Unravelling the role of innovation platforms in supporting co-evolution of innovation: Contributions and tensions in a smallholder dairy development programme

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A B S T R A C T

The agricultural innovation systems approach emphasizes the collective nature of innovation and stresses that innovation is a co-evolutionary process, resulting from alignment of technical, social, institutional and organizational dimensions. These insights are increasingly informing interventions that focus on setting up multi-stakeholder initiatives, such as innovation platforms and networks, as mechanisms for enhancing agricultural innovation, particularly in sub-Saharan Africa. There has been much emphasis on how such platforms are organized, but only limited analysis unravelling how they shape co-evolution of innovation processes. This paper addresses this gap and conceptualizes platforms as intermediaries that connect the different actors in innovation systems in order to foster effective co-evolution. We present a case study of a smallholder dairy development programme in Kenya, led by a consortium of five organizations that provide a platform for building multi-actor partnerships to enhance smallholder dairy productivity and improve livelihoods. The findings indicate that co-evolution of innovation is a highly dynamic process with various interactional tensions and unexpected effects, and that the distributed nature of intermediation is important in resolving some of these tensions emerging at different actor interfaces. However, platforms are not always able to adapt adequately to emerging issues. This points to the need to look at platforms dynamically and pay more attention to mechanisms that strengthen feedback, learning and adaptive management in innovation processes.

1. Introduction

Smallholder agricultural development in developing countries faces challenges and constraints related to persistent food insecurity, food price volatility, food safety and sustainability concerns, but also is experiencing increased opportunities arising from growing domestic and global agricultural market demand (McCullough et al., 2008; World Bank, 2006, 2007). Such a dynamic context requires the sector to continually innovate if it is to contribute to sustainable socio-economic development. In this regard, the agricultural innovation systems (AIS) approach has gained currency as a framework for understanding bottlenecks and identifying opportunities for enhancing the innovation capacity of agricultural systems, particularly in sub-Saharan Africa (SSA) (Hounkon nou et al., 2012; Spielman et al., 2009; Sumberg, 2005; World Bank, 2006).

AIS thinking recognizes that innovation occurs through the collective interplay among many actors – including farmers, researchers, extension officers, traders, service providers, processors, development organizations – and is influenced by factors such as technology, infrastructure, markets, policies, rules and regulations, and cultural practices (actors’ values and norms). Thus, innovations are not just about technology but also include social and institutional change, and have a systemic and co-evolutionary nature (Biggs, 1990; Leeuwis and van den Ban, 2004). Co-evolution entails mutual interaction and adaptation over time between the technological, social and institutional components of an innovation, and therefore innovation cannot be understood and managed by separating these different components (Edquist and Johnson, 1997; Ekboir, 2003; Hall and Clark, 2010; Nelson and Nelson, 2002). However, co-evolution does not mean seamless and smooth evolution, but is accompanied by tensions and sometimes incongruent actions that affect the outcomes of complex innovation processes (Leeuwis and Aarts, 2011; Smits, 2002).

Following the AIS perspective, the importance of recognizing and stimulating co-evolution has been noted as key to promoting smallholder agricultural development in SSA, and interventions increasingly focus on supporting interaction among multiple actors at different levels in agricultural production systems and value chains to enable innovation and enhance livelihoods (Ayele et al., 2013).
technical devices), software (new modes of thinking and corresponding practices and learning processes), and orgware (new institutions and socio-organizational arrangements) aptly captures this view on co-evolution of innovation and provides a heuristic for analytical purposes. The hardware elements refer to a tangible product or a well-defined set of practices that define a technology. The software dimension captures the essence of AIS thinking, which emphasizes innovation as the outcome of interactive learning among multiple actors involving both explicit and tacit knowledge from different sources, such as scientific, experiential and indigenous knowledge (Leeuwis and van den Ban, 2004; Oreszczyn et al., 2010). The characterization of the orgware dimension follows North (1990) definition of institutions as the ‘rules of the game’ or as human-devised rules that structure interaction, in which a distinction can be made between formal (e.g. laws, regulations, standards) and informal (norms, attitudes, values) institutions. Institutions can be considered to have a twofold role, in that they provide the environment or conditions for collaboration necessary for innovation, but are also part of the innovation process and so they also need to be changed (Klerkx et al., 2010; Hung and Whittington, 2011). Conducive institutional conditions enhancing collaboration for institutional change, or conversely a lack of them, have been underlined as key elements that enable or constrain innovation (Hounkonnou et al., 2012; Klerkx et al., 2010; Leeuwis and van den Ban, 2004; Roep et al., 2003).

Co-evolution thus points to deliberate efforts to align the technological and socio-institutional arrangements not only in the sense of trying to fit into pre-existing conditions (Leeuwis and Aarts, 2011; Smits and Kuhlmann, 2004), but also in actively trying to change the socio-institutional environment, which has been referred to as effective reformism (Klerkx et al., 2010; Roep et al., 2003). Thus, innovation processes are marked by dynamics of alignment and conflict, with often unpredictable outcomes.

2.2. Agricultural innovation platforms and their role as intermediaries in innovation co-evolution

Multi-actor platforms have been noted as important interventions for creating spaces to orient interaction in order to enable innovation as they stimulate changes among platform actors that eventually have greater effects in the broader environments in which these actors operate (Dormon et al., 2007; Klerkx et al., 2010). The platform concept has already been applied in the agricultural innovation context to explore different modalities for collective action among multi-stakeholders around natural resource management, e.g. farmer field schools (FFS), local research committees (CIALs), natural resource management platforms (Braun et al., 2000; Röling and Jiggins, 1998). More recently, various forms of agricultural innovation platforms have been promoted as arenas for action in operationalizing AIS interventions (Adekunle and Fatunbi, 2012; Devaux et al., 2009; Nederlof et al., 2011). Platforms can have different goals and can also be structured and conceptualized in diverse forms: the focus of platforms can be research oriented, development oriented, or both, and some platforms take on more centralized forms with central coordinating structures, whereas others consist of distributed networks of interaction (Nederlof et al., 2011; Steins and Edwards, 1999).

