*International Journal of Applied Science and Engineering*
Citation: *IJASE*: **13**(01): 01-06, June 2025
**DOI:** 10.30954/2322-0465.1.2025.2

RESEARCH PAPER

AGRO BUSINESS

# Exploring the Role of Millet Farming in Achieving SDG 12 in Odisha

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**Received:** 14 Mar., 2025 **Revised:** 26 May, 2025 **Accepted:** 03 June, 2025

## ABSTRACT

Achieving Sustainable Development Goal 12 (SDG 12), focused on responsible consumption and production, hinges significantly on the agricultural sector. Millet farming, characterized by its climate resilience, minimal resource needs, and high nutritional value, presents a sustainable alternative to traditional agricultural practices, especially in susceptible areas like Odisha, India. This research examines how millet farming promotes sustainable consumption and production by assessing the impact of socio-economic, ecological, and consumption/production-related elements. Based on data from 568 smallholder millet farmers, Structural Equation Modelling (SEM) is used to analyse both the direct and indirect effects of these variables on sustainability results. The results demonstrate that millet farming substantially mediates the relationship between external factors and sustainability outcomes, highlighting its potential as a key strategy for achieving SDG 12. This paper offers empirical evidence and policy recommendations to encourage sustainable agriculture based on millet.

**Keywords**: Millet farming, sustainable agriculture, sustainable consumption and production, SDG 12, ecological resilience

Agriculture's substantial footprint, accounting for 70% of global freshwater use, 38% of the world's land area, and up to 24% of greenhouse gas emissions (FAO, 2021), underscores the urgency of transitioning to sustainable agricultural practices for both environmental preservation and reliable food supplies. The United Nations' Sustainable Development Goal 12 (SDG 12) directly addresses this need, advocating for responsible consumption and production models. Millets, traditional grains native to South Asia and

**How to cite this article:** Jena, S., Sahoo, S. and Das, S. (2025). Exploring the Role of Millet Farming in Achieving SDG 12 in Odisha. *IJASE.,* **13**(01): 01-06.

**Source of Support:** None; **Conflict of Interest:** None

Africa, emerge as a promising solution for sustainable farming due to their minimal input requirements and resilience in dry environments (FAO, 2018).

In India, millets, once dietary staples in tribal and rain-dependent areas, were side-lined during the Green Revolution. Current efforts, such as the Odisha Millets Mission (OMM), are striving to revitalize millet cultivation to enhance climate resilience, improve nutritional security, and promote sustainable livelihoods (Odisha Agriculture Department, 2022). However, comprehensive research assessing the systemic impact of millet farming on achieving SDG 12 targets remains scarce (Thapliyal *et al.* 2025). This study seeks to address this deficiency by analysing how adopting millet farming influences the relationship between socio-economic, ecological, and consumption/production factors and broader sustainability outcomes.

Odisha presents a vital case study due to its variable climate, economic sensitivities, and strong reliance on agriculture for livelihoods. While Odisha's tribal and rural communities possess a deep-rooted history of millet cultivation and consumption, broader adoption faces obstacles such as limited market access, inadequate infrastructure, and negative consumer perceptions. Consequently, this research explores the critical question of whether millet farming can function as a practical and sustainable agricultural model that aligns with national and international objectives for environmental sustainability, secure food supplies, and rural development.

## OBJECTIVES AND RESEARCH PROBLEM

This research is driven by the following key objectives:

1. To determine how socio-economic conditions, ecological factors, and consumption/production practices impact the adoption of millet farming in Odisha.
2. To investigate the contribution of millet farming adoption to the establishment of sustainable consumption and production patterns.
3. To assess the mediating influence of millet adoption on sustainability outcomes.

The core research problem this study seeks to address is the insufficiently explored empirical relationship between millet farming and the realization of Sustainable Development Goal 12 (SDG 12), specifically within resource-limited environments such as Odisha. Although policies promote millet farming, a solid, evidence-based understanding of the factors influencing its adoption and its subsequent impact on sustainability is missing. This study aims to fill this void by employing a rigorous, quantitative analysis based on Structural Equation Modelling (SEM).

Although existing research emphasizes the environmental and nutritional advantages of millets (Amgain *et al.* 2022; Anitha *et al.* 2024), there is a scarcity of empirical data illustrating their systemic role in fostering sustainable production and consumption models at the community level. By concentrating on smallholder farmers and employing structural modelling, this study intends to offer methodologically sound insights to a field of research that is predominantly theoretical or descriptive to date.

## LITERATURE REVIEW AND THEORETICAL FRAMEWORK

Millet farming actively supports Sustainable Development Goal 12 by promoting sustainable consumption and production through efficient resource use, waste reduction, and minimal environmental disruption (UNEP, 2021; Hotta *et al.* 2021). Notably, millets use 70% less water than rice and flourish without

synthetic fertilizers or pesticides, thereby diminishing chemical pollution and greenhouse gas emissions (Bana *et al.* 2023; Thilakarathna & Raizada, 2015).

From an ecological perspective, millets enhance soil quality, bolster biodiversity, and promote climate adaptation (Kaira *et al.* 2025). Their ability to thrive in less fertile lands alleviates strain on prime agricultural areas and forests. Given their drought resistance and reduced needs for water, fertilizers, and pesticides compared to rice and wheat, millets are perfectly suited for climate-resilient agriculture (Tara Satyavathi *et al.* 2024; Ouda *et al.* 2022). Socioeconomically, millets present marginalized communities with affordable farming options and the potential to alleviate rural poverty (Amgain *et al.* 2016). Nutritionally, millets are packed with fiber, iron, calcium, and antioxidants, combating malnutrition and various chronic health issues (Anitha *et al.* 2024).

