support, has helped farmers maintain basic economic stability during lean seasons

(Kumar, 2024). The KCC initiative, though underutilized, has the potential to enable timely investment in agricultural inputs such as seeds and fertilizers (Kumar et al., 2023). PMFBY, though not widely trusted, is designed to offer critical protection against crop failure due to natural calamities (Rudramuni & Venkatesh, 2024). Similarly, the Soil Health Card scheme promotes informed fertilizer usage, leading to improved soil fertility and reduced input costs (Kumar et al., 2023). Infrastructure-oriented schemes such as the AIF and PMKSY aim to enhance long-term productivity through better post-harvest infrastructure and irrigation facilities, though their impact is limited by poor awareness and uptake among smallholders (Kumar et al., 2023).

4.8 Household food consumption patterns

4.8.1 Food Consumption Score (FCS) of farmers

The Food Consumption Score (FCS) assesses dietary diversity, food frequency, and the nutritional significance of various food groups consumed over a week. It is determined by classifying food items into specific categories, summing their consumption frequencies, and assigning weights according to their nutritional value. Based on the final score, households are classified into three consumption levels: poor, borderline, and acceptable.

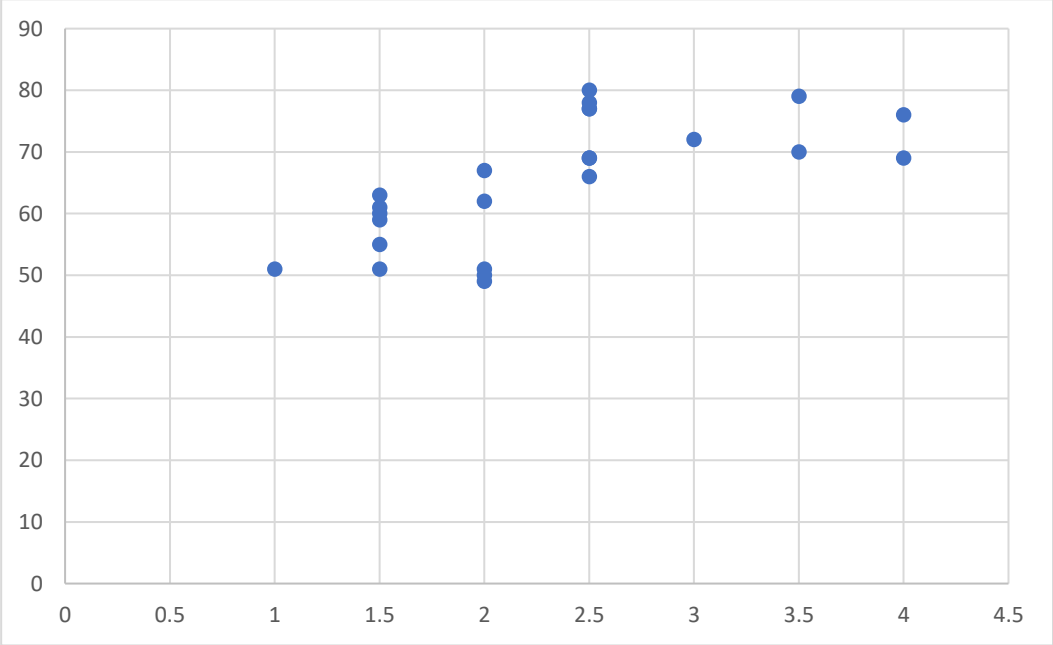

Figure 4.8.1 Relationship Between Land size and Food Consumption Score

Figure 4.8.1 illustrates the relationship between land size and the Food Consumption Score (FCS). Overall, the graph shows a positive trend, suggesting that as land size increases, the FCS also tends to rise. Households with larger land sizes generally have higher food consumption scores, indicating better food security and possibly greater access to diverse and sufficient food sources. While there is noticeable variability in FCS scores among households with smaller land sizes (between 1 to 2 acres), the scores become more consistent and higher typically ranging from 70 to 80 as land size increases beyond 2.5 acres. However, some exceptions exist, where households with smaller plots still maintain relatively good food consumption, hinting that other factor such as farming practices, crop diversity, or alternative income sources may also play a role. In summary, the graph suggests a positive association between land ownership and food security, with land size being an important, though not the only, factor influencing dietary outcomes.

4.8.2 Contribution of Food groups to Food Consumption Score among farmers

Cereals exhibit the highest Food Consumption Score (FCS) values (7) across all households for both small and marginal farmers, reflecting their consistent and frequent consumption. As a staple food group, cereals contribute substantially to the overall FCS. However, variations in FCS between small and marginal farmers are primarily influenced by differences in milk and pulse consumption, with small farmers benefiting from a higher intake of dairy products.

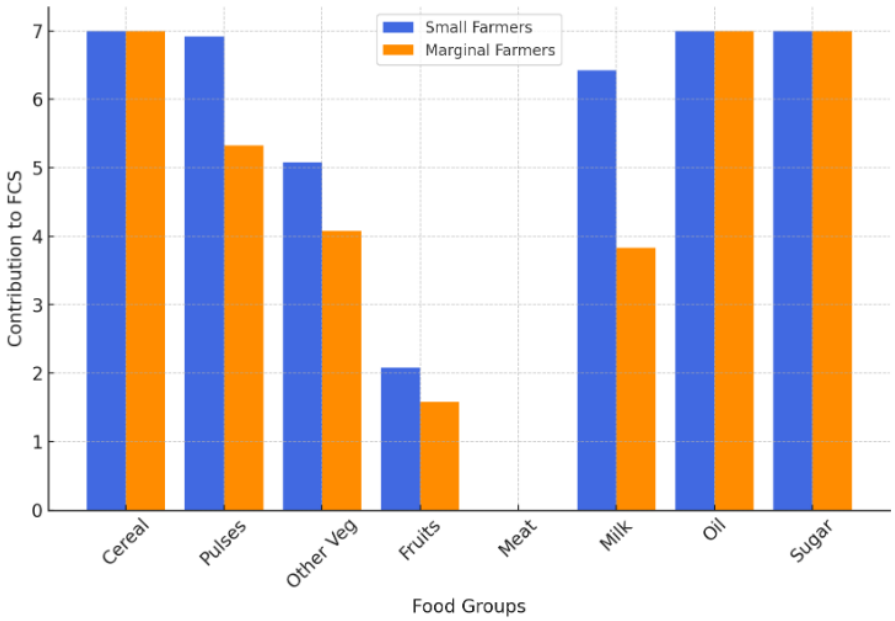

Figure 4.8.2 Contribution of different food groups to FCS

4.8.3 Total grain and Food Consumption Score

While **Food Consumption Score** reflects food access and consumption patterns, it is crucial to examine the factors influencing these scores, particularly the role of food safety net programs. In this analysis, the total food grains obtained from the Public Distribution System (PDS) and farm produce is assessed to determine its relationship with household FCS. Understanding this relationship provides insights into the extent to which subsidized food distribution and self-produced food contribute to dietary adequacy and resilience among small and marginal farmers

Table 4.8 Correlation Between Total grain and FCS Using Pearson's r and Spearman's ρ

Correlation Test	Correlation Coefficient	Significance (p-value)
Pearson's r	0.828	< 0.001
Spearman's ρ (rho)	0.795	< 0.001

As presented in Table 4.8, correlation analysis using both Pearson's r and Spearman's ρ revealed a very strong positive association between total grain availability and FCS. The Pearson's correlation coefficient was $r = 0.828$ ($p < 0.001$), and Spearman's rho was $\rho = 0.795$ ($p < 0.001$), indicating a statistically significant and robust linear and monotonic relationship, respectively. These results imply that as households gain greater access to food grains either through PDS entitlements or own agricultural production their dietary diversity and consumption quality improve correspondingly.

This strong correlation underscores the pivotal role of both public provisioning systems and farm-level food production in ensuring nutritional security. The findings align with existing literature that highlights how consistent access to staple foods significantly improves food consumption indicators and contributes to food system resilience at the household level.

The relationship between food consumption and household productivity is particularly relevant in rural, agrarian settings. Higher FCS, which signals improved dietary quality and diversity, has been positively correlated with increased labor productivity among smallholder farmers (Berha et al., 2021). This link is more pronounced in households with initially low FCS, indicating that improvements in nutrition can help break the cycle of undernutrition and low productivity.

In these low-consumption households, enhanced access to food through both subsidized and self-produced sources can lead to better energy levels, cognitive function, and work efficiency, thereby influencing overall farm productivity and livelihood outcomes.

The strong positive relationship between total grain availability and FCS reinforces the relevance of integrated approaches in food security strategies. Ensuring access to

affordable grains through the PDS and supporting smallholder production systems can significantly enhance dietary quality and household resilience. Furthermore, policies that consider the nutrition-productivity nexus particularly for vulnerable and low-consumption groups can amplify the long-term developmental outcomes of food safety nets. Farmers who rely on their own agricultural production for food tend to achieve greater nutrient adequacy than those dependent on market-bought foods, which are often high in calories but low in essential nutrients (Deaconu et al., 2021). Implementing agroecological practices that encourage the cultivation of a variety of crops can further improve Food Consumption Scores (FCS) and strengthen the overall nutritional status of farming households.

In conclusion, improving food access through public distribution and promoting household-level food production emerges as a key strategy to enhance food system resilience, nutritional well-being, and farm productivity among small and marginal farmers.

4.8.4 Food Insecurity Experience Scale (FIES)

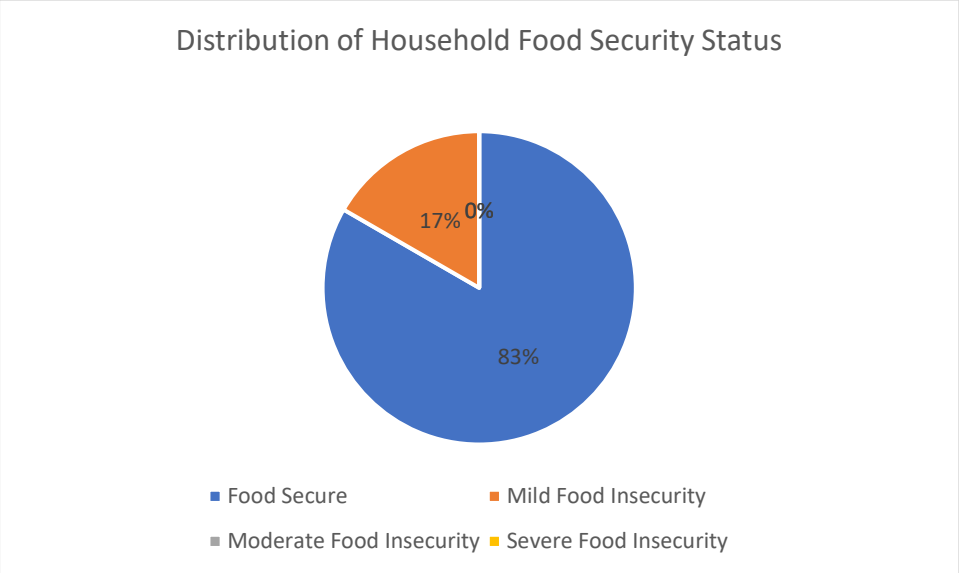

Figure 4.8.3 Distribution of Household Food Security Status

The figure 4.8.3 presents the distribution of food insecurity levels among the surveyed households based on the Food Insecurity Experience Scale (FIES). The majority of households are categorized as food secure, indicating that they did not face any significant issues related to food access or availability during the reference period. A smaller proportion of households experienced mild food insecurity, meaning they may have occasionally worried about food or compromised on quality, but did not face serious deprivation. Notably, no households were classified under moderate or severe food insecurity, suggesting that extreme forms of food access limitations were not present in the sample. Overall, the analysis indicates a generally stable food security

situation, with only a small segment of the population requiring attention for early signs of vulnerability. The figure presents the distribution of food insecurity levels among the surveyed households based on the Food Insecurity Experience Scale (FIES). The majority of households are categorized as food secure, indicating that they did not face any significant issues related to food access or availability during the reference period. A smaller proportion of households experienced mild food insecurity, meaning they may have occasionally worried about food or compromised on quality, but did not face serious deprivation. Notably, no households were classified under moderate or severe food insecurity, suggesting that extreme forms of food access limitations were not present in the sample. Overall, the analysis indicates a generally stable food security situation, with only a small segment of the population requiring attention for early signs of vulnerability.

Food security among farmers is shaped by a complex interplay of socio-economic, environmental, and technical factors. The present study underscores that households experiencing food security are more likely to engage in commercial farming, possess farming skills, utilize diverse cropping systems, and have better access to agricultural resources. Farmers who rely on commercial farming exhibit greater food security compared to those practicing subsistence agriculture. As noted by Nkoko et al. (2024), income diversification through market-oriented farming enables households to access a broader range of food items, improving both dietary diversity and overall nutrition. In contrast, households dependent solely on subsistence farming face challenges in buffering against crop failures or seasonal shortages, making them more prone to food insecurity.

Crop diversity plays a pivotal role in food availability and dietary adequacy. Access to high-quality seeds and the cultivation of a range of crops including vegetables, pulses, and fruits enhances not only yield stability but also micronutrient intake (Gebrehiwot et al., 2024). Food secure households often benefit from diversified cropping systems, while food insecure households are frequently limited to staple grains due to lack of resources or knowledge.

4.9 Resilience Index Construction and validation

Principal Component Analysis (PCA)

Table 4.9.1: Principal Component Analysis (PCA) Results for Different Pillars

Pillar	Standard Deviation (PC1)	Proportion of Variance Explained
Asset	1.4922	55.66%
Access to Basic Services	1.465	42.90%
Social Safety Net	1.6783	56.34%
Adaptive Capacity	1.4826	43.96%

Principal Component Analysis (PCA) was conducted individually for each of the four pillars of resilience Asset (AST), Access to Basic Services (ABS), Social Safety Nets (SSN), and Adaptive Capacity (AC) with the objective of reducing multiple indicators within each pillar into a single, representative component score. PCA transforms the original correlated indicators into a new set of uncorrelated components, ordered by the amount of variance they explain in the data. The first principal component (PC1) captures the maximum possible variance and is commonly used as a composite score when the purpose is data reduction.

In this analysis, the standard deviation of PC1 and the proportion of variance it explains were examined for each pillar. The variance explained by PC1 reflects the percentage of total information retained from the original indicators. It indicates how well the new component represents the variation in the underlying data. A higher percentage of variance explained suggests that a greater amount of the original information is captured in the component score, thus improving the reliability and interpretability of the summary measure.

The proportion of variance explained by PC1 was 55.66 percent for the Asset pillar, 42.90 percent for ABS, 56.34 percent for SSN, and 43.96 percent for AC. These values indicate that more than 40 percent of the total variation in the original indicators of each pillar is successfully retained in the respective PC1. In the context of social science research, where constructs are often complex and influenced by multiple interacting variables, a variance explained above 40 percent is generally considered acceptable. The relatively high values observed for the Asset (AST) and SSN pillars suggest that the indicators within those dimensions are well-aligned and internally consistent, making the composite scores derived from PC1 reliable summaries of household characteristics in those areas. The slightly lower values for ABS and AC suggest that while those indicators are still informative, they may reflect more diverse or weaker relationships among variables.

Overall, the PCA results demonstrate that the selected indicators within each pillar were appropriate for dimensional reduction, and the extracted PC1 scores provide a statistically sound basis for constructing composite indices. These scores were subsequently used to calculate the overall Resilience Index by averaging the four pillar scores. The relatively strong proportion of variance explained across all pillars supports the validity of using PCA as a method to quantify household resilience in the study context.