Innovation platforms generally do not emerge autonomously, but connections between platform members need to be forged and their interaction needs to be coordinated (Leeuwis and van den Ban, 2004; Röling and Jiggins, 1998). Building on the theoretical and empirical insights from the broader innovation studies literature (Howells, 2006; van Lente et al., 2003; Winch and Courtney, 2007), AIS scholars have argued that there is thus an important role for so-called innovation intermediaries, who engage in coordinating and brokering relations at several interfaces in complex multi-actor configurations in the AIS (Devaux et al., 2012; Dormon et al., 2007; Hounkonnou et al., 2012).
Kilelu et al. (2011) provide a collated range of functions that innovation intermediaries in agricultural innovation can fulfill; we apply these to understand the role of innovation platforms (for details see Kilelu et al., 2011). These functions include:

- Demand articulation – Facilitating the process of identifying innovation challenges and opportunities as perceived by the various stakeholders through diagnostic exercises, visioning, needs assessment. The needs could include access to information, technologies, finance or institutional gaps.
- Institutional support – Facilitating and advocating institutional change (e.g., policy change, new business models and stimulating new actor relationships).
- Network brokering – Identifying and linking different actors.
- Capacity building – Strengthening and incubating new organizational forms.
- Innovation process management – Coordinating interaction and facilitating negotiation and learning among different actors.
- Knowledge brokering – Identifying knowledge/technology needs and mobilizing and disseminating the technology and knowledge from different sources.

Whereas literature which takes a more structural perspective on categorizing such innovation intermediaries in AIS suggests that a single innovation intermediary orchestrates innovation platforms (Batterink et al., 2010; Kilelu et al., 2011; Klerkx and Leeuwis, 2009), innovation process-oriented studies show that several intermediaries are active and that they make different connections between actors and components in innovation processes and act as change agents (Eastwood et al., 2012; Klerkx et al., 2010; Stewart and Hyysalo, 2008). This derives from the fact that innovation processes are of a highly distributed nature in terms of space and time. To resolve different problems and uncertainties (technological, social, market-related, institutional in nature) in relation to realizing an innovative vision or problem, work is needed simultaneously at several interfaces in the innovation system (Klerkx et al., 2010). This suggests that the role of intermediaries in platforms can be conceptualized as ecologies or nested systems of intermediaries connecting different components of AIS and fulfilling complementary functions in order to guide co-evolution.

Integrating these insights distilled from the literature on co-evolution of innovation, innovation platforms and innovation intermediaries, we construct an analytical framework, presented in Fig. 1, to unravel the role of innovation intermediaries in supporting co-evolution of innovation processes on the EADD multi-actor platform. The model places the platform at the center and is the arena in which intermediation of innovation processes takes place, by undertaking the various intermediation functions described above. Outlining these functions provides a frame for understanding the nature of intermediation and how this contributes to innovation outcomes on the platform. The innovation processes are characterized as change, loosely from one system (A) to another (B). The change can happen through either radical (fundamental change to the system) or incremental (stepwise improvement of a system) innovation. The platform is situated in a broader socio-technical context that influences how the change process evolves.

We now apply the analytical framework to answer the main question of this article as set out in the introduction: how do innovation platforms shape and contribute to the dynamics of co-evolution?

3. Case description and research methods

3.1. Background of the EADD programme

The smallholder-dominated dairy sector in Kenya is considered to be relatively successful in the SSA context, but the sector still contends with many challenges that have limited its potential in terms of productivity, competitiveness and improving livelihoods (Moll et al., 2007; Muriuki et al., 2003; Technoserve, 2008). To tackle these challenges, the EADD multi-actor programme was initiated in 2008. The EADD is being implemented in three countries in East Africa: Kenya, Uganda and Rwanda, but this research focuses on Kenya only. The modality of the programme as a multi-actor platform (see Fig. 2) in the dairy sector was noted as interesting for an in-depth study of innovation processes. EADD Kenya works at 19 sites in the Rift Valley and Central Kenya regions where dairy
3.2. Case study methods

In line with other studies on agricultural innovation processes (Eastwood et al., 2012; Klerkx et al., 2010), a single case study research design was selected as appropriate for providing in-depth insights into the dynamism of innovation processes (following Flyvbjerg, 2006; Hoholm and Araujo, 2011; Yin, 2003). The EADD programme in Kenya was selected for this study following initial exploratory research (see Kilelu et al., 2011 for details) that identified several on-going initiatives supporting smallholder agricultural innovation in Kenya. From the exploration, the case provided indications of an innovation platform achieving tangible outcomes that made it interesting for a more in-depth study to elucidate the role of innovation platforms in supporting innovation processes. Further, as an on-going project, it provided the opportunity to both reconstruct the innovation dynamics (Van de Ven et al., 2008) and follow the process in real-time (Hoholm and Araujo, 2011).

