

Stakeholder roles for fostering ambidexterity in Sub-Saharan African agricultural netchains for the emergence of multi-stakeholder cooperatives

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RESEARCH ARTICLE

Abstract

The Sub-Saharan African smallholder agricultural sector faces multiple and usually complex challenges, which can potentially be overcome by collective action. Smallholder farmers and other value chain stakeholders can tackle temporal, structural and contextual challenges by joining multi-level innovation networks to benefit collectively from shared information, knowledge, improved capacities and economies of scale in a process of innovation. Ambidexterity is a capability of innovation networks to balance exploration and exploitation dynamics in an innovation process, and is applicable at multiple levels: individuals, leaders, champions, teams and clusters. In the paradigm of open innovation, these levels become intertwined in hybrid social structures of innovation netchains. The objective of this paper is to describe the roles and identify the stakeholders that play those roles in an innovation process. We present case studies on farmer groups who participate in collective action and we compare multi-stakeholder platforms with other configurations of actors that tackle challenges in potato netchains in three Sub-Saharan African countries. We track and analyse innovation trajectories for six cases adapting netchain analysis techniques linking roles with the challenges faced at particular stages of each innovation trajectory. We find three management designs for fostering exploration and exploitation: (1) exploratory or exploitative management designs for small innovation networks; (2) exploitative management designs for larger networks; and (3) ambidextrous management designs for multi-stakeholder networks. Traditional roles played by managers are identified to manage exploration and exploitation in an ambidextrous way, but also evidence of roles of civil society actors facilitating collective action for the emergence of multi-stakeholder cooperatives. Since ambidexterity is about dynamism, we identified three types of mobility to be fostered when tackling challenges in an innovation process: (1) mobility-dynamism of the innovation process over time; (2) structural-knowledge mobility in innovation networks; and (3) boundary mobility.

Keywords: collective action, innovation platforms, management, challenges, innovation networks, innovation process, R&D interventions, cooperatives, producer organisations

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1. Introduction

In Africa an estimated 80% of farms are below two hectares (Wiggins, 2009) and producers are hindered by a scarcity of financial resources, degradation of natural resources, an uncertain climate, and a rapidly changing landscape of markets and consumer demands. Many agricultural producers also experience information and power asymmetries that exclude them from benefiting from opportunities offered by local, national and international markets. Smallholder farmers can tackle these challenges by forming networks to benefit collectively

from shared information, knowledge, improved capacities and economies of scale in a process of innovation. Such 'innovation networks' have always existed but have only recently been theorised as a 'new form of organisation within knowledge production for the exploration of synergies and the exploitation of complementarities' (Pyka and Küppers, 2002) in an innovation process. Farmers may be part of larger innovation networks, but also be part of self-help approaches, such as producer organisations, which are a collective mechanism for farmers to pool resources to benefit from economies of scale and overcome challenges such as lack of technologies or credit, limited access to markets,

and poor infrastructure for processing (Arnould *et al.*, 2007; Mendoza and Thelen, 2008; Ton, 2008). Cooperatives are a specialised type of producer organisation that ‘...is an autonomous association of persons united voluntarily to meet their common economic, social, and cultural needs and aspirations through a jointly owned and democratically controlled enterprise’ (International Co-operative Alliance, 2015). Ton *et al.* (2007) argue, however, that most benefits offered by farmer cooperatives in developing countries reach relatively resource-rich farmers, offering less to the majority of potential beneficiaries.

Over the past 20 years there have been various agricultural research and development (R&D) intervention approaches that aim to improve the flow and production of knowledge and technologies to improve the livelihoods of smallholder farmers in Sub-Saharan developing countries. Agricultural R&D interventions for the diffusion of technological packages have been criticised (Staatz and Dembélé, 2008) because they mainly focus on exploration, i.e. knowledge sharing and learning activities, rather than exploitation, which transforms learning into tangible economic outcomes via, for instance, contract farming or business networks.

Consequently multi-stakeholder platforms have been proposed to enhance the capabilities of producer organisations to explore solutions to production challenges, exploit market opportunities and benefit economically (Devaux *et al.*, 2007; Kaaria *et al.*, 2008; KIT *et al.*, 2006; Lightfoot and Scheuermeier, 2007; Prasad and Hambly, 2009; Sanginga *et al.*, 2004; Shepherd, 2007). Multi-stakeholder platforms are a complex innovation network established to help farmers address multi-dimensional problems, by allowing for interaction among stakeholders at various levels of an agricultural value chain. This combination of value-chain and innovation network results in a type of netchain, i.e. ‘a set of networks comprised of horizontal ties between firms within a particular industry or group, such that these networks (or layers) are sequentially arranged based on the vertical ties between firms in different layers’ (Lazzarini *et al.*, 2001: 7).

Ambidexterity in netchains

Ambidexterity is a concept used in management and innovation studies to describe the ability of organisations to manage simultaneously exploration and exploitation (O’Reilly and Tushman, 2008), and is comparable to the human physical capability to conduct an activity easily with both hands (Moreno Luzon and Valls Pasola, 2011). Ambidexterity as a managerial capability was traditionally studied in mainly large firms from developed countries,

and subsequently in R&D organisations in the context of inter-firm collaboration (McCarthy and Gordon, 2011; Michelfelder and Kratzer, 2013; Riccaboni and Moliterni, 2009). Gilley *et al.* (2010) observe ambidexterity at the team level, which could be the case of smallholder farmers who explore new ways of doing things (exploration) for tackling their problems in communities of practice formed with family peers and neighbours. Other studies show ambidexterity as a capability of larger innovation networks (Turner *et al.*, 2013), which is the case of smallholder farmers participating in agricultural R&D interventions.

Currently the open innovation paradigm (Chesbrough, 2003) implies the blurring of hybrid organisation boundaries in innovation networks, and the inclusion of various stakeholders facilitating innovation processes to solve collective problems. In this paradigm the concept of ambidexterity has further evolved into a more collective managerial capability, pursued by diverse actors of civil society and various productive sectors, such as small and medium enterprises (Chang *et al.*, 2011), supply chain networks (Narasimhan and Narayanan, 2013), projects (Li and Huang, 2013), entrepreneurial universities (Ambos *et al.*, 2008; Chang *et al.*, 2009; Tahar *et al.*, 2011), family (Koenig *et al.*, 2013), and individual-leadership levels (Rosing *et al.*, 2011). In netchains, there is an aggregative and complex setting of networks with multiple actors at multiple levels. Managing the netchain for exploration and exploitation is far from easy due to the diversity of hybrid organisations and the complexity of the challenges. It is therefore important to understand how the roles of managers and other stakeholders at different network levels foster ambidexterity as a collective managerial capability in netchains.

Stakeholder roles for fostering ambidexterity in netchains

Simultaneous exploration and exploitation requires netchain stakeholders to play roles to manage contradictory strategies like flexibility versus efficiency, open versus closed innovation, incremental versus radical innovation, and formal versus informal control (Cantarello *et al.*, 2012). The tensions resulting from these contradictory strategies represent three inter-related types of challenges: temporal, structural and contextual.

1. Temporal challenges relate to the timing of managing netchains for change, simultaneously exploring new approaches and exploiting new capabilities. This management maintains the ‘cycle of innovation’ (Gilsing and Nooteboom, 2006), which might be repeated various times at different organisational levels if resources are available (Van de Ven *et al.*, 2008). Few studies report

on specific roles played in the timing of innovation processes, or observe the dynamics of exploration and exploitation over time. O'Reilly and Tushman (2008) mention the importance of dynamic capabilities, like sensing, seizing and reconfiguring, for managing timing in large firms in developed countries. In the automobile industry, Adler *et al.* (2009), show how Toyota managed exploration and exploitation by its continuous learning approach, introducing deliberate perturbation to avoid routinisation and stagnation. Managing temporal dynamics in some telecommunication firms (Ferrary, 2011) has been achieved by engaging in a cycle of disruptive innovation where ambidexterity is a capability of a cluster of organisations (e.g. universities, research laboratories, law firms, and investment banks), who individually specialise in exploration, exploitation or the transition between the two. In this case of disruptive technology-driven open innovation the timing is managed via market or quasi-market mechanisms (Ferrary, 2011). There is, however, a dearth of studies on which roles are important for managing temporal challenges in agricultural netchains in developing countries where the pace of the innovation process might be slower than in developed countries and where there is less emphasis on new technologies and more on optimising social processes for solving problems in more complex unstable environments.

2. Structural challenges relate to the configuration of actors in a social structure to organise exploration and exploitation in an innovation process. Managing structural challenges in netchains refers to how different roles can help to organise collective action of stakeholders, whether by working separately in innovation networks with peers, or in combination with other stakeholders at different levels of the innovation network. Network management and coordination are suggested as important roles to foster ambidexterity of networks, managing the network diversity, network governance (Vanhaverbeke *et al.*, 2012), and network mobility (Dhanaraj and Parkhe, 2006). Enhancing the connectedness of societal actors, through facilitating both loose organisational relationships (ORs) for exploration, and more formal alliances for exploitation (Gilsing and Nooteboom, 2006), is also important (Capaldo, 2007; Tiwana, 2008, 2010; Vanhaverbeke *et al.*, 2012). Facilitating ORs also adds value in an innovation process since it affects the integration, alignment, and openness of the innovation network and hence the ability to organise collective action, share resources and foster other capabilities.

Roles like boundary spanning, facilitating the combination of direct and indirect ties for knowledge exchange (Tiwana, 2008; Vanhaverbeke *et al.*, 2012),

facilitating competitor alliance relationships, facilitating organisational and social learning; brokering external knowledge, building peer networks (Lyytinen *et al.*, 2010), co-design of participatory processes, are important for overcoming structural challenges. Strategies like managing networks of practice (Agterberg *et al.*, 2010) and management of information and communication technologies (ICTs) are also important. However, most studies have been conducted in organisations in developed countries, and there are few insights from developing countries on the roles for managing structural challenges, particularly in complex social structures like netchains (Martini *et al.*, 2013; Mueller *et al.*, 2013; Turner *et al.*, 2013).

