E3 Journal of Agricultural Research and Development Vol. 6(1). pp. 012-029, February, 2016
Available online http://www.e3journals.org
ISSN: 2276-9897 © E3 Journals 2016
DOI: http://dx.doi.org/10.18685/EJARD(6)1_EJARD-15-023

Full Length Research Paper

Characterization of dairy innovation systems in two peri-urban areas in western Oromia, Ethiopia: structural dimensions, systemic problems and systemic instruments for improvement

Diriba Geleti[1*], Mekonnen Hailemariam[2], Ashenafi Mengistu[2] and Adugna Tolera[3]

[1]Ethiopian Institute of Agricultural Research, Debre Zeit Research Center, Ethiopia
[2]Addis Ababa University, College of Veterinary Medicine and Agriculture, Ethiopia
[3]School of Animal and Range Sciences, Hawassa University, Ethiopia

Accepted 12 January, 2016

Generation, transfer and putting into use of agricultural technologies require insights on the structural and functional dimensions of the innovation system. Using an integrated value chain and innovation systems perspective, the present study characterized the actors of the dairy innovation systems in two peri-urban sites in western Ethiopia. Diverse actors (entrepreneurs, intermediaries, knowledge generators, demand side actors and policy makers) were observed to operate in the system. Using a systemic policy framework, systemic problems hindering innovation and learning were pinpointed. The existing linkages among the various actors were observed to be weak and unfavorable for collective learning and innovation to take place. Five categories of systemic problems, including infrastructural (physical, knowledge and financial); institutional (hard and soft); weak network; capability and 'missing actor' problems were identified. Policy tools that could potentially contribute to the alleviation of these problems were finally suggested.

Key words: actors, interactions, institutions, infrastructures, capability, systemic policy framework, systemic instruments

INTRODUCTION

The productivity of Ethiopian dairy sector is constrained by a number of factors including feed shortage (Diriba *et al*., 2014) and low productivity of the local cattle (Kefena *et al*., 2006). In view of this, regional, national and international research and development actors have been attempting to generate and disseminate feed and breed related technologies (BARC, 2003; Kebebe *et al*., 2010; Seife *et al*., 2012). Technology generation and transfer activities for development of the dairy sector are dominated by the paradigm of experimental and reductionist science. The "transfer of technology" approach claims that when technical solutions generated by research are trickled down to farmers, they can serve as a cure to farm level technical problems (Rogers, 2004). But uptake of the technical solutions popularized through this approach has generally remained low mainly due to the top-down and supply-driven nature of the scheme and its little concern to the various sources of knowledge and demand for knowledge (Lundvall *et al*., 2002; Hall *et al*., 2006). The model thus lost its utility, leading to a search for new models of enhancing innovation and new roles for science.

Considering the limitations of linear thinking for understanding the source and thus the solutions of agricultural problems, alternative approaches have been employed since the 1970s in Ethiopia (Hjorth and Bagheri, 2006). A notable event has been the use of a farming systems research and extension approach which contributed to a better understanding of the role of diverse actors in bringing progress in agricultural development. This approach facilitated the creation of awareness on new ways of doing research that takes into account prevailing contextual factors (Schiere *et al*., 1999; Darnhofer *et al*., 2012). This move highlighted the need for interaction and dialogue between different actors and networks based on the realization that flows of

*Corresponding authors E mail: dgeleti2005@yahoo.com

communication and exchange between different actors is critical for the existing knowledge to be either reinforced or somehow transformed, finally leading to the emergence of new forms of economically useful knowledge (Leeuwis *et al*., 1990).

