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Malithi Perera
Department of Rural,
Development Studies, Kandy
College of Agriculture, Kandy,
Sri Lanka

Socio-Economic Perspectives on Climate-Resilient Sorghum Farming: Smallholder Adaptation and Rural Livelihoods

Malithi Perera

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Abstract

Sorghum, cultivated across more than 40 million hectares globally, has long been considered a “climate-smart” cereal due to its tolerance of drought and heat. Yet its socio-economic dimensions remain underexplored compared to its agronomic traits. For millions of smallholder farmers in Sub-Saharan Africa, South Asia, and parts of Latin America, sorghum is both a subsistence staple and a source of income. As climate change intensifies production risks, the adoption of climate-resilient sorghum farming practices carries implications not only for yield stability but also for rural livelihoods, gender equity, and food security. Drawing on global production data, World Bank livelihood assessments, and FAO rural poverty reports, this paper examines the socio-economic drivers and barriers shaping smallholder adaptation. Case studies from Nigeria, India, and Brazil illustrate how sorghum farming intersects with household income, livestock feed security, and rural employment. The findings reveal that climate-resilient sorghum is less about genetic traits alone and more about enabling socio-economic systems—markets, policies, and institutions—that allow smallholders to benefit from its resilience.

Keywords: Sorghum, climate-smart cereal, smallholder farmers, Sub-Saharan Africa, South Asia, Latin America

1. Introduction

Climate change is reshaping agricultural landscapes worldwide, but its impact is most severe on smallholder farmers in semi-arid and marginal regions. Sorghum, a cereal historically marginalized in global trade, is increasingly regaining relevance due to its capacity to endure erratic rainfall and rising temperatures. For many smallholders, sorghum farming is not a commercial choice but a survival strategy that integrates food, fodder, and cultural heritage. Its value lies in its multifunctionality, providing grain for human consumption, stover for livestock, and raw material for brewing and bioenergy.

Despite its resilience, sorghum farming remains economically precarious. Yields in Sub-Saharan Africa average less than one tonne per hectare, compared to more than four tonnes per hectare in the United States. This disparity reflects structural inequalities in input access, research investments, and market connectivity. As climate change intensifies, the stakes for smallholder farmers become not only agronomic but also socio-economic: how can climate-resilient sorghum farming contribute to rural livelihoods, household income diversification, and long-term adaptation? This paper addresses this question by examining the socio-economic perspectives of climate-resilient sorghum farming.

2. Sorghum and Smallholder Livelihoods in Global Context

Globally, more than 500 million people depend on sorghum as a staple food. In Sub-Saharan Africa, it accounts for up to 25 percent of caloric intake in rural communities. Beyond direct consumption, sorghum provides fodder for cattle, poultry, and goats, anchoring mixed farming systems that sustain rural households. Its by-products—beer brewing residues, flour blends, and silage—generate informal employment in rural economies.

Smallholder sorghum farmers, however, remain embedded in contexts of low resource availability. Limited fertilizer use, dependence on rainfed cultivation, and restricted access to credit and insurance exacerbate vulnerability to climatic shocks. Socio-economic data from

Corresponding Author:
Malithi Perera
Department of Rural,
Development Studies, Kandy
College of Agriculture, Kandy,
Sri Lanka

the World Bank's rural livelihoods assessments reveal that households relying heavily on sorghum farming often experience seasonal food shortages, particularly in drought years. Climate-resilient farming practices, therefore, are not merely about maintaining yields but about ensuring livelihood continuity during stress periods.

3. Adaptation Practices and Their Socio-Economic Implications

Adaptation in sorghum farming takes multiple forms, ranging from varietal adoption to shifts in farming systems. Early-maturing and drought-tolerant sorghum cultivars, promoted through international research programs, reduce the risk of total crop failure during shortened rainy seasons. For households, the socio-economic value of such varieties lies in the assurance of a harvest that secures food availability and prevents the need for distress sales of livestock.