Because of the breadth of the programme areas of focus, the research was conducted at two sites purposively selected with guidance from EADD staff – Tanykina (Kipkaren) Dairy Company Limited and Metkei Multipurpose Dairy Company Limited. Although we only studied two sites, the risk of bias in such a sampling strategy was minimized by selecting sites that were sufficiently advanced in the process of hub establishment but had followed different innovation trajectories and thus provided adequate depth of diverse experiences to elucidate the innovation process. The sites are located in separate districts in the Rift Valley region with different agro-ecosystems but similar mixed farming systems. Because the two sites have different histories with dairy farming, it was possible to glean a variety of insights on the dynamics of the innovation process. Tanykina was considered a pre-established site as it had recently been established as a cooperative that had already been operating a chilling tank for cooling and bulking milk. Metkei was considered a new site where four small dairy societies worked separately and had no chilling tank. The aim of the case study was not to develop generalized, prescriptive accounts but rather to look for patterns that could provide adequate depth of diverse experiences to elucidate the innovation process. The sites are located in separate districts in the Rift Valley region with different agro-ecosystems but similar mixed farming systems. Because the two sites have different histories with dairy farming, it was possible to glean a variety of insights on the dynamics of the innovation process. Tanykina was considered a pre-established site as it had recently been established as a cooperative that had already been operating a chilling tank for cooling and bulking milk. Metkei was considered a new site where four small dairy societies worked separately and had no chilling tank.
Other data sources included direct observations and informal discussions from participation in various meetings and discussions during site and EADD office visits. We also conducted a semi-structured group interview with six EADD team members. All focus group discussions and interviews were taped and fully transcribed for systematic analysis. Various project reports (including annual project reports, mid-term evaluation) provided additional information. Following the analytical framework, we coded and characterized the data to identify different elements of the co-evolution process in relation to the three intervention (innovation) areas and unravel the role of the intermediaries on the platform.

### 4. Findings

In this section, we describe the process of how EADD established and executed the programme, distilling from this description the components of the co-evolution of the innovation processes on the platform, and highlight some of the issues and tensions that emerged as the process unfolded. We also examine the role of intermediaries in the processes, using the six intermediation functions described in the conceptual framework in Section 2. Quotes derived from the interviews are used to illustrate key points.

#### 4.1. The entry point – setting the agenda, mobilizing the platform and the role of EADD

The EADD programme was established with the goal of improving the incomes of smallholder dairy households by implementing interventions that enhance both dairy production and market access. To guide these interventions, EADD first conducted diagnostic studies to better understand the bottlenecks in smallholder dairy farming. These studies focused on three main areas: (i) improving breeding and animal health; (ii) improving feed management and enhancing access to quality and affordable feeds; and (iii) strengthening market access for smallholders (EADD, 2009a,b,c,d). The studies pointed to areas of intervention; subsequently, how these were addressed evolved through testing and implementing various socio-technical and institutional innovations. Furthermore, the EADD team also conducted feasibility studies to guide site selection.

As an entry point to the communities, the EADD consortium started by advancing a vision for the establishment of farmer-owned DFBA as an alternative to dairy co-operatives, which are the dominant institutional model of dairy farming enterprises in Kenya (EADD, 2011a; Technoserve, 2008). Dairy co-operatives had faced several challenges over the years, with many of them disbanding for reasons such as mismanagement coupled with the collapse of the government-owned Kenya Co-operative Creameries (KCC), the main marketing channel before liberalization of the market in 1992. This had resulted in huge losses for farmers who hence became wary of co-operatives. This context informed EADD’s drive for an alternative dairy business model, as illustrated by the following quote:

**EADD was clear that we were only dealing with a limited liability company. Limited companies were considered less prone to challenges of accountability, governance, sound business management (EADD team interview, September 2010).**

With this vision, the EADD started mobilizing dairy farming communities. A key mobilizing strategy used by the EADD team was the involvement of the local administration and relevant government ministries at different administrative levels (e.g. division and district) and local politicians. It was thought that getting these actors on board would ease entry into communities and also ensure their long-term co-operation beyond the lifespan of the programme. Involving the local administration was also useful in supporting the process of selecting the interim leaders for the DFBA. As one EADD team member noted on this point:

**In sites where we worked with government from the word go and we had their buy-in, and they contributed in selecting representatives from the community that served on the steering committee – When there was this interaction, it [mobilization] worked well (EADD team interview, September 2010).**

EADD organized various public meetings to present the ideas of the programme. After these first meetings, communities were invited to nominate an interim board of directors. The board members were to represent different administrative divisions where they were expected to mobilize farmers to register and purchase shares in the new company. These meetings spurred the initial platforms for interaction among multiple actors leading to the setting up of the DFBA. To demonstrate their commitment to the vision, farmers were expected to raise an initial portion of the equity (10%) for the start-up that would go towards purchasing the cooling tanks and cover initial operational costs. To match farmers’ 10%
contribution, the EADD provided an interest free loan of 30% from programme funding, with the remaining 60% to be financed through commercial loans. Thus an important intermediation role of EADD at the early stages was to mobilize farmers, support the interim leadership of the DFBA to draw up business plans, facilitate the set-up of governance structures, and bring on board other relevant actors as collaborators, broker their interactions and support the interim leadership to raise capital.

In Tanykina, the farmer mobilization process progressed fast because there was a pre-existing co-operative with a cooling tank (albeit running unprofitably), installed with support from Heifer International. EADD was to assist in remodeling Tanykina co-operative into a limited company and support its further development into a business hub. In contrast, the Metkei Multipurpose DFBA was a conglomerate of four co-operative societies that were still operational but struggling: Tulwobei, Metkei, Kapkitony and Kiposaos. This made mobilizing farmers a challenge. Although the co-operatives agreed to form the company, they still retained their own members and respective organizational structure, making it difficult to mobilize farmers for the new Metkei Multipurpose Company, which was to encompass all four societies. There were underlying suspicions and competition between the respective co-operatives, as one EADD staff member noted:

There is a superficial barrier where you are working through the co-operative as a proxy. This is why in Metkei we are stuck with membership of 2,440 though there is potential to mobilize 5,000 farmers (EADD staff, interview September 2010).

In Metkei, it took longer to raise the equity; this delayed the setting up of the chilling plant which began full operations in February 2010, a year after EADD started its engagement with the community. Discussions with farmers indicated that there was confusion about the new entity, and this also affected service delivery at later stages, as discussed in Sections 4.2. One farmer noted the following on this confusion:

All of us have some Metkei shares but are registered with the co-operatives. . . There are four co-operatives and, according to the constitution, the members have to go through the co-operatives (Farmer focus group discussion, Metkei November 2011).

The establishment of the DFBA therefore provided the entry point and a local-level platform for interventions and multi-actor interactions as discussed below.

