



Sustainable intensification of agricultural systems in the Central African Highlands: The need for institutional innovation



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ABSTRACT

This study identifies entry points for innovation for sustainable intensification of agricultural systems. An agricultural innovation systems approach is used to provide a holistic image of (relations between) constraints faced by different stakeholder groups, the dimensions and causes of these constraints, and intervention levels, timeframes and types of innovations needed. Our data shows that constraints for sustainable intensification of agricultural systems are mainly of economic and institutional nature. Constraints are caused by the absence, or poor functioning of institutions such as policies and markets, limited capabilities and financial resources, and ineffective interaction and collaboration between stakeholders. Addressing these constraints would mainly require short- and middle-term productivity and institutional innovations, combined with middle- to long-term NRM innovations across farm and national levels. Institutional innovation (e.g. better access to credit, services, inputs and markets) is required to address 69% of the constraints for sustainable intensification in the Central Africa Highlands. This needs to go hand in hand with productivity innovation (e.g. improved knowhow of agricultural production techniques, and effective use of inputs) and NRM innovation (e.g. targeted nutrient applications, climate smart agriculture). Constraint network analysis shows that institutional innovation to address government constraints at national level related to poor interaction and collaboration will have a positive impact on constraints faced by other stakeholder groups. We conclude that much of the R4D investments and innovation in the Central Africa Highlands remain targeting household productivity at farm level. Reasons for that include (1) a narrow focus on sustainable intensification, (2) institutional mandates and pre-analytical choices based project objectives and disciplinary bias, (3) short project cycles that impede work on middle- and long-term NRM and institutional innovation, (4) the likelihood that institutional experimentation can become political, and (5) complexity in terms of expanded systems boundaries and measuring impact.

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1. Introduction

Growths in human population and food consumption are expected to increase global food demand of between 70% and 100% by 2050 (Royal Society of London, 2009). Sustainable intensification of agricultural systems in developing countries is perceived essential to meet

this growing global food demand (Tilman et al., 2011). Especially in regions where pressure on agricultural land is high, and soil fertility and yields are low, sustainable intensification can enhance food security and economic development (Drechsel et al., 2001; Vanlauwe et al., 2014). The literature on intensification of agricultural systems in developing countries – be it sustainable or ecological¹ – generally

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¹ We acknowledge the similarities and differences between sustainable and ecological intensification, but feel that discussing their semantics and practices is beyond the scope and objective of this paper. Therefore we consistently refer to 'sustainable intensification'.

focuses on generating more produce or income from existing agricultural land. To achieve that objective, sustainable intensification requires (1) productivity innovation (e.g. improved varieties, fertilizer, new crop management practices), (2) Natural Resource Management (NRM) innovation (e.g. reforestation and erosion control), and (3) institutional innovation (e.g. social infrastructure, policy, partnerships, access to finance, services, inputs and markets) (Pretty et al., 2011; Tiftonell, 2014; Vanlauwe et al., 2014). These different types of innovations need to emerge in an integrated way, making smart use of available agro-ecological, human and financial resources across different systems levels in a specific context (Robinson et al., 2015). But this seems easier said than done. Review of sustainable intensification literature reveals a strong focus on productivity innovation, for instance the use of new varieties or fertilizers to increase crop yield (e.g. Folberth et al., 2014; Ojiem et al., 2014), and NRM innovation, such as water harvesting and agro-forestry (e.g. Carsan et al., 2014; Dile et al., 2013; Lurance et al., 2014). The importance of institutional innovation to support sustainable intensification is acknowledged in the literature, mainly in relation to access to credit, inputs, extension services and markets (e.g. Robinson et al., 2015; Vanlauwe et al., 2014). However, evidence from experimentation with, and investment in, institutional innovation to provide an enabling environment for sustainable intensification is limited. We wonder whether this is justified and why this is the case?

Perhaps the answer to the above question is rooted in different ideas about what sustainable intensification actually implies. A narrow approach to sustainable intensification would focus on understanding and alleviating biophysical and technological constraints for improved yields and revenues at plot or farm level. A broader systems approach to sustainable intensification seeks to understand the complex interrelations between biophysical, technological, social-cultural, economic, institutional and political problem dimensions across farm, village, district, regional and national levels, and how these are shaped through interaction and negotiation between different stakeholders and organisations. The title of this paper – referring to “sustainable intensification of agricultural systems” – reveals that we use a systems approach as our starting point.