An innovation systems (IS) framework has also emerged recently as a framework that embraces the totality and interaction of actors involved in innovation and extending beyond the generation of knowledge to encompass the factors affecting demand for and use of knowledge (Hall *et al*., 2006). The approach focuses more on the process of innovation and claims that this process is multifaceted with new ideas being developed and implemented by actors engaging in networks and making adjustments to achieve desired results. Currently, innovation studies increasingly focus on learning itself, with emphasis on facilitation and the processes of human interaction from which learning emerges (Roling and Wagemakers, 1998). Similarly, Leeuwis (2000) pointed out the importance of considering the perceptions of farmers on the suitability of new technical solutions with prevailing management demands and overall social and organizational contexts. An approach with growing popularity is also a value chain approach, which deals with analysis of the various actors and their activities from production to consumption, and the dynamic relationships existing between the actors involved in a value chain (Rich *et al*., 2011). Key to both analytical frameworks is the mapping and characterization of actors and their interactions and identification of embedding systemic problems to be able to suggest systemic instruments. An innovation systems approach focuses on knowledge generation and use, often at a particular stage of a value chain, while the value chain approach is more about value creation and market opportunities and linkages along a commodity value chain.

In Ethiopia, regardless of the extensive efforts made over years to generate and disseminate forage and dairy technologies, their sustainable adoption and utilization has remained low under the various research and development paradigms implemented thus far. For example, taking the case of forage technologies, a recent study indicated that only 0.15% of farmers practice production of improved forage crops and 0.8% use energy and protein concentrates. Generally, access to adequate feed has become fiercer at present than ever before, and in certain cases was reported to seriously damage the relationships between communities by triggering conflict over grazing lands (Seife *et al*., 2012). Regarding breed interventions, the population of cross-bred and pure exotic dairy cattle was reported to account for only 0.64% and 0.1%, respectively, with the latter largely owned by commercial farms (Chencha *et al*., 2012). This suggests that efforts made over years to ensure adequate feed production had little impact on the productivity of the subsector (Tesfaye *et al*., 2010) At present, it is widely understood that dissemination of new technical options and their subsequent adoption is not a smooth and efficient process. Generation of innovations requires insights on the systemic problems that hinder the successful adoption and use of technologies. In contemporary systemic literatures, these problems are labeled as “system failures” (Jaccobson and Johnson, 2000), “system imperfections” (van Mierlo *et al*., 2010), “systemic problems” (Farla *et al*., 2010) or “blocking mechanisms” (Lamprinopoulou *et al*., 2012). While some authors have attempted to characterize the dairy innovation systems and identify constraints hindering its positive evolution mainly under rural production scenarios (Amlaku, 2012), there are still significant gaps in understanding systemic problems that embed in peri-urban dairy innovation system under varying production contexts. Such study is an important first step for designing appropriate systemic instruments to alleviate the embedding systemic problems.

Equally, systemic instruments are receiving growing attention among policy makers as novel means to bring about successful evolution of a given technological innovation system (Voss *et al*., 2009; Raven *et al*., 2010). These instruments focus on the wider technological innovation system than on its particular elements and support processes that play crucial roles in enhancing the progress of technological innovation systems (Smits and Kuhlmann, 2004). Systemic instruments aim at addressing systemic problems that arise at the innovation system level and negatively influence the speed and direction of innovation processes (Edquist, 1997). In addition to pinpointing systemic problems, it is also important to know as to what systemic policy instruments best address the systemic problems. This suggests the need for building systemic instruments on the systemic problems so that the latter will be successfully alleviated.

The present study analyzed a peri-urban dairy innovation system in two peri-urban sites in western Oromia, Ethiopia. The aim was to characterize the technological innovation system with respect to actors involved and their functions, and the patterns of interaction among the actors. Systemic problems hindering successful evolution of the innovation system were further diagnosed, followed by suggestion of systemic instruments to address the problems using a systemic policy framework approach. The paper is organized in four sections. In the next section, the research methodology is described, and the procedures employed for data collection and for systemic problem identification are outlined. Section three presents the findings of the work and in the fourth section, conclusions and recommendations are presented.