3. Contextual challenges in the innovation process refer to how exploration and exploitation in innovation networks are managed within spatial, institutional, political, and technological boundaries (Mueller *et al.*, 2013; Schemel, 2013). When comparing differences between Japanese and Korean firms, for instance, Yoon and Chae (2012) show how decision making structures (decentralisation and control) depend on the nature of the external environment, and that market, clan and bureaucracy influence the management designs to manage paradoxes (different management styles of exploration and exploitation). More fundamentally, Mueller *et al.* (2013) show how institutional factors, like national culture (e.g. different conception of power distance) have an impact on the benefits to firms of exploratory innovations, whereas those same factors had less effect on the benefits derived from exploitative innovations. Institutional boundaries can be determined by modes of governance (Blome *et al.*, 2013), formal and informal control (Tiwana, 2010), and systems of rewards and sanctions. Other innovation boundaries are virtual-mediated by ICTs (Ashurst *et al.*, 2012).

Managing contextual challenges requires adaptability (Thongpapanl *et al.*, 2012; Weigelt and Sarkar, 2012), adaptive management (Moellenkamp *et al.*, 2010), environmental dynamism and embeddedness, as well as access to organisational capital, human capital (Zhou *et al.*, 2013), social capital and the more political and institutional roles of global institutions (Schemel, 2013). However, it is less clear who plays which roles to span and mobilise multi-dimensional contextual boundaries (Gupta *et al.*, 2006; Nosella *et al.*, 2012). Similarly the role that information and communication technologies can play (Martini *et al.*, 2013) to foster ambidexterity in netchains is a gap in the literature.

Hence the research question that we address in this paper is the following:

What roles are played and by whom to foster ambidexterity in netchains for tackling challenges faced by smallholder farmers in Sub-Saharan African countries?

The next section will present our multi-case longitudinal research design and describe briefly our choice of cases and analytical approach. This is followed by the results of our analysis specifically focusing on the challenges encountered and the roles played to tackle those challenges. Finally, we conclude and discuss the implications of our findings on the roles played by traditional managers and other civil society stakeholders in innovation processes, with propositions for management design.

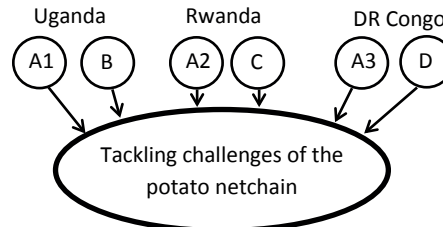
2. Methods and materials

Sub-Saharan African potato netchain case studies

We used a multi-case longitudinal design to observe the management of temporal, structural and contextual challenges in six netchains, selecting a single agricultural enterprise – potato production and marketing.

We selected the case study method since it is appropriate for addressing research in which the researcher has little or no control of events (Yin, 2003). Our case studies comprised six farmer groups (Figure 1) as part of different levels of innovation networks collectively tackling challenges of potato (*Solanum tuberosum*) netchains in south west Uganda, northwest Rwanda and eastern Democratic Republic of the Congo (DR Congo).

Three cases were smallholder farmer groups, taking part in multi-level innovation networks, that were supported by multi-stakeholder innovation platforms (MSIPs) (Figure 1, A1, A2, A3). These farmer groups were participating in the Lake Kivu Pilot Learning Site of the Sub-Saharan Africa Challenge Program (SSACP) implementing the Integrated Agricultural Research for Development (IAR4D) approach. The SSACP was conceived to implement and prove the effectiveness of IAR4D (Hawkins *et al.*, 2009), addressing interactions between agricultural productivity, natural resource management and linkages to markets (Buruchara *et al.*, 2013). Key principles of IAR4D at the time of implementation (Forum for Agricultural Research in Africa (FARA), 2007) were: (1) multisectoral, multi-institution



A1	Integrated Agricultural Research for Development (IAR4D) Bufundi sub-county, Kabale district, Uganda Farmers in <i>Bufundi United</i> Multi-Stakeholder Innovation Platform	B	Producer organisation engaged in contract farming Kamuganguzi sub-county, Kabale district, Uganda Farmers in <i>Nyabyumba</i> farmers group (previously in a Multi-Stakeholder Innovation Platform)
A2	Integrated Agricultural Research for Development (IAR4D) Gataraga sector, Musanze district, Rwanda Farmers in <i>Gataraga</i> Multi-Stakeholder Innovation Platform	C	Agricultural research for development (AR4D) Nyange sector, Musanze district, Rwanda Farmers in <i>Abahujumugambi</i> farmer association working in 3G Potato project with International Potato Center (CIP)
A3	Integrated Agricultural Research for Development (IAR4D) Kisigari <i>groupement</i> , Rutshuru <i>territoire</i> , North Kivu province, DR Congo Farmers in <i>Muungano</i> Multi-Stakeholder Innovation Platform	D	Group of smallholder farmers without formal intervention Rugari <i>groupement</i> , Rutshuru <i>territoire</i> , North Kivu province, DR Congo Farmers in <i>Gamaru</i> farmers group

Figure 1. Case studies. 3G: third generation seed.

coalition of actors; (2) non-linear collaboration among actors, in contrast to conventional agricultural R&D that is focused on technology transfer; (3) address constraints along the whole value chain; (4) multidisciplinary and participatory research process; and (5) incorporate capacity building for all actors.

The fourth case was a farmer group that participated as part of a large innovation network engaged in contract farming, with a history of involvement in a MSIP (Figure 1B). The fifth case was a large innovation network in which farmers participated in a conventional agricultural R&D intervention (Figure 1C), with the diffusion of technology by the International Potato Center (CIP). Finally the sixth case (Figure 1D) was a farmer group being part of a small innovation network, without any formal intervention. Cases B, C and D were chosen for their similarities in context and were considered in the SSACP as counter-factual sites to Cases A1, A2, and A3 respectively (Farrow *et al.*, 2013).

Tracking the roles of stakeholders tackling challenges in the innovation process

The cases represent different configurations of innovation networks, involving certain layers of the netchain. We compare the roles played in the MSIPs with the other cases with the assumption that an MSIP has more layers of the netchain and stakeholders involved in the process. Turner *et al.* (2013) suggest using qualitative approaches to study what roles are played and by whom to manage exploration and exploitation in complex settings, particularly for studies from emerging economies (Wei *et al.*, 2011).

The data collection comprised two phases, with the objective of capturing the roles of stakeholders at different phases of the innovation process. We identified challenges and described the innovation trajectories of each case to draw similarities and differences in roles in the innovation process of these networks. We complemented the primary data with project reports, institutional brochures, minutes of meetings, didactic manuals and innovation platform action plans. There was also frequent communication with stakeholders after the primary data collection phases.

First phase of data collection

In the first phase of data collection in October 2010, we conducted key informant semi-structured interviews. We asked farmers what were the main challenges that they faced in the potato netchain in their district or province. The questions were retrospective, and covered antecedents (since one of the cases had the antecedents of participation

in a multi-stakeholder platform) of the innovation process of the farmer group, and the arrangements that were made by the innovation networks until the point of time of this interview. We asked farmers which stakeholders had been playing which roles to help them to solve the main challenges in the potato netchain. Farmers mentioned the names of individuals or organisations that had been helping them to deal with challenges. We subsequently interviewed those individuals or organisations regarding the roles they had played. For all interviews we used a check list with roles extracted *a priori* from the ambidexterity literature, and augmented this list with new and more specific roles which emerged from the interviews.

Second phase of data collection

In October 2011, one year after the first phase of data collection, we convened focus groups with farmers and other stakeholders for each case. We presented the trajectory of innovation (a result of the first phase of data collection) to the focus group and discussed our description of the innovation process. We asked participants to observe the trajectory and confirm or modify the activities, challenges and the facilitation roles played by some organisations. A further aim of the second phase of data collection was to continue tracking how innovation networks had been tackling challenges since the first phase of data collection.

Analytical approaches

We used the data collected in the first and second phase of data collection to identify temporal, contextual and structural challenges in the innovation process, and the roles played to tackle them. We identified the challenges and stakeholders in each case, and tracked the most relevant roles and by whom (organisations, teams, association, individuals, etc.). We grouped the stakeholders according to their level in the netchain, and assessed how intensely each stakeholder group played a certain role, comparing differences in stakeholders and roles between the two cases in each country. We constructed an innovation trajectory with an axis representing the history through time of the producer organisation and associated innovation networks. We annotated this trajectory with the most relevant activities over the innovation process and the challenges (Van de Ven, 1999).

We used the following protocol to analyse and annotate the trajectories:

- For temporal challenges we assessed how the timing of the process was managed (or not), and by whom. We paid particular attention to the mechanisms to

foster dynamism in the process (investigating stages of exploration for creating new ways of doing things; or/and stages of exploitation for the consolidation of capabilities).

- For assessing the management of structural challenges, we tracked the roles played by stakeholders that influenced organisational relationships (ORs) and facilitated the horizontal, vertical and cross-network integration of the netchain. We indicated on the innovation trajectories the roles influencing ORs, and characterised the ORs that emerged in the innovation process according to their formality and whether they resulted in reciprocal, sequential or pooled interdependencies (Thompson, 1967) among the members of the innovation network (Table 1). Tracking the ORs at different stages of the process allows us to observe the evolution of ORs and identify exploratory and exploitative phases of the innovation process. Contractual relationships were used as indicators of informal and formal ORs in addition to project documents and the testimonies of stakeholders.

To assess the management of contextual challenges, we analysed the roles played by stakeholders to solve problems within the environment in which innovation networks were embedded, comparing in detail cases from the same contexts (countries). Ambidexterity is a capability to tackle simultaneously the dynamics of the environment and its multidimensional boundaries (cultural, political,

institutional, physical, etc.) to aim for better and amicable environment for exploration and exploitation.

3. Results

Challenges over the innovation process

Respondents reported various challenges but we found little difference between the challenges encountered by potato netchain actors in the two case studies in each country. However, there was some variation in challenges among the three different countries, and not just the contextual challenges that we had expected (Table 2).

Structural challenges common to the three countries were the lack of knowledge of natural resource and crop management, lack of technologies, and lack of information for producers on market demands and prices, all of which combined to reduce potato productivity. Farmers also reported having poor linkages to external actors or other stakeholders related to the potato netchain. Contextual challenges encountered in all three countries were the limited capacity of potato producers to access credit due to a lack of collateral and to pay back loans. Potato yields were also reduced in all three countries by diseases, with bacterial wilt (caused by *Ralstonia solanacearum*) a particular problem. Poor infrastructure was seen as a challenge in Uganda and DR Congo but less so in Rwanda where the distances to major markets were shorter and road infrastructure was

Table 1. Organisational relationships in netchains.

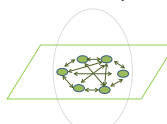
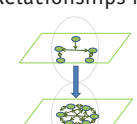
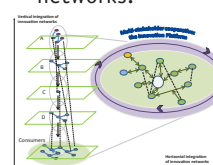
<p>A. Relationships involving stakeholders playing roles to facilitate horizontal integration of the innovation networks.</p> 	<p>We marked interdependencies as pooled (---) when there was facilitation of collaborative organisational relationships (ORs), without formal agreement, e.g. peer-to-peer collaborative relationships. We marked interdependencies as reciprocal (↔) when there was a more formal agreement, e.g. peer-to-peer lending in an agricultural cooperative (Pollet, 2009), peer-to-peer knowledge sharing in communities of practice.</p>
<p>B. Relationships involving stakeholders playing roles to facilitate vertical integration of the innovation networks.</p> 	<p>We marked interdependencies as sequential (↓) when there was facilitation of a hierarchical formal relationship among sequentially interdependent stakeholders, at different layers of the netchain. For instance, the role played by an organisation to link potato producers to potato chip processors (Cromme <i>et al.</i>, 2010).</p>
<p>C. Relationships involving stakeholders playing roles to facilitate both horizontal and vertical integration of the innovation networks.</p> 	<p>We marked simultaneous facilitation of ORs for pooled (---), sequential (↓) and reciprocal (↔) interdependencies across multi-level networks of the netchain. These relationships are commonly found in multi-stakeholder innovation platforms (Thiele <i>et al.</i>, 2011).</p>

Table 2. Challenges reported by key informants per country.

	Uganda, Kabale district: Cases A1 and B	Rwanda, Musanze district, Nord Province: Cases A2 and C	DR Congo, Rutshuru territory, North Kivu province: Cases A3 and D
Temporal challenges	<ul style="list-style-type: none"> • Delays in solving local issues affect the business performance of the potato netchain and diminish business opportunities • Comply with timing in multi-stakeholder innovation platform (MSIP) Action plans • Comply with delivery schedule as part of contract farming • React to (and anticipate) changes in local potato market requirements (e.g. size, dry matter content, harvest date) 	<ul style="list-style-type: none"> • The innovation network needed to solve issues such as lack of clean seeds in a timely manner since potatoes are a very important crop in Rwanda, main source of income for many farmers • Comply with timing in MSIP Action plans • React to (and anticipate) changes in local potato market requirements (e.g. size, quantity, harvest date) 	<ul style="list-style-type: none"> • War dictated the timing of the innovation process, stability needed for the innovation network to conduct activities in the netchain was interrupted, affecting the process and its outcomes • Comply with timing in MSIP Action plans • React to (and anticipate) changes in local potato market requirements (e.g. starch content, quality)
Structural challenges	<ul style="list-style-type: none"> • Potatoes produced and marketed by individual farmers • Farmers lack information on markets and prices • Farmers have limited bargaining power • Few initiatives to improve linkages among actors of the potato netchain • Poor farmer organisation makes collective marketing difficult • Limited physical and economic access to potato seeds and fertilisers • Limited knowledge and diffusion of soil erosion, soil fertility management and crop disease management 	<ul style="list-style-type: none"> • Potatoes marketed mainly by individual farmers • Farmers lack information on markets and prices • Farmers have limited bargaining power • Resistance to use improved potato varieties • Limited knowledge and diffusion of crop disease management • Limited access to clean potato seeds and inputs • Poor linkages to other actors of the potato netchain 	<ul style="list-style-type: none"> • Potatoes produced and marketed by individual farmers • Farmers lack information on markets and prices • Farmers have limited bargaining power • No initiatives to improve linkages among actors of the potato netchain • Poor farmer organisation makes collective marketing difficult • Limited physical and economic access to potato seeds and fertilisers • Limited knowledge and diffusion of crop management • Few netchain actors in general
Contextual challenges	<ul style="list-style-type: none"> • Competing claims on use of land • Soil infertility and erosion • Production of poor quality potatoes due to diseases • Farmers lack collateral to access credit • Farmers lack financial capacity to respond to credit • Lack of trust among local population • Corruption, governance problems • No operational policies • Poor road infrastructure and high transport costs 	<ul style="list-style-type: none"> • Land scarcity, small plots for producing potatoes • Production of poor quality potatoes due to diseases • Imbalance in bargaining power • Farmers lack collateral to access credit • Farmers lack financial capacity to respond to credit 	<ul style="list-style-type: none"> • Land scarcity, small plots for producing potatoes • Unpredictable climate • Civil war leading to forced displacement • Poverty • Low levels of trust • Soil erosion • Production of poor quality potatoes due to diseases • Farmers lack collateral to access credit • Farmers lack financial capacity to respond to credit • Poor reputation of potatoes from this area • No access to ICTs like mobile phones • Corruption, governance problems • No written policies • Poor road infrastructure and high transport costs
Favourable contextual conditions and opportunities	<ul style="list-style-type: none"> • Microfinance facilities like Savings and Credit Cooperatives (SACCOS) • Written policies • Connectivity of farmers using mobile phones • Cross-border trade with Rwanda and East African Common Market 	<ul style="list-style-type: none"> • Organised farmers, cooperatives (e.g. Imbaraga) • Increasing financial opportunities • Access to technologies and inputs, coordinated through farmer groups (e.g. Imbaraga national federation) • Policies written and more operational • Government tackling corruption • Good infrastructure, no high transport costs • Connectivity of farmers using mobiles phones • Cross-border trade with Uganda and East African Common Market 	<ul style="list-style-type: none"> • Market opportunities in Kinshasa due to large population and high prices of potatoes • Cross-border trade with Uganda and Rwanda and East African Common Market

better. Regarding temporal challenges, timing problems were not mentioned by the respondents, but we observed that dynamic markets and changing consumer demands were temporal challenges in the potato netchains in both Uganda and Rwanda. We now discuss the challenges that were particular to each country.

Challenges in Kabale district, Uganda

In Uganda the challenges of managing the timing of the innovation process were intrinsically linked to the need to successfully address local contextual challenges. In Nyabyumba (B) the temporal challenge for farmers was to produce sufficient quality and quantity of potatoes at specific times to comply with the terms of a contract with a restaurant chain. Producers in Bufundi United (A1) faced a similar temporal challenge to produce specific quantities at specific times for a potato distributor.

A structural challenge that affected both cases at the beginning of their innovation trajectories was that farmers were not working collectively for producing and marketing potatoes, and they were not organised as a producer organisation.

Contextual challenges particular to Uganda were of an institutional nature like competing claims for land between agriculturalists and livestock owners (in Bufundi United), as well as the lack of implementation of national policies and local bylaws on potato disease mitigation. However, other contextual conditions were favourable for innovation like the opportunities afforded by the East African Common Market, the existence of national policies that support modernisation in agriculture (Asiimwe and Nakanyike, 2007) (despite poor operationalisation), the existence of microfinance facilities like Savings and Credit Cooperatives (SACCOS) and a good ICT infrastructure that facilitated the connectivity of farmers with the use of mobile phones (Asiimwe and Nakanyike, 2007).

Challenges in Musanze district, Rwanda

Potato is a very important crop in northern Rwanda, and the main source of income for many farmers. Temporal challenges revolved around the need of farmers to resolve the lack of clean seeds and other issues in a timely manner to comply with markets and consumer demands.

Farmers faced fewer structural challenges than in Uganda due to their membership of farmer associations which provided access to training and technical support. Association membership was a common channel for farmers

to access land and other benefits from the government and non-governmental organisations (NGOs) (Bingen and Munyankusi, 2003). A comparative advantage for Rwandese farmers was a strong national umbrella farmer federation (Imbaraga) that supported farmers, as part of an important presence of the cooperative movement in this country (Pollet, 2009). In common with Ugandan farmers, a crucial structural challenge that hindered the possibility for farmers to make potatoes a successful enterprise was not having access to technologies, particularly clean (i.e. disease-free) seeds, that resulted in the production of poor quality potatoes. Land scarcity, with small plots for producing potatoes was a particular contextual challenge in Rwanda and implied that some form of collective action was required to aggregate production to meet market and transporter demands.

Challenges for in Rutshuru province, Democratic Republic of Congo

The cases in DR Congo were examples of resilient innovation networks to cope with more complex challenges compared to Uganda and Rwanda. In DR Congo, temporal challenges were dominated by the stages of the civil war that highly affected collective efforts. In the first phase of data collection, farmers mentioned that they were in a post-war period, restarting farming activities. In 2012, the war started again and farmers were displaced to neighbouring countries.

For both the Muungano (A3) and the Gamaru (D) farmer groups the conditions were very complex and sub-optimal for making the potato enterprise a success. The main contextual challenge was the civil war and a lack of trust, which also caused structural challenges affecting the organisation and stability of the innovation network. The poor reputation of potatoes was a contextual challenge that reduced the bargaining power of farmers to negotiate the price with traders from the nearest city of Goma. Nevertheless, farmers had some opportunities to explore the market in Kinshasa (the capital city of DR Congo), where potatoes were expensive and considered a luxury. Local processors were interested in buying potatoes from smallholder farmers to exploit this market opportunity, but bad roads and long distances to transport to Kinshasa hindered this business option.

Roles by stakeholder to tackle challenges over the innovation process

Ambidexterity is the dynamic capability to manage temporal, structural and contextual challenges that exploration and exploitation entail in practice. Consequently, for both

potato netchains in each country we observed which kinds of stakeholders played which roles to tackle challenges.

We first refer to a summary showing the intensity of the activity for each stakeholder group, followed by an analysis of the innovation trajectory and the roles of different stakeholders. Intensity is determined by whether a particular role is a core activity or responsibility of a particular stakeholder group, or only a side activity; the tones of grey in Tables 2, 3 and 4 relate to the average intensity for all stakeholders in a particular stakeholder group. Dark grey signifies that the role is core for all stakeholders in the group, and white signifies that none of the stakeholders in the group play that particular role.

Stakeholder roles in Kabale district, Uganda

Potato netchains in Bufundi United (A1) and Nyabyumba (B) comprised nine and eight stakeholder groups of the potato netchain respectively, with similar configurations of stakeholders participating in multi-stakeholder platforms (Table 3). The MSIP fora coordinated the activities playing multiple roles with high intensity. Each forum orchestrated the roles played by stakeholders in a participatory and collective manner, taking into account the specialisation of stakeholders in certain roles, e.g. sharing information by the data manager in Bufundi United, or formalisation of agreements by the retailer and service provider in Nyabyumba. Some roles, like implementing innovations and lending capital for innovations were not played directly by the MSIP but facilitated to be played by specialist stakeholders.

All of the *a priori* identified roles were played by at least one stakeholder in Bufundi United, while in Nyabyumba there was no stakeholder lending capital, and only low intensity by farmers to implement innovations. This is due to the longer trajectory that had previously taken place in Nyabyumba. Nyabyumba farmers were in another stage of the innovation process, mainly exploiting their capabilities doing contract farming. Therefore they had fewer connections to other stakeholders of the netchain compared to when they were part of the Enabling Rural Innovation Consortium, and also less emphasis on the participatory decision making role.

For overcoming temporal challenges, the management design of the IAR4D intervention in Bufundi United included monthly meetings of the MSIP to discuss challenges, develop action plans and re-frame these according to new developments. This timing of the innovation process fostered simultaneously stability and

consolidation of capabilities (exploitation), and also exploration. A monitoring and evaluation committee was in charge of tracking the process. Similarly, the Nyabyumba farmers managed their timing when part of the Enabling Rural Innovation (ERI) consortium (Figure 2). Before 2003 their timing was managed by previous interventions. When consolidating as a business network, their timing was coordinated according to the contracts with the retailer, for the delivery of potatoes in a timely manner.

To manage structural challenges, the Bufundi United MSIP and the Nyabyumba ERI consortium (a non-IAR4D MSIP) played similar facilitation roles. At the beginning of the innovation process of Nyabyumba farmers (Figure 2), there was scattered marketing of potatoes, followed by collective production and marketing of potatoes as part of a Farmer Field School initiative. These farmers had therefore already developed some organisational and other capabilities when they became part of the ERI consortium, and after one year they had explored market opportunities and signed a contract to supply a restaurant chain. Farmers in Bufundi in contrast had little experience of collective marketing and production when they were invited to participate in the IAR4D MSIP (Figure 3). In both cases the MSIP played the role of organising small innovation networks as teams or communities of practice for crop management and exploring new ways to organise the potato netchain. At this point in the trajectory a lack of linkages to other stakeholders was a structural challenge because the horizontal integration of the innovation network was insufficient to overcome collective contextual challenges like seed potatoes free of bacterial wilt. The roles of research organisations, extension agents and seed producers were crucial in the facilitation of clean seeds, training and linking farmers to other stakeholders. Researchers also trained the Bufundi United producers in value addition technologies and coordinated the Open Distance Learning Network for farmers to access information using mobile phones and share information on prices and markets. The situation in Nyabyumba was slightly different because the farmers managed the innovation process themselves and emphasised the important proactive leadership role played by the president of the farmer association in collaboration with farmer committee members in linking with relevant actors when needed. In both cases, a combination of reciprocal, sequential and pooled ORs were observed over time with stakeholders at various levels (Figure 2 and 3).

Innovation networks were consolidated into business networks in both cases, and after developing their organisational, knowledge, natural resource management and production capabilities Nyabyumba farmers became

Table 3. Roles played by stakeholder groups in the Bufundi United MSIP and the Nyabyumba cases in Uganda.^{1,2}

Roles	Stakeholder groups (# of stakeholders)																
	A1 – Bufundi United							B – Nyabyumba									
	MSIP forum (4)	Farmer (10)	Distributor/wholesaler (2)	Researcher (2)	Policy maker (1)	Seed processor (1)	SSACP data manager (1)	SSACP task force leader (1)	Financial service provider (1)	ERI consortium (1) (2003)	Farmer (13)	Researcher (1)	Seed producer (1)	Extension agent (1)	Retail/food outlet/processor (1)	Service provider (1)	Farmer association (2)
Develop action plan collectively	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark
Follow up and re-frame plans	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark
Participatory decision making	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark
Administrative management	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark
Explore innovations collectively	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark
Share information	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark
Share knowledge	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark
Facilitate communication among actors	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark
Build network for innovation	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark
Invite new stakeholders	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark
Link relevant stakeholders	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark
Match common interests	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark
Facilitate access to technological innovations	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark
Implement innovations	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark
Link farmers to markets	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark
Add value to products and/or services	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark
Formalise agreements	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark
Diagnose challenges	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark
Mediate in conflicts	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark
Lend capital for innovations	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark
Design rewards and sanctions	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark
Influence policies	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark

¹ Different tones of grey represent the intensity of how the roles are played to tackle temporal, structural and contextual challenges.

² ERI: Enabling Rural Innovation; MSIP: multi-stakeholder innovation platform; SSACP: Sub-Saharan Africa Challenge Program.

part of a Saving and Credit Co-operative Society (SACCO). In order to grow their business capacity and overcome the contextual challenge of accessing credit the Bufundi United MSIP made an innovative cross-boundary partnership with a financial organisation from DR Congo. A major contextual challenge was the competing claims on land use with pastoralists and potato growers. The MSIP mediated to solve the conflict and played an advocacy role in the process of writing by-laws. However, the mediation was not effective

since more operational decisions needed to be made by higher government representatives to solve the conflict.

Stakeholder roles in Musanze district, Rwanda

Potato netchains in Gataraga (A2) and Nyange (C) were composed of nine and three netchain stakeholder groups respectively (Table 4). The Gataraga netchain covered a diverse group of stakeholders and the role of lending capital was not played by a Rwandese stakeholder, but instead by

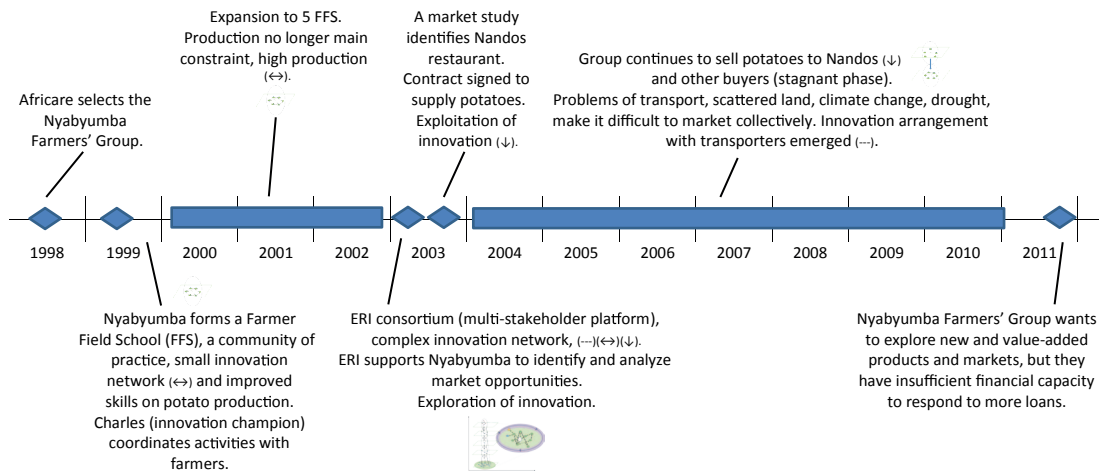


Figure 2. Innovation trajectory of the Nyabyumba group (B). ERI: Enabling Rural Innovation

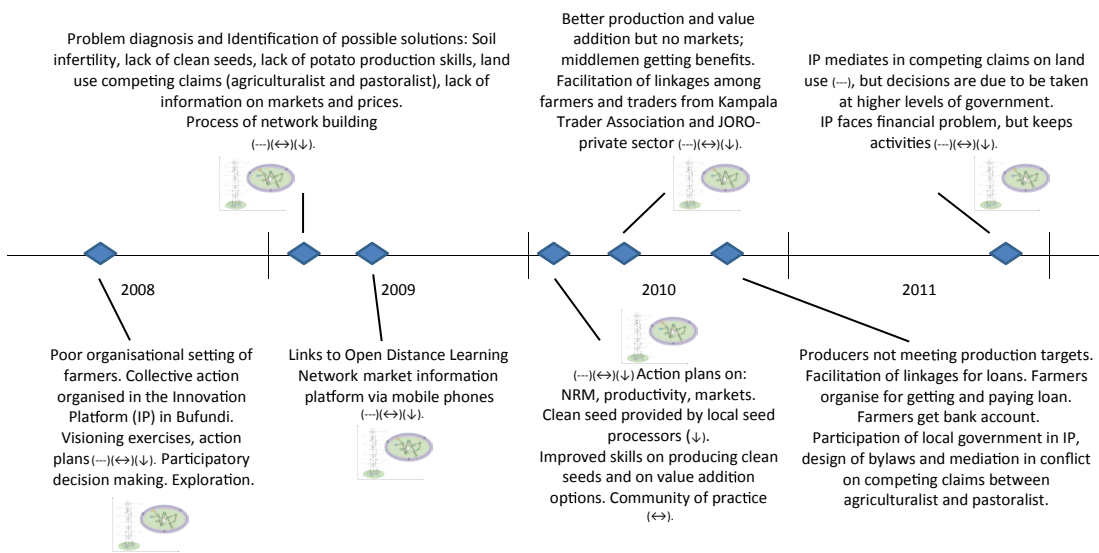


Figure 3. Innovation trajectory of the Bufundi United multi-stakeholder innovation platform (A1). NRM: Natural resource management.

MECREGO a partner organisation of the MSIP from DR Congo. In contrast in Nyange there were far fewer roles that were played and more effort was directed by stakeholders at implementing innovations. Many roles were played by the forum of the Gataraga MSIP, but in both cases the extension agent was dominant in sharing knowledge and information, with the agent being particularly important in Nyange for facilitating communication and network building. Private sector processors and retailers collaborated strongly in Gataraga for linking farmers to markets and subsequently formalising agreements. Abahujumugambi farmers in Nyange took fewer roles than in Gataraga and were more focused on exploring innovations collectively, implementing

innovations, sharing knowledge and sharing information, using the didactic materials in the local language developed by CIP.

Temporal challenges were managed differently in the two Rwandan potato netchains. In Gataraga the stages of exploration and exploitation were fostered simultaneously and there were action plans which were reviewed and adjusted every month. Abahujumugambi farmers in Nyange were participating as part of a conventional agricultural R&D approach, focused on the diffusion of the positive selection technology (Figure 4) to address the contextual challenge of lack of clean seeds. Consequently, this R&D intervention

Table 4. Roles played by stakeholders in the Gataraga MSIP and the Abahujumugambi cases in Rwanda.^{1,2}

Roles	Stakeholder groups (# of stakeholders)											
	A2 – Gataraga					C – Abahujumugambi						
	MSIP forum (5)	Farmer (6)	Distributor/wholesaler (1)	Researcher (1)	SSACP national data manager (1)	SSACP task force leader (1)	Retail/food outlet/processor (1)	Extension agent (1)	Financial service provider (1)	Farmer (27)	Researcher (1)	Extension agent (1)
Develop action plan collectively	Dark	Light	Light	Light	Light	Light	Light	Light	Light	Light	Light	Light
Follow up and re-frame plans	Dark	Light	Light	Light	Light	Light	Light	Light	Light	Light	Light	Light
Participatory decision making	Dark	Light	Light	Light	Light	Light	Light	Light	Light	Light	Light	Light
Administrative management	Light	Light	Light	Light	Light	Light	Light	Light	Light	Light	Light	Light
Explore innovations collectively	Dark	Light	Light	Light	Light	Light	Light	Light	Light	Light	Light	Light
Share information	Light	Light	Light	Light	Light	Light	Light	Light	Light	Light	Light	Light
Share knowledge	Light	Light	Light	Light	Light	Light	Light	Light	Light	Light	Light	Light
Facilitate communication among actors	Dark	Light	Light	Light	Light	Light	Light	Light	Light	Light	Light	Light
Build network for innovation	Dark	Light	Light	Light	Light	Light	Light	Light	Light	Light	Light	Light
Invite new stakeholders	Dark	Light	Light	Light	Light	Light	Light	Light	Light	Light	Light	Light
Link relevant stakeholders	Dark	Light	Light	Light	Light	Light	Light	Light	Light	Light	Light	Light
Match common interests	Dark	Light	Light	Light	Light	Light	Light	Light	Light	Light	Light	Light
Facilitate access to technological innovations	Dark	Light	Light	Light	Light	Light	Light	Light	Light	Light	Light	Light
Implement innovations	Light	Light	Light	Light	Light	Light	Light	Light	Light	Light	Light	Light
Link farmers to markets	Dark	Light	Light	Light	Light	Light	Light	Light	Light	Light	Light	Light
Add value to products and/or services	Dark	Light	Light	Light	Light	Light	Light	Light	Light	Light	Light	Light
Formalise agreements	Dark	Light	Light	Light	Light	Light	Light	Light	Light	Light	Light	Light
Diagnose challenges	Light	Light	Light	Light	Light	Light	Light	Light	Light	Light	Light	Light
Mediate in conflicts	Dark	Light	Light	Light	Light	Light	Light	Light	Light	Light	Light	Light
Lend capital for innovations	Light	Light	Light	Light	Light	Light	Light	Light	Light	Light	Light	Light
Design rewards and sanctions	Dark	Light	Light	Light	Light	Light	Light	Light	Light	Light	Light	Light
Influence policies	Dark	Light	Light	Light	Light	Light	Light	Light	Light	Light	Light	Light

¹ Different tones of grey represent the intensity with which the roles are played to tackle temporal, structural and contextual challenges.

² MSIP: multi-stakeholder innovation platform; SSACP: Sub-Saharan Africa Challenge Program.

design had a fixed and short-term agenda with an emphasis on developing and exploiting capabilities for implementing a specific technology to tackle a specific challenge.

The structure of the netchain in Nyange was limited to just three levels of stakeholder groups, with a community of practice of farmers (horizontal integration) integrated vertically to a lead organisation (CIP) via an extension agent. No linkages to markets were being facilitated and innovation networks were not consolidated into business

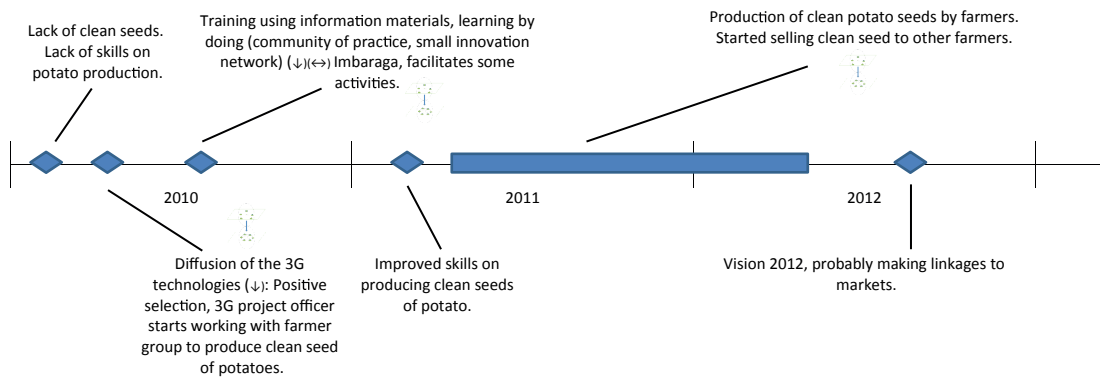


Figure 4. Innovation trajectory of the Abahujumugambi group (C). 3G: third generation seed.

networks, with just a handful of farmers selling clean seeds to their neighbours. The structural challenges of lack of access to technologies and inputs were being successfully tackled, but there was no attempt, or remit, to address the lack of information on markets and prices. Farmers in Gataraga also benefitted from training in positive selection technology (Figure 5), using the specialised knowledge and didactic materials of CIP, but the MSIP forum was particularly active in linking farmers to markets and other stakeholders. Farmers were introduced to ‘e-soko’, a mobile-phone information and communication system used to access market information, and were successfully consolidated into business networks selling potatoes to hotels and the Nakumati supermarket in Kigali. The MSIP enhanced their capacity to monitor their own progress and evaluate themselves, and to keep track of information in the MSIPs, by keeping records on productivity and profit,

as part of a data management strategy facilitated by the national data manager and the monitoring and evaluation committee.

A local extension agent who facilitated activities in the Gataraga MSIP co-operated with farmers to explore and design the packaging of potatoes using no-cost locally sourced banana fibre, a value addition that urban consumers were willing to pay for. The roles of community champions were also very important in Gataraga where a female champion farmer became a trader and overcame contextual challenges of land scarcity by aggregating potatoes from 300 participating farmers, gaining bargaining power and better prices for all producers.

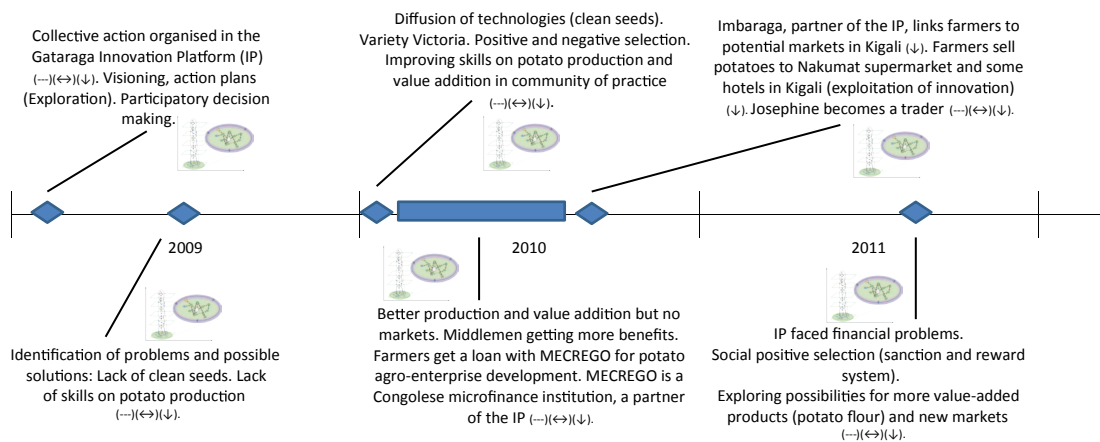


Figure 5. Innovation trajectory of the Gataraga multi-stakeholder innovation platform (A2).

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Stakeholder roles in Rutshuru territoire, Democratic Republic of the Congo

We observed that farmers of the Gamaru group (D) were not connected to external stakeholders (Table 5) apart from an extension agent, a member of the local-small innovation network, who facilitated collective action to

tackle challenges. Farmers commented that, given the tense environment in Rutshuru, it was difficult to attract other service providers willing to work in the area. In contrast the Muungano farmers in Kisigari (A3) were connected to diverse stakeholders at nine netchain levels. As in Uganda and Rwanda, the MSIP forum orchestrated the facilitation and roles played by stakeholders. The forum played roles

Table 5. Roles played by stakeholders in the Gamaru farmer group and the Muungano MSIP cases in Democratic Republic of Congo.¹

Roles	Stakeholder groups (# of stakeholders)										
	A3 – Muungano								D – Gamaru		
	MSIP forum (4)	Farmer (5)	Farmer union (1)	Researcher (1)	SSACP national data manager (1)	Financial service provider (1)	Extension agent (2)	Retail/food outlet/processor (1)	Local NGO (Diobass) (2)	Farmer (7)	Extension agent (1)
Develop action plan collectively	■	■									
Follow up and re-frame plans											■
Participatory decision making											■
Administrative management	■										
Explore innovations collectively	■										■
Share information	■			■	■		■				■
Share knowledge	■										■
Facilitate communication among actors	■			■							
Build network for innovation	■										
Invite new stakeholders										■	
Link relevant stakeholders											■
Match common interests											
Facilitate access to technological innovations	■			■							
Implement innovations											
Link farmers to markets	■	■								■	■
Add value to products and/or services	■										
Formalise agreements	■					■		■			
Diagnose challenges	■			■						■	■
Mediate in conflicts	■									■	■
Lend capital for innovations						■					
Design rewards and sanctions	■	■			■		■	■	■		
Influence policies	■	■	■								

¹ Different tones of grey represent the intensity with which the roles are played to tackle temporal, structural and contextual challenges.

² MSIP: multi-stakeholder innovation platform; SSACP: Sub-Saharan Africa Challenge Program.

for sharing information and knowledge, facilitated by the SSACP national data manager, who requested the cooperation and facilitation of other more specialised stakeholders when needed (for instance, extension agents for the diffusion of technological packages). Financial services were provided and agreements formalised with end users. Specialised service providers in the MSIP played direct roles in the netchain like a financial service provider (MECREGO), which provided loans to farmers not only in the Muungano MSIP in DR Congo but also to MSIPs in Uganda and Rwanda. Roles played by stakeholders were facilitated at a national level by an NGO (Diobass), which centralised the resources and services for farmers. A farmer union for the advocacy of farmer rights (Sydip) played an important role in organising farmers for collective marketing.

Middlemen were a type of service provider mentioned, with whom farmers made linkages. Sometimes the bad reputation of potatoes from Rutshuru was used for opportunistic behaviour.

For the famers in Gamaru, there was no strategy to manage timing, and decisions were dictated by the civil war; in periods of relative peace farmers kept exploring new ways of doing things in their community of practice. In the Muungano MSIP the stages of exploration and exploitation were fostered simultaneously and there were actions plans for tackling challenges, these plans were reviewed and adjusted every month.

Low levels of trust and high migratory movements made it difficult for the Gamaru farmers to overcome the structural challenges of poor organisation of farmers to improve production and to make potatoes a business. Farmers in Gamaru had been growing potatoes individually just for

subsistence and working in isolation. Production, natural resource management, crop management, and marketing practices were based on individual exploration and tradition, and were limited by a lack of agricultural inputs such as clean seeds. Being organised as a group or team was important to tackle contextual challenges but external facilitation was not given, even in the post-war period (in 2010). Farmers said that an extension agent used to go to the province but that because of the war people no longer received visits; they therefore relied on the knowledge shared by a local leader, an agronomist (Figure 6) and their peers. However, farmers were unable to overcome challenges like soil erosion, and access to clean seeds and other inputs.

The facilitation of the Kisigari MSIP was important for tackling structural challenges and the MSIP helped to rebuild social structures after the war by connecting various stakeholders in DR Congo and regionally. In common with the MSIPs in Uganda and Rwanda, linkages were facilitated between farmers and stakeholders at different layers of the netchain (Figure 7). Diobass, a NGO, played important roles helping farmers in Kisigari to tackle structural challenges in the Muungano MSIP, and organising the farmers to produce and market potatoes collectively in collaboration with other stakeholders. For instance, INERA, SYDIP (farmer union), CIAT-TSBF (International Research Center for Tropical Agriculture), the Goma Volcano Observatory and Diobass worked together to help farmers improve their production and post-harvest management of potatoes, for complying with quality and quantity standards. Farmers also got access to technologies for improving the productivity of potatoes, like clean seeds (variety *Victoria*) and were trained in crop management.

Lack of information on markets and prices was a structural challenge that was only partially solved in the MSIP. Farmers

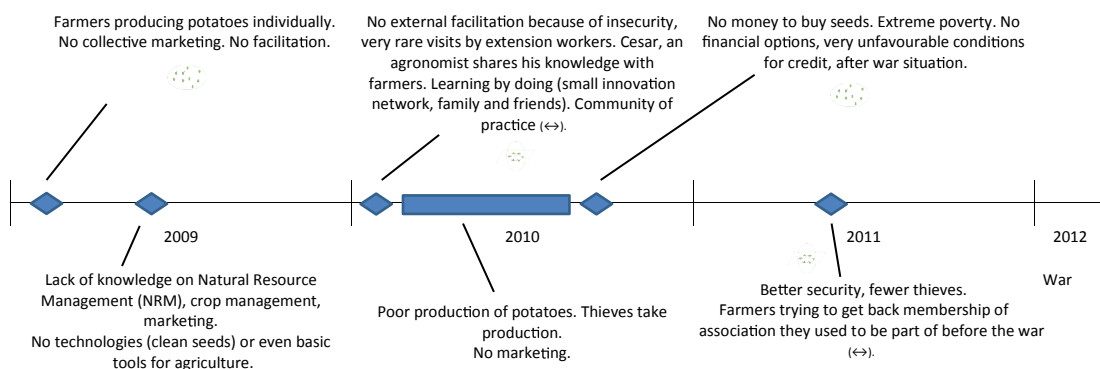


Figure 6. Innovation trajectory of the Gamaru farmer group (D).

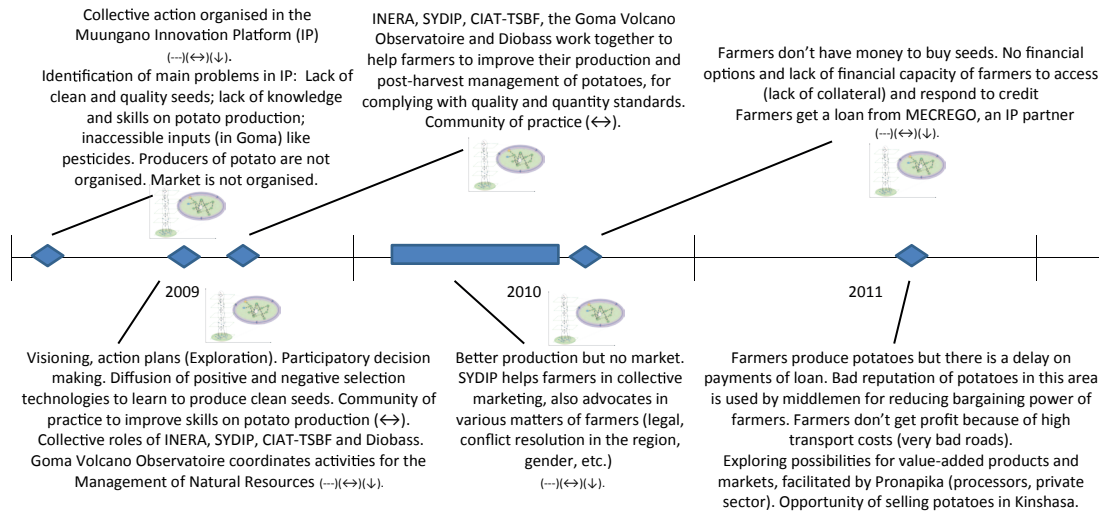


Figure 7. Innovation trajectory of the Muungano multi-stakeholder innovation platform (A3).

could not afford ICTs like mobiles phones hindering price negotiations with middlemen and reducing the bargaining power of farmers. The innovation networks did not succeed as business networks in the potato netchain, mainly because of the effects of the civil war but also because of other factors like the poor road infrastructure, which together hindered the exploitation of the business opportunities that arose with local processors. Finally, in 2012 the war started again and many farmers were displaced to Uganda and other neighbouring countries.

4. Discussion and conclusions

We have presented what roles are played and by whom to foster ambidexterity in netchains for tackling challenges faced by smallholder farmers in Sub-Saharan African countries. We have identified traditional roles played by traditional actors, but we have also identified how roles are played by civil society actors, which reflects the new dynamics of how exploration and exploitation are organised in the open innovation paradigm. Innovation networks offer new ways of producing knowledge and allow diverse stakeholders to tackle the contextual, structural and temporal challenges faced by smallholder producers and other stakeholders in Sub-Saharan Africa. Roles played by a diversity of stakeholders working in synergy for collaboration and cooperation within the netchain fostered multiple capabilities of the innovation network, particularly in MSIPs. We have shown that ambidexterity was a dynamic managerial capability of innovation networks in MSIPs in the potato netchain. This ambidexterity implied facilitation and design of management mechanisms to balance

simultaneously exploration (of issues related to crop and disease management for instance) and exploitation (e.g. bulking, grading and packaging). Orchestrating collective action among the multiple levels of the netchain required a dynamic meta-governance of the innovation networks. The outcomes of the facilitation and management generally resulted in the solution of various collective issues and in some cases in the consolidation of business networks and the emergence of multi-stakeholder cooperatives (Figure 8).

Management designs for tackling collective challenges

From the major characteristics of our six case studies (Table 6) we can identify three types of management designs of innovation networks for tackling collective challenges. The management design reflects and limits the complexity of the challenges that netchains face:

1. Exploratory or exploitative management designs for small innovation networks, which foster mainly knowledge and information-sharing capabilities (Case D Table 6). We found that in contrast to other experiences in developed countries (e.g. Gilsing and Nooteboom, 2006) small innovation networks are not just for exploration. The small networks can be exploitative when members sustain mutual interdependence, for instance, at the farmer level in the cases of (MSIPs), farmers united with their peers to work as collateral to obtain credit from a financial institution (Cases A1, A2, A3 Table 6). Roles are mainly played by leaders, champions and teams (i.e. communities of practice) for exploring (informally) or for exploiting (formally) the capabilities.

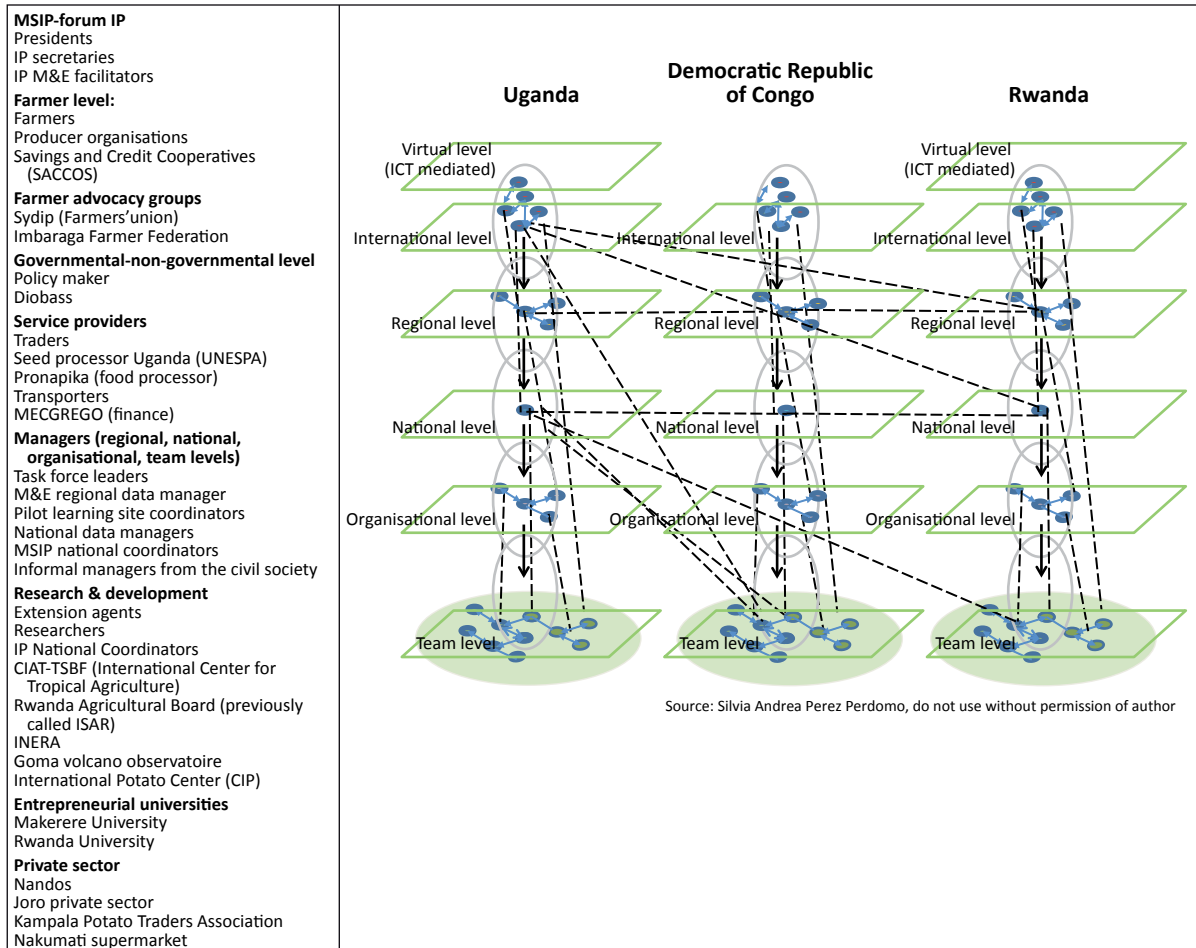


Figure 8. Pooled, reciprocal and sequential interdependencies among stakeholders at various levels in emergent multi-stakeholder cooperatives. MSIP: multi-stakeholder innovation platform.

For tackling structural challenges, leaders or champions organise activities for strengthening reciprocal interdependencies among members of the innovation network (horizontal integration of the innovation networks), who are generally members of the family and neighbours. The management structure of the network is democratic and horizontal. The role of teams was important for exploring new ways of doing things and learning, but also to exploit the capabilities of the small innovation networks of peers or communities of practice at the beginning of the innovation process for organising for collective action.

However, despite the important role of teams and local leadership for exploring new ways of doing things, too much exploration without facilitation and proper management just makes farmers stagnant in the cycle of innovation, reinforcing the circle of poverty. The problem

with this mode of management for structural challenges is that these small networks do not have the capacity to comply with high production volumes generally demanded to benefit from economies of scale.

Temporal challenges in this design are managed in a flexible sometimes very resilient manner, without action plans or set goals that orient collective action. Similarly, contextual challenges are managed with little planning or possibility of mitigation (for instance, by changing policies), and collective efforts are mainly focused on adaptation and exploring new ways of doing things, which is insufficient to consolidate business opportunities.

2. Exploitative management designs for larger networks are for exploiting the capabilities and scaling innovations, in a more formal manner, generally (but not necessarily) consolidated in written agreements. This management

Table 6. Summary of major characteristics of potato netchain case studies.

	A1 – Bufundi United	A2 – Gataraga	A3 – Muungano	B – Nyabyumba	C – Abahujumugambi	D – Gamaru
Stakeholders involved: netchain levels	<ul style="list-style-type: none"> MSIP forum Producer organisation Traders Service providers Extension agents Retail/food outlet/processor Entrepreneurial university Researchers IAR4D Policy maker National and regional task force leaders (managers) Informal managers civil society Other partner organisations 	<ul style="list-style-type: none"> MSIP forum Producer organisation National farmer federation Traders Financial service provider Extension agents Retail/food outlet/processor Entrepreneurial university Researchers IAR4D National and regional task force leaders (managers) Informal managers civil society Other partner organisations 	<ul style="list-style-type: none"> MSIP forum Producer organisation Traders Financial service provider Extension agents Retail/food outlet/processor Local NGO Researchers IAR4D National and regional task force leaders (managers) Informal managers civil society Other partner organisations 	<p>MSIP in 2003</p> <ul style="list-style-type: none"> ERI Consortium-platform Non-governmental organisation Producer organisation Researchers ERI Project managers Informal managers (civil society) Other partner organisations Retailer 	<p>2010-2011 Contract farming</p> <ul style="list-style-type: none"> Producer organisation SACCO Informal managers (civil society) Transporter Retailer 	<ul style="list-style-type: none"> Farmers Extension agent Researcher Farmers Extension agent Farmer
Main roles	<ul style="list-style-type: none"> Multiple roles of stakeholders, collective actions orchestrated by forum of MSIP 	<ul style="list-style-type: none"> Multiple roles of stakeholders, collective actions orchestrated by forum of MSIP 	<ul style="list-style-type: none"> Multiple roles of stakeholders, collective actions orchestrated by forum of MSIP 	<ul style="list-style-type: none"> Multiple roles of stakeholders, collective actions orchestrated by forum of MSIP 	<ul style="list-style-type: none"> Sharing information, sharing knowledge; implementing innovations (technological packages) Linking farmers to markets; formalisation of agreements 	<ul style="list-style-type: none"> Sharing information, sharing knowledge, implementing innovations (technological packages) Exploring new ways of doing things collectively, sharing knowledge
Main challenges tackled	<ul style="list-style-type: none"> Tackling simultaneously temporal, structural and contextual challenges 	<ul style="list-style-type: none"> Tackling simultaneously temporal, structural and contextual challenges 	<ul style="list-style-type: none"> Tackling simultaneously temporal, structural and contextual challenges 	<ul style="list-style-type: none"> Tackling simultaneously temporal, structural and contextual challenges 	<ul style="list-style-type: none"> Mainly structural and contextual 	<ul style="list-style-type: none"> Mainly contextual Mainly structural-related challenges
Challenges not tackled	<ul style="list-style-type: none"> Contextual – competing claims Structural – vertical integration with higher level decision makers 	<ul style="list-style-type: none"> Contextual – sporadic challenges of meeting quantity and quality demands Vertical integration – strengthen ties with clean seed suppliers 	<ul style="list-style-type: none"> Contextual – satisfying quantity and quality demands Vertical integration with higher level decision makers to ensure security Horizontal integration with more producers 	<ul style="list-style-type: none"> Structural – sub-optimal transportation 	<ul style="list-style-type: none"> Contextual – sporadic challenges of meeting quantity and quality demands Vertical integration – strengthen ties with research 	<ul style="list-style-type: none"> Temporal, little vertical integration, many contextual challenges Temporal timeframe limited by R4D intervention Structural – no links to markets

¹ ERI: enabling rural innovation; IAR4D: integrated agricultural research for development; MSIP: multi-stakeholder innovation platform.

design involves planning to reach some specific goals such as the diffusion of a technology in the case of Abahujumugambi farmers, or for complying with production and quality demands in the case of contract farming of Nyabyumba (Cases B, C Table 6). Although agricultural R&D approaches have been criticised for their linearity, we found that the roles of specialised stakeholders are key to solving specific challenges and linearity is sometimes needed to scale-out innovation. In the other cases we also observed that tackling some structural or contextual challenges requires a leading specialised stakeholder. For instance, if the challenge is lack of credit a financial institution – whether a Savings and Credit Cooperative in Uganda or a private sector actor in DR Congo – plays the Lending capital role since that is its core function. Implementing innovations is a role mainly played by research organisations – like KAZARDI in Uganda, CIP in Rwanda and INERA in DR Congo – that are specialised in the diffusion of technologies. Given the specialised character of an exploitative management design, stakeholders do not necessarily play roles that are beyond their core function to help tackle other challenges.

In this management design, temporal challenges are managed generally in a fixed and short-term agenda, according to established formal agreements among parties.

Structural challenges are tackled by fostering not only the horizontal, but also the vertical integration of the innovation network. The organisation of these larger networks corresponds to the traditional management structure of the specialised organisation, such as agricultural extension or a financial organisation, with a hierarchical management structure. There are no further linkages to other stakeholders, implying less new knowledge and innovation to trigger exploration.

