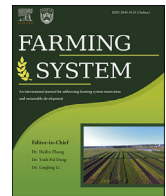


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Farming System

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Unlocking the potential of smallholder farming systems for sustainable development

Small farms, comprising less than 2 ha, constitute a remarkable 84% of all global farms, totalling approximately 608 million. Despite cultivating a mere 12% of agricultural land, they contribute around 35% of the world's food production (Lowder et al., 2016). In the low-and lower-middle-income countries (LLMICs), which are located primarily in East Asia and the Pacific, South Asia and sub-Saharan Africa, about 80% of farms on average are smaller than 2 ha and are the biggest source of employment for rural population. Smallholder farming systems (SFSs) are one of the major sources of growth and contributor to national GDP particularly in the LLMICs. SFSs are not only the source of food and nutrition but also the single largest provider of employment for the rural population. They also provide multiple ecosystem services-provisioning, regulating, supporting and cultural, critical for the sustainability of agro-ecosystems, environment, livelihoods, and rural societies. It's ironic that the majority of the 768 million people who face hunger (FAO, 2021) are associated with the smallholder farming systems in Sub-Saharan Africa and Asia.

The major challenges of SFSs in the LLMICs are the non-sustainable use of land and water resources resulting in land-degradation, unhealthy soils and natural resource depletion, climate change and increasing frequency of climatic extremes resulting in losses of agricultural production of quantity and quality, increasing market risk in the globalized economies, poor infrastructure, conflicts, inequities, and information imperfections and asymmetry limits the potential of SFSs. These limitations lead to low farm productivity, high transaction costs, assets and income poverty, high environmental footprints, and overall vulnerability. The smalllandholding size is further decreasing, increasing the pressure on per unit land and making it hard for smallholders to attain economically viable systems. However, the sustainability and economic viability of the smallholder farming systems in sync with ecological sustainability is a necessity for achieving sustainable development goals (SDGs), as 11 out of the 17 SDGs are directly linked to agriculture. Sustainably managing smallholder farming systems within the planetary boundaries ensuring increased production, income and inclusiveness is the goal. This needs to be achieved under the climate change, increasing frequency of weather extremes and other shocks like covid19, and increasing geo-political tensions. Nevertheless, all smallholder farming systems are not operating at the same stage of the growth and development trajectory and differ also in terms of the challenges they face. Many SFSs in Asia which have been part of the Green Revolution phenomena are confronted with second generation challenges such as overexploitation of groundwater, unbalanced and excessive use of chemical fertilizers and pesticides impacting water, soil and food quality as well as human health in addition to the inherent constraints of the SHFs. Further the increasing transactions cost, and climate and market

risk are major emerging limitations. The challenges of the other category of SFSs covering most parts of sub-Saharan Africa and rainfed low input low output systems in Asia are the low adoption of improved technologies, insecure land tenure, low productivity, high yield gaps, poor soils and land degradation, poor access to markets resulting in high poverty and rural unemployment.

Poor access to cost-effective financing, improved technologies, climate, and market information, and uneconomic size of the SFSs severely limit their potential. Despite women's substantial and quintessential role in the SFSs their participation in SFS related decision making and limited access to resources and technologies at farm household level are other key drivers of sub-optimal outcomes of the farming systems.

Though confronted with several intractable challenges, the SFSs have tremendous untapped potential to increase agricultural and food production. These systems are not only the major source of future growth of food production, but their sustainability and development are quintessential for ensuring the availability of food locally across all geographies in the face of increasing frequency of shocks such as covid19, Ukraine war, climate change. The sustainability of SFSs is paramount also because of their role as the largest source of livelihoods for rural people as well as in meeting the food demand from the fast-increasing urban population in the LLMICs.

Sustainable intensification and resilience building of SFSs in an inclusive way is critical for achieving multiple SDGs, ecosystem services and biodiversity. Food insecurity driven by underperformance of SFSs particularly in Sub Saharan Africa is one of the underlying factors of conflicts which further leads multitude of problems and human sufferings (Läderach et al., 2021). Thus, making SFSs resilient and sustainable may contribute significantly towards minimising conflicts particularly among farmers, pastoralist, and agro pastoralists. In the light of recent shocks of covid19 and Ukraine war that exposed the weaknesses and vulnerability of global food supply chains, the SFSs becomes more critical for securing global food security especially in the LLMICs. In the light of climate crisis and increasing frequency of other shocks there is an emerging consensus among the food policy stakeholders on the need to strengthen local food systems for achieving inclusive and stable food security and nutrition. This further makes the role of SFSs more important as the foundation of local food systems.

Since SFSs are of fundamental importance for achieving multiple SDGs particularly related to food security, poverty, ecosystem services, climate change, inclusion and human health, there is a need for efforts at global, regional, national, and local scales to achieve resilient, sustainable, and prosperous smallholder farming and livelihood systems. A holistic and integrated approach may include: i) interventions on context specific agricultural technologies; ii) digital innovations for seamless

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flow of information and knowledge, and as well as linking farmers to other stakeholders; and iii) institutional innovations to improve ability of smallholders to participate in input and output markets and access technologies cost effectively. The modern agriculture technologies need to be contextualized adopting an integrated approach by harnessing synergies of various agroecosystems components to optimise farming system's productivity. Climate smart agricultural (CSA) technologies have big potential in improving resilience and profitability of SFSs (Lipper et al., 2014). In addition to optimizing productivity in a sustainable way the SFSs need to focus on producing good quality and safe food which would also create niche market opportunities. However, enabling policies and organizational solutions would be needed to promote CSA and other need-based innovations. Digital innovations including machine learning and artificial intelligence has huge potential to transform SFSs. This needs more applied research including on cost-effective delivery models as a business case. The SFSs are highly diverse and hence understanding the heterogeneity and undertaking a cropping and farming systems suitability analysis and across any region or country would help in better targeting sustainable and profitable farming system development aligning with natural resources, social-ecological systems and markets. Women play a critical role in smallholder farming systems, and empowering them with access to resources, education, and decision-making can have a transformative impact on sustainability. Gender-responsive approaches should be integrated into all aspects of smallholder agriculture development. Further the efforts are needed for valuation of multiple ecosystem services (ESSs) generated by SFSs. Creating mechanisms to monetize the ESSs can encourage farmers to adopt regenerative and sustainable agricultural practices that are good for the long-term health of agro-ecosystems as

well as the consumers.

Supportive policies and an enabling environment that prioritize smallholder agriculture are essential for ensuring sustainable, resilient, and productive smallholder farming systems. By implementing strategies that foster economic viability, enhance resilience, and promote environmental conservation, smallholder farming systems can contribute significantly to food security, poverty alleviation, and environmental sustainability. Researchers must continue to generate context-specific and relevant evidence to inform policy and practice in smallholder agriculture.

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