Research Methodology

Location

The study was undertaken in Bako and Nekemte peri-

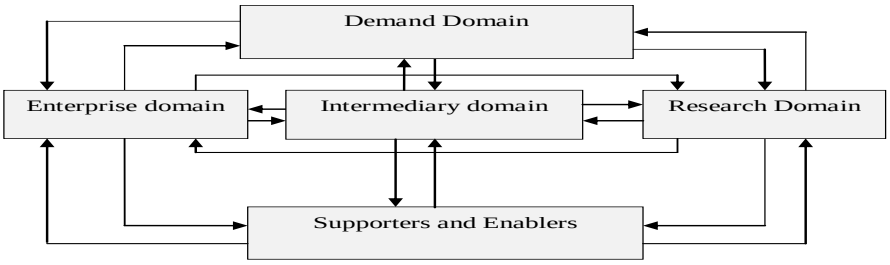

Figure 1: Conceptual framework used in the study (Adapted from Rajalahti *et al*. (2008).

urban areas. Bako peri-urban site is located in Bako Tibe District of West Shoa zone of Oromia Regional State, while the latter is located in Guto Gida district of East Wollega zone of the same region. Description of the edaphic, climatic and farming system characteristics of the two areas was reported earlier (Diriba *et al*., 2014).

- **Feed and dairy cattle research and development in the study peri-urban sites:** time line, achievements and challenges

Formal feed and dairy research efforts in the present case study sites were started in 1974 at Bako Agricultural Research Center (BARC), which was affiliated to the then Institute of Agricultural Research, established in 1966. The center has been undertaking research activities leading to generation of feed and dairy breed technologies suitable to the farming contexts of the case study sites through its department of Animal Production.

Following the establishment of regional governments and the decentralization of the national agricultural research system, the Oromia Agricultural Research Coordination Service (OARCS) came into existence in 1991, shortly following the establishment of the Oromia Regional State (OARI, 2003). The OARCS began delivering its responsibilities in 1993, following the formal transfer of BARC from the then IAR to OARCS. To further strengthen the research activities in the Region, the Regional Government established the Oromia Agricultural Research Institute (OARI) in 2001 (Megeleta Oromia, 2001). As a result, various forage species have been developed, tested and recommended (Lemma and Diriba, 1997).

Dairy cattle crossbreeding activities for developing appropriate genotypes have been underway and it was concluded that crosses of local cattle breed and Holestien Friesian with exotic inheritance of 50% to 62.5% are suitable for market oriented smallholder production systems if integrated with appropriate feed, health and husbandry packages (Gizaw *et al*., 2011). On-farm evaluation studies carried out in Bako and Nekemte peri-urban areas, however, showed that milk production levels of the crossbred cattle remained much lower than that achieved under on-station condition (Gizaw *et al*., 2011; Diriba *et al*., 2014). A closer look at interventions initiated by the center in collaboration with other stakeholders also revealed that these efforts have mainly been supply-driven, focusing on trickle down of technical inputs through a top-down technology transfer approach. The focus has largely been on alleviating the supply side constraints such as feed, breed and animal health services. The strengthening of the organizational and technical staff capacity for enhanced technology supply and transfer has also been the main areas of focus. Despite these efforts, the feed and improved dairy cattle breed based integrated interventions have not been able to take off (Tesfaye *et al*., 2010).

Indeed, the supply-side technical constraints such as feeds, improved breeds and animal health were and still are vital to enhance productivity of the peri-urban dairy subsector. However, it is now widely recognized that for enhancing adoption and use of technologies generated, it is imperative that technological innovations go hand in hand with organizational, institutional and process innovations (Leeuwis, 2004). Although knowledge about technology and production is necessary, it is now widely understood that this is not enough to enable innovation and enhance economic gains from introduced technical interventions. This suggests the need to characterize the complementarities between technical and non-technical factors conditioning the evolution of the feed and breed integrated innovation systems.

Data collection methods

Data collection for the present study was undertaken between May 2013 and July 2013. The key actors were identified on the basis of information available from various sources. A series of semi-structured interviews were conducted with relevant actors involved in the generation, transfer and use of feed and dairy technical innovations. Insights of various actors on feed and peri-urban dairy development issues were elicited, the discussion topics including: types of actors and their functions; the patterns of linkages; institutions (both hard and soft) and aspects of actors' capabilities conditioning inter-actor interactions, and the perceptions of actors regarding the policy structures relevant to feed and peri-urban dairy production. The conceptual framework used is illustrated in Figure 1.