Conservation agriculture practices—such as minimum tillage, residue retention, and intercropping with legumes—enhance soil moisture and fertility. These practices reduce labor burdens for women and children, who often manage weeding and residue collection. In regions like Northern Nigeria, intercropping sorghum with cowpea has both agronomic benefits and socio-economic advantages, as it diversifies diets and income streams. Similarly, the promotion of sorghum silage in Brazil has strengthened the resilience of mixed crop-livestock systems, ensuring fodder supply and stabilizing dairy incomes during droughts.

Microbial inoculants, discussed in agronomic literature, also carry socio-economic dimensions. Their affordability relative to synthetic fertilizers makes them attractive to smallholders, though adoption depends on extension support and trust in product quality. Where such technologies are integrated into community seed and input systems, they create opportunities for local entrepreneurship and cooperative distribution, reinforcing rural economies.

4. Gender, Social Equity, and Institutional Dimensions

Sorghum is often labeled as a “women's crop” in parts of Africa, where women control its cultivation, processing, and marketing. The socio-economic impacts of climate-resilient sorghum farming thus extend beyond productivity to gender relations. Access to improved sorghum varieties and climate-smart practices enhances women's bargaining power within households and communities, as they gain control over food security and income from processed products.

Institutional support, however, remains uneven. Government subsidies and research investments frequently favor export-oriented crops such as maize or rice, leaving sorghum underfunded. This neglect perpetuates its image as a “poor person's crop” and discourages youth from engaging in sorghum farming. Yet, global dietary shifts toward gluten-free grains and health foods are creating new urban markets for sorghum, from flour blends to craft beers. Tapping into these opportunities requires linking smallholder producers with value chains that reward climate-resilient sorghum production, a process that demands institutional facilitation.

5. Livelihood Outcomes and Resilience Pathways

Climate-resilient sorghum farming contributes to rural livelihoods in multiple ways. At the household level, it stabilizes food availability, reduces vulnerability to price

shocks, and provides fodder security for livestock. At the community level, it supports employment in seed systems, grain processing, and local marketing networks. At the regional level, it underpins resilience in semi-arid economies where agriculture is the primary livelihood source.

The socio-economic impacts are not uniform, however. In areas with access to extension services, credit, and markets, smallholders are more likely to adopt resilient practices and realize livelihood gains. In contrast, farmers in marginalized areas without institutional support may continue to experience chronic vulnerability. Bridging this gap requires policy interventions that combine technological support with social protection, ensuring that the poorest benefit from sorghum's resilience potential.

6. Policy and Development Perspectives

International organizations such as FAO and CGIAR increasingly frame sorghum within the discourse of climate-smart agriculture. Their reports highlight the need to scale up resilient sorghum varieties, strengthen seed systems, and promote diversification into livestock and value-added products. From a socio-economic perspective, policies that incentivize smallholder adaptation to climate-resilient sorghum farming must go beyond input supply. They must address structural barriers such as land tenure insecurity, gender inequities, and limited access to markets and finance. Investments in rural infrastructure, including roads, storage facilities, and irrigation, enhance the returns to sorghum farming and reduce post-harvest losses. Market-oriented policies that integrate sorghum into food industry supply chains—such as school feeding programs, urban nutrition initiatives, and brewery partnerships—create stable demand that reinforces the economic rationale for adoption. At the same time, safety nets and climate insurance schemes are essential to buffer smallholders against residual risks that microbial inoculants, improved seeds, or agronomic practices alone cannot eliminate.

7. Conclusion

The socio-economic perspectives on climate-resilient sorghum farming emphasize that resilience is not simply a biological property of the crop but a function of the livelihood systems in which it is embedded. Sorghum's contribution to rural food security, income diversification, and gender empowerment positions it as a strategic crop for climate adaptation. However, realizing its potential requires institutional support, policy alignment, and inclusive value chains that connect smallholder farmers to emerging opportunities. In this sense, the resilience of sorghum farming is inseparable from the resilience of rural livelihoods themselves.

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