4.2. The dynamics of co-evolution of innovation on the EADD platform

In this section, we unravel this co-evolution of innovation and the role of intermediaries on the platform in relation to the three main areas of intervention – milk marketing, breeding and feeding. The findings also include some of the tensions that emerged in the process and affected the innovation processes in unexpected ways, revealing the complexity of such processes. Fig. 3 presents a broad overview of events in the innovation process at the two sites, illustrating the interweaving of technical, social and institutional dimensions of innovation that involved mobilizing different actors and resources at various points in time.

4.2.1. Enhancing innovation for improved milk marketing

As noted in Section 4.1, the starting point for EADD was the establishment of dairy limited companies as an alternative dairy business model to address constraints faced by smallholders in production and marketing (EADD, 2009b; Technoserve, 2008). This model was in itself an institutional innovation which started by first setting up the chilling plant for bulking and cooling milk, and putting in place interim governance structures for the DFBA. This genesis provided the platform that triggered a series of other socio-technical and institutional innovations that in combination enhanced marketing (see Table 2 for a summary).

With support from EADD consortium partners, the DFBA were linked to different actors to support different dimensions that were vital to improve marketing. In Metkei, EADD brought in a food pro-

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Fig. 3. Timeline of important events in the innovation process in the two study sites. Note: X – Denotes processes in Tanykina DFBA; ○ – Denotes processes in Metkei DFBA.
cessing and packaging firm as a partner that offered the financing of a cooling tank, some laboratory equipment and the dairy management software for the DFBA. As the firm manager noted “[their] interest in supporting the cooling tank in Metkei was because it was important being part of the dairy value chain to ensure an increase in the quantity and quality of milk processed” (Interview, February 2011). As noted in Section 2.2, there was already a pre-existing chilling plant in Tanykina, so the starting point was the establishment of the DFBA, but also the improvement of the facilities where the chilling plant was located. Later on, Tanykina was linked to a commercial bank that financed a loan to purchase additional cooling tanks for satellite collection centres, thereby reducing the distance to be covered and time it took for milk to be delivered, and ensuring the quality of the milk. 

Farmers commented that the installation of the cooling tanks and the establishment of the DFBA with new governance structures boosted their confidence about accessing markets for their milk. This was reflected in the increased number of farmers selling their milk through the two DFBA. In 2009, about 2757 farmers sold an average of 15,000 L per day in Tanykina; this rose to an average of 21,700 L from 4432 farmers. In Metkei, 1188 farmers supplied an average of 4990 L per day in 2009; this increased to an average of 21,700 L from 4432 farmers. In Metkei, farmers involved with EADD increased production from 4 to about 8.1 L per cow on average, whereas in Metkei the estimated production increased from 4 to 6 L (EADD, 2011b; EADD Kenya, 2011).

Although this is a notable increase, these average volumes are considered below the minimal levels estimated as necessary for households to move beyond the poverty line (TANGO International, 2010; Technoserve, 2008).

The increased milk volumes marketed by the DFBA and higher milk prices resulted in their profitability as enterprises and thus enabled them to expand services to farmers (EADD Kenya, 2011; TANGO International, 2010). The interviews revealed that EADD guided the DFBA in establishing business hubs within the chilling plants to offer a bundle of goods and services (e.g. credit and financial services, AI, feeds, drugs, extension and transportation) to farmers that supplied milk. The business hub integrated a “check-off” system where the farmers could access the goods and services through a credit system, and the cost was deducted from the monthly final payment to farmers. Tanykina was offering more services to its members than Metkei at the time of the study, but Metkei was offering more services through a credit system, and the cost was deducted from the monthly final payment to farmers. Tanykina was offering more services to its members than Metkei at the time of the study, but there was an overall increase in service delivery to farmers at both sites. The hub was managed by a professional team and guided by the board of directors. From observations, we noted that, in both DFBA, older men continued to dominate the boards, reflecting the cultures of both communities. Hub development was accompanied by the integration of other technological devices (weighing scales, dairy information management software). To support delivery of some services such as extension, other new organizational structures such as formation of dairy management groups (DMGs) were also put in place. From the group discussion, farmers who had joined DMGs associated their increased production with the training and support introduced through these groups. At both sites, EADD facilitated financing arrangements with commercial banks to buy motorbikes for various service providers, including transporters, AI service providers (AISPs) and animal health assistants linked to the DFBA. Bringing together diverse actors with different stakes and interests required the platform intermediaries to continually broker and negotiate relationships.

**Table 2**

<table>
<thead>
<tr>
<th>Summary of co-evolution of innovation relating to milk marketing and the roles of intermediaries in supporting the process.</th>
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<tbody>
<tr>
<td><strong>Dimension of innovation</strong></td>
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<td><strong>Hardware</strong></td>
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<td><strong>Software</strong></td>
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**Note:** F1 – Demand articulation; F2 – Institutional support; F3 – Knowledge brokering; F4 – Network brokering; F5 – Capacity building; F6 – Innovation process management.
Nonetheless, marketing remained precarious as indicated by some of the issues and tensions that emerged from discussions and observations. The bulking and cooling of milk as a way of collective marketing was expected to streamline supply to the DFBA, but there was no control over competition among the different buyers who formed part of the broader market environment in the sector. Many farmers at both sites indicated that they divided their milk and sold through different channels, including informal milk traders. The main reasons cited for selling to different buyers were price and transportation. We observed that some farmers from both sites were located very far from the chilling plants, and some areas were unreachable even by motorbike, particularly during the rainy season. This made transportation not only expensive but also unpredictable. Many of these farmers stated that they opted to sell their milk to whoever could collect it at the farm gate. Both Tanykina and Metkei set up a few satellite collection centres to try to address this challenge.

Farmers also pointed to seasonal fluctuations in prices and indicated that in some cases the processors reduced the volumes that they bought during glut periods in the rainy season when there was increased milk production. Thus, the processing companies had control of the market and signing contracts did not deter this uncertainty in the market. Consistency in milk quality was also an issue that affected marketing. In Tanykina, it was noted that farmers continued to use plastic containers to deliver milk even though these were not hygienically ideal. The DFBA was trying to change this practice by making the more hygienic aluminum cans available through check-off, but not many farmers were using them. Further, in an effort to increase milk volumes in the DFBA, EADD was encouraging collection of evening milk. Metkei had started receiving evening milk toward the end of 2011. However, the discussions revealed that the evening milk was consumed mainly at home, and some was sold to neighbours, mainly by women, to acquire ready cash for daily use. Whether this marketing emphasis has an effect on intra-household dynamics is an area for further research.

As illustrated above, the different consortium actors fulfilled complementary intermediary functions in the innovation process. In supporting the co-evolution process, the intermediaries also shaped how the network structure of the platform changed over time. However, from interviews we found that consortium partners had divergent views regarding the goal of enhanced market access. Some partners considered that the primary focus should be on strengthening the DFBA as agro-enterprises and enhancing their profitability, which would then cascade down to improved productivity at farm level, whereas other partners thought that this emphasis on DFBA profitability deflected attention from the primary goal of improving productivity at farm level so that the farming households could benefit from marketing more milk. This observation was also noted in the mid-term evaluation (TANGO International, 2010). This may suggest that intermediaries also brought in competing interests into such processes that needed to be negotiated.

### 4.2.2. Dynamics of improving breeding practices

The improvement of breeding practices through AI was one of the key interventions to enhance milk productivity. A combination of technical and institutional interventions to improve breeding practices was guided by a diagnostic study conducted at the early stages of the programme (EADD, 2009c). AI was not a new technology in Metkei and Tanykina as noted in discussions with farmers, but its uptake had declined over the years due to various factors, including a policy shift to privatization of AI services, as some farmers noted:

**There was government AI but they since stopped around the 1980s. The government used to do it for 1 KSh but now it has hiked to 1,000 KSh so it is now only for the rich** (Metkei farmer focus group discussion, November 2011).

The first issue tackled was ensuring availability of, and access to, quality semen. To enable this, one of the EADD partners – ABS-TCM – facilitated procurement of semen tanks and semen for the DFBA. With semen available, the DFBA had then to ensure the service was delivered to farmers. At both sites, there was a shortage of well-trained AISPs, therefore EADD supported the training of more AISPs, four in Metkei and five in Tanykina. These AISPs were then linked to the DFBA where arrangements were later made for them to provide AI services through the check-off system. The AISPs mainly used the semen that was available at the DFBA, but sometimes had to acquire other semen that was not stocked at the DFBA and which farmers demanded. The check-off system ensured quality service delivery by the AISPs who were now directly linked to DFBA. To further ensure service delivery, the platform also facilitated AISPs to acquire equipment (AI tanks and motorbikes). Table 3 summarizes and characterizes the co-evolu-

### Table 3

**Summary of co-evolution of innovation related to breeding and the roles of intermediaries in supporting the process.**

<table>
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<tr>
<th>Dimension of innovation</th>
<th>Activities</th>
<th>Function of intermediary actors</th>
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<tbody>
<tr>
<td><strong>Orgware</strong></td>
<td>Training of AISP to improve the AI delivery system</td>
<td>F4, F5, F6 –Forging partnerships with various organizations for training AI service providers – Heifer and ABS-TCM</td>
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<td></td>
<td>Providing AI with necessary equipment (e.g. motor bikes, semen tanks)</td>
<td>F2 and F5 – Supporting entrepreneurial development of the AISPs (as a business development service) by facilitating access to finance and business skills training through partnering with relevant actors – ABS, Heifer and TNS</td>
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<td>through loans and integrating AI service delivery with check-off system</td>
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<td></td>
<td>Formation of dairy management groups (DMGs) as platforms for farmer training</td>
<td>F4, F5 and F6 – Facilitating the mobilization of farmers into groups – Heifer</td>
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<tr>
<td><strong>Hardware</strong></td>
<td>Acquisition of semen tanks by DFBA for semen storage and distribution to AIRS</td>
<td>F3 and F5 – Providing information on semen tanks and facilitating their procurement – ABS-TCM and Heifer</td>
</tr>
<tr>
<td></td>
<td>Acquisition of quality semen from various suppliers</td>
<td>F1, F3 and F5 – Guiding procurement and distribution of selected semen at a subsidized price due to bulk buying – ABS-TCM</td>
</tr>
<tr>
<td></td>
<td>Promoting “village bull” concept, i.e. encouraging farmer groups (DMGs) to acquire semen tanks to store their preferred semen at village level</td>
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<tr>
<td><strong>Software</strong></td>
<td>Improving service delivery through contracts between DFBA and AI service providers</td>
<td>F5 and F6 – Facilitating the drafting and signing of contracts – Heifer F1 – Conducting baseline/diagnostic studies on breeding issues – ILRI F5 – Providing funding for extension services at the beginning, and later (from 2011) cost sharing with the DFBA – EADD consortia</td>
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<tr>
<td></td>
<td>Promoting informed farmer decision making and AI service demand articulation by farmers to improve breeding practices through training and information dissemination</td>
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</table>

**Note:** F1 – Demand articulation; F2 – Institutional support; F3 – Knowledge brokering; F4 – Network brokering; F5 – Capacity building; F6 – Innovation process management.
tion process, showing the interdependence of the interventions and actors and how the platform intermediaries supported the process.

Several respondents, including farmers and ministry of livestock officers, pointed at the increased uptake of AI at both sites, indicating that the innovation platform contributed to innovation outcomes. Many DMG farmers indicated that the increased uptake was facilitated by the training on breeding that improved their knowledge about AI, complemented by the check-off system that allowed them readily to access AI services. Conversely, many farmers not in a group said that they did not use AI and linked this to their limited access to knowledge on breeding, as groups were the platform for training and information dissemination. However, many farmers still perceived AI to be expensive, even with the check-off system and the subsidization of some semen through the programme. The perceived high cost was linked to many instances of repeat inseminations because of missed conceptions, as illustrated by the following quote:

“When you take the cow for insemination, there are times it will fail and people will decide that if the AI is failing yet it is very costly, it will be better to go back to the bull system” (Tanykina farmers’ focus group discussion, August 2011).

On the one hand, many farmers linked repeats to delayed responses by service providers, particularly because there was still a shortage of personnel and the few available had to cover long distances over very poor terrain. AISPs, on the other hand, stated that part of the challenge was that farmers were not detecting heat on time and that this resulted in delays in insemination. Thus, some farmers reverted to using bulls as a cheaper option, although the use of bulls also persisted because of other traditional practices, including uncontrolled open grazing.

At both sites, AISPs, DFBA managers and even EADD partners were aware and agreed that missed conception was an issue, but from interviews we noted that there was no systematic feedback process that could guide collective learning in solving the problem. A few DMGs indicated that they had tried out the “village bull” idea that was being promoted as one way of giving farmers more control of AI services, but these groups ran into the challenge of lack of qualified service providers. The operation of a village bull depended on a group being able to hire their own service provider, but there was a shortage of locally available qualified AISPs. Some farmers expressed some reservations about the subsidized imported semen, pointing to issues of perceived poor quality (e.g. weak calves from the semen) and also suitability of the semen (e.g. adaptability). Further, the improvement of breeding practices depends also on farmers keeping proper records for all inseminations and on ear tagging; but discussions with farmers indicated that many of them did not consistently keep records on items such as AI servings, conception, calving, milking and tracking of progeny, and there was no structured support through the platform to improve these.

This section indicates that the platform to a certain extent induced the uptake of improved AI practices by building adequate linkages with different actors at different times and also by integrating new organizational and institutional structures (such as the check-off system, village bull). However, the various gaps and tensions noted indicate that the interventions could not cater for all categories of farmers and also did not put in place all necessary conditions to address the bottlenecks to successful AI innovation.

4.2.3. Enhancing production through improved feeds and feeding practices

In both Metkei and Tanykina, natural pastures for grazing comprised the largest portion of livestock feed. The predominant feeding system combined extensive open grazing, complemented by the use of planted fodder (mainly napier grass and oats) and supplemented by purchased concentrate feeds. The reliance on pastures by a majority of the farmers resulted in a perennial problem of limited quality feeds, and this affected milk production. Many farmers indicated that growing fodder was a good alternative to expensive concentrate feeds. The platform supported various interventions that combined extension and training on new feed technologies (i.e. forage and fodder production) and promotion of feed conservation methods so as to maximize milk production while minimizing feed cost. First, a trainer of trainers (TOT) approach that combined model (demonstration) farmers and community-based trainers was used to disseminate information and technologies to farmers in DMGs. ICRAF and ILRI provided dissemination support and conducted participatory research on some new fodder crops (e.g. dual purpose sweet potatoes) and on silage making. The district-level Ministry of Agriculture extension office also collaborated to support the trainers. However, the TOT approach faced challenges as the trainers were not effectively reaching farmers as a result of an oversight relating to their supervision, because it was not clear whether they reported to the DFBA management or the EADD facilitators. This challenge resulted in extension services being halted for a period time. Consequently, a new extension approach had to be designed, whereby community extension service providers (CESPs) were to be hired directly through the DFBA; this

<table>
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<th>Table 4</th>
<th>Summary of innovation activities for improved feeding and the roles of intermediaries in supporting the process.</th>
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<td><strong>Dimension of innovation</strong></td>
<td><strong>Activities</strong></td>
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<tr>
<td>Orgware</td>
<td>Training and dissemination of information on improved feeds and feed conservation management through DMGs</td>
</tr>
<tr>
<td></td>
<td>Establishment of demonstration plots in farmer trainer fields for use in training on growing various types of feeds and for seed multiplication</td>
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<tr>
<td>Hardware</td>
<td>Promoting the use of small-scale feed processing technologies, i.e. pulverizers and chuff cutters</td>
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<td></td>
<td>Dissemination of various types of fodder crops (seeds, vines)</td>
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<tr>
<td>Software</td>
<td>Conducting participatory research with farmers to test various newly introduced fodder crops (e.g. dual purpose sweet potatoes)</td>
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Note: F1 – Demand articulation; F2 – Institutional support; F3 – Knowledge brokering; F4 – Network brokering; F5 – Capacity building; F6 – Innovation process management.
meant that the DFBAs had to contribute financially for this service from their revenues. Table 4 provides a summary of how the feed innovation dynamics co-evolved.

At both sites, most farmers belonging to DMGs indicated increased knowledge about different types of feeds (e.g. lucerne, calliandra, sweet potatoes, desmodium) and feed conservation methods (e.g. silage, hay) compared to those that were not in groups. Most of the DMG farmers indicated that they made better use of crop residue as feed, particularly maize stovers (leaves and stalks) which previously were not highly valued as feed, and some had also planted new fodder crops. However, we generally noted from the focus group discussions with farmers that the adoption of the new feeding technologies and practices was still a challenge. The most common problem cited by farmers was the lack of access to seeds. Most of the seeds for the newly introduced feeds were not easily available at the local agro-vet shops so farmers could not purchase them. Further, in some areas, farmers stated that the demonstration plots which were to serve as multiplying sites for seeds did not work as well as expected. In Metkei, farmers indicated that most demonstration plots had not yet been established and those that were set up did not receive adequate technical support from the programme as planned. Various informants attributed some of the difficulties to how the extension approach was structured when the programme began. However, although the extension approach was restructured and incorporated into the DFBAs, the changes still did not address many of the challenges noted.

From discussions with various informants, we found that feedback and learning from some of these challenges were not systematically captured. We found that, although learning on EADD’s function was embedded into the programme plan and led by one of the consortium partners (ILRI), this learning was not transferred to different levels on the platform. A mid-term evaluation report highlighted this challenge, pointing to the constraint of a focus on fulfilling programme milestones as reflected in the monitoring and evaluation system which did not necessarily link to a learning agenda at the different levels of operation of the platform (EADD, 2011b; TANGO International, 2010). Additionally, at both sites, many farmers indicated that shrinking plot size constrained the possibility of switching from food crops to fodder crops on part of their land. The issue of access to land was particularly challenging for the youth and women who had less control over land because of cultural factors. Furthermore, it emerged from both sites that poor rainfall also affected their plans to plant fodder crops, causing technologic innovation also triggers new practices. For example, the introduction of the dairy management software for records management introduced more transparency not only in the weighing of milk but also in systematically tracking the various transactions relating to services used by each farmers, thus enhancing farmers’ trust in the dairy company. Also, the establishment of dairy companies with improved governance and management structures, coupled with a credit guarantee provided through the EADD programme, enabled companies to secure credit from commercial banks, which previously were wary of lending to farmers because of the perceived risk of agricultural enterprises. Thus, it is in the co-evolution process that the different elements mutually reinforce one another, almost in a virtuous cycle (cf. Hekkert and Negro, 2009), which is also linked to changing and emergent network configurations (Ekboir, 2003; Kash and Rycroft, 2002; Klerkx et al., 2010). This is what contributes to overall system change - in our case moving from predominantly smallholder subsistence dairy farming (comparable to system A in Fig. 1) to increasingly commercial dairy farming (system B in Fig. 1).

As our findings demonstrate, the key role of platforms is in connecting the orgware component (institutional change) to the hardware and software components of innovation by establishing effective patterns of interactions for negotiating institutional change; this confirms earlier findings (Dordon et al., 2007). Here, it clearly emerges that the intermediation on the platform is critical in strengthening more system-level capacities relating to orchestrating and organizing networks, thus enabling the co-evolution of innovation by facilitating linkages among different stakeholders who were previously not connected for various reasons (e.g. cognitive distance, high transaction costs and information asymmetry). But importantly, as others also have shown, it is the negotiated institutional changes as the outcomes of these linkages that can then provide opportunities for successful innovation for smallholders (see Dordon et al., 2007; Hall et al., 2001; Nederlof et al., 2011).

From these findings, we note that the important role of the EADD consortium actors as innovation intermediaries could be seen from the beginning of the innovation process, facilitating the articulation of the innovation vision, and mobilizing funding and other resources necessary for the programme. This was followed by orchestrating networks of different actors who were brought in at different points in time, mainly around specific issues. This included selecting which actors were important for fulfilling particular objectives of the programme at various points in the innovation process. This contributed to reconfiguration among actors, including patterns of co-operation. This indicates that platforms are highly dynamic and distributed in composition, as opposed to static structures, as Nederlof et al. (2011) have also found.

The results thus indicate that platforms are effective in coordinating innovation because of the complementary skills and compe-

5. Analysis and discussion
5.1. Innovation platforms synchronize mutually reinforcing developments through distributed intermediation

The findings indicate how the innovation platform shaped the innovation process in addressing the various system weaknesses which had been impeding the enhancement of smallholder dairy farming and contributed to outcomes in relation to access to services and inputs and improved productivity. The strength of EADD as an innovation platform was in sequentially (but with recurring and sometimes simultaneous attention to the same issues if needed) implementing combinations of technical and social institutional innovations; this also contributed to some reconfiguration of relations among different actors. As the results show, the new dairy business model as an institutional innovation integrated technological elements which further catalysed business hub development and accompanying institutional re-arrangements in service delivery. Most of the innovations were institutional in nature, confirming earlier findings on institutional change as a sine qua non for innovation (Cleaver, 2002; Hounkonou et al., 2012). However, the integration of technological elements (albeit incremental technological innovation) was also of key importance because technological innovation also triggers new practices. For example, the introduction of the dairy management software for records management introduced more transparency not only in the weighing of milk but also in systematically tracking the various transactions relating to services used by each farmers, thus enhancing farmers’ trust in the dairy company. Also, the establishment of dairy companies with improved governance and management structures, coupled with a credit guarantee provided through the EADD programme, enabled companies to secure credit from commercial banks, which previously were wary of lending to farmers because of the perceived risk of agricultural enterprises. Thus, it is in the co-evolution process that the different elements mutually reinforce one another, almost in a virtuous cycle (cf. Hekkert and Negro, 2009), which is also linked to changing and emergent network configurations (Ekboir, 2003; Kash and Rycroft, 2002; Klerkx et al., 2010). This is what contributes to overall system change – in our case moving from predominantly smallholder subsistence dairy farming (comparable to system A in Fig. 1) to increasingly commercial dairy farming (system B in Fig. 1).

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The results thus indicate that platforms are effective in coordinating innovation because of the complementary skills and compe-
tencies that the various intermediary actors bring to the platform. The organizations in EADD were able to connect different actors representing different ambits of the innovation process. These findings confirm the complexity of innovation intermediation, which entails fulfilling a myriad of functions distributed over time and fulfilled by different actors. Rather than just one central innovation intermediation acting as a platform facilitator, there is a set of innovation intermediaries, as other studies (Klerkx et al., 2010; Stewart and Hyysalo, 2008) also have observed.

5.2. Tensions and caveats of innovation platforms in stimulating co-evolution

Despite innovation platforms acting as catalysts for innovation systems interaction, the results also point to the limitations of platforms. As other scholars have also argued (Hall and Clark, 2010; Hekkert and Negro, 2009; Leeuwis and Aarts, 2011), co-evolutionary processes cannot be steered and controlled fully, so the platform is not a magic bullet for fully managing innovation processes. From our analysis, we can identify several tensions in relation to employing platforms as a tool to stimulate innovation.