3. Ambidextrous management designs for multi-level networks are required for the simultaneous exploration of synergies and exploitation of capabilities. This management design entails a simultaneous management of structural, contextual and temporal challenges at multiple levels, as observed in the case of MSIPs (Table 6 Cases A1, A2, A3 and B, in 2003). In this design farmers are linked to more diverse stakeholders and farmers grow their capabilities by being facilitated by managers that contribute to keeping the innovation process dynamic. To tackle temporal challenges stakeholders must play roles that maintain innovation processes in stages of stability and also in stages of change-flux, keeping the innovation process in a 'dynamic-stability'. For temporal challenges, it is important to have a management design that fosters the exploration of new ways of doing things

when the innovation process stagnates, and fosters stages of stability when the innovation process needs to consolidate. Complex challenges require management over short-, medium- and long-term timeframes. In contrast, in the cases without MSIPs there was still a need to manage the timing of activities, although the lack of a platform of diverse stakeholders limited these netchains to tackle specific challenges and kept them in explorative (Gamaru, DR Congo) or exploitative (Abahujumugambi, Rwanda) stages of the innovation process. Monitoring and evaluation of the innovation process is an important strategy in MSIPs for managing the timing of activities and avoiding stagnation of the process. Specific roles played by stakeholders to keep the dynamism of the innovation process (temporal mobility) were: developing collectively action plans, follow-up and frequent (monthly) re-framing of plans, and participatory decision making.

In MSIPs, innovation networks for exploration and exploitation are orchestrated dynamically by a forum, which democratically decides which stakeholders should play which roles for tackling which challenges, organising the netchain through hybrid managerial designs over the innovation process. Different organisations lead the innovation process at different stages according to the challenges for the exploration and exploitation of capabilities of the innovation network.

A common structural challenge in the three countries was the poor linkages between farmers and other stakeholders of the netchain. For tackling such structural challenges, network building for innovation, matching common interests, inviting new stakeholders, and linking farmers to markets, were important, which fostered horizontal, vertical and cross-network integration of the innovation network.

At the beginning of most of the trajectories a general problem was how to enhance the organisational capabilities of farmers, particularly when they were not organised as a farmer group. Then, the facilitation by community leaders and champions of activities for strengthening their reciprocal interdependencies as part of the horizontal integration of the innovation networks was vital, especially for farmers in DR Congo. The role of teams was also important for exploring new ways of doing things and learning, but also to exploit the capabilities of the small innovation networks at the beginning of the innovation process for organising collective action (exploratory-exploitative management design for small innovation networks). Horizontal integration via the organisation and mobilisation of communities of practice at different network levels also enhances the movement of knowledge, even leading to the formation of virtually

mediated communities of practice using information and communication technologies (ICTs, mainly mobile phones) in combination with traditional communication media.

For fostering the vertical integration in the netchain, there was again a need for some specialised stakeholders leading the process of tackling specific challenges (exploitative management design). For instance, lending capital for innovation was a role which was not directly played within the MSIP in Uganda and Rwanda (Cases A1, and A2), but instead by a financial institution partner of the MSIP in DR Congo (A3). Lending capital for innovation was crucial given that without investment in services and inputs (e.g. seed), producers would be unable to develop their self-help entrepreneurial capabilities. Another leading role was played by universities (like Makerere in Uganda and Rwanda National University), facilitating access to technological innovations, showing a shift in their traditional roles, and emerging as entrepreneurial universities (Ambos *et al.*, 2008).

Cross-network integration was observed in all of the cases with MSIPs, with simultaneous pooled, reciprocal and sequential interdependencies among stakeholders at various levels (Figure 8). The organisations that play these roles can be from different netchain layers according to the composition of the netchain, and the specific roles vary according to the context and the maturity of the network. Network building for innovation, inviting new stakeholders, linking relevant stakeholders and linking farmers to markets are roles that foster cross-network integration.

In relation to roles tackling structural challenges, we found that stakeholders had different incentives for participating in the innovation process so that aligning efforts for collective action was complex. For instance, a seed processor in Uganda manifested his interest in participating in the MSIP but with the clear incentive of collaborating with future potential buyers of seeds. Similarly, a local retailer and processor wished to construct a potato crisp factory in Kabale and their incentive to participate in the MSIP was to contact farmers as potential future suppliers. Meanwhile the local government in Kabale, which is a permanent local actor, had an incentive to contribute to policy development for the benefit of its citizens as well as to oversee the implementation of regulations. To align such a diversity of incentives and interests, the MSIP played a role as an open forum governing the innovation networks at different levels (multi-scalar complex innovation networks), with a dynamic meta-governance (hybrid governance). From the innovation trajectories we observed that the MSIP decided democratically what challenges, where (multi-dimensional

boundaries), how (technological, knowledge, institutional capabilities, etc.), when (timing) and with whom exploration and/or exploitation needed to be organised. It also coordinated organisational relationships (pooled, sequential and reciprocal) for simultaneous exploration and/or exploitation over time. The MSIP helped farmers in particular to access resources such as new sources of knowledge, information materials, technology, agricultural inputs, and credit. The MSIP had a knowledge and information management facilitated for boundary spanning (Goldberger, 2008; Kristjanson *et al.*, 2009), by mobilising communities of practice at different network levels, and dynamically over time.

The cases of IAR4D platforms (Cases A1, A2, A3) benefited from regional task managers (from different types of organisations) for coordinating the interfaces between markets, productivity and natural resource management respectively, as well as national managers; both sets of managers tended to be from NGOs, research institutions and universities. Nevertheless there was a combination of collective managerial roles played by leaders, champions, teams, and organisations, all as part of innovation networks, which were orchestrated by the forum of the MSIP to keep a balance in the network structures for exploration and exploitation (structural and knowledge mobility).

The role of public and private partnerships was important for giving space for synergy among the various stakeholders of the netchain. Stakeholders part of innovation networks of such hybrid organisations (like MSIPs) play simultaneously multi-tasking roles (further traditional roles), enhancing more multi-dextrous capabilities (organisational, technological, knowledge, institutional, and financial) to tackle challenges, compared to the innovation networks without MSIPs.

Most importantly, farmers' participation in the innovation process was not restricted to farming activities (exploitation). More inclusiveness of farmers in the innovation process is observed, changing the linearity of the diffusion or implementation of technological packages to a more collective and inclusive network approach. Farmers participated in democratic decision making to organise collective action in order to tackle problems (exploration and exploitation) in synergy with a larger number of stakeholders of the netchain.

We found that contextual challenges are marked by geographical, social, institutional, political, and virtual boundaries (sometimes as barriers, sometimes as enablers) and influence interactions of stakeholders and thus the

innovation process and its outcomes. MSIPs not only facilitated linkages among stakeholders of the network but, in contrast to the other cases, also managed contextual challenges, by playing different roles for mobilising the boundaries that limited the collective action of the innovation network.

The most common roles to mobilise the boundaries were: mediation in conflicts and communication facilitation among actors, formalisation of agreements, influencing policies, like in the mediation in conflicts in the Bufundi United MSIP, trying to integrate government in the solution of competing claims and facilitating amicable institutional arrangements (e.g. bylaws, or a written MSIP constitution). Also, in the MSIPs a system of sanctions and rewards were in place, like in the Gataraga MSIP where social 'positive selection' (learnt from CIP didactic materials to fight bacteria wilt of potatoes) was employed to tackle the entrance of free riders in the network. A similar strategy was observed in DR Congo where the MSIP forum created sanctions to avoid free riders in the MSIP who benefitted from inputs (like trees) without paying membership fees, and applied economic sanctions to members who did not contribute to collective work in the field. The dynamics of innovation networks were embedded in an environment with multi-dimensional boundaries (geographical, virtual, institutional, political, cultural), which marked a barrier or an enabler for exploration and/or exploitation. For instance, the cooperative movement in Rwanda was an enabler or positive factor of the environment that fostered collective action; while in contrast, in DR Congo the environment and its political problems hindered the process of tackling collective challenges. In accordance with Mueller *et al.* (2013) we found that institutional factors, like national culture had an impact on the benefits of exploration and exploitation, but further research is needed to see to what extent these factors influence the outcome of the innovation process in a developing country setting.

5. Conclusions

What roles are played and by whom to foster ambidexterity as a capability of innovation networks for tackling challenges faced by smallholder farmers in Sub-Saharan African countries?

Fostering ambidexterity as a dynamic capability of innovation networks for tackling challenges through collective action is a complex task not only for managers but for other stakeholders of the network that aim to tackle challenges in Sub-Saharan Africa.

We observed that the time taken by innovation networks to become business networks varies. Facilitation and management by a diversity of stakeholders is necessary at different stages in the innovation process in order that smallholder farmers in developing countries develop enough capabilities and consolidate as entrepreneurs. In particular, cases like the Nyabyumba farmers in Uganda and Gataraga farmers in Rwanda show that MSIPs are important incubators of innovation and entrepreneurship.

Given the long-term timeframes required in Sub-Saharan Africa, interventions that intend to make substantial and tangible impacts must be designed to provide proper facilitation and management. Moreover, the timing of an innovation process can be affected by the entrance and exit of development interventions, interrupting or reversing the process of developing and exploiting capabilities. One of the biggest constraints affecting the timing of the innovation process is the shortage of funding for facilitation that limits the design of interventions and the sustainability of the process. Scaling out and up require facilitation to extend the network and continue to develop capabilities, and when resources are available facilitation offers the potential to repeat the cycle of innovation at different organisational levels (Gilsing and Nooteboom, 2006; Van de Ven *et al.*, 2008).

Another constraint mentioned by farmers concerns ownership of the innovation process, given that when interventions are designed without the input of the farmers, the sustainability of the process is affected. In this regard, it is important to consider the embeddedness of the innovation process in local governance structures, as observed in the MSIPs. These local governance structures are an entry point for engaging in their innovation process, and are an opportunity to better organise and maintain the sustainability of the innovation process. But facilitation and management must respond to the local dynamics and demands, according to the capabilities or level of maturity of the innovation network.

Factors that enable the empowerment of farmers as entrepreneurs like good infrastructure, input supply, operational policies, and market opportunities are often decided or influenced at a national or regional level. It follows that the local network and the facilitators of the innovation process need to identify the enabling factors and the actors responsible for making, and furthermore determine how the innovation network can influence decisions. There are still likely to be some missing players whose roles are vital for tackling complex challenges like power and gender imbalances, and other asymmetries, but

public and private partnerships like MSIPs are vehicles to engage with these actors.

We conclude that balancing exploration and exploitation with an ambidextrous capability of innovation networks requires collective roles to orchestrate change and innovation in developing countries.

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