In the face of these clear benefits, consumer perception and insufficient policy support have hindered the widespread adoption of millets (Hazra & Chatterjee, 2024). Initiatives like the Odisha Millets Mission (OMM) show encouraging results, but further empirical research is essential to fully assess their comprehensive sustainability impact (Swain *et al.* 2024).

This research employs a systems thinking approach, acknowledging the interconnectedness of socioeconomic, ecological, and market factors in determining sustainability outcomes. This framework is particularly valuable for analysing how various external factors interact to influence both the uptake of millet farming and its subsequent effects on sustainable consumption and production. It posits that adoption is not solely dependent on access to resources but is influenced by a complex interplay of environmental conditions, economic motivations, and social conventions.

## METHODOLOGY

This study employed a quantitative, cross-sectional design, guided by a pragmatist research philosophy. Data were gathered from 568 smallholder millet farmers in Odisha between February and November 2024 using structured Likert-scale surveys. To ensure a representative sample, stratified random sampling was implemented, considering income levels, geographical regions, and educational attainment. The analytical framework utilized Structural Equation Modelling (SEM) to investigate the interrelationships among five constructs: socio-economic factors (SEF), ecological factors (EF), consumption and production factors (CPF), millet farming adoption (MFA), and sustainable consumption and production (SCP). SEM was chosen for its capability to estimate multiple relationships concurrently, thereby providing a comprehensive understanding of the mediating pathways. The reliability of the measurement instruments was assessed using Cronbach's Alpha, yielding the following results: SEF (0.878), EF (0.859), CPF (0.931), MFA (0.915), and SCP (0.880). Construct validity was established through Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA). Sampling adequacy was verified with a Kaiser-Meyer-Olkin value of 0.919, and Bartlett's test of sphericity was statistically significant ($p < 0.001$).

## RESULTS AND DISCUSSION

Descriptive statistics revealed that respondents generally exhibited a strong understanding of socio-economic factors (SEF, mean = 3.97) and ecological factors (EF, mean = 3.91). In contrast, the mean score for millet farming adoption (MFA) was lower (3.43), suggesting that the adoption of this practice is still developing. The slight leftward skewness observed across the constructs indicates that respondents generally held positive perceptions of these factors.

Structural Equation Modelling (SEM) analysis demonstrated significant direct effects: SEF significantly influenced MFA ($\beta = 0.412$, $p < 0.001$), as did EF ($\beta = 0.381$, $p < 0.001$) and consumption and production factors (CPF) ($\beta = 0.348$, $p < 0.001$). Furthermore, MFA had a significant positive effect on sustainable crop production (SCP) ($\beta = 0.506$, $p < 0.001$).

Mediation analysis confirmed that MFA significantly mediates the relationships between SEF, EF, CPF and SCP. The $R^2$ values for MFA (0.61) and SCP (0.69) indicate a strong ability of the model to explain variance in these outcomes. The path coefficients highlight the crucial role of socio-economic support (e.g., education, financial access, institutional support) in fostering the adoption of millet farming. Additionally, ecological variables like soil health and water availability were found to significantly predict MFA, emphasizing the environmental context of sustainable agriculture.

These findings align with previous research (Tara Satyavathi *et al.* 2024; Kumar *et al.* 2018) suggesting that millet farming contributes to both climate resilience and improved livelihoods. This study expands upon existing literature by providing empirical quantification of these relationships and by demonstrating the mediating role of adoption in enabling sustainable crop production.

A key insight from this study is the influence of consumption and production factors, such as consumer awareness, demand for millet-based products, and the availability of processing facilities. These factors influence farmers' decisions to adopt millets, shifting the focus beyond ecological suitability to include market demand and economic viability. The findings suggest that even ecologically advantageous crops may be underutilized without adequate market mechanisms in place.

## CONCLUSION AND POLICY IMPLICATIONS

In climate-vulnerable areas, millet farming presents a promising path toward sustainable agriculture, directly supporting several Sustainable Development Goals (SDGs) such as SDG 1 (No Poverty), SDG 2 (Zero Hunger), SDG 3 (Good Health), SDG 12 (Responsible Consumption and Production), and SDG 13 (Climate Action). A Structural Equation Model (SEM) validates that embracing millet farming serves as a pivotal bridge connecting socio-economic and ecological factors with achieving sustainability goals.

The policy implications stemming from this research are:

1. Inclusion of millets in Public Distribution Systems (PDS): This action can simultaneously boost demand and bolster food security.
2. Strategic infrastructure investments: Prioritizing cold chain systems, specialized millet storage facilities, and localized processing centres is crucial.
3. Empowering Farmer Producer Organizations (FPOs): Strengthening millet value chains and improving market access through FPO support is essential.
4. Targeted consumer awareness initiatives: These initiatives aim to transform the perception of millets from a "poor man's food" to a smart, healthy, and climate-resilient dietary option.

Future research endeavours should incorporate longitudinal studies and regional comparisons to assess variations in adoption patterns and their enduring impact on sustainability. Furthermore, employing mixed-methods research can illuminate subtle social and cultural factors that shape millet farming practices.

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