A first tension relates to the structure of platforms in relation to purpose. As the results indicate, EADD appeared to be successful with regard to improving marketing at the DFBA level, but, despite some positive results, the platform appeared to be less successful with outcomes relating to farmer-level innovation and productivity linked to uptake of AI and improved feeding management strategies. Despite the fact that EADD enabled the formation of different lateral networks to address a variety of emerging issues relevant to the overall innovation process, the platform appeared not to have sufficient capacity to enact the effective reformism needed to change all structures; this impeded change at different levels. This raises the question of whether all innovation platforms should have a similar composition in terms of diversity of participants and governance structure, or should also differ according to different types of outcomes (such as strengthening value chain interaction, raising farm-level productivity and livelihood improvement) and the different levels of operation (such as platforms aiming at developing innovative solutions to problems, and platforms aiming at upsaling such solutions), as the recent findings by Hermans et al. (2012) suggest.

A second tension is that, despite the usefulness of the distributed nature of innovation intermediation, it could also be seen as a source of tension and competition among the innovation intermediaries, which are essentially different organizations each with its own objectives. In this context, each organization focused on or pursued strategies that reflected imperatives and mandates of their organizations, and in some case this resulted in tensions that undermined the broader vision of the programme. In relation to this finding, there is also a limitation in our analysis: by focusing only on the platform’s formal innovation intermediaries (the EADD consortium), we did not necessarily capture the distributed agency of other actors involved in the network; but these could also be acting as innovation intermediaries in less formal ways and could even counteract overall platform objectives, as Klerkx and Aarts (2013) have observed elsewhere.

A third tension relates to the flexibility that platforms need to have vis-à-vis programme planning. As the EADD case shows, platforms are continuously facilitating interactions with different actors, dictated by circumstances and unanticipated effects of actions. These findings confirm earlier findings that the management of innovation processes needs to be adaptive and guided by iterative learning (Klerkx et al., 2010; Kouvéi et al., 2011). Although the EADD platform was designed with a learning component, it was not always sufficiently adaptive and responsive, at least in the short term, to the new problems and tensions that emerged. This implies that platforms should not be seen as a development tool for executing a preconceived plan in a blueprint fashion, but rather they should be arenas for strengthening capacities to better deal with the complex and dynamic nature of agricultural innovation (following Elkboir, 2003; Hall and Clark, 2010; Leeuwis and van den Ban, 2004). This connects to the issue of the need to balance and reconcile results-based, milestone-focused monitoring (e.g. logical frameworks) with process-based monitoring, where the intermediaries systematically capture feedback and enhance reflectivity in order to adequately support adaptive capacity in the innovation process (Regeer, 2009; van Mierlo et al., 2010).

This is an important finding in light of the increasing application of platforms in agricultural innovation and development programmes. Such adaptive capacity can be a challenge in development programme-driven innovation platforms. One of the reasons is the scale of programmes and the platforms connected to them (e.g. the sub-Saharan Challenge Programme working in nine countries – van Rijn et al., 2012) and demands in terms of clear planning for budgeting, implementation and accountability purposes. Another reason is that some issues that emerge are beyond the scope of the platform given the broader contextual factors that impinge on the process. For example, infrastructural problems linked to inadequate access to water or poor feeder roads could not be adequately addressed by EADD. This hints at the need to be aware that adaptive management of innovation through platforms requires also funding schemes that are responsive to emerging challenges or finding ways to leverage the required resources.

6. Conclusion

This paper has demonstrated how innovation platforms are important mechanisms for stimulating and coordinating co-evolution of innovation. A main implication of our study for theory is that the co-evolving nature of innovation processes requires a conceptualization of platforms as dynamic and distributed networks instead of static and centralized networks. They have a nested structure comprising different intermediary actors who build bridges between the different components in innovation systems, and it is the variety of intermediary actors that makes the platform effective. A key policy implication is that supporting innovation platforms as mechanisms for enhancing innovation requires platform funding, planning and governance mechanisms that allow for continual adaptation to emerging issues. This also points to the need to integrate more reflexive forms of monitoring to optimally enable adaptive management of innovation through innovation platforms.

The study also highlights a number of areas for future research, connected to the tensions and caveats identified in Section 5.2. A first area is about platform structure and governance in relation to the objective of the innovation platform (such as strengthening value chain interaction, raising farm-level productivity, livelihood improvement). A key question is how to determine a priori the optimal diversity of participants on innovation platforms and the optimal governance form for innovation platforms. This also relates to issues such as the costs of operating innovation platforms (efficiency) and sustaining action initiated by innovation platforms (effectiveness). It could be relevant to explore work from organization and management studies in order to inform studies on platform composition and governance (Provan and Kenis, 2008; Klerkx and Aarts, 2013).

A second area relates to the role of innovation intermediaries. Our study has shown that different innovation intermediaries are complementary, but it also revealed diverging priorities among the different innovation intermediaries operating on the platform. For platform efficiency and effectiveness, a key issue is that overall
facilitation should be in place to minimize such divergence and maximize complementarities between different innovation intermediaries. It is still an open question as to who is best placed to fulfill this role of overall platform facilitator. Klerx et al. (2009) have suggested that a specialized and independent organization has certain advantages for overall platform facilitation vis-à-vis innovation intermediaries on the platform, who also have a substantive role (for example in undertaking research or providing technical services) and a stronger normative orientation or political or commercial interest, but further research is needed to verify this. Furthermore, whereas this study focused on the formal intermediaries on the platform, future studies should analyze the many informal intermediaries which may be active on the platform or in its broader environment.

Finally, a third area for future research relates to how to shape monitoring to enable adaptive management of innovation through innovation platforms. Future studies should investigate whether and how different ways of monitoring can be combined to satisfy the needs of both innovation platform participants and innovation platform funders.

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