Among the more advanced systems approaches to agricultural innovation is the Agricultural Innovation Systems (AIS) approach (Foran et al., 2014; Klerkx et al., 2012a). The AIS approach provides a framework for the integrated analysis of dimensions, levels and stakeholder perceptions related to a specific agricultural problem, and the functioning of the more generic innovation system in which the problem is embedded (Klerkx et al., 2010; Spielman et al., 2008). The active engagement of different stakeholder groups from different levels in identifying, prioritising and alleviating constraints is an important feature of the AIS approach (Foran et al., 2014). That this also applies to sustainable intensification is emphasised by Tiftonell (2014) and Struik et al. (2014c) who underline that ‘sustainable intensification’ is likely to have different meaning for different groups of stakeholders. Stakeholder engagement is important for three reasons. First, different stakeholder groups can provide important insights about the different dimensions of constraints for sustainable intensification across different levels (Schut et al., 2016). Second, it can facilitate negotiation about what combination of sustainable intensification innovations would best align with specific constraints, as well as with the motivation, needs and interests of different stakeholder groups (Struik and Kuiper, 2014). Third, stakeholder engagement provides a basis for collective ex-ante design of AIS research, policy and development agendas for sustainable intensification (Foran et al., 2014).

This study provides AIS analysis of constraints and opportunities for sustainable intensification in the Central African Highlands. The region is in many ways representative for agricultural systems that require sustainable intensification: (a) population is expected to increase 2–3 fold in the next 35 years (United Nations, 2015), (b) yield

gaps are among the largest in the world (Tiftonell and Giller, 2013), (c) fallow land is virtually absent and the hilly landscape is prone to erosion which causes soil fertility challenges (Drechsel et al., 2001), (d) years of conflict have weakened agricultural extension systems and input and service supply, resulting in significantly output losses (FAO, 2000), and (e) similar to other tropical regions in the world, climate change and variability are threatening already vulnerable smallholder livelihoods (Morton, 2007). The study has three specific objectives. First, we identify and analyse constraints for sustainable intensification as experienced by different stakeholder groups. Second, we explore similarities, differences and linkages between the constraints identified across the stakeholder groups and study sites. Third, based on constraint network analysis and stakeholder prioritisation, we identify entry points for innovation for sustainable intensification of agricultural systems in the Central African Highlands.

2. Conceptual and methodological framework

2.1. Key-concepts

Stakeholders are those actors or actor groups with a stake in a specific problem or in the innovations that can lead to their resolution (McNie, 2007). In this study we distinguish between farmers, civil society and non-governmental organisations (NGOs), private sector, government officials, and researchers and trainers (Ortiz et al., 2013; Schut et al., 2015b). To address complex problems (such as sustainable intensification according to Struik et al., 2014c) interaction, negotiation and collaboration between stakeholders in describing, explaining and prioritising problems, and exploring, designing and testing solutions has been proposed (Douthwaite et al., 2009; Giller et al., 2008; Neef and Neubert, 2011). Innovation is defined as a co-evolving process of technological (e.g. seeds, breeds, fertilizer, agronomic practices) and socio-organisational (e.g. policy, markets, partnerships) change (Hall and Clark, 2010; Hounkonnou et al., 2012; Leeuwis, 2004). Many productivity, NRM and institutional innovations have both technological and socio-organisational dimensions. Innovations occur across different levels, and are shaped by interactions between stakeholders and organisations inside and outside the agricultural system (Kilelu et al., 2013; Klerkx et al., 2010). We use Spedding's (1988) definition of the agricultural system as the operational units of agriculture including all actors and organisations involved in agricultural production, processing and commercialization activities. In line with the objectives of this study, the delineation of the agricultural system's boundaries – a key challenge when doing (innovation) systems research (Klerkx et al., 2012b) – is done in a participatory way, by stakeholders. Sustainable intensification of agricultural systems is conceptualised as increasing the output of agricultural production, processing and commercialization activities, while at the same time increasing the efficiency of natural, physical, financial and human resource investments and reducing negative environmental and social impacts (Pretty et al., 2011). An entry theme is a broad topic or objective that applies across a region (e.g. intensification of crop-livestock systems). Entry points are the more specific productivity, NRM and institutional innovations, that combined can contribute to achieving the entry theme (Humidtropics, 2014).

2.2. Study site selection and characteristics

Data for this study were collected in the highlands of Burundi, Rwanda and eastern Democratic Republic of Congo (DR Congo). The region is part of one of the ‘action areas’ of the CGIAR Research Program on Integrated Systems for the Humid Tropics (Humidtropics). Humidtropics has adopted sustainable intensification of agricultural systems as its main approach to achieving

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