Construction of the Resilience Index

After deriving standardized pillar scores through Principal Component Analysis (PCA) for the four dimensions Asset (AST), Access to Basic Services (ABS), Adaptive Capacity (AC), and Social Safety Nets (SSN) a composite Resilience Index was constructed. This was achieved by calculating the simple arithmetic mean of the four PCA-based scores for each household. The formula used was:

Resilience Index as the average of the four PCA scores:

Resilience index = (Asset score + ABS score + AC score + SSN score) / 4

Categorization into Resilience Levels

To facilitate interpretation and policy relevance, households were grouped into three categories based on their composite Resilience Index scores: Low, Medium, and High resilience. This classification was carried out using tertile-based cut-offs, dividing the households into approximately equal groups according to their index values.

The distribution of households across these categories was as follows: 9 households (34.6 percent) were classified as having Low resilience, 8 households (30.8 percent) as medium resilience, and 9 households (34.6 percent) as High resilience. A bar plot was generated to visually represent this distribution (Figure 4.9.1)

This categorization helps in understanding not just the relative position of households in terms of resilience, but also in identifying specific groups that require focused intervention. Households in the Low resilience category may be characterized by limited access to resources, fewer coping strategies, and weaker social safety nets, making them more vulnerable to shocks. Conversely, households classified as High resilience are more likely to possess the means and flexibility to withstand and recover from adverse events. Medium resilience households may fluctuate depending on context-specific shocks or stressors and represent a crucial group for preventative interventions.

By converting continuous scores into discrete categories, the resilience level classification offers a practical tool for planners and development practitioners to prioritize resources, design tailored programs, and monitor progress in enhancing community resilience over time.

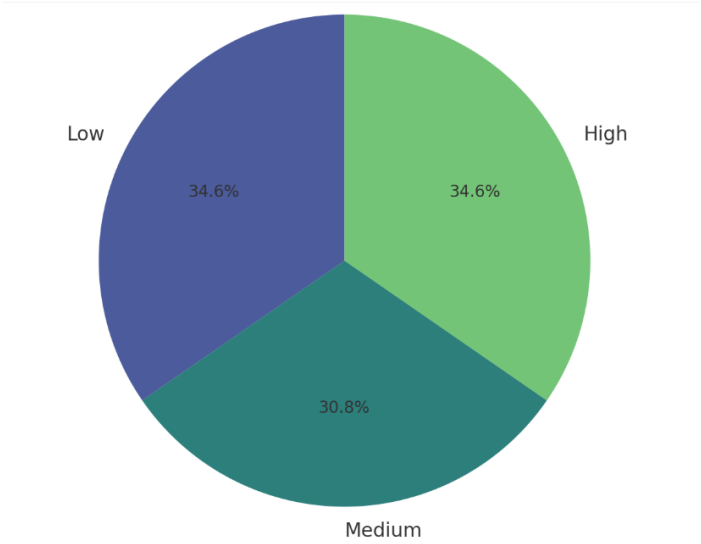

Figure 4.9.1 Distribution of households by Resilience Level

4.9.3 Exploratory Factor Analysis (EFA)

Exploratory Factor Analysis (EFA) was conducted to assess whether the four PCA-derived pillar scores Asset, Access to Basic Services (ABS), Adaptive Capacity (AC), and Social Safety Nets (SSN) reflect a single underlying construct representing household resilience. The analysis was based on maximum likelihood extraction with one-factor solution, in line with the conceptual assumption that resilience is a latent variable manifested through multiple dimensions.

4.9.4 Factor Loadings and Communalities

Table 4.9.2 Factor Analysis Results: Loadings, Communality, and Uniqueness of Different Pillars

Pillar	Loading (ML1)	Communality (h^2)	Uniqueness (u^2)
Asset Score	0.81	0.656	0.34
ABS Score	-0.22*	0.051	0.95
AC Score	-0.86*	0.745	0.25
SSN Score	0.63	0.400	0.60

**A negative loading does not indicate a negative influence but rather a reverse direction of association. The strength of the relationship remains valid.*

The factor loadings indicate the strength and direction of the relationship between each pillar and the underlying resilience factor. The Asset Score showed a strong positive loading of 0.81, suggesting it contributes significantly to the resilience construct. Similarly, Adaptive Capacity (AC) had a strong loading of -0.86. Although the sign is negative, this does not indicate a negative influence, but rather an inverse relationship in the direction of variation. The Social Safety Net (SSN) score also showed a meaningful loading of 0.63, indicating a moderate contribution. In contrast, the ABS Score had a very low loading of -0.22, indicating a weak association with the resilience factor.

Communalities (h^2) represent the proportion of variance in each variable explained by the common factor. The highest communality was observed for AC (0.745), followed by Asset (0.656) and SSN (0.400), indicating that a large portion of the variance in these scores is captured by the resilience factor. ABS had a very low communality (0.051), suggesting that it contributes very little to the underlying factor and may be weakly connected to the overall resilience construct in this context.

The uniqueness values (u^2), which represent the proportion of variance not explained by the common factor, were highest for ABS (0.95), further confirming its limited alignment with the resilience construct. Asset and AC had relatively low uniqueness values (0.34 and 0.25, respectively), reinforcing their strong explanatory power.

Overall, the factor analysis supports the conceptualization of resilience as a single latent construct predominantly shaped by Asset, AC, and SSN dimensions. The findings also indicate that the ABS dimension, as currently measured, may not be a strong component of resilience and may require refinement in future assessments or inclusion of additional indicators.

Model Fit Statistics

To assess the adequacy of the one-factor model representing household resilience, several model fit indices were examined. These fit measures help determine whether the factor model accurately captures the relationships among the observed variables (pillar scores) without overfitting or underfitting the data

Table 4.9.3 Model Fit Statistics and Interpretation

Fit Measure	Value	Interpretation
RMSEA	0.00	Excellent fit
Chi-square (p)	0.61	Model is a good fit (not rejected)
RMSR	0.05	Very low residuals
TLI	1.15	Excellent model reliability
BIC	-5.52	Model fit superior to null model

The Root Mean Square Error of Approximation (RMSEA) was 0.00, indicating an excellent fit of the model to the data. An RMSEA value below 0.05 is considered indicative of a close fit in structural equation modeling and factor analysis. The Chi-

square p-value was 0.61, suggesting that the null hypothesis of good model fit cannot be rejected; this supports the adequacy of the one-factor solution. The Root Mean Square Residual (RMSR) was 0.05, reflecting low average residuals between the observed and model-implied correlations, which further supports the model's suitability.

The Tucker-Lewis Index (TLI) was 1.15, which exceeds the commonly accepted threshold of 0.90 for good model reliability. A TLI value above 1 is uncommon and may occur in small samples with well-fitting models, reflecting very high explanatory power. The Bayesian Information Criterion (BIC) was -5.52, which is lower than that of the null model, indicating that the one-factor model provides a more parsimonious and better-fitting explanation of the data.

Overall, these fit statistics confirm that the one-factor model is statistically appropriate and provides a reliable representation of the underlying structure of household resilience as captured by the four pillar scores. The results support the interpretation of resilience as a latent construct emerging from key dimensions such as Asset, Adaptive Capacity, and Social Safety Nets.

4.9.6 Validation of Resilience Index Using Factor Analysis

To statistically validate whether the four PCA-derived pillar scores Asset, Access to Basic Services (ABS), Adaptive Capacity (AC), and Social Safety Nets (SSN) represent a single underlying construct of household resilience, both Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) were conducted. EFA was used as an initial step to uncover potential factor structures without predefined assumptions, while CFA was employed to formally test the one-factor structure based on theoretical expectations. This two-step approach strengthens the construct validity of the resilience index and supports its use for further analysis.

Difference Between Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA)

Exploratory Factor Analysis (EFA) is a data-driven technique used when the underlying factor structure is unknown. It helps identify how many latent factors may exist and how observed variables load onto them. In contrast, Confirmatory Factor Analysis (CFA) is theory-driven and used when the researcher has a predefined model of how variables should relate to one or more latent factors. CFA allows for formal testing of model fit, provides detailed fit indices, and helps validate hypothesized relationships between observed variables and latent constructs.

4.9.7 Confirmatory Factor Analysis (CFA) Results

CFA was conducted using the lavaan package in R, specifying a one-factor model of resilience based on the four PCA-derived pillar scores. The model fit was excellent as indicated by several key indices. The Chi-square test was non-significant ($\chi^2 = 0.080$, df = 2, p = 0.961), suggesting good model fit. The RMSEA value was 0.000, indicating perfect fit, and the SRMR was 0.011, showing minimal residuals. The Comparative Fit Index (CFI) was 1.000, and the Tucker-Lewis Index (TLI) was 1.270, both exceeding the standard thresholds for excellent fit. These results confirm the appropriateness of a single latent resilience factor.

Table: 4.9.4 Standardized Factor Loadings

Pillar	Standardized Loading	P-value	Interpretation
Asset	0.783	-	Strong positive contribution
ABS	-0.166	0.439	Weak and not statistically significant
AC	-0.896	0.001	Strong inverse relationship, significant
SSN	0.614	0.003	Moderate positive contribution

Table: 4.9.5 CFA Model Fit Indices

Fit Measure	Value	Interpretation
Chi-square (df=2)	0.080 (p=0.961)	Excellent fit
RMSEA	0.000	Excellent fit
SRMR	0.011	Very low residuals
CFI	1.000	Excellent fit
TLI	1.270	Excellent model reliability

The results of the CFA support the conceptualization of resilience as a single latent construct primarily shaped by Asset, Adaptive Capacity, and Social Safety Nets. ABS showed a weak and statistically non-significant relationship with the latent factor, consistent with earlier findings from EFA. Overall, the model demonstrates excellent statistical fit and confirms the validity of the composite resilience index constructed from the PCA-derived pillar scores.

4.9.8 Interpretation of Scatter Plots Between RIMA Dimensions and Resilience Index

To visually examine the association between each of the four RIMA pillars and the composite Resilience Index, scatter plots were generated with regression lines overlaying the data points. These plots provide an intuitive understanding of how individual pillar scores relate to overall household resilience levels.

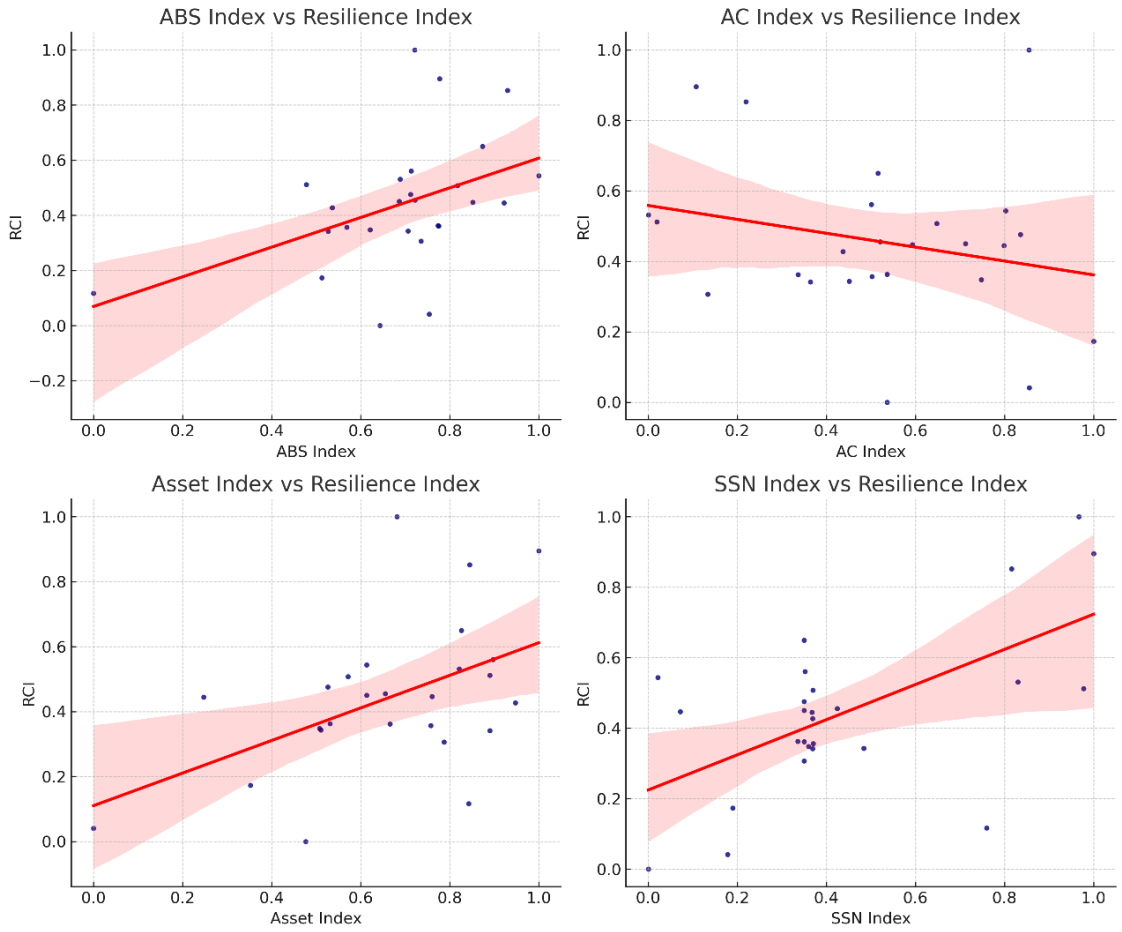

Figure 4.9.2: Interpretation of Scatter Plots Between RIMA Dimensions and Resilience Index

Asset Index vs Resilience Index

The scatter plot demonstrates a moderate positive association between the Asset Index and the Resilience Index. Households with higher asset scores generally show higher resilience levels, indicating that material wealth and access to productive resources contribute meaningfully to a household's capacity to withstand and recover from shocks.

Adaptive Capacity (AC) Index vs Resilience Index

A slight negative trend is observed in the relationship between AC and the Resilience Index. This is consistent with the factor analysis results where the AC score had a negative loading. This inverse relationship may suggest that in the study area, households with higher reported adaptive strategies may be those under greater stress or risk, thus engaging more in coping strategies out of necessity rather than opportunity.

Access to Basic Services (ABS) Index vs Resilience Index

The ABS Index shows a weak positive correlation with the Resilience Index. While the direction of the trend aligns with theoretical expectations, the scatter indicates considerable dispersion, suggesting that access to services alone may not be a strong predictor of resilience in this context possibly due to limited variability or uniformly poor access in the tribal area studied.

Social Safety Net (SSN) Index vs Resilience Index

A positive trend is evident between SSN scores and the Resilience Index. Households with stronger access to informal or formal social support mechanisms (such as government schemes, remittances, or community assistance) tend to report higher resilience scores. This highlights the role of social protection and community ties in enhancing resilience.

Overall, these visual relationships are consistent with the findings from PCA and factor analysis. Asset ownership and access to social support systems emerge as key dimensions contributing to household resilience, while the weaker or inverse relationships with ABS and AC highlight the need for context-specific evaluation of each pillar.

4.9.9 Determinants of Household Resilience Levels

Linear Regression: Pillar Contributions to Resilience Index

A linear regression model was fitted with the composite Resilience Index as the dependent variable and the four PCA-derived pillar scores Asset, Access to Basic Services (ABS), Adaptive Capacity (AC), and Social Safety Nets (SSN) as predictors. As expected, given that the index was calculated as the average of these four components, the model demonstrated a perfect fit ($R^2 = 1$), with each predictor contributing equally (coefficient = 0.25) and significantly ($p < 0.001$). While this confirms the structure of

the composite index, it does not provide insight into the relative explanatory power of each pillar. To explore this, one-way ANOVA was conducted.