Table 1: Categories of systemic problems and their mechanisms as used in this study

Problem type	Problem mechanism
Infrastructural problems	Lack of physical, knowledge and financial infrastructures (mainly focusing on large scale structures with long time horizon of operation and low return for private investment)
Hard institutional problems	Absence or shortcomings of formal institutions such as regulations and standards that create an unfavourable environment for innovation.
Soft institutional problems	Informal institutions such as culture, social norms and values, entrepreneurial spirit, trust and risk-taking that hinder innovation
Weak network problems	Too limited interaction and knowledge exchange with other actors inhibits exploitation of complementary sources of knowledge and processes of interactive learning
Capability problems	Lack of appropriate competencies and resources at actor and firm level that prevent access to new knowledge, and lead to an inability to adapt to changing circumstances, to open up new opportunities, and to switch from an old to a new technological trajectory
Missing actor problem	Absence of important actors in the innovation system

- Identification of systemic problems and policy instruments to alleviate them Successful adoption of technological interventions generally takes time, and the process is not smooth and efficient due to various systemic problems. Along with Smith (2000), Woolthuis *et al*. (2005), Chaminade and Edquist (2006) and Lamprinopoulou *et al*. (2012), the technological innovation system in the present study was diagnosed for systemic problem categories described in Table 1. Following Woolthuis *et al*. (2005), the lock-in (path dependence) problem was left out from the list as it by itself is an outcome of other systemic problems.

The theoretical systemic problems described in Table 1 were linked with the empirical innovation system problems driven from two case studies: (1) analysis of dairy feed and fluid milk value chains at the two peri-urban study sites in which a value chain approach was used (Diriba *et al*., 2014); and (2) a complementary innovation systems appraisal study that used an innovation systems framework (Hall *et al*., 2006).

The empirically identified systemic problems were recorded and then clustered under particular theoretical groupings (Woolthuis *et al*., 2005). The systemic problems clustered under the different typologies were further combined in a matrix that integrates functional dimensions of the system diagnosed with specific actor types (see Table 4 of the result and discussion section). Further, a group of actors that are affected by a specific problem typology were combined in a matrix and this gave an insight on the type of actors whose problem can be addressed through similar systemic instruments as summarized in Table 5.

Linking the goals of systemic instruments with systemic problems led to the completion of the systemic policy framework illustrated in Figure 2. Within this framework, the functions were analyzed through the perspective of the structural elements of the innovation system, leading to detection of factors hindering specific functions and then hindering the progress of the innovation system. Identification of the goals of systemic instruments facilitated detection of coherent and mutually reinforcing systemic instruments. The qualitative information generated through various interlinked processes were systematically classified by thematic areas and tabulated to enhance description and discussion of the results.

RESULTS AND DISCUSSION

This section presents the results from the diagnosis of the innovation systems, focusing on actors and their functions, patterns of their interaction, actors attributes in terms of competencies and the institutional factors conditioning inter-actor interactions. Systemic problems embedding in the innovation system as captured during the field study were described to draw implications for systemic policy instruments that would help alleviate the problems.

- Actors and their functions diverse actors were observed to engage in peri-urban dairy development in the case study sites and these are mapped in Figure 2. In line with Hall (2006), the actors were categorized into six domains: (1) Enterprise domain – actors using codified knowledge and generating largely tacit knowledge; (2) Research domain – actors generating codified knowledge; (3) Intermediary domain – actors playing an intermediary (knowledge brokering) roles; (4) Demand domain – actors that consume feed and peri-urban dairy products and services; (5) Support domain – actors that support the integrated intervention

Table 4: Innovation system function, actor type and systemic problems identified technological innovation system analysis

System function	Actor type	Systemic problems clustered by specific structural element
Entrepreneurial	**Dairy producers**	**Physical infrastructure problem**: Shortage of reliable electric power supply; unfavourable feeder roads for input and output transport; unreliable water supply; shortage of land for adequate feