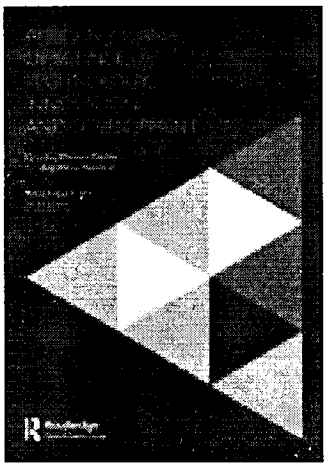

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Contribution of innovation intermediaries in agricultural innovation: the case of agricultural R&D in Tanzania

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With the current global economic reforms and advances in science, the move has been towards privatisation of the agricultural knowledge infrastructure. However, inadequate capacity of agricultural entrepreneurs and the diversity in the characteristics of the agricultural technologies have created market and system failures, resulting in imbalances of the supply and demand of technologies and hampering private agricultural business development. Experience from countries with mature innovation systems indicates the emergence of innovation intermediaries that facilitate agricultural entrepreneurs to innovate. Using a case-study approach, the present study identified and mapped the recipients of technologies from agricultural research institutions in Tanzania and analysed the extent to which 'innovation intermediation roles' have been applied by recipients in relation to demand articulation, network brokerage and innovation process management. Through an in-depth analysis of twelve cases, the study revealed the role of innovation intermediation performed by NGOs and R&D as project interventions not as their core activities. The study demonstrates the potential contributions of innovation intermediaries in agricultural innovation processes and recommends official recognition and government support in the establishment and implementation of innovation intermediation activities outside the project set-ups.

Keywords: innovation, innovation intermediaries, National Agricultural Research System, marketable technologies, innovation networks, Tanzania

JEL classification: O30, O55, Q10, Q16

Introduction

The requirements for successful application of new agricultural knowledge in the current market-based global economy are changing (Sumberg 2005, 22–23, Hall et al. 2005, 1, Hall et al. 2006, 7). In the 1980s, the sub-Saharan African countries created the National Agricultural Research Systems (NARS) purposely to conduct applied research so as to adapt the imported technologies to relevant ecological and production conditions (Rajalahti 2009, 3). But, much of the knowledge and many of the technologies created through such activities, which were mainly appropriate agronomic practices (i.e. seed rate) had little market value and relied on public research institutions and universities (Pineiro 2007). This system worked well especially with the diffusion (non-commercial) model of technology dissemination, whereby public agricultural extension services linked researchers and farmers (Rogers 2003, Simpson 2006, 10).

Nevertheless, the model is no longer feasible, as public funding for agricultural research and extension services has diminished and science has grown more complex (Chema et al. 2003, 38, Sumberg 2005, 22–23). Thus, the technologies produced by research are requiring private entrepreneurs to develop them further (multiplication/ manufacturing/purification) before dissemination, depending on the nature of the technology. However, the economic characteristics of agricultural technologies (either public or private goods) influence participation of the private sector in technology development and dissemination. For example, seeds of open-pollinated crop varieties and legumes are regarded as public goods (farmers can collect seeds from previous harvests), and hence are not attractive to private entrepreneurs. In additional, inadequate technical knowhow and the lack of capital are preventing agricultural entrepreneurs from investing in sophisticated and/or expensive technologies such as tissue culture to enhance mass multiplication (Mtui 2011, 194).

Apart from the characteristics of technologies, ongoing government reforms are also influencing the actors needed for putting agricultural technologies into economic use. As a case example, the privatisation of public knowledge from Research and Development institutions (R&D) (Skarstein 2005, 341) has resulted in increased numbers and categories of stakeholders in the NARS, and their interactions have become more complex (World Bank 2006,

Anandajayasekeram 2011, 2–3), hence innovation processes are less linear.