ANOVA: Pillar Score Variation Across Resilience Categories

To determine whether the pillar scores differ significantly across households classified into Low, Medium, and High Resilience categories, one-way ANOVA tests were performed. The results are summarized below:

Table 4.9.6 ANOVA Results for Differences Across Pillars of Food System Resilience

Pillar	F-value	p-value	Interpretation
Asset Score	2.62	0.0945	Marginally significant difference
AC Score	1.23	0.312	No significant difference
SSN Score	4.04	0.0314	Significant difference
ABS Score	3.95	0.0336	Significant difference

The ANOVA results indicate that Social Safety Nets (SSN) and Access to Basic Services (ABS) scores vary significantly across resilience levels, with higher values generally associated with High Resilience households. Asset Score showed a marginal difference suggesting a possible trend, while Adaptive Capacity did not significantly vary across groups. These findings suggest that improved access to services and social protection programs may play a more immediate and visible role in differentiating household resilience levels in the tribal context of Dahod. The results complement factor analysis findings and help inform targeted interventions aimed at enhancing resilience.

This study aimed to assess household resilience in a tribal block of Dahod district using the FAO's Resilience Index Measurement and Analysis (RIMA) framework. A multi-dimensional approach was adopted to measure four key pillars: Asset, Access to Basic Services (ABS), Adaptive Capacity (AC), and Social Safety Nets (SSN). Principal Component Analysis (PCA) was used to reduce each pillar's indicators into a single representative score (PC1). These scores were then averaged to construct a composite Resilience Index for each household.

PCA results showed that all four resilience pillars had acceptable variance, with SSN and Asset contributing the most. Resilience Index scores were categorized into Low, Medium, and High, showing a balanced household distribution. EFA and CFA confirmed that Asset, AC, and SSN strongly represent the resilience construct, while ABS was weak, likely due to uniform access issues. Regression showed equal contribution from all pillars, but ANOVA revealed that SSN and ABS significantly differed across resilience levels, highlighting the importance of social protection and service access in this tribal context.

Overall, the analysis demonstrates that the RIMA framework can be effectively applied in tribal settings to measure and understand household resilience. The findings underscore the importance of strengthening access to social safety nets and services, alongside promoting asset creation and adaptive strategies. This study contributes to the literature by offering the first empirical application of RIMA in the Dahod tribal block and provides practical insights for policymakers and program implementers seeking to enhance resilience in vulnerable rural communities.

The ABS dimension, while theoretically important, showed weaker internal coherence, explaining only 39.65% of the variance. Indicators like access to drinking water, healthcare, and transportation exhibited limited variability across households, likely due to the uniformly poor infrastructure in the region. This pattern is consistent with studies in similar tribal geographies where deprivation is widespread, thereby limiting the ability of service access to act as a differentiating factor in resilience (Verma et al., 2021).

Adaptive Capacity had the lowest explained variance (34.01%) and was notable for its negative path coefficient (-0.416) in the Confirmatory Factor Analysis (CFA). Indicators such as livelihood diversification, use of improved farming practices, and decision-making involvement showed moderate factor loadings (ranging from 0.563 to 0.602), but the negative association suggests that these behaviors may be stress-induced responses rather than signs of empowerment. This reflects a broader concern in resilience research where adaptive actions in vulnerable settings often emerge from necessity rather than strategic planning (Béné et al., 2016).

Study done in Ethiopia shows household resilience to food insecurity was measured using the RIMA. Each of the latent pillars was estimated using factor analysis. The factor

analysis shows that the most important variables for household resilience are access to market (ABS), income diversification (AC), land size (AST), and formal cash transfers (SSN). These variables had the highest factor loadings in their respective dimensions, indicating they play a key role in strengthening household capacity to cope with shocks and improve livelihood resilience (Mossie et al, 2024).

4.10 Qualitative analysis

Table 4.10.1 Key Parameters of Focus Group Discussions

Parameter	Description
Number of FGDs conducted	3
Target population	Marginal farmers – 2 FGDs Small farmers – 1 FGD
Geographic location	Villages – Abhlod & Dadur, Garbada Taluka, Dahod District, Gujarat, India
Participant selection criteria	Participants were selected using purposive sampling based on their involvement in agriculture and availability during the discussion period.
Number of participants per FGD	6 participants per group
Age range of participants	25 to 55 years
Languages used	Gujarati
Moderators and note-takers	Rosemary Mondal
Date and duration	Each FGD lasted approximately 30–60 minutes and was conducted on 02/03/2025
Ethical considerations	Informed consent was obtained. Confidentiality and voluntary participation were ensured. Audio recordings were made with permission.

Thematic summary of FGD Responses (Group 1: Marginal farmer)

Table 4.10.2 Key Themes and Illustrative Quotes

Theme	Frequency	Summary Insight	Example Quote
Access to Services	3	Some households face difficulty accessing government support.	If there is any help given by the government to the farmers we are happy to accept but the due to access paperwork we hesitate to go to bank.
Crop Preference	9	White maize is preferred over yellow due to taste and satiety.	In this area both White maize and yellow maize are grown but only white maize is preferred.
Livelihood Challenges	2	Seasonal work and migration affect income stability.	Yes during summer we dont do farming thus, we have to go for daily wage work. If we get good job then we have good income.
Other	25	Responses that did not clearly fall under the main themes.	We eat bajra sometimes when it is provided from the control
Role of Women	7	Women contribute significantly to agriculture but lack recognition.	all works are done by female only

Triangulation of Themes Using Latent Dirichlet Allocation and Key Word In Context

A triangulated thematic analysis was employed, integrating both Latent Dirichlet Allocation (LDA) topic modeling and Keyword-in-Context (KWIC) analysis to ensure a comprehensive understanding of the qualitative data obtained from FGDs. The LDA method was used to algorithmically identify dominant themes by analyzing patterns of word co-occurrence within participant responses. This data-driven technique allowed for the extraction of latent thematic structures that may not be immediately apparent through manual analysis.

Complementing this, KWIC analysis provided rich, qualitative insights by highlighting specific keywords within their original conversational contexts. This method enabled the identification of nuanced meanings and participant perspectives, offering illustrative quotes that deepened the interpretation of the LDA-derived themes. Together, these methods allowed for both thematic breadth and contextual depth, enhancing the reliability and validity of the findings.

Table 4.10.3 Thematic Analysis from LDA Topic Modeling with (KWIC)

Topic	Top Words (LDA)	Theme Interpretation	KWIC Examples
Topic 1	maize, yellow, grown, area, millets, white, people	Crop preferences, particularly white vs yellow maize.	...In this area both White maize and yellow maize are grown but only white maize is preferred.... ...Due to taste white maize is preferred. Yellow maize is not tasty enough....
Topic 2	land, don, dont, ownership, farming, daughter, sell	Gender norms in land inheritance and access.	...If yellow maize is grown then it is for animals. Due to less land yellow maize is not grown... ...Land ownership is only to the son...
Topic 3	work, farm, female, holi, help, harvesting, male	Role of women in agriculture and festival-season labor shifts.	...all works are done by female only... ...Many of the work is done by female only like weeding, watering, during harvest and seed sowing male play a major role...

Thematic Summary of FGD 2 (Group 2- Marginal Farmers)

Table 4.10.4 Key Themes and Illustrative Quotes

Theme	Frequency	Summary Insight	Example Quote
Access to Services	4	Access to ration and government schemes influences household stability.	We occasionally eat bajra when it is provided through government distribution.
Crop Preference	8	Preferences for white maize are driven by taste and cooking qualities.	Although both white and yellow maize are cultivated in this area, white maize is the preferred choice.
Other	19	Responses did not directly align with main thematic codes.	We eat bajra sometimes when it is provided from the PDS
Role of Women	5	Women are deeply involved in farming activities and contribute significantly.	All works are done by female only

Triangulation of Themes Using LDA and KWIC

This section triangulates the thematic clusters derived through unsupervised machine learning (LDA topic modeling) with contextual keyword analysis (KWIC). Latent Dirichlet Allocation (LDA) groups responses into topics based on word co-occurrence patterns, while KWIC (Keyword-in-Context) provides specific excerpts where important words like 'land' or 'maize' appear. Together, these approaches strengthen the reliability of qualitative findings.

Table 4.10.5: LDA Topics and Corresponding KWIC Quotes

LDA Topic	Top Words (from LDA)	Theme Interpretation	KWIC Example
Topic 1	work, help, take, female, male, farming	Gender roles in farming and household labor	"Daughter don't take land" "Females don't take land ownership."
Topic 2	sell, money, government, provided, household, Dahod	Livelihoods, income dependency, and government support	"Land ownership is only to the men"
Topic 3	maize, yellow, white, chapati, made, area	Crop and food preferences (esp. white maize)	"White maize is the preferred choice." "Chapati made from yellow maize tends to be dense."

Thematic Interpretation

Table 4.10.6 Latent Themes from LDA Topic Modeling Highlighting Livelihoods, Institutional Access, and Food Preferences

LDA Topic	Top Words	Theme Interpretation	KWIC Examples
Topic 1	sell, work, get, money, go, dahod	Market access and livelihood challenges	—
Topic 2	land, take, government, help, ownership, daughters	Support systems and institutional access	...nan **land** ownership son... ...Daughters take **land** think land brother take brother...
Topic 3	maize, yellow, millets, chapati, made, area	Food preferences and crop usage (maize vs. yellow maize)	...Although white yellow **maize** cultivated area white maize preferred... ...yellow maize cultivated area white **maize** preferred choice Chapati made yellow...

Triangulated Analysis: Small Farmers FGD

This report presents a triangulated qualitative analysis of the Small Farmers Focus Group Discussion (FGD). Themes were identified using Latent Dirichlet Allocation (LDA)

topic modeling and validated with Keyword-in-Context (KWIC) excerpts. Thematic clustering via LDA offers an automated way to detect latent topics, while KWIC provides human-readable, contextual examples.

Interpretation and Insights

The triangulation of LDA topic modeling with KWIC analysis reveals nuanced insights into the challenges and practices of small farmers. Themes of crop preference (especially maize), market access, and gendered labor are recurring. LDA highlighted structural concerns (e.g., selling practices, institutional support), while KWIC grounded these in everyday language, enhancing the credibility of the identified themes.

Table 4.10.7 Key Themes from Focus Group Discussions on Agricultural Practices and Livelihood

Theme	Frequency	Summary Insight	Example Quote
Crop Preference	5	White maize is culturally preferred over yellow maize due to taste, texture, and usability.	*"Although both white and yellow maize are cultivated in this area, white maize is the preferred choice."*
Millet Consumption	4	Millets are not traditionally grown; people prefer maize and occasionally buy millet from markets.	*"Since we have grown up eating maize, millets are not a part of our regular diet."*
Market Access	5	Farmers prefer selling in Dahod due to better merchant access; Jesawada has limited opportunities.	*"Jesawada is near but there is no big merchant to buy, so we to sit there and sell."*
Institutional Support	6	Formal cooperatives are lacking; people rely on neighbors, SHGs, or NGOs for help in farming.	*"We don't have any farmers group... we ask neighbors for help or hire people."*
Government Assistance	5	Farmers are willing to accept help but face barriers like paperwork and digital access issues.	*"We are happy to accept assistance... but due to paperwork, we hesitate to go to the bank."*
Seasonal Livelihood	3	Income and food security fluctuate based on seasonal crop success.	*"Last year our wheat and maize were not in good condition so we didn't sell."*
Role of Women	4	Women contribute heavily to agricultural labor, often more than men due to male outmigration.	*"All works are done by female only."*

Land Ownership Norms	4	Daughters are culturally excluded from land ownership, despite laws supporting gender equity.	*"The land is given to male relatives but not accepted to give land to female."*

Interpretation of Results

Topic 1 focuses on the division of labor by gender. Words like 'female', 'male', and 'farming' indicate how responsibilities are perceived and distributed in tribal communities. KWIC quotes such as 'Daughter don't take land' reveal cultural limitations placed on women regarding land ownership.
Topic 2 highlights challenges related to livelihood and dependence on government support. Keywords like 'money', 'government', and 'provided' reflect concerns with economic hardship and welfare schemes. The KWIC result mentioning 'land ownership is only to the men' links structural land access to broader economic insecurity.

Topic 3 relates to crop and food preferences. Frequent mentions of 'maize', 'white', and 'chapati' reflect community preferences for certain varieties of maize based on taste and cooking outcomes. This is supported by KWIC quotes such as 'White maize is the preferred choice.'

Thematic comparison table of all three FGDs

Table 4.10.8 Thematic comparison table of all three FGDs

Theme	Frequency	Example Quote	FGD
Access to Services	3	If there is any help given by the government to the farmers we are happy to accept but the due to access paperwork we hesitate to go to bank.	Marginal Farmers 1
Crop Preference	9	In this area both White maize and yellow maize are grown but only white maize is preferred.	Marginal Farmers 1
Livelihood Challenges	2	Yes during summer we dont do farming thus, we have to go for daily wage work. If we get good job then we have good income.	Marginal Farmers 1
Other	25	We eat bajra sometimes when it is provided from the control	Marginal Farmers 1
Role of Women	7	all works are done by female only	Marginal Farmers 1

Crop Preference	64	Although both white and yellow maize are cultivated in this area, white maize is the preferred choice.	Marginal Farmers 2
Government Support	25	We occasionally eat bajra when it is provided through government distribution.	Marginal Farmers 2
Land Ownership	9	Land ownership is only to the son	Marginal Farmers 2
Livelihood Challenges	1	Right now, it is the harvesting season, and everyone is occupied with harvesting wheat and chana. The process will be completed before Holi.	Marginal Farmers 2
Market Access	64	We buy from the market if we want to consume sometimes	Marginal Farmers 2
Other	36	We eat bajra sometimes when it is provided from the control	Marginal Farmers 2
Role of Women	25	All works are done by female only	Marginal Farmers 2
Crop Preference	144	Although both white and yellow maize are cultivated in this area, white maize is the preferred choice. Chapati made from yellow maize dont look appealing.	Small Farmers
Government Support	49	We occasionally eat bajra when it is provided through government distribution.	Small Farmers
Land Ownership	9	Land ownership is only to the son	Small Farmers
Livelihood Challenges	9	We take pak diran for 1 year and when we get money we return it. So we don't get extra money for saving.	Small Farmers
Market Access	64	We sell in Dahod to big shops or merchant	Small Farmers
Other	25	I have never heard of cooperatives assisting farmers in this area.	Small Farmers
Role of Women	36	All works are done by female only	Small Farmers

Sentimental analysis of all three FGDs (NLP)

Table 4.10.9 Sentimental analysis of all three FGDs (NLP)

FGD	Theme	Average Sentiment *	Sample Quote
Marginal Farmers 1	Access to Services	0.3375	If there is any help given by the government to the farmers we are happy to accept but the due to excess paperwork we hesitate to go to the bank.
Marginal Farmers 1	Crop Preference	0	In this area both White maize and yellow maize are grown but only white maize is preferred.
Marginal Farmers 1	Livelihood Challenges	0.466667	Yes during summer, we don't do farming thus, we have to go for daily wage work. If we get good job then we have good income.
Marginal Farmers 1	Other	0	We eat bajra sometimes when it is provided from the control
Marginal Farmers 1	Role of Women	0	all works are done by female only
Marginal Farmers 2	Crop Preference	0.042622	Although both white and yellow maize are cultivated in this area, white maize is the preferred choice.
Marginal Farmers 2	Government Support	-0.03	We occasionally eat bajra when it is provided through government distribution.
Marginal Farmers 2	Land Ownership	0	Land ownership is only to the son
Marginal Farmers 2	Livelihood Challenges	0.285714	Right now, it is the harvesting season, and everyone is occupied with harvesting wheat and chana. The process will be completed before Holi.
Marginal Farmers 2	Market Access	-0.05	We buy from the market if we want to consume sometimes
Marginal Farmers 2	Other	0.011111	We eat bajra sometimes when it is provided from the control
Marginal Farmers 2	Role of Women	0.01	All works are done by female only

Small Farmers	Crop Preference	0.047859	Although both white and yellow maize are cultivated in this area, white maize is the preferred choice. Chapati made from yellow maize dont look appealing.
Small Farmers	Government Support	-0.00655	We occasionally eat bajra when it is provided through government distribution.
Small Farmers	Land Ownership	0.066667	Land ownership is only to the son
Small Farmers	Livelihood Challenges	0.095238	We take pak diran for 1 year and when we get money we return it. So we don't get extra money for saving.
Small Farmers	Market Access	-0.05938	We sell in Dahod to big shops or merchant
Small Farmers	Other	0.013333	I have never heard of cooperatives assisting farmers in this area.
Small Farmers	Role of Women	0.008333	All works are done by female only

*Sentiment Score

Sentiment Score	**Meaning**	**Interpretation in Your Context**
+1 to +0.3	Positive	People are hopeful, satisfied, or grateful
+0.3 to -0.3	Neutral	Responses are factual, balanced, or unclear
-0.3 to -1	Negative	People are frustrated, critical, or disappointed

Seasonal Timing & Festivals of all FGDs

Table 4.10.10 Seasonal Timing & Festivals as derived from all FGDs

FGD	Time Reference	Mentions	Sample Quote
Marginal Farmers 2	Festival	2	No one does farming during the festival.
Marginal Farmers 2	Season	4	Yes, during summer I only sow vegetables for household use. If we have stored grains and need money we sell and get money.
Small Farmers	Festival	2	No one does farming during the festival.
Small Farmers	Season	4	Yes, during summer I only sow vegetables for household use. If we have stored grains and need money we sell and get money.

Table 4.10.10 Comparative Thematic Summary of Marginal and Small Farmers

Theme	Marginal Farmers 1	Marginal Farmers 2	Small Farmers
Crop Preference	White maize preferred over yellow	Similar taste-based preference	White maize preferred; yellow for fodder
Millet Use	Mentioned as occasional food from PDS	Not preferred; not grown traditionally	Not grown; sometimes bought; not part of routine
Market Access	Go to Dahod to sell	Sell in Dahod; Jesawada has limited options	Prefer Dahod; Jesawada has no major buyers
Government Support	Paperwork limits access	Hesitation due to bureaucracy	Happy to accept help, but online forms & paperwork are barriers
Institutional Help	Little mention of SHGs	Mention of SHG/Sakhi Mandal for loan help	Use of neighbors and SHG (Sakhi Mandal)
Role of Women	Women do most of the work	Similar distribution noted (women: 85%)	Same as women do majority of farming labor
Land Ownership Norms	Land to sons; daughters excluded	Daughters don't take land legally or culturally	Daughters excluded despite legal provisions
Income Seasonality	Daily wage work during non-crop seasons	Food security impacted by crop failure	Seasonal fluctuations, stored grain usage

The thematic analysis across marginal and small farmers reveals both common patterns and contextual differences in their agricultural experiences and livelihood challenges. A clear preference for white maize over yellow maize is observed among all groups, rooted in taste and cultural acceptability, with yellow maize either underutilized or used primarily as fodder. Millets, despite their nutritional benefits, are not traditionally grown and are rarely consumed. Marginal farmers occasionally receive them through the Public Distribution System (PDS), while small farmers report purchasing them infrequently, indicating that millets have not been integrated into the routine diet.

Market access remains a concern, with all groups preferring to sell their produce in Dahod due to the presence of larger buyers. Jesawada, despite its proximity, lacks sufficient market infrastructure or merchant presence, limiting local selling opportunities. Government support is generally welcomed, but procedural barriers such as extensive paperwork and online form requirements discourage engagement, especially among marginal farmers who express hesitation due to bureaucratic processes. While small farmers are more open to receiving assistance, they too face difficulties navigating digital systems.

Institutional support varies across the groups. Marginal Farmers 1 report minimal engagement with Self Help Groups (SHGs), whereas others, particularly Marginal

Farmers 2 and small farmers, reference the Sakhi Mandal and neighbor support networks for loans and assistance, showing uneven access or awareness of such institutions. The role of women in agriculture is consistently emphasized, with women performing the majority of farm labor. This trend is often intensified by male outmigration, yet the significant contribution of women remains underrecognized.

Land ownership norms continue to reflect strong patriarchal traditions, with daughters being excluded from inheriting land despite existing legal provisions that support gender equity. This cultural resistance is common across both marginal and small farmer households. Lastly, income and food security are deeply influenced by seasonality. Marginal farmers often depend on daily wage labor during non-crop periods, while small farmers demonstrate slightly more resilience by relying on stored grain to manage lean seasons. These insights collectively highlight the structural and cultural barriers that impact the resilience and well-being of farming households.

Summary and Conclusion

Chapter 5: Summary and Conclusion

Food system resilience refers to the capacity of food systems to withstand, recover from, and adapt to various disruptions such as environmental, economic, and social shocks while ensuring continuous access to adequate and appropriate food. Originally derived from ecological studies, the concept now informs strategies for sustainable food security. It highlights the importance of strong governance, stakeholder involvement, and adaptable market structures in building resilient systems. Understanding these dynamics is crucial for developing effective policy interventions.

Rationale

Small and marginal farmers, especially in rural and tribal regions like Dahod in Gujarat, are highly vulnerable to natural and economic shocks such as erratic rainfall, climate change, and market instability. These challenges threaten food security and livelihoods. Building food system resilience is critical to ensuring food availability, accessibility, and sustainable agricultural practices. This study aligns to identify the key factors that help farmers adapt, recover, and sustain their livelihoods amid growing uncertainties.

Broad Objective

Broad objective: To assess food system resilience among Selected Stakeholders of Selected villages in Dahod

Specific objective:

1. To study the impact of the availability, accessibility and utilization of government schemes, services from NGOs and agricultural extension programs on resilience among producers in the food system.

2. To study the impact of the availability, accessibility and utilization of social safety net programs among small & marginal farmer's households as consumers in the food system.

3. To assess adaptive capacity in coping with threats to resilience among farmers and their households.

Methods and Materials

The study adopted a cross-sectional, mixed-methods design to assess food system resilience among small and marginal farmers in Dahod district, Gujarat. A purposive sampling technique was used to select 24 farmers and their households based on specific inclusion criteria such as land ownership, active engagement in farming, and residency in

the selected villages. Given practical constraints like time limitations and the seasonal nature of farming activities, this approach ensured relevant participants were included. Data collection was conducted through structured interviews, household surveys, and focus group discussions (FGDs), allowing for both quantitative and qualitative insights. The farmer interviews focused on agricultural practices, market access, climate resilience, and access to services, while the household surveys covered socio-demographic profiles, income sources, food access, government schemes, and coping strategies. FGDs captured shared challenges, local knowledge, and community-based coping mechanisms.

For the analysis, the Resilience Index Measurement and Analysis (RIMA) framework developed by the FAO was utilized to quantify resilience as a latent construct using four key pillars: Access to Basic Services (ABS), Adaptive Capacity (AC), Assets (AST), and Social Safety Nets (SSN). Data analysis was conducted using R Studio and Jamovi. Quantitative data underwent Principal Component Analysis (PCA) to reduce dimensionality and identify relevant indicators, followed by Exploratory Factor Analysis (EFA) to uncover underlying factors and Confirmatory Factor Analysis (CFA) to validate the structure and compute the Resilience Capacity Index (RCI). The final Resilience Index was derived by averaging the PCA-based scores of the four pillars. Qualitative data from FGDs and interviews were analyzed through thematic analysis to explore recurring patterns related to agricultural adaptation, resource management, and livelihood strategies. This mixed-method approach provided a comprehensive understanding of the resilience capacities of farmers in a highly vulnerable and rain-dependent region.

Results

The result of theme 1 reveal the socio-demographic profile of the respondents, comparing small and marginal farmers in the selected villages of Dahod district. The findings highlight that a majority of both small (70%) and marginal (58.33%) farmer households had a family size of 5–7 members. A smaller proportion of small farmers (20%) and marginal farmers (33.33%) had family sizes ranging from 1–4 members, while only 10% and 8.3% respectively had more than 8 members. A strong positive correlation was observed between family size and the number of working members in both groups, with larger households contributing more labor to farming activities. For instance, households with more than eight members typically had about four working members, compared to one or two in smaller households. This suggests the prevalence of extended family systems and highlights the role of family size in shaping economic participation and agricultural productivity.

Housing conditions also differed notably between the two groups. While 50% of small farmers lived in Pakka houses and the other 50% in semi-pakka houses, none lived in kacha houses. Conversely, marginal farmers had no pakka houses, with 66.67% residing in semi-pakka and 33.33% in kacha structures. This indicates that small farmers generally have better housing, potentially reflecting relatively greater economic stability. In terms

of water sources, 66.66% of small farmers relied on wells and 33.33% on borewells, whereas marginal farmers had more limited access—50% depended on wells, 25% on borewells, and 25% on government hand pumps. Access to sanitation was also better among small farmers, with 100% reporting toilet availability compared to 83.33% among marginal farmers.

These differences in basic amenities underline the disparities in living conditions and highlight the vulnerability of marginal farmers, particularly regarding water and sanitation. Lack of consistent water supply and sanitation facilities not only affects health and hygiene but also increases the burden on household members, especially women. These findings align with broader literature emphasizing the relationship between household size, labor availability, and economic resilience. For example, studies by Kadir & Prasetyo (2023) and Munćan & Božić (2017) stress the importance of adequate labor and landholding size in improving food security and income, while Filandri et al. (2020) emphasize the role of multiple working members in enhancing household financial stability. Together, the data reveal that small farmers generally enjoy better socio-economic conditions than marginal farmers, which may contribute to greater resilience in the face of agricultural and livelihood shocks.

The result of theme 2 reveals a clear distinction in crop diversity and cropping patterns between small and marginal farmers. Crop diversification, which includes cultivating multiple crop species or varieties within a given land area, is recognized as a sustainable and cost-effective strategy to enhance agricultural resilience. This diversification can be achieved by incorporating new crops, replacing low-value crops with high-value ones such as fruits and vegetables, or practicing mixed farming. Small farmers reported higher crop diversity, with an average of 3.92 (± 0.79) Kharif crops and 3.83 (± 0.72) Rabi crops, whereas marginal farmers cultivated fewer crops, averaging 2.83 (± 0.94) in both seasons. This disparity is largely due to landholding size, as larger land areas enable greater flexibility in experimenting with and integrating diverse crops. Maize was universally cultivated by both groups during the Kharif season, indicating its staple status. However, paddy (Oryza sativa), groundnut (Arachis hypogaea), and soybean (Glycine max) were significantly more prevalent among small farmers. For example, 92% of small farmers grew paddy, while only 58% of marginal farmers did. Similarly, 33% of small farmers cultivated groundnut and 58% grew soybean, compared to none among marginal farmers. This suggests that small farmers are more likely to take risks and diversify their cropping choices, possibly due to better resource access and greater land availability.

In the Rabi season, both groups showed similarities in cultivating wheat (Triticum aestivum) and chickpea (Cicer arietinum), with 100% and 92% adoption rates, respectively. However, pigeon pea (Cajanus cajan) was grown by 83% of small farmers but only 50% of marginal farmers, again pointing to greater diversification among the former. During the summer season, 66.66% of small farmers engaged in cultivation, focusing on vegetables, mangoes, and pulses like mung and tuver, whereas only 33.33%

of marginal farmers participated, growing mostly vegetables. The broader summer cropping among small farmers highlights their adaptability and resource capacity to utilize off-season opportunities.

Crop growth patterns were also influenced by climatic and agronomic factors. Rabi crops require cooler temperatures, moderate soil moisture, and well-drained loamy soils for optimal yield. Wheat, for instance, grows best between 10°C and 25°C, with adequate moisture during sowing and long daylight hours during flowering. In contrast, Kharif crops thrive in warm, humid conditions and are heavily dependent on monsoon rainfall. Crops like rice and maize require high soil moisture, but excess rainfall can lead to waterlogging and disease outbreaks. Hence, the success of Kharif crops is closely tied to effective water management, timely sowing, and pest control.

Overall, small farmers exhibit a more diversified and resilient cropping pattern compared to marginal farmers, enabled by better land access, market opportunities, and risk-bearing capacity.

The result of theme 3 reveals how small and marginal farmers in Dahod district utilize their agricultural produce. Among small farmers, a significant majority (83.33%) adopted a mixed strategy, cultivating crops for both household use and commercial sale. In contrast, 66.66% of marginal farmers prioritized subsistence farming, with only one-third engaging in market-oriented cultivation.

This distinction underscores the influence of landholding size on production decisions. Small farmers, with relatively more cultivable land and resources, are better positioned to produce surplus for the market while ensuring household food security. Their integration into local markets not only supplements income but also facilitates access to goods and services. Marginal farmers, constrained by smaller plots and limited yield, lean towards subsistence farming as a food security strategy. While this ensures basic nutrition during lean seasons, it often limits opportunities for income diversification.

The findings highlight a crucial dimension of food system resilience: the strategic balance between self-consumption and market engagement. Small farmers are more likely to pursue this balance, benefiting from greater land access and market opportunities. Marginal farmers, though more vulnerable, demonstrate resilience through subsistence-oriented cultivation.

The result of theme 4 reveals the financial profile of small and marginal farmers by comparing their primary farming income (net income from agriculture) and total household income (which includes secondary and other household income sources). The analysis reveals notable differences in income levels and variability between the two groups.

Box plot analysis of annual incomes shows that small farmers have a higher median income (₹2,14,000) compared to marginal farmers (₹1,44,000). The interquartile range for small farmers (₹92,400–₹2,59,450) is broader than that of marginal farmers (₹73,750–₹2,62,500), suggesting greater variability and a wider spread in earnings. Small farmers also recorded a higher maximum income (₹5,48,000), indicating potential for higher returns, often associated with diversified crop choices and supplementary income activities.

In contrast, marginal farmers showed a narrower range and lower median, indicating more uniform but limited income levels. These trends can be attributed to their smaller landholdings, fewer productive assets, and reduced access to profitable markets. The analysis underscores the significant income disparity between small and marginal farmers, with smallholders earning more on average but also experiencing greater income fluctuations. Marginal farmers, though earning less, exhibit more consistent but constrained financial patterns due to resource limitations.

These findings highlight the critical need for income diversification as a resilience strategy for all farming households. While small farmers benefit from engaging in high-value crops and market activities, marginal farmers must be supported through policies that enhance their access to non-farm income opportunities, improve agricultural productivity, and reduce risk exposure.

The result of theme 5 reveals farm assets among small and marginal farmers. The data revealed a clear disparity in machinery ownership, with small farmers owning an average of 0.67 units, compared to 0.25 units among marginal farmers. Despite small farmers having relatively greater access, the overall levels of mechanization remained low across both groups. High standard deviations in both categories indicated wide variation, suggesting that while a few farmers may own multiple machines, many still rely heavily on manual labor or rented equipment. The limited access to farm machinery poses serious constraints on timely agricultural operations, labor efficiency, and crop productivity, particularly during peak seasons like sowing and harvesting.

In terms of livestock, small farmers reported a significantly higher mean ownership (4.75 animals) than marginal farmers (2.33 animals). While livestock serves as a vital source of supplementary income and a buffer during times of crop failure or unemployment, the high variability among marginal farmers reflects unequal access to essential inputs like fodder, shelter, and veterinary services. The difference in livestock holdings suggests that asset accumulation is closely linked to landholding size and financial capacity, further highlighting disparities between the two groups.

One of the most concerning findings was the complete absence of storage facilities among both small and marginal farmers. Without adequate storage infrastructure, farmers are unable to preserve their produce effectively, leading to post-harvest losses and a reduced ability to sell crops at favorable market prices. This lack of storage also limits their control over market timing and leaves them vulnerable to price fluctuations, thereby directly impacting income and food security.

The findings from this theme underscore significant asset-based inequalities between small and marginal farmers, which in turn shape their productivity, resilience, and economic opportunities. Although small farmers are relatively better off in terms of farm machinery and livestock ownership, both groups suffer from severe infrastructure deficits most notably, the total lack of storage facilities. These limitations hinder their ability to cope with environmental shocks, market volatility, and seasonal changes, which are crucial dimensions of food system resilience.

The result of theme 7 reveals farmers' awareness and participation in several key schemes, including PM-Kisan, Kisan Credit Card (KCC), PM Fasal Bima Yojana (PMFBY), Agriculture Infrastructure Fund (AIF), Soil Health Card, Pradhan Mantri Krishi Sinchayi Yojana (PMKSY), and Paramparagat Krishi Vikas Yojana (PKVY). Among these, PM-Kisan emerged as the most widely known and utilized scheme, with around 90% awareness and over 80% actual participation. Its simplified application process and direct cash transfer mechanism likely contribute to its broad reach.

Other schemes, such as KCC, Soil Health Card, and PMFBY, showed moderate awareness but low utilization, revealing barriers like bureaucratic red tape, lack of technical guidance, and low perceived benefits. Worryingly, schemes such as AIF, PMKSY, and PKVY had negligible awareness and zero participation among respondents, underscoring deep-rooted issues in outreach and accessibility. When comparing small and marginal farmers, small farmers demonstrated slightly higher participation levels, especially in PM-Kisan and KCC, possibly due to better landholdings and greater access to institutional networks. However, marginal farmers arguably the most vulnerable—remain significantly underserved across most schemes.

Challenges like complex procedures, limited financial literacy, delayed payments, and weak follow-up mechanisms were commonly cited barriers. A lack of trust in certain programs, especially credit and insurance-based ones, further discouraged participation. These issues have forced many farmers to continue depending on informal sources for credit and support, limiting the long-term benefits of structured government interventions.

The findings highlight a substantial disconnect between the design and delivery of agricultural support schemes and the realities faced by small and marginal farmers. While PM-Kisan has succeeded in reaching a majority of farmers due to its simplicity and direct benefit model, other schemes have fallen short in both awareness and implementation.

Addressing these gaps will require a multipronged approach: simplifying processes, improving last-mile communication, ensuring timely disbursement, and building trust through transparency and effective grievance redressal. Strengthening institutional outreach and tailoring support schemes to the local context are essential steps toward inclusive agricultural resilience and long-term rural development.

The result of theme 8 explored household food consumption patterns using the Food Consumption Score (FCS) and the Food Insecurity Experience Scale (FIES) among small and marginal farmers. The FCS, which reflects dietary diversity and frequency over a 7-day period, revealed a positive correlation between landholding size and food security. Households with larger landholdings tended to have higher FCS, suggesting better access to diverse food sources. Notably, cereal consumption contributed the highest to the FCS across both small and marginal farmers, while differences in milk and pulse consumption created slight variations in overall scores, with small farmers showing relatively better dietary intake.

A strong positive correlation was found between total grain availability—comprising both Public Distribution System (PDS) grains and homegrown produce—and FCS. This underscores the critical role of food safety nets and farm-level productivity in ensuring dietary adequacy. The data revealed that greater access to staple grains directly translated into improved food consumption and nutritional outcomes. These findings reinforce the importance of integrated food security strategies that combine subsidized public provisioning with support for household food production. The nutrition-productivity link was also evident, as better food consumption was associated with improved labor efficiency and resilience, particularly in low-FCS households. Encouraging diversified, agroecological farming practices can further enhance nutrient adequacy and dietary outcomes.

The Food Insecurity Experience Scale (FIES) results complemented the FCS findings. Most households were classified as food secure, with a few experiencing only mild insecurity. There were no instances of moderate or severe food insecurity, indicating an overall stable food environment among the surveyed farmers.

The findings affirm that household food consumption and food security among small and marginal farmers are closely tied to landholding size, grain availability, and access to both PDS entitlements and self-produced food. The strong correlation between grain access and FCS highlights the dual importance of government-supported safety nets and on-farm food production in maintaining dietary quality. While most households appear food secure, attention must be paid to those showing mild food insecurity to prevent further vulnerability.

The results of Theme 9 give insights into the systematic process undertaken to construct and validate a household-level Resilience Index using the FAO's RIMA framework. This

study aimed to assess household resilience in a tribal block of Dahod district using the FAO's Resilience Index Measurement and Analysis (RIMA) framework. A multi-dimensional approach was adopted to measure four key pillars: Asset, Access to Basic Services (ABS), Adaptive Capacity (AC), and Social Safety Nets (SSN). Principal Component Analysis (PCA) was used to reduce each pillar's indicators into a single representative score (PC1). These scores were then averaged to construct a composite Resilience Index for each household.

The PCA results indicated that all four pillars had acceptable levels of internal variance explained by the first principal component, with SSN and Asset having the highest explained variance. The Resilience Index scores were further categorized into Low, Medium, and High levels based on tertile-based cutoffs. A balanced distribution of households was observed across these categories.

To validate the construct of resilience, both Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) were conducted. The CFA results demonstrated excellent model fit, confirming that Asset, AC, and SSN are valid contributors to the resilience construct. ABS showed a weak and non-significant relationship, suggesting limited explanatory power in the present context, possibly due to uniform service access constraints in the region.

Further statistical analysis through multiple linear regression showed all four pillars contributed equally to the composite Resilience Index, which was expected given the method of its construction. However, ANOVA results revealed that SSN and ABS scores varied significantly across the resilience categories, while Asset showed a marginally significant difference and AC did not vary significantly. **These findings highlight that social protection and service access are key differentiators of resilience in the tribal population studied.**

Overall, the analysis demonstrates that the RIMA framework can be effectively applied in tribal settings to measure and understand household resilience. The findings underscore the importance of strengthening access to social safety nets and services, alongside promoting asset creation and adaptive strategies. This study contributes to the literature by offering the first empirical application of RIMA in the Dahod tribal block and provides practical insights for policymakers and program implementers seeking to enhance resilience in vulnerable rural communities.

Theme 9 qualitative analysis of Focus Group Discussions (FGDs) with marginal and small farmers revealed key themes related to crop preferences, institutional support, gender roles, and market access. Government support emerged as another significant theme. While farmers expressed willingness to accept assistance from schemes, many cited barriers such as paperwork and digital access, leading to hesitancy in approaching banks or government offices. This was reinforced by the sentiment analysis, which showed

largely neutral or mildly negative sentiments associated with institutional support and market access, reflecting both the need and the frustration farmers feel toward bureaucratic hurdles.

In terms of market access, Dahod was a preferred location due to better availability of merchants, while Jesawada was considered limited in this regard. Most farmers reported traveling to Dahod to sell their produce, especially maize, indicating the lack of local market infrastructure. Moreover, there was limited awareness or presence of formal farmer cooperatives; instead, farmers relied on informal networks like neighbors, self-help groups (SHGs), or NGOs for labor and support.

Across all groups, white maize was preferred over yellow maize for its taste and suitability for chapatis, while millets were consumed occasionally, mostly when distributed through the Public Distribution System (PDS). A recurring theme was the critical but unrecognized role of women in agriculture. Women actively participated in all farming stages but were rarely credited or given ownership. Cultural norms favored sons in land inheritance, reinforcing gender inequality, a trend accepted by most as normal.

Income insecurity and seasonal labor were major concerns. During non-cropping months, households often relied on daily wage labor or grain sales to meet expenses. Cropping was largely seasonal, with limited summer farming focused on vegetables for home use. Overall, the triangulated analysis combining manual coding with machine learning (LDA and KWIC) revealed deeply rooted cultural preferences and systemic challenges. To enhance resilience and equity, there is a clear need for simplified access to schemes, improved local markets, and recognition of women's contributions in farming.

In conclusion, the triangulated thematic analysis using both manual coding and machine learning techniques like Latent Dirichlet Allocation (LDA) and Keyword-in-Context (KWIC) offers robust insights into the realities, preferences, and struggles of marginal and small farmers. While food preferences and labor roles are deeply cultural, challenges around institutional access, gender equity, and market connectivity point to the need for policy-level interventions that are both inclusive and accessible. Addressing these systemic gaps can improve food security, gender justice, and economic resilience in these rural communities.

Limitation of the study

Due to time and resource limitations, the sample size was relatively small, which may limit the statistical power and broader applicability of findings.

The study relied on self-reported data from farmers, which may be subject to recall bias, social desirability bias, or misunderstanding of questions.

The data collection was cross-sectional, capturing resilience and food system dynamics at a single point in time. Therefore, it cannot assess causality or changes over time.

While the Food Consumption Score (FCS) was included, more nutritional assessments (like anthropometry, dietary diversity score, or nutrient adequacy ratio) were not used to understand nutritional status and health

Thematic analysis of FGDs, while rich in insights, is subject to the researcher's interpretation and may be influenced by personal bias

The Resilience Index Measurement and Analysis (RIMA) model depends on availability and quality of specific indicators. Any missing or weak data may affect the robustness of the resilience index constructed.

Agricultural and food security outcomes are heavily influenced by seasonal variations. Since the data was collected at one time, seasonal effects on resilience, food access, and income patterns may not have been captured.

Future scope of study

- **Expansion to Other Regions**
  Future research can extend this study to other districts and states to allow comparative analysis of food system resilience across diverse agro-climatic and socio-economic contexts.
- **Longitudinal Research**
  A longitudinal design would provide deeper insights into how resilience evolves over time, especially in response to shocks such as droughts, market fluctuations, or policy changes.
- **Gender and Social Equity Analysis**
  A focused analysis on gender roles, decision-making power, and social hierarchies (like caste or tribal affiliation) would enhance understanding of intra-household and inter-group variations in resilience.
- **Advanced Nutritional Indicators**
  Incorporating additional nutritional assessments such as Minimum Dietary Diversity (MDD), anthropometric measurements, or Household Dietary Diversity Scores (HDDS) can strengthen the linkage between food access and nutritional resilience.
- **Technology and Market Access**
  Investigating the role of digital agriculture, mobile-based advisories, market linkages, and infrastructure in shaping farmer resilience can add a modern perspective to resilience research.
- **Policy Simulation Models**
  Utilizing simulation models can help forecast the impact of policy changes on food system resilience, allowing policymakers to make more informed decisions.
- **Behavioral and Psychological Aspects**
  Incorporating elements of mental health, hope, and motivation—especially post-shock—could provide a richer understanding of how psychosocial factors influence resilience.

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Abbreviation

Abbreviation	Description
ABS	Access to Basic Services
AC	Adaptive Capacity
AIF	Agriculture Infrastructure Fund
ASS	Assets
AWC	Anganwadi Center
CFA	Confirmatory Factor Analysis
CSA	Climate-Smart Agriculture
CSAT	Climate-Smart Agriculture Technologies
EFA	Exploratory Factor Analysis
EWS	Early Warning Systems
FAO	Food and Agriculture Organization
FCS	Food Consumption Score
FGD	Focus Group Discussion
FGDs	Focus Group Discussions
FIES	Food Insecurity Experience Scale
FS	Food Security
FSR	Food System Resilience
GDP	Gross Domestic Product
GOI	Government of India
HH	Households
HLPE	High Level Panel of Experts on Food Security and Nutrition
ICDS	Integrated Child Development Services
ICT	Information and Communication Technology
IHDS	Indian Human Development Survey
KCC	Kisan Credit Card
KWIC	Key Word In Context
LDA	Latent Dirichlet Allocation
MDM	Mid-Day Meal
MF	Marginal Farmers
NITI Aayog	National Institution for Transforming India Aayog
ONORC	One Nation One Ration Card
PCA	Principal Component Analysis
PDS	Public Distribution System
PEP-CBMS	Poverty and Economic Policy–Community-Based Monitoring System
PKVY	Paramparagat Krishi Vikas Yojana
PMFBY	Pradhan Mantri Fasal Bima Yojana
PM-KISAN	Pradhan Mantri Kisan Samman Nidhi
PMKSY	Pradhan Mantri Krishi Sinchayi Yojana
RCI	Resilience Capacity Index
RIMA	Resilience Index Measurement and Analysis

S&MF	Small and Marginal Farmers
SDGs	Sustainable Development Goals
SES	Social-Ecological Systems
SHC	Soil Health Card
SSN	Social Safety Nets
UN	United Nations

Annexure 1

Consent letter in English

FACULTY OF FAMILY AND COMMUNITY SCIENCES
THE MAHARAJA SAYAJIRAO UNIVERSITY OF BARODA VADODARA 390 002, GUJARAT – INDIA
DEPARTMENT OF FOODS AND NUTRITION

Date: **Village:**

My name is Rosemary Mondal, a senior MSc student in Public Health Nutrition under the guidance of Dr. Suneeta Chandorkar. I am conducting research on the topic: **"Food System Resilience among Small and Marginal Farmers in Selected Villages of Dahod District, Gujarat."**

We are conducting a study to assess the resilience of farmers and their households. The purpose of this study is to understand the key factors that contribute to the resilience of farmers and how they affect their livelihoods and well-being.

If you agree to participate, you will be asked to complete a questionnaire covering the following areas:

- **Access to Basic Services**: Including healthcare, education, water, and sanitation.
- **Assets**: Such as natural, physical, financial, human, and social resources.
- **Social Safety Nets**: Both formal and informal support systems.
- **Adaptive Capacity**: Your ability to cope with changes and manage risks.
- **Food Insecurity Experience Scale (FIES)**: Questions regarding your household's experience with food insecurity.

Your responses will be confidential and will be used solely for research purposes. Participation is entirely voluntary, and you may refuse to answer any question or withdraw from the study at any time, without facing any consequences.

There are no major risks associated with participating in this study. All collected information will be kept secure, and your identity will remain anonymous. No monetary compensation will be provided for participation.

I thereby, give consent to enroll myself and my family

Participant's Name: _____
Participant's Signature: _____
Date: _____

Rosemary Mondal
Sr, MSc student

Guide
Dr. Suneeta Chandorkar
Department of foods and Nutrition
The Maharaja Sayajirao university

Annexure 2

ફેકલ્ટી ઓફ ફેમિલી એન્ડ કોમ્યુનિટી સાયન્સ
ધ મહારાજા સયાજીરાવ યુનિવર્સિટી ઓફ બરોડા
વડોદરા ૩૯૦ ૦૦૨, ગુજરાત - ભારત
ખાદ્ય અને પોષણ વિભાગ

તારીખ: ગામ:

મારું નામ રોઝમેરી મોન્ડલ છે, અને હું પબ્લિક હેલ્થ ન્યુટ્રીશનમાં સિનિયર MSc વિદ્યાર્થી છું, જેને ડૉ. સુનીતા ચંદોરકર માર્ગદર્શન આપે છે. હું "દાહોદ જિલ્લાના પસંદ કરાયેલા ગામોમાં નાના અને ગરીબ ખેડુતોના ફૂડ સિસ્ટમ રીઝિલિયન્સ" વિષય પર સંશોધન કરી રહી છું.

અમે ખેડુતો અને તેમના પરિવારોની રીઝિલિયન્સ (આફતો અને પરિસ્થિતિઓ સામે તકો) માપવા માટે અભ્યાસ કરી રહ્યા છીએ. આ અભ્યાસનો હેતુ એ છે કે કઈ મુખ્ય બાબતો ખેડુતોની રીઝિલિયન્સમાં યોગદાન આપે છે અને તે તેમના જીવન અને જીવનનિર્વાહ પર કેવી અસર કરે છે તે સમજવું.

જો તમે ભાગ લેવા માટે તૈયાર હો, તો તમને નીચેના ક્ષેત્રોનો સમાવેશ કરતો પ્રશ્નાવલી ભરવાનો રહેશે:

• **આધારભૂત સેવાઓની ઉપલબ્ધતા**: જેમાં આરોગ્યસંભાળ, શિક્ષણ, પાણી અને સ્વચ્છતાનો સમાવેશ થાય છે.
• **સંપત્તિ**: જેમ કે કુદરતી, ભૌતિક, નાણાકીય, માનવ અને સામાજિક સંસાધનો.
• **સામાજિક સુરક્ષા નેટવર્ક્સ**: જેમાં ઔપચારિક અને અનૌપચારિક સહાયતાનો સમાવેશ થાય છે.
• **અનુકૂળ ક્ષમતા**: બદલાવ સાથે સરળતાથી ગોઠવાઇ જવાની તમારી ક્ષમતા અને જોખમોને મેનેજ કરવાની ક્ષમતા.
• **ખાદ્ય અસુરક્ષા અનુભવ માપક (FIES)**: તમારા ઘરના ખાદ્ય અસુરક્ષાના અનુભવને લગતા પ્રશ્નો.

તમારા જવાબોને ગુપ્ત રાખવામાં આવશે અને માત્ર સંશોધન હેતુ માટે ઉપયોગમાં લેવામાં આવશે. આ અભ્યાસમાં ભાગ લેવું સંપૂર્ણપણે સ્વૈચ્છિક છે, અને તમે કોઈપણ પ્રશ્નનો જવાબ આપવા માટે ઇનકાર કરી શકો છો અથવા કોઈ પણ સમયે અભ્યાસમાંથી બહાર જઈ શકો છો, અને તેનો તમને કોઈ નકારાત્મક પ્રભાવ નહીં થાય.

આ અભ્યાસમાં ભાગ લેવાના કોઈ મોટા જોખમો નથી. એકત્રિત કરાયેલ તમામ માહિતી સલામત રાખવામાં આવશે, અને તમારી ઓળખ ગુપ્ત રાખવામાં આવશે. ભાગ લેવાની કોઈ નાણાકીય આપૂર્તિ કરવામાં નહીં આવે.

હું અને મારું પરિવાર અભ્યાસમાં ભાગ લેવા માટે સંમતિ આપું છું.

ભાગધારકનું નામ: _____

ભાગધારકના હસ્તાક્ષર: _____

તારીખ: _____

રોઝમેરી મોન્ડલ માર્ગદર્શક
સિનિયર MSc વિદ્યાર્થી

ડૉ. સુનીતા ચંદોરકર
ખાદ્ય અને પોષણ વિભાગ
ધ મહારાજા સયાજીરાવ યુનિવર્સિટી

Study title: Food System Resilience among small and marginal farmers in the selected villages of Dahod district, Gujarat

Questionnaire for the Producer

Q-x

Name of the investigator:
Farmer Demographic Information

	Particular	Option
dx1	Name	
dx2	Village	
dx3	Landholding	dx3.1 Marginal (less than 1 hectare) dx3.2 Small (1-2 hectares)
dx4	Experience in farming	
dx5	Education Level:	dx5.1 No formal education dx5.2 Primary education dx5.3 Secondary education dx5.4 Higher secondary dx5.5 Graduate or higher
dx6	Family size	
dx7	Family member and their occupation	
	Name	Occupation
dx8	How many crops do you grow in a year?	dx8.1 Only Kharif crops dx8.2 Only Rabi crops dx8.3 Both dx8.4 Summer crops dx8.5 Cash crops dx8.6 Other
dx9	What crops do you grow on your farm?	**Kharif crops** Dx9.1 Rice (Paddy)

		Dx9.2 Maize (Corn) Dx9.3 Groundnut (Peanut) Dx9.4 Soybean Dx9.5 Bajra Dx9.6 Vegetable(if any) Dx9.7 Any other: **Rabi crops** Dx9.8 Wheat Dx9.9 Maize Dx9.10 Chickpeas (Gram) Dx9.11 Cumin Sesame (Til) Dx9.12 Vegetable(if any) Dx9.13 Any other: **Summer crops** Dx9.14 Green moong Dx9.15 Any other: **Cash crops** Dx9.16 Sugarcane Dx9.17 Cotton Dx9.18 Any other
dx10	For each crop you mentioned, do you primarily use it for:	dx10.1 Family consumption dx10.2 Sell it dx10.3 Both
dx11	From total yield how much do you keep for family consumption? (in kg)	
dx12	From total yield how much do you sell? (in kg)	
dx13	What is the total monthly income after sales?	dx13.1 Upto 1000 dx13.2 1000-3000 dx13.3 3000-5000
dx14	Do you have any secondary occupations or income sources aside from farming?	dx14.1 yes dx14.2 no (If no go to ABSx1)
dx15	If yes, what is the nature of the secondary occupation?	dx15.1 Animal husbandry dx15.2 Agricultural consultancy dx15.3 Beekeeping dx15.4 Fish farming dx15.5 Food processing dx15.6 Horticulture dx15.7 Kitchen garden

		dx15.8 Other (specify):
dx16	What is the total monthly income from your secondary occupation?	dx16.1 Upto 1000 dx16.2 1000-3000 dx16.3 3000-5000
	Access to basic services	
ABSx1	What type of irrigation facility do you use?	ABSx1.1 Rainfed ABSx1.2 well ABSx1.3Tube well ABSx1.4 Pond ABSx1.5Canal ABSx1.6 Other (Please specify)
ABSx2	Do you have infrastructure for storing crops?	ABSx2.1 Yes ABSx2.2 No
ABSx3	What type of infrastructure do you have to store crops?	ABSx3.1 Shed ABSx3.2 Kacha ghar ABSx3.3 Pacha ghar
ABSx4	Where do you usually get your seeds for planting?	ABSx4.1 Local suppliers ABSx4.2 government agencies ABSx4.3 NGOs
ABSx5	Do you have access to transportation for moving goods to market?	ABSx5.1 Yes ABSx5.2 No
ABSx6	Vehicles to move goods to market:	ABSx6.1 Truck ABSx6.2 Van ABSx6.3 Pickup truck ABSx6.4 Animal-powered Cart ABSx6.5 Hand-pulled Cart
ABSx7	How did you acquire it?	ABxS7.1 Purchased with personal funds ABSx7.2 Generational ABSx7.3 Purchased with a bank loan ABSx7.4Government

		subsidy/financial assistance ABSx7.5 Rental/custom service ABSx7.6 Others (please specify):
	Assets	
ASTx1	Do you own any of the following farm assets?	ASTx1.1 Tractor: ASTx1.2 Trolley: ASTx1.3 Thresher ASTx1.4 Reaper ASTx1.4 Harrow ASTx1.5 Electric Tubewell ASTx1.6 Spray Pump ASTx1.7 Pump ASTx1.8 Fodder Cutter ASTx1.9 Leveler ASTx1.10 Farm Generator ASTx1.11 Others (please specify):
ASTx2	How did you acquire most of your farm assets?	ASTx1.1 Purchased with personal funds ASTx1.2 Generational ASTx1.3 Purchased with a bank loan ASTx1.4Government subsidy/financial assistance ASTx2.5 Rental/custom service ASTx2.6 Others (please specify):
ASTx3	If you do not own certain farm machinery, how do you access it?	ASTx3.1 Rent/lease from others/ borrow ASTx3.2 Use government service ASTx3.3Do not use the machinery ASTx3.4 Others (please specify):
ASTx4	What types of livestock do you currently own?	Cattle Goats Sheep Poultry Pigs
ASTx5	How many of each type of livestock do you currently have?	

ASTx6	How do you manage the feeding of your livestock? A) Grazing B) Supplementary Feeding C) Commercial Feed D) Home-Made Feed E) Other (please specify): _____	
SSNx1	Are you aware of any government or institutional schemes providing assistance for the purchase or rental of farm machinery?	SSNx1.1 Yes SSNx1.2 No
SSNx2	Are you aware of any government or institutional schemes providing assistance for the purchase or rental of farm machinery, such as the following?	SSNx2.1 Agriculture Infrastructure Fund (AIF) SSNx2.2 Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyan (PM KUSUM) SSNx2.3 Mukhyamantri Kisan Sahay Yojana SSNx2.4 Gujarat Agricultural Mechanization Scheme SSNx2.5 National Bank for Agriculture and Rural Development (NABARD) Assistance SSNx2.6 State Agricultural Universities SSNx2.7 Krishi Vigyan Kendra's (KVKs) SSNx2.8 Gujarat Cooperative Agricultural Marketing Federation (GUJCOMASOL) SSNx2.9 National Agricultural Market (eNAM) SSNx2.10 Others, _
SSNx3	Have you utilized any of the schemes listed above? If yes, which ones have you accessed?	
SSNx4	How easy or difficult was it for you to access the assistance provided by these schemes?	SSNx4.1 1 SSNx4.2 2

	(Please rate on a scale of 1 to 5, where 1 is very difficult and 5 is very easy)	SSNx4.3 3 SSNx4.4 4 SSNx4.5 5
SSNx5	Have you benefited from these schemes?	SSNx5.1 Yes SSNx5.2 No
SSNx6	What barriers, if any, have you faced in accessing these schemes? Lack of information, Complicated application processes, Eligibility criteria	
SSNx7	Are you covered by any social protection programs?	SSNx7.1 Yes SSNx7.2 No
SSNx8	Are you aware of the following social safety net programs for farmers? (Check all that apply)	SSNx8.1 Pradhan Mantri Kisan Samman Nidhi (PM-KISAN) SSNx8.2 Pradhan Mantri Fasal Bima Yojana (PMFBY) SSNx8.3 Kisan Credit Card (KCC) Scheme SSNx8.4 Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) SSNx8.5 Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) SSNx8.6 Rashtriya Krishi Vikas Yojana (RKVY)
SSNx9	Do you have insurance for your crops?	SSNx9.1 yes SSNx9.2 no
SSNx10	Do you have insurance for your livestock?	SSNx10.1 Yes SSNx10.2 No
SSNx11	Are you currently enrolled in any of the following programs? (Check all that apply)	SSNx11.1 PM-KISAN SSNx11.2 PMFBY SSNx11.3 KCC Scheme SSNx11.4 MGNREGA SSNx11.5 PMKSY SSNx11.6 RKVY
SSNx12	What challenges have you faced in accessing or enrolling in social safety net programs? (Check all that apply)	SSNx12.1 Lack of information SSNx12.2 Complex application process SSNx12.3 Delayed benefits

		SSNx12.4 Corruption or favouritism SSNx12.5 Lack of documentation (e.g., land records) SSNx12.6 Other (Please specify):

		Fully adopted	**Partially adopted**	**Not adopted**
ACx1	Have you switched to drought-resistant varieties?			
ACx2	Have you switched to higher-yielding varieties?			
ACx3	Have you regularly removed weeds to avoid competition with crops?			
ACx4	Have you adopted mixed cropping?			
ACx5	Have you adopted double cropping?			
ACx6	Have you dug farm ponds to			

	store rainwater?			
ACx7	**Have you dug a borewell?**			
ACx8	**Have you dug an open well?**			
ACx9	**Have you ever used alternate row irrigation to conserve water?**			
ACx10	**Have you used more farmyard manure?**			
ACx11	**Have you purchased a milch animal to generate income?**			
ACx12	**Have you planted fodder trees to provide feed for animals?**			
ACx13	**Have you sold dry land and used the money for expenses?**			
ACx14	**Have you planted improved grass on dry land?**			

ACx15	**Have you leased out dry land and used the money for expenses?**			
ACx16	**Have you attended training programs on agriculture?**			

Annexure 4

Study title: Food System Resilience among small and marginal farmers in the selected villages of Dahod district, Gujarat

Questionnaire for the Producer

Q-x

ખેડૂતોની વસ્તી વિષયક માહિતી

	Particular	Options
dx1	નામ	
dx2	સરનામું	
dx3	જમીનના માલિકી હક્ક	dx3.1માર્જિનલ(1 હેક્ટર સુધી) dx3.2 સ્માલ(1-2 હેક્ટર)
dx4	ખેતિનો અનુભવ વર્ષોમાં:	
dx5	શિક્ષણ સ્તર:	dx5.1 કોઈ ઔપચારિક શિક્ષણ નથી dx5.2 પ્રાથમિક શિક્ષણ dx5.3 મધ્યમિક શિક્ષણ dx5.4 ઉચ્ચતર માધ્યમિક dx5.5 સ્નાતક અથવા ઉચ્ચ
dx6	તમારા પરિવારમાં કુલ કેટલા સભ્યો છે?	

dx7	તમે વર્ષમાં કેટલા પાકો ઉગાડો છો?	dx7.1 માત્ર રબ્બી પાક dx7.2 માત્ર ખરીફ પાક dx7.3 બન્ને dx7.4 રોકડિયો પાક dx7.5 અન્ય
dx8	તમારા ખેતરમાં તમે કયા પાક ઉગાડો છો?	રબી પાક • ઘઉં • મકાઈ • ચણા (ચણો) • જીરૂ • તલ • શાકભાજી (જો હોય તો) • અન્ય કોઈ: ખરીફ પાક • ચોખા (દાંદી) • મકાઈ (કોર્ન) • મગફળી • સોયાબીન • બાજરી • શાકભાજી (જો હોય તો) • અન્ય કોઈ: ઉનાળુ પાક • લીલો મગ • અન્ય કોઈ: રોકડિયો પાક • શેરડી • કપાસ • અન્ય કોઈ:
dx9	તમે ઉગાડેલા દરેક પાકનો ઉપયોગ મુખ્યત્વે શેના માટે કરો છો:	dx9.1 કુટુંબ માટે વપરાશ dx9.2 વેચાણ માટે

		dx9.3 બન્ને
dx10	કુલ પેદાશમાંથી કેટલી માત્રા તમે પરિવાર માટે વપરાશ માટે રાખો છો? (કિલોગ્રામમાં)	
dx11	કુલ પેદાશમાંથી કેટલી માત્રા તમે વેચો છો? (કિલોગ્રામમાં)	
dx12	વેચાણ પછી કુલ માસિક આવક કેટલી છે?	dx12.1 1000 સુધી dx12.2 1000-3000 dx12.3 3000-5000
dx13	શું તમારે ખેતી સિવાય કોઈ અન્ય વ્યવસાય અથવા આવકનો સ્રોત છે?	**dx13.1: હા** **dx13.2: ના**
dx14	જો હા, તો અન્ય વ્યવસાય શું છે?	dx14.1 પશુપાલન dx14.2 કૃષિ પરામર્શ dx14.3 મક્ષિકાપાલન (મધમાખી પાળવું) dx14.4 મત્સ્ય-ઉછેર dx14.5 ખાદ્ય પ્રોસેસિંગ dx14.6 બાગાયત dx14.7 રસોઈ બાગ dx14.8 અન્ય(સ્પષ્ટ કરો):
dx15	તમારા અન્ય વ્યવસાયથી કુલ માસિક આવક કેટલી છે?	dx15.1 1000 સુધી dx15.2 1000-3000 dx15.3 3000-5000
dx16	તમારી પાસે **પિયત જમીન** અથવા **વરસાદ આધારિત જમીન** છે?	

	મૂળભૂત સેવાઓની ઉપલબ્ધતા	
ABSx1	તમે કયા પ્રકારની સિંચાઈ સુવિધાનો ઉપયોગ કરો છો?	ABSx1.1 વર્ષા આધારિત ABSx1.2 કૂવો ABSx1.3 ટ્યુબવેલ ABSx1.4 તળાવ ABSx1.5 કેનાલ ABSx1.6 અન્ય (કૃપા કરીને વિશેષ વિગતો આપો)
ABSx2	શું તમારી પાસે પાક સંગ્રહ માટે કોઈ ઢાંચો છે?	ABSx2.1 હા ABSx2.2 ના
ABSx3	આપ પાસે પાક સંગ્રહ માટે કઈ પ્રકારની ઢાંચાકીય સુવિધા છે?	ABSx3.1 શેડ ABSx3.2 કાચું ઘર ABSx3.3 પાકું ઘર
ABSx4	તમે સામાન્ય રીતે વાવણી માટે બીજ ક્યાંથી મેળવો છો?	ABSx4.1 સ્થાનિક વેપારીઓ ABSx4.2 સરકારી એજન્સીઓ ABSx4.3 એનજીઓ ABSx4.4 અન્ય
ABSx5	શું તમારા માલને બજારમાં લઇ જવા માટે તમારા પાસે વાહનની સુવિધા છે?	ABSx5.1 હા ABSx5.2 ના
ABSx6	બજારમાં માલ પહોંચાડવા માટેના વાહનો:	ABSx6.1 ટ્રક ABSx6.2 વાન ABSx6.3 પીકઅપ ટ્રક ABSx6.4 પ્રાણીઓથી ચાલતી ગાડી

		ABSx6.5 હાથથી ખેંચાતી ગાડી ABSx6.6 અન્ય
ABSx7	તમે તે કેવી રીતે મેળવ્યું?	ABSx7.1 અંગત નાણાંથી ખરીદી ABSx7.2 વારસાગત ABSx7.3 બેન્ક લોનથી ખરીદી ABSx7.4 સરકારી વિત્તીય મદદ ABSx7.5 ભાડે/કસ્ટમ સેવા ABSx7.6 અન્ય (કૃપા કરીને સ્પષ્ટ કરો)
	માલમત્તા	
ASTx1	શું તમારી પાસે નીચેની ખેતીની સાધનો છે?	ASTx1.1 ટ્રેક્ટર ASTx1.2 ટ્રોલી ASTx1.3 થ્રેશર ASTx1.4 રીપર ASTx1.4 હેરો ASTx1.5 ઇલેક્ટ્રિક ટ્યુબવેલ ASTx1.6 સ્પ્રે પંપ ASTx1.7 પંપ ASTx1.8 ચારો કાપવાનું યંત્ર ASTx1.9 લેવલર ASTx1.10 ફાર્મ જનરેટર ASTx1.11 અન્ય (કૃપા કરીને સ્પષ્ટ કરો):
ASTx2	તમે તમારા મોટાભાગના ખેતીના સાધનો કેવી રીતે મેળવ્યા છે?	ASTx2.1 અંગત નાણાંથી ખરીદી ASTx2.2 પેઢીનિંધાણ ASTx2.3 બેન્ક લોનથી ખરીદી ASTx2.4 સરકારી વિત્તીય મદદ ASTx2.5 ભાડે/કસ્ટમ સેવા

		ASTx2.6 અન્ય
ASTx3	જો તમારી પાસે અમુક ખેતીના સાધનો નથી, તો તમે તેને કેવી રીતે મેળવો છો?	ASTx3.1 ભાડે/લીઝ પર અન્ય લોકો પાસેથી/ઉધાર લો ASTx3.2 સરકારી સેવાનો ઉપયોગ કરો ASTx3.3 આ યંત્રો નો ઉપયોગ નથી કરતો ASTx3.4 અન્ય (કૃપા કરીને સ્પષ્ટ કરો):
ASTx4	તમે હાલમાં કયા પ્રકારના પશુઓના માલિક છો?	ASTx4.1 ગાય ASTx4.2 બેંકરી ASTx4.3 ભેંસ ASTx4.4 મકાઈ ASTx4.5 પીગ્સ ASTx4.6 બળદ ASTx4.7 મરઘી
ASTx5	હાલ તમારા પાસે કેટલા પશુઓ છે?	
	સામાજિક સુરક્ષા નેટ કાર્યક્રમ	
SSNx1	શું તમે ખેતરી મશીનરીની ખરીદી અથવા ભાડા માટે સહાય પૂરી પાડતી કોઈ સરકારી અથવા સંસ્થાકીય યોજનાઓ વિશે જાણો છો?	SSNx1.1 હા SSNx1.2 ના

SSNx2	શું તમે ખેતરી સાધનો ખરીદી અથવા ભાડા માટે સહાય પૂરી પાડતી નીચે મુજબની કોઈ સરકારી અથવા સંસ્થાકીય યોજનાઓ વિશે જાણો છો?	SSNx2.1 કૃષિ બાંધકામ ફંડ (AIF) SSNx2.2 પ્રધાનમંત્રી કિસાન ઊર્જા સુરક્ષા અને ઉત્થાન મહાભિયાન (PM કસુમ) SSNx2.3 મુખ્યમંત્રી કિસાન સહાય યોજના SSNx2.4 ગુજરાત કૃષિ યાંત્રિકીકરણ યોજના SSNx2.5 નેશનલ બેન્ક ફોર એગ્રીકલ્ચર એન્ડ રૂરલ ડેવલપમેન્ટ (NABARD) સહાય
SSNx3	શું તમે ઉપર સૂચિત કોઈ યોજનાઓનો લાભ લીધો છે? જો હા, તો કઈ યોજનાઓનો તમે ઉપયોગ કર્યો છે?	
SSNx4	આ યોજનાઓ દ્વારા પૂરી પાડવામાં આવેલી સહાય મેળવવી તમારી માટે કેટલી સરળ કે મુશ્કેલ હતી? (કૃપા કરીને 1 થી 5 સુધીની સ્કેલ પર રેટ કરો, જ્યાં 1 ખૂબ જ મુશ્કેલ છે અને 5 ખૂબ જ સરળ છે)	1. ખૂબ જ મુશ્કેલ 2. મુશ્કેલ 3. મધ્યમ 4. સરળ 5. ખૂબ જ સરળ
SSNx5	શું તમને આ યોજનાઓનો લાભ મળ્યો છે?	SSNx5.1 હા SSNx5.2 ના
SSNx6	આ યોજનાઓનો લાભ મેળવવામાં તમને કોઈ તકલિફ પડી?	SSNx6.1 માહિતીની અછત SSNx6.2 જટિલ અરજી પ્રક્રિયા
SSNx7	શું તમે કોઈ સામાજિક સુરક્ષા યોજનાનો લાભ મેળવો છો?	SSNx7.1 હા SSNx7.2 ના
SSNx8	શું તમને ખેડૂતો માટેની નીચે આપેલ સામાજિક **સુરક્ષા જાળની** યોજનાઓ વિશે જાણ છે? (બધા લાગુ થતી પસંદ કરો)	SSNx8.1 પ્રધાનમંત્રી કિસાન સન્માન નિધિ (PM-KISAN) SSNx8.2 પ્રધાનમંત્રી ફસલ વિમા

		યોજના (PMFBY) SSNx8.3 કિસાન ક્રેડિટ કાર્ડ (KCC) યોજના SSNx8.4 મહાત્મા ગાંધી રાષ્ટ્રીય ગ્રામિણ રોજગાર ગેરંટી અધિનિયમ (MGNREGA) SSNx8.5 પ્રધાનમંત્રી કૃષિ સિંચાઈ યોજના (PMKSY)
SSNx9	શું તમારા પાક માટે વિમો છે?	SSNx9.1 હા SSNx9.2 ના
SSNx10	શું તમારા પશુઓ માટે વિમો છે?	SSNx10.1 હા SSNx10.2 ના
SSNx11	શું તમે હાલ નીચેની યોજનાઓમાંથી કોઈમાં નોંધણી કરાવી છે? (બધા લાગુ થતી પસંદ કરો)	SSNx11.1 PM-KISAN SSNx11.2 PMFBY SSNx11.3 KCC યોજના SSNx11.4 MGNREGA SSNx11.5 PMKSY
SSNx12	સામાજિક સુરક્ષા જાળની યોજનાઓમાં પ્રવેશ મેળવવામાં અથવા નોંધણી કરાવવામાં તમે કયા પડકારોનો સામનો કર્યો છે? (બધા લાગુ થતી પસંદ કરો)	SSNx12.1 માહિતીની અછત SSNx12.2 જટિલ અરજી પ્રક્રિયા SSNx12.3 લાભોમાં વિલંબ SSNx12.4 ભ્રષ્ટાચાર અથવા પક્ષપાત SSNx12.5 દસ્તાવેજોની કમી (જેમ કે જમીનના રેકોર્ડ) SSNx12.6 અન્ય(કૃપા કરીને સ્પષ્ટ કરો):
	સમાયોજન ક્ષમતા	

		પુર્ણપણે અપનાવ્યું	અર્ધપુર્ણપણે અપનાવ્યું	અપનાવ્યું નથી

ACx1	શું તમે પાણીની અછત અથવા હવામાનમાં ફેરફારને કારણે તમારા ખેતરમાં ખેતી કરતી પાકોને બદલી છે?			
ACx2	શું તમે ખેતર માટે સુકાં પ્રતિરોધક જાતિઓ તરફ બદલાવ કર્યો છે તેવા પરિવર્તન તરીકે?			
ACx3	શું તમે અનુકૂલન તરીકે ટૂંકી અવધિની જાતોમાં ફેરફાર કર્યો છે?			
ACx4	શું તમે વધુ ઉપજ આપતી જાતિ (HYV) વાપરવા માટે બદલાવ કર્યો છે, જેનાથી ખેતીમાં ઉત્પાદન વધે અને આબોહવા બદલાના પ્રભાવોને નિયંત્રિત કરી શકાય?			
ACx5	શું તમે વરસાદ આધારિત પાકની ઉપજ વધારવા માટે ખાતરનો ઉપયોગ કર્યો છે?			
ACx6	શું તમે સૂકી જમીન પર લગાવેલા ખાતરનું પ્રમાણ ઘટાડ્યું છે?			
ACx7	જો તમે કઠોળ અથવા તેલીબિયાં ઉગાડો છો, તો શું તમે કઠોળ અથવા તેલીબિયાંના પાક હેઠળનું ક્ષેત્રફળ વધાર્યું છે?			
ACx8	શું તમે પાક સાથેની સ્પર્ધા અટકાવવા માટે નિયમિતપણે નીંદણ દૂર કરી છે?			
ACx9	શું તમે મિશ્ર પાક અપનાવ્યો છે?			

ACx10	શું તમે બેવડી ખેતી અપનાવી છે?			
ACx11	જ્યારે ખરિફ પાક નિષ્ફળ ગયો ત્યારે શું તમે રવી પાકની ખેતીને વધુ તીવ્ર બનાવી છે?			
ACx12	જ્યારે ખરિફ પાક નિષ્ફળ ગયો હોય ત્યારે શું તમે રવી પાકની વહેલી વાવણી કરી છે?			
ACx13	શું તમે સૂકા જમીનમાં સુધારેલ ઘાસ વાવ્યા છે?			
ACx14	શું તમે સૂકી જમીન ભાડે આપી અને પૈસા ખપત માટે વપરાયા.			
ACx15	શું તમે ભેજ બચાવવા માટે બંધ બાંધ્યા છે?			
ACx16	શું તમે વરસાદના પાણીનો સંગ્રહ કરવા માટે ખેતરમા તળાવ ખોદ્યું છે?			
ACx17	શું તમે જીરુંના પાક માટે ઊભા બેડ સિસ્ટમ અપનાવી છે?			
ACx18	સુ તમે મલ્ચ કરીયુ છે?			
ACx19	શું તમે વધુ ખાતર (ફાર્મયાર્ડ મેન્યોર) લગાવ્યું છે?			
ACx20	શું તમે પાણીના અભાવે સિંચાઈ હેઠળના વિસ્તારમાં ઘટાડો કર્યો છે?			

ACx21	શું તમે પાણીનો મહત્તમ ઉપયોગ કરવા માટે વૈકલ્પિક પંક્તિઓમાં સિંચાઇ કરી છે?			
ACx22	શું તમે પૈસા મેળવવા માટે પશુઓ વેચ્યા છે?			
ACx23	શું તમે આવક મેળવવા માટે દૂધ આપતી ગાયો અથવા ભેંસ ખરીદી છ			
ACx24	શું તમે ઘાસચારા પર નાણાં બચાવવા માટે મોટા પ્રાણીઓને નાના પ્રાણીઓ (ઘેટાં, બકરા) સાથે બદલ્યા છે?			
ACx25	શું તમે તમારા પશુઓ માટે ઘાસચારાના વૃક્ષો વાવ્યા છે?			
ACx26	શું તમે ખરીદેલો ઘાસચારો આપીને પશુધનને ખવડાવ્યું છે?			
ACx27	શું તમે દુષ્કાળના સમયગાળા માટે ઘાસચારાની બચત કરો છો?			
ACx28	શું તમે ભાગીદારી આધાર પર પ્રાણીઓ પાળતા છો?			
ACx29	શું તમે પશુધનને પૂરક ખોરાક આપો છો?			
ACx30	શું તમે જમીનનો એક ભાગ તેની ફળદ્રુપતા પુનઃસ્થાપિત કરવા માટે અમુક સમય માટે પડતર રાખો છો?			

ACx31	શું તમે સૂકી જમીન વેચી છે અને વપરાશ માટે નાણાંનો ઉપયોગ કર્યો છે?			
ACx32	શું તમે સૂકી જમીનનો એક ભાગ વેચી દીધો છે અને બીજા ભાગને સિંચિત જમીનમાં રૂપાંતરિત કર્યો છે?			
ACx33	શું તમે સૂકી જમીન ભાડે આપી છે?			
ACx34	શું તમે સૂકી જમીન છોડીને સિંચિત જમીન પર કૃષિ પ્રવૃત્તિઓને વધુ તીવ્ર બનાવી છે?			

Annexure 5

Study title: Food System Resilience among small and marginal farmers in the selected villages of Dahod district, Gujarat

Questionnaire for the Consumer

Q-Y

Demographic Information

dy.1	Name of Respondent:	
dy.2	Village/Location:	
dy.3	Land holding	dy.3.1 Marginal (up to 1 hectare) dy.3.2 Small (1-2 hectares)
dy.4	Family size	
	Access to basic services	
ABSy1	What is the main source of water?	ABSy1.1 Well ABSy1.2 Handpump ABSy1.3 Water tank ABSy1.4 River ABSy1.5 Pond
ABSy2	Is there a toilet facility in the house?	ABSy2.1 Yes (If yes, go to ABSY4) ABSy2.2 No
ABSy3	If not, Where do you and your family members typically go for sanitation needs?	ABSy3.1 Open defecation ABSy3.2 Community/shared toilets ABSy3.3 Other (please specify)
ABSy4	If yes, Is there a water facility in the toilet?	ABSy4.1 Yes ABSy4.2 No
ABSy5	Does your household have access to electricity?	ABSy5.1 Yes ABSy5.2 No
ABSy6	Does your household have access to Television for communication?	ABSy6.1 Yes ABSy6.2 No
ABSy7	Does your household have access to Internet connection for communication?	ABSy7.1 Yes ABSy7.2 No
ABSy8	Does your household have access to Mobile for communication?	ABSy8.1 Yes ABSy8.2 No
ABSy9	How far (one way) is the household dwelling from the closest accessible/ functioning [SERVICE] in minutes (walking distance)?	ABSy9.1 Primary school ABSy9.2 Public hospital / health facility

		ABSy9.3 Livestock market ABSy9.4 Agricultural/crops market Public means of transport ABSy9.5 Anganwadi ABSy9.6 Pds
	Assets	
ASTy1	What type of housing do you live in	ASTy1.1 Kacha ASTy1.2 Pukka
ASTy2	Do you have means for transportation?	ASTy1.1 Bicycle ASTy1.2 Motorcycle ASTy1.3 Car ASTy1.4 Other
ASTy3	Does your household have savings or financial reserves?	ASTy3.1 yes ASTy3.2 No
	Social Safety Net Program	
SSNy1	Are you currently receiving any form of cash transfer assistance for education?	SSNy1.1 yes SSNy1.2 No
SSNy2	Are any of your family members currently receiving any form of cash transfer assistance?	SSNy2.1 yes SSNy2.2 No
SSNy3	How has cash transfer assistance helped you in meeting your household needs?	SSNy3.1 Food SSNy3.2 Shelter SSNy3.3 Healthcare SSNy3.4 Education SSNy3.5 Other: _____
SSNy4	Do your children benefit from ICDS?	SSNy4.1 yes SSNy4.2 No
SSNy5	Does your child get a Mid-day meal at school?	SSNy5.1 Yes SSNy5.2 No
SSNy6	Do you have insurance coverage for your home?	SSNy6.1 yes SSNy6.2 No
SSNy7	Does your house insurance policy include protection against natural disasters (e.g., floods, earthquakes, cyclones)?	SSNy7.1 yes SSNy7.2 No
SSNy8	Does your household have health insurance?	SSNy8.1 yes SSNy8.2 No
	Adaptive capacity	

ACy1	Can the head of the household read and write (in any language / alphabet)?	ACy1.1 yes ACy1.2 No
ACy2	Have the children stopped their schooling?	ACy2.1 Yes ACy2.2 No
ACy3	Have you stopped spending on social programs and festivals?	ACy3.1 Yes ACy3.2 No
ACy4	Have you reduced spending on expensive food items?	ACy4.1 Yes ACy4.2 No
ACy5	Have you ever borrowed grains from relatives?	ACy5.1 Yes ACy5.2 No
ACy6	Have you ever borrowed money against jewellery?	ACy6.1 Yes ACy6.2 No
ACy7	Have you sold jewellery during dry years due to financial needs?	ACy7.1 Yes ACy7.2 No
ACy8	Does anyone in your household have an occupation other than farming?	ACy8.1 Yes ACy8.2 No
ACy9	If yes, what is the nature of the side occupation?	ACy9.1 Animal husbandry ACy9.2 Handicrafts ACy9.3 Tailoring ACy9.4 Small business ACy9.5 Beekeeping ACy9.6 Fishing ACy9.7 Food processing ACy9.8 Freelance work ACy9.9 Education or training

Annexure 6

Study title: Food System Resilience among small and marginal farmers in the selected villages of Dahod district, Gujarat

Questionnaire for the Consumer

Q-Y

ખેડૂતોની વસ્તી વિષયક માહિતી

dy1	નામ:	
dy2	સરનામું:	
dy3	જમીનના માલિકી હક્ક	dy3.1 માર્જિનલ(1 હેક્ટર સુધી) dx3.2 સ્માલ(1-2 હેક્ટર)
dy4	તમારા પરિવારમાં કુલ કેટલા સભ્યો છે?	

dy5. પરિવારના સભ્યો અને તેમની વ્યવસાય

	dy5.1 નામ	dy5.2 શિક્ષણ સ્તર	dy5.3 વ્યવસાય	dy5.4 આવક

	માલમત્તા	
ASTy1	તમે કયા પ્રકારના મકાનમાં રહેતા છો?	• ASTy1.1 કાચા • ASTy1.2 આધા પક્કા • ASTy1.2 પક્કા

ASTy2	શું તમે રસોઈ માટે ગેસનો ઉપયોગ કરો છો?	• ASTy2.1 હા • ASTy2.2 ના
ASTy3	જો નહીં, તો તમે શું વાપરો છો?	—--------
ASTy4	શું તમારી પાસે વાહનો છે?	• ASTy4.1 બાઇક • ASTy4.2 મોટરબાઇક • ASTy4.3 કાર • ASTy4.4 અન્ય (કૃપા કરીને સ્પષ્ટ કરો): _____
ASTy5	શું તમારા ઘરમાં ટેલિવિઝન છે?	• ABSy5.1 હા • ABSy5.2 ના
ASTy6	શું તમારા ઘરમાં સંચાર માટે મોબાઈલની સુવિધા છે?	• ABSy6.1 હા • ABSy6.2 ના
ASTy7	શું તમારા ઘરમાં ઈન્ટરનેટ, વાઈ-ફાઈ કનેક્શનની સુવિધા છે?	• ABSy7.1 હા • ABSy7.2 ના
ASTy8	તમારા પરિવારમાં કોણ-કોણ ફોન વાપરે છે?	
ASTy9	તમે સામાન્ય રીતે તમારા ફોન પર કેવા પ્રકારની સામગ્રી જુઓ છો અથવા તેનો ઉપયોગ કરો છો?	ASTy9.1 મનોરંજન (દા. ત., ચલચિત્રો, સંગીત અથવા સોશિયલ મીડિયા) ASTy9.2 શૈક્ષણિક સામગ્રી (દા. ત., ઓનલાઇન અભ્યાસક્રમો, ટ્યુટોરિયલ્સ અથવા શીખવાની એપ્સ)

		ASTy9.3 નાણાકીય માહિતી (દા. ત., બેંકિંગ, લોન અથવા રોકાણની ટીપ્સ) ASTy9.4કૃષિ જ્ઞાન (દા. ત., હવામાન અપડેટ, બજારની કિંમતો, ખેતીની તકનીકો) અન્ય (મહેરબાની કરીને સ્પષ્ટ કરો)
ASTy10	શું તમારું બેંકમાં બચત ખાતું છે?	• ASTy3.1 હા • ASTy3.2 ના
ASTy11	શું તમારું બેંકમાં FD છે?	• ASTy4.1 હા • ASTy4.2 ના

	મૂળભૂત સેવાઓની ઉપલબ્ધતા	
ABSy1	પાણીના મુખ્ય સ્ત્રોત શું છે?	• ABSy1.1 કૂવો • ABSy1.2 હેન્ડપંપ • ABSy1.3 પાણીની ટાંકી • ABSy1.4 નદી • ABSy1.5 તળાવ
ABSy2	ઘરમાં ટોઇલેટની સુવિધા છે?	• ABSy2.1 હા(જો હા, તો ABSY4 પર જાઓ.) • ABSy2.2 ના
ABSy3	જો ના, તો તમે અને તમારા પરિવારના સભ્યો સામાન્ય રીતે શૌચાલયની જરૂરિયાતો માટે ક્યાં જાતા હોય છે?	• ABSy3.1 ખુલ્લી શૌચાલય • ABSy3.2 સમુદાય/સાથે શેર કરેલ ટોઇલેટ

		• ABSy3.3 અન્ય (કૃપા કરીને સ્પષ્ટ કરો): _____
ABSy4	જો હા, તો શું ટોઇલેટમાં પાણીની સુવિધા છે?	• ABSy4.1 હા • ABSy4.2 ના
ABSy5	શું તમારા ઘરમાં વીજળીની સુવિધા છે?	• ABSy5.1 હા • ABSy5.2 ના
ABSy6	તમારા ઘરથી સૌથી નજીકની પ્રાથમિક અને માધ્યમિક શાળા કેટલી દૂર છે?	
ABSy7	શું તમારા બાળકો નિયમિતપણે શાળાએ જાય છે?	• ABSy7.1 હા • ABSy7.2 ના
ABSy8	જો નહીં, તો અવરોધો શું છે?	
ABSy9	તેઓ શાળાએ કેવી રીતે જાય છે?	ચાલીને વાહન દ્વારા જાહેર પરિવહન દ્વારા અન્ય રીતે
ABSy10	સૌથી નજીકનું બજાર કેટલું દૂર છે જ્યાં તમે કૃષિ ઉત્પાદનો ખરીદી શકો છો?	
ABSy11	તમે માર્કેટ પર કેવી રીતે જાઓ છો?	ચાલીને

		વાહન દ્વારા જાહેર પરિવહન દ્વારા અન્ય રીતે
ABSy12	સૌથી નજીકનું બજાર કેટલું દૂર છે જ્યાં તમે કૃષિ ઉત્પાદનો વેચી શકો છો?	
ABSy13	તમારા ઘરથી પીડીએસ કેટલું દૂર છે?	

	સામાજિક સુરક્ષા નેટ કાર્યક્રમ	
SSNy1	શું તમે હાલમાં શિક્ષણ માટે સહાય મેળવી રહ્યા છો?	• SSNy1.1 હા • SSNy1.2 ના
SSNy2	શું તમારા પરિવારના કોઈ સભ્યો હાલમાં કોઈ રોકડ સહાય મેળવી રહ્યા છે?	• SSNy2.1 હા • SSNy2.2 ના
SSNy3	રોકડ સહાય કેવી રીતે તમારા પરિવારની જરૂરિયાતોને પૂર્ણ કરવામાં મદદરૂપ થઈ છે? (ચૂંટો બધા લાગુ પડે)	• SSNy3.1 ખોરાક • SSNy3.2 આશ્રય • SSNy3.3 આરોગ્યસંભાળ • SSNy3.4 શિક્ષણ • SSNy3.5 અન્ય: _____
SSNy4	શું તમારા બાળકો ICDSનો લાભ મેળવે છે?	• SSNy4.1 હા • SSNy4.2 ના

SSNy5	શું તમારા બાળકને શાળામાં મધ્યાહ્ન ભોજન મળે છે?	• SSNy5.1 હા • SSNy5.2 ના
SSNy6	શું તમે પીડીએસની સેવાઓ લેતા છો?	• SSNy6.1 હા • SSNy6.2 ના
SSNy7	શું તમારા ઘરને વિમો છે?	• SSNy7.1 હા • SSNy7.2 ના
	સમાયોજન ક્ષમતા	
ACy1	ઘરના પ્રમુખ વાંચી અને લખી શકે છે (કોઈ પણ ભાષા/અક્ષરમાં)?	• ACy1.1 હા • ACy1.2 ના
ACy2	શું પૈસાની કમીને કારણે બાળકોના અભ્યાસ ઉપર અસર પડી છે?	• ACy2.1 હા • ACy2.2 ના
ACy3	શું તમે સામાજિક કાર્યક્રમો અને ઉત્સવોમાં વધુ ખર્ચ કરવા બંધ કર્યું છે?	• ACy3.1 હા • ACy3.2 ના
ACy4	શું તમે ખર્ચાળ ખોરાકની વસ્તુઓ પર ખર્ચ ઘટાડ્યો છે?	• ACy4.1 હા • ACy4.2 ના

ACy5	શું તમે ક્યારેય સંબંધીઓ પાસેથી અનાજ ઊધાર લીધો છે?	• ACy5.1 હા • ACy5.2 ના
ACy6	શું તમે ક્યારેક ઝવેરાતપર પૈસા ઊધાર લીધા છે?	• ACy6.1 હા • ACy6.2 ના
ACy7	સૂકા / પૂર દરમિયાન પૈસાની જરૂરિયાતે ઝવેરાત વેચી છે?	• ACy7.1 હા • ACy7.2 ના
ACy8	શું તમારા ઘરમાં કોઈ વ્યક્તિ ખેતી સિવાય બીજું વ્યવસાય કરે છે?	• ACy8.1 હા • ACy8.2 ના
ACy9	જો હા, તો બાજુના વ્યવસાયની પ્રકૃતિ શું છે?	• ACy9.1 પશુપાલન • ACy9.2 હેન્ડિક્રાફ્ટસ • ACy9.3 ટેઈલરિંગ • ACy9.4 નાનકડી વાણિજ્ય • ACy9.5 મધપાલન • ACy9.6 માછલીછાંટણ • ACy9.7 ખોરાક પ્રક્રિયા • ACy9.8 ફ્રીલાન્સ કામ • ACy9.9 શિક્ષણ અથવા તાલીમ • ACy9.10 અન્ય (વિશેષણ કરો): _____

	FIES	• હા	• ના
FIES1	તમને ચિંતા હતી કે પૈસા કે અન્ય સંસાધનોની અછતને કારણે તમારી પાસે ખાવા માટે પૂરતું ભોજન નહીં હોય?		
FIES1	શું તમે પૈસા કે અન્ય સંસાધનોના અભાવને કારણે તંદુરસ્ત અને પૌષ્ટિક ખોરાક ન ખાઈ શક્યા?		
FIES1	તમે પૈસા કે અન્ય સંસાધનોના અભાવને કારણે માત્ર અમુક પ્રકારના ખોરાક જ ખાધા?		
FIES1	ખોરાક મેળવવા માટે પૂરતા પૈસા કે અન્ય સંસાધનો ન હોવાને કારણે તમારે ભોજન છોડવું પડ્યું?		
FIES1	પૈસા કે અન્ય સંસાધનોની અછતને કારણે તમે જેટલું વિચાર્યું હતું તેના કરતાં ઓછું ખાધું?		
FIES1	પૈસા કે અન્ય સંસાધનોના અભાવે તમારા ઘરનું ભોજન ખતમ થઈ ગયું હતું?		
FIES1	તમે ભૂખ્યા હતા પણ ખોરાક માટે પૂરતા પૈસા કે અન્ય સંસાધનો ન હોવાને કારણે તમે ખાધું નહીં?		
FIES1	શું તમે પૈસા કે અન્ય સંસાધનોના અભાવે આખો દિવસ ખાધા વગર રહ્યા?		

ખાદ્ય ખર્ચ અને પોષણ: FCS

FCS	છેલ્લા 7 દિવસમાં, ઘરના સભ્યોએ કેટલા દિવસો સુધી ખાદ્ય સમૂહ નું સેવન કર્યું છે?	
FCS1	અનાજ, સફેદ કંદ અને મૂળ	
FCS2	ઘેરા લીલા પાંદડાવાળા શાકભાજી, અન્ય શાકભાજી	
FCS 3	ફળો	
FCS 4	માંસ,ઇંડા; માછલી અને સીફૂડ	

FCS5	કઠોળ	
FCS6	દૂધ અને દૂધના ઉત્પાદનો	
FCS7	તેલ	
FCS8	મીઠાઈઓ	

सत्यं शिवं सुन्दरम्
Estd. 1949

Institutional Ethics Committee for Human Research (IECHR)

FACULTY OF FAMILY AND COMMUNITY SCIENCES
THE MAHARAJA SAYAJIRAO UNIVERSITY OF BARODA

Ethical Compliance Certificate 2024-2025

This is to certify Ms. Rosemary Mondal study titled; "Food System Resilience Among Small and Marginal Farmers in Selected Villages of Dahod District, Gujarat." from Department of Foods and Nutrition has been approved by the Institutional Ethics Committee for Human Research (IECHR), Faculty of Family and Community Sciences, The Maharaja Sayajirao University of Baroda. The study has been allotted the ethical approval number IECHR/FCSc/M.Sc./10/2024/37.

Komal

Prof. Komal Chauhan
Member Secretary
IECHR

Prof. Mini Sheth
Chairperson
IECHR

Chair Person
IECHR
Faculty of Family & Community Sciences
The Maharaja Sayajirao University of Baroda