Recent literature on agricultural innovation from developed countries highlights the role of emerging specialised actors characterised as 'systemic intermediaries' or 'systemic facilitators', whose function is to connect multiple actors (Howells 2006, 717–718). They also facilitate small and medium-scale agricultural entrepreneurs to participate in the commercialisation of agricultural innovations (Klerkx and Leeuwis 2008a, 260). Howells (2006, 718) identified these organisations as innovation intermediaries. In other countries, including developing ones, a conglomeration of actors such as research organisations, NGOs and projects have taken up this intermediation role either as a core or a side activity (Klerkx and Leeuwis 2008a, 265–266). The working definition of *innovation intermediary* for this study as adopted from Howells (2006, 720) is:

> ... an organization or body that acts as an agent or a broker between two or more parties in any aspect of the innovation process. Such intermediary activities include helping to provide information about potential collaborators; brokering a transaction between two or more parties; acting as a mediator, or go-between bodies or organizations that are already collaborating; and helping to find advice, funding and support for the innovation outcomes of such collaborations.

In Tanzania, like in many sub-Saharan African countries, despite the fact that NARS have allowed new actors (i.e NGOs, the private sector, farmer organisations, Local Government Authorities) to participate in agricultural innovation (Sempeho 2004, 1, Rutatora and Mattee 2001, 157), the existence and contribution of the innovation intermediaries in the agricultural knowledge infrastructure (R&D, agricultural extension) is not yet clearly recognised. This poses the question as to how these actors that are involved in the innovation process, operating under different institutional frameworks (public, private), with different knowledge backgrounds (scientific and business) and different socio-economic backgrounds, can create and maintain effective networks needed for agricultural innovation in Tanzania?

This study sought to highlight the importance of innovation intermediaries in agricultural innovation and emphasises the need for setting-up of a more enabling environment for these actors to facilitate linkages and relationships between stakeholders, which operate under different institutional and knowledge backgrounds, but have the potential contribution to innovate when coupled with existing opportunities.

It is against this background that this study was carried out with the aim of analysing organisations that facilitate the economic use of new knowledge and technologies generated from Agricultural Research Institutions (ARIs) and how they are positioned as 'innovation intermediaries' within innovation networks. Specifically, the study attempted to answer the following questions: What are the categories of organisations that perform innovation intermediation functions? What are their roles in supporting the agricultural innovation? and what are the outcomes of the innovation process? We begin by providing a conceptual background on recent thinking on 'systems' mode of agricultural innovation and the innovation intermediation roles, followed by a presentation of case studies in which innovation intermediation roles were applied in agricultural innovation in different organisational settings in Tanzania.

Conceptual framework

Systems of agricultural innovation

Over the past four decades, a range of agricultural innovation (AI) approaches have emerged and resulted in the widening of theoretical perspectives of the AI approaches (Klerkx 2012, 459, Leeuwis 2004). Innovation is understood to be neither research nor science and technology, but rather 'the application of knowledge (of all types) in the production of goods and services to achieve desired social or economic outcomes' (World Bank 2006, 16).

The innovation system concept in agriculture evolved, though not consecutively, from the National Agricultural Research System (NARS) that dominated in the 1980s through Agricultural Knowledge and Information System (AKIS), which emerged in the 1990s (Assefa et al. 2009), to the current Agricultural Innovation System (AIS). Despite the fact that the NARS has been effective in creating agricultural science capacities, it did not explicitly link research to technology users and other actors in the sector. Similarly, the AKIS framework was mainly focused on the rural environment while the role of the market, private sector and enabling policy environment were not given adequate consideration (World Bank 2006, 27).

Agricultural Innovation Systems (AIS) were developed from the research perspective reflecting the thinking of National Innovation System (NIS) approach developed by Lundvall (2004). The AIS concept, in addition to capacities and processes emphasised in NARS and AKIS frameworks, recognises the broader range of actors and particularly the private sector involved in innovation (Hall et al 2006a, 17). AIS regard other factors such as policy, legislation, infrastructure, funding and market development, as equally important in innovation processes, as mechanisms for the generation and dissemination of new knowledge (World Bank 2006, 27). This makes the features of AIS approaches distinct from NARS and AKIS, in that they are complex with multiple actors preforming evolving roles (Klerkx 2012, 462–463).

Roles of innovation intermediary organisations

Experiences of innovation intermediary organisations with regards to supporting SMEs, particularly in the industrial sector, are adequately documented in the current literature (Howells 2006, Szogs and Wilson 2006, Szogs 2008, Szogs et al. 2011). In the agricultural sector, however, the focus of these organisations is on overcoming

uncertainties arising from the commercialisation of research results that hinders effective cooperation for innovation (Klerkx and Leeuwis 2008b). The uncertainties on the supply side (R&D and extension services) include: funding instability in terms of availability and timely disbursements and lack of space for actors to interact and achieve demand-driven models of working. Uncertainties on the demand side (SMEs, farmers and consumers) include information and managerial gaps.

Using case examples from the United Kingdom, Howells (2006, 720–725) shows a range of functions that an innovation intermediary should normally perform, such as foresight and diagnostics, scanning and information processing, knowledge and processing, testing and validation, accreditation, gatekeeping and brokering, validation and regulation, protecting the results and commercialisation. In the context of economic utilisation of agricultural knowledge, the innovation intermediaries are positioned as facilitators of linkages and interactions that govern the flow of knowledge needed by innovation networks (the providers of R&D on the supply side and users of knowledge on the demand side) (Klerkx and Leeuwis 2008a, 263). At that point, scholars summarised the different innovation intermediation functions into three main functional frameworks: '*demand articulation*', '*network composition*' and '*innovation process management*', aiming at overcoming market and system failures (Klerkx and Leeuwis 2008a, 262–263, Perez Perdomo et al. 2010)

Demand articulation: is a terminology used in the field of innovation to explain a learning process about the needs not only for new technologies but also for technologies in their early phase of development, or emerging technology whereby the needs of users are not yet specified (Smits 2002). Demand articulation is an iterative, inherently creative process in which stakeholders try to address what they perceive as important characteristics of new technology, and attempt to express preferences for an emerging innovation (Boon and Moors 2008, 4). Demand, as a major driver of client oriented systems, entails demand articulation as a key role of innovation intermediaries (Smits and Kuhlmann 2004, 12, Izushi 2003, Boon and Moors 2008, 4). This role can be achieved through establishing dialogues between users and providers of knowledge, diagnosing problems and exercising foresight.

Network composition: involves developing links between a variety of producers and users of information and their effective working relationship where there is a wide gap between them (Izushi 2003, 786). Thus, network brokerage includes channeling of knowledge between different actors (Bessant and Rush 1995), organising space for dialogue between players of innovation (innovation platforms) (Anandajayasekeram 2011, 10–14) and sourcing of funds for innovating activities such as subsidies (Kolodny et al. 2001, 216).

Innovation process management: This involves alignment of and facilitating interaction between relevant actors with different institutional frameworks (norms, values, incentive and rewarding systems). Due to the differences in backgrounds of actors, to achieve the intended functioning stakeholder coalitions requires: continuous interface management (Smits and Kuhlman 2004); interpretations amongst the different actor's domains, described as 'boundary work' (Kristjanson et al. 2009); facilitation roles to attain productive and sustainable interactions among actors, the building of trust, managing conflict and managing intellectual property (Klerkx and Gildemacher 2012).

Thus, Innovation intermediaries facilitate linkages and interactions not only at the *innovation network* (supply and demand sides) level but also between innovation networks and the national agricultural innovation system (e.g. policies, infrastructure) (Klerkx and Leeuwis 2008a, 263). Hence, success in facilitating such a diverse set of actors can be achieved when innovation intermediaries operate as neutrally and unbiasedly as possible (Hanna and Walsh 2002, 205–206). Also the outcomes of process-oriented innovation intermediation roles are both technical and social (institutional, managerial and organisational) innovations. This illustrates the complex nature of packages for agricultural innovations. Therefore, it is because of the complexity of agricultural innovation that the role to be played by innovation intermediaries is envisioned as activating the non-linear innovation process, connecting different actors of the system, filling the gap between knowledge and practice and facilitating platforms for innovation.

A need for innovation intermediation in Tanzania

Agricultural technology dissemination, which was principally provided by extension services, has largely been a public undertaking. Following the Local Government Reform Programme (LGRP) and decentralisation reforms (URT 1998), most of the public services including agricultural extension were decentralised and moved from the Ministry of Agriculture to Local Government Authorities (LGAs), which is under different ministry, resulting in weak linkages between research institutions and extension services (Sibuga 2008, 25). This institutional framework hindered the flow of information regarding new knowledge not only from researchers to farmers but also from researchers to the private sector. Technologies generated from research are also diverse in nature, that is, from simple agronomic practices such as fertiliser rates disseminated through extension services, to physical products (e.g planting materials) and sophisticated bio-technological technologies requiring entrepreneurs for multiplication and commercialisation (URT 2013, 10).

Since the 2000s, organisational reforms as well as national strategies, particularly in the agricultural sector, were geared towards making the private sector more active in the transfer and commercialisation of intellectual property emerging from public research institutions. For example, Zonal Information and Extension Liaison Units (ZIELUs) were established to enhance the linkage between R&D and

other stakeholders. Additionally, through the Agricultural Sector Development Programme (ASDP), various technical committees were established to oversee the entire process of technology development, which consisted of sector-wide representation, including the private sector. Examples are the Zonal Research Technical Committees (ZRTCs), the Zonal Agricultural Research and Extension Development Funds (ZARDEFs) and the District Facilitation Teams (DFTs) as platforms of key players at district level (URT 2003, Sibuga 2008, 17). However, with all the efforts made by the ASDP in encouraging the private sector to participate in the innovation process, they did not bring changes as expected (Thornton et al. 2011, 47–51). The incentive scheme incorporated in ZARDEFs encouraged the researchers to publish rather than to innovate technology and DFTs were hardly utilised (URT 2011). This situation indicated that the key actors of innovation including researchers, the private sector, farmers, extension services providers, NGOs, etc. operate in isolation due to lack of mechanisms that allow adequate linkage and interactions of the actors to innovate.

Study methodology

Description of study sites

This study was conducted from July 2012 to March 2013, involving 13 out of 16 government agricultural research centres located in seven ecological zones in Tanzania. The study involved technologies related to crop, food and soil science research under the mandate of the Ministry of Agriculture Food Security and Cooperatives (MAFSC). The remaining three research centres could not be reached due to logistical difficulties. The study also included two private Agricultural Research Institutions (ARIs) involved with two major cash crops: coffee and tobacco; and at Sokoine University of Agriculture (SUA), the only agricultural university in the country, five relevant Departments were involved: four in the Faculty of Agriculture including Crop Science and Production, Soil Science, Food Science and Technology and Animal Science Production and the Department of Veterinary Medicine and Public Health in the Faculty of Veterinary Medicine.

Data collection and data sources

Data were collected in two phases employing two different methods. The first phase involved a questionnaire while the second phase employed personal interviews. In the first phase, all marketable or commercialisable technologies were identified from research centres. The sources included the officers-in-charge, commodity delivery books at each centre, and research catalogues (specifically for SUA). After identification of technologies, each technology was subjected to questionnaire survey whereby, at least one researcher who was involved in the development of the technology responded to a questionnaire. Marketable technologies for this study were described as technologies in the form of a physical product (which needed further investment such as multiplication or manufacturing before dissemination) and processing technologies (eg food formulations) that needed associated technologies such as processing machinery or equipment. One of the outcomes of the data collection in phase one included identification of intermediary organisations involved in engaging businesses in dissemination of the technologies to end-users.

The second phase involved interviews with people in charge of the intermediary organisations identified in the first phase. The data collection tools included detailed semi-structured interviews focusing on their functions, roles, and challenges.

Data analysis

The analysis of the data involved quantitative and qualitative methods. The quantitative data of the identified technologies and their associated intermediary organisations were subjected to descriptive statistical analysis using Statistical Product and Service Solutions (SPSS) version 16. The qualitative findings from interviews (case studies) were fully transcribed and analyzed using content analysis method whereby both conceptual and relational analyses were employed.

Results and discussion

Technologies identified and their recipient organisations

A total of 134 technologies were identified covering three agricultural sub-sectors: Crop 125 (93%), food 5 (4%) and soil 4 (3%) (Table 1).

Two types of actors received the technologies from R&Ds: business enterprises and intermediary organisations for the purposes of dissemination. About forty-four (44) different intermediary organisations were identified while business enterprises were mainly Agricultural Seed Agency (ASA). ASA is a semi-autonomous government seed agency that was mandated to handle pre-basic and basic seed from government R&D institutions. Under that arrangement, other private seed companies purchased certified seed from ASA for further multiplication and dissemination. A total of 34 (25.4%) technologies were taken by business enterprises; 69 (51.5%) were taken by intermediary organisations and about 31 (23.1%) technologies were handled by both business enterprises and intermediary organisations (Table 1). This implies that intermediary organisations are playing a role in the dissemination and utilisation of most agricultural innovations, particularly vegetative propagated and OPV seed varieties.

Innovation Intermediation Projects: what are they?

According to the Howells's definition of innovation intermediaries, out of the 44 intermediary organisations (Table 1), only 12 organisations (Table 2) were engaged in activities such as bridging between supply and demand sides, not by carrying technologies but facilitating other actors to innovate, hence qualifying as innovation intermediary

Table 1: Identified technologies from R&Ds and the recipient organisations

Types and number of technologies surveyed			Number of technologies received by the recipient organisations		
			Business enterprises	Intermediary organisation (IO)	Both business enterprises and IO
Crop	Vegetative	17	0	17 (14)	
	OPV	102	28	43 (18)	29
	Hybrid	5	5	2 (4)	2
	Protocol	1	-	1 (1)	
Food	Protocols	5	-	5 (4)	
Soil	Fertilisers	4	1	1 (3)	
Total		134	34	69 (44)	31
			25.4%	51.5%	23.1%

Note: In brackets are numbers of intermediary organisations dealing with that particular type of technology
OPV: Open (self-pollinated) pollinated variety

project interventions (IIPIs) (Table 2). Furthermore, out of the 12 identified organisations that perform innovation intermediation functions, nine were project interventions, of which eight were coordinated at R&D institutions as side activities, and the remaining three organisations were projects implemented by NGOs, though not as specialised innovation intermediaries (Table 3). The IIPIs were funded by external donors except the soya bean project and ATTC, which were funded by the government.

The remaining 32 organisations either procured technologies directly from R&D or commissioned government R&D to multiply the technology for them then distributed the technologies free to the end-users (farmers). This happened mainly during food crises or natural disasters such as floods and droughts that necessitated emergency supply of planting materials to affected communities. These observations further confirm that the capacity of the traditional agricultural extension service providers and private companies is inadequate to handle these types of technologies.

Innovation Intermediary Projects: categories, functions and outcomes

Categories of innovation intermediary projects

The analysis of the identified IIPIs can lead to further categorisation based on the main targets and type of implementing organisations. Based on the category of targeted audiences, IIPIs can be grouped into three categories:

- Category 1: Projects that facilitated setting-up of innovation-specific business enterprises, targeting farmer groups and individuals, purposely for mass production and commercialisation of a specific technology
- Category 2: Projects that support establishment of business enterprise at R&D institutions (as a spin-off) for multiplication and commercialisation of a specific technology
- Category 3: Brokering organisations that demonstrate the actual and latent potential of the new technologies generated from R&D to the public.

The setup of IIPIs categories 1, 2 and 3 illustrates the 'facilitation' role, which contrasts the IIPIs with the

Table 2: Names of the identified Intermediary Innovation Organisations and the technologies involved

Name of Innovation Intermediation Project Interventions (IIPIs)	Acronym	Technology involved
Belgium Development Agency – Tanzania *	BTC Tanzania	Five improved banana varieties
Dissemination of New Agricultural Technologies in Africa – for Quality Protein Maize*	DONATA-QPM	Maize (QPM)
Dissemination of New Agricultural Technologies in Africa – Orange Fleshed Sweet Potato*	DONATA-OFSP	Sweet potato (orange flavoured)
Soya bean for the Southern Highlands of Tanzania Project*	Soya bean project	Soya bean (Bossuer)
Tanzania Food Security Project: Integrated Soil Fertility Management In Southern Highlands Zone *	TFSP	Minjingu phosphate fertiliser / Minjingu mazao
Food security and increases income to farmers: implemented by Vredeseilanden Tanzania	VECO-TZ	Cassava (*Kiroba*)
Common Fund for Commodity, International Institute for Tropical Agriculture (IITA) – in collaboration with TFNC	IITA	Cassava (*Kiroba*)
Project for Improvement of banana multiplication and cultural practices in Eastern and Southern Zones of Tanzania*	TC- Banana	Improved banana varieties (*in vitro* micro propagation)
Agricultural Technology Transfer Centre**	ATTC	Many varieties
Uluguru Mountains Agricultural Development Project	UMADEP	Sunflower (*Record*)
Mwanza Rural Housing Project Agricultural Project*	MHRP	Green gram and pigeon peas
Cassava Processing Technology Project*	CPTP	Cassava flour and feed processing

Note: Source: own data
*Phased out IIPIs (not necessarily the implementing organisations)
**The centre has a collection of all technologies generated from two ARIs in the northern zone of Tanzania (Selian and Tengeru)

Table 3: Innovation Intermediary Organisations, Core Functions, Knowledge produced, categories and implementing organisation.

Innovation Intermediary Projects	Core functions	Category	Knowledge produced*				Implementing organisations
			T	I	M	O	
BTC Tanzania	Improve banana cropping system	1,2	✓		✓	✓	ARI Maruku
DONATA-QPM	Innovation platform for technology adoption	1	✓	✓	✓	✓	ARI
DONATA-OFSP		1	✓	✓	✓	✓	SARI
Soya Bean Project	Awareness, seed multiplication, utilisation and varietal development	2	✓	✓			Uyole AC
TFSP	Fertiliser promotion	1,3	✓	✓			Uyole AC
VECO-TZ	Food security and increase income to farmers	1	✓	✓	✓	✓	NGO
IITA	Develop Small-scale cassava processing	1	✓	✓		✓	NGO
TC- Banana	In-vitro mass production of clean planting materials of banana	2	✓		✓		SUA
ATTC	Technology Transfer (agronomic practices)	3	✓		✓		MAFSC
UMADEP	Support rural livelihood security	1	✓	✓		✓	SUA
MHRP	Improve rural habitat	1	✓	✓	✓	✓	NGO
CPTP	Develop cassava processing technology	1	✓	✓	✓	✓	SUA

Note: Source own data

*Knowledge produced T – technological, I – institutional, M – marketing, O –organisational

traditional roles of R&D institutions (source) and agricultural extension services (technology transfer). Haga (2009) describes innovation intermediation functions as indirect innovation processes, contrary to extension, which is a direct carrier (technology transfer) of technologies. Nine out of twelve IIPIs (75%) belong to Category 1 (Table 3), which implies that either appropriate business enterprises do not exist or for some reason are not willing to commercialise these types of technologies. According to Kaul et al. (1999, 459), whenever goods face supply problems, a market failure occurs. On the other hand, for the three technologies handled by Category 2 organisations (Table 3), the inability of entrepreneurs to adapt new technological development is due to the lack of competences, capacity, or resources. Literatures of innovation refer to this failure as capabilities' failure (Klein-Woolthuis 2005, 614) or transition failure (Smith 2000, 95).

The analysis of IIPIs according to the types of implementing organisations (either R&D institutions of NGOs), the findings showed that the majority (9 organisations) of them are based at government R&D institutions and only three (IITA, MHRP and VECO tz) are independent NGOs (Table 3). Thus, the effectiveness of innovation intermediation functions being embedded and not specialised to the implementing organisation, may be influenced by lack of capacity, lack of favorable policy environment and a linear, transfer-of–technology mindset of the implementers (Klerkx 2012, 462–463).

Functions and outcomes of innovation intermediation interventions

The IIPIs were neither the core functions of the projects (Table 3) nor areas of specialisation for the implementing organisations. However, the outcome (knowledge produced) included both technical and social (institutional, managerial and organisational) innovations (Table 3). These findings illustrate the complex nature of packages for these types of technologies to be handled by traditional extension service providers using the traditional technology transfer approaches. The following section unpacks innovation intermediation functions and outcomes:

Unpacking contributions of the innovation intermediation

The following are contributions from the identified IIPIs gathered from the survey, which were aimed at either articulation of the demand of new technology, forming innovation networks (network brokerage) or managing innovation processes. The descriptions of the contributions are complemented with examples of the innovation intermediation roles and their outcomes presented in Table 4.

Creating awareness of new technology to potential partners and collaborators

The IIPIs raises awareness about new technologies by facilitating a dialogue between the source (R&D), the end-users (farmers) and potential partners or collaborators to clarify demand and supply of the technology. This was achieved through verification trials, demonstrations, subsidies, facilitating creative processes to arrive at a 'real need,' and piloting creative models of various technologies to validate and demonstrate their efficacy and other comparative advantages.

This role may resemble traditional agricultural extension services, but the focus for the IIPIs went beyond the connection with farmers (through dialogue, incentives etc.) to the interface with strategic partners, including decision makers at district level, especially the councilors who are responsible for allocating funds for promoting agricultural technologies through District Agricultural Development Plans (DADPs).

Table 4: The contribution from innovation intermediation project interventions and the outcome of innovations

	Unpacked roles	Outcomes
Creating awareness of new technology to potential partners and collaborators		
TFSP	Validation (on farm) of *Minjingu* fertilisers	*Minjingu* fertilisers were included in
VECO tz	in Mbinga District	subsidy scheme starting from 2009.
	On farm demonstration of clean cassava planting materials	Establishment of farmer's managed commercial cassava seed farms
Capacity building to potential partners and collaborators for network brokerage:		
BCT tz	Establish commercial banana seedlings macro-propagation unit at ARI-Maruku	ARI- Maruku were consulted by Bukoba District Council and individuals to build the units for commercial purposes.
TC banana	Facilitate application of *in vitro* micro-propagation technique at SUA for commercial banana seedling production	The SUA-Horticulture unit took over the enterprise when the project was phased out, though at a very reduced production level.
Soya bean Project	Seed multiplication at Uyole Agricultural Research	Activated demand of soya bean in Mbeya region
Establishing and managing innovation networks		
DONATA	IPTAs involving stakeholders at district levels to; identify and align actors needed for specific innovations (QPM & OFSP)	QPM and OFSP are produced and distributed commercially through 'innovative' collaborations between farmer groups, entrepreneur.
VECO tz	Regular stakeholders platform meetings for cassava stakeholders in Mkuranga District	Motivated partners to share resources, negotiate solutions and later took over intermediation activities when VECO tz phased out in 2013
Enhance communication between actors with different institutional frameworks		
MRHP UMADEP/ VECO	Setting up of network of village – animators which was crucial for the organisation of Savings and Internal Lending Communities (SILCs) in Mwanza region Trained and motivated paraprofessionals	Dissemination of chickpea, pigeon peas, groundnuts and sweet potato in Mwanza Tanzania through collective market, seed multiplication, input loan and insurance for the members of SILC Reduced cognitive and cultural gaps between farmers and other actors (researchers and extension workers)
ATTC	Display agricultural technologies from R&D Member of technical committees of R&D Liaise the MAFSC and its institutions* with stakeholders.	Facilitate channeling of the new knowledge from R&D to intermediate users (SMEs), end-users (Farmers) and decision makers (councilors**). Many users were linked to reliable sources of technologies
Facilitating social innovation (non-market factors) in order to respond/ overcome economic behaviour of technology		
CPTP	Identified and assigned entrepreneurs to design and manufacture appropriate machines Mobilised a sizeable group of users for optimum use of the machine. Motivated credible organisations to manage the revolving funds for the groups to purchase the machines	Introduces the commercial perspective on cassava processing technology (protocol) by coupling it with the processing technology (machine).

*Includes Agricultural Seed Agency (ASA), Tanzania Official Seed Certification Institute (TOSCI), National Food Reserve Agency (NFRA).
**Responsible for allocating funds for promotion of new technologies through subsidies and other infrastructure

Capacity building to potential partners and collaborators (network brokerage).

The establishment of business enterprises at R&D institutions served not only as an important link for the innovation networks (especially for sophisticated technologies) but also activated the needs of the technologies and demonstrated the potential market.

This is in line with the concept of 'spin-off' whereby an employee or a group of employees takes the existing products from the parent organisation (R&D institutions) to form an independent start-up firm where expertise and facilities from the owner of the technology can easily be accessed (Cook 2007). However, the success of this arrangement needs institutional policies that can respond favorably to market forces and provide incentives to both supply and demand side, or else the scalability and sustainability of supply will be questionable regardless of the existence of demand for the technologies.

Establishing and managing innovation networks

Some of the IIPIs supported establishment of innovation platforms or meeting places for various actors. This is another approach for demand articulation (Boon and Moors 2008). The forums were made more dialogical and neutral spaces where stakeholders of all levels (farmers, professionals, decision makers and NGOs) met for the purpose of sharing resources, coupling of the existing technical possibilities with opportunities and identifying potential collaborators to innovate. Two approaches were recorded during the survey: Innovation Platforms for Technology Adoption (IPATs) supported by DONATA (QPM & OFSP), stakeholders' platforms by VECO TZ and farmers group networks by UMADEP.

Enhance communication between actors with different institutional frameworks

This function involved engagement of local facilitators as an interface to overcome cognitive and cultural barriers between sources and users of the knowledge (network brokerage). Different forms of local facilitators were reported including village-animators engaged by MRHP and para-professionals established by UMADEP, VECO tz. The other IIPIs implemented by VECO tz, UMADEP, BTCtz and DONATAs collaborated with government departments through hired staff from different government departments. This arrangement served not only as a conduit of knowledge from government (technical and policy guidelines) to the targeted audiences, but also serves as a source of expertise for the projects. In this way, the projects overcome one of the controversy of innovation intermediaries posed by Koutsouris (2012, 68) that IIPIs as a 'facilitators', are unlikely to have both the facilitation and technical background for different technologies.

The ATTC on the other hand played liaison roles to connect various stakeholders needed for agricultural innovation networks. This connection function of ATTC allowed flow of knowledge, hence actors with different institutional backgrounds effectively interact to innovate. As commented by the Officer in-charge of ATTC:

> '...it is easier for the farmers or small entrepreneurs to access new knowledge when visiting the centre than seeking information from R&D institutions'

Facilitating social innovation (non-market factors) to overcome unfavorable economic behavior of some agricultural technology:

For the commercialisation of process-oriented technologies, the IIPIs facilitated a creative process to establish organisational and institutional innovations (Table 3) and coordinate them to influence the economic behavior of the agricultural technologies. In this way technologies that entrepreneurs were not willing to adopt due to high capital investment or lack of highly skilled labour and/or sophisticated facilities could be commercialised.

These cases demonstrate the valuable contribution of organisational and institutional innovations (Table 3) as an outcome of the IIPIs' capacity building, which is as important as technical innovations for realisation of the intended innovations (Hall et al. 2005).

Conclusion and recommendations

The study revealed innovation intermediations performed by R&D institutions and NGOs as project interventions though not as their specialised functions but rather as side activities. The innovation intermediation roles are aimed at establishing commercial perspectives of new agricultural technologies through activities such as demand articulation, network brokering and innovation process management.

However, building innovation intermediation capacities into existing organisations such as R&D and agricultural extension service providers requires more favourable institutional features. These features include flexibility in plans of actions, less restricted source of funds, reliable sources of knowledge and information and timely response to the challenges encountered by innovation-based enterprises which might be difficult to achieve in the government institutions, private companies or consultancy.

The connection functions were essential in overcoming the challenges of fragmentation of actors along agricultural knowledge infrastructure, which were caused mainly by differences in incentive structures for the actors (public or private institutions). Thus, the 'unbiased' nature of innovation intermediaries, particularly between the source (public R&D) and the user (SMEs), requires public funding.

However, apart from the demonstrated importance of innovation intermediary organisations in harmonising the supply and demand of technologies, the innovation intermediation roles are not clearly recognised within the NARS, thus threatening the sustainability of organisations or intermediation activities. This furthermore, being process-oriented, contributions (such as organisational and institutional innovations) of innovation intermediaries in the innovation process, though appearing to be essential, are not easily captured and managed by the system. Therefore, changes in institutional features in R&D and extension service providers are necessary, such as the core functions and policy focus to accommodate innovation intermediation. Also the system should develop evaluation tools with indictors sensitive to capture rather intangible activities and outcomes of innovation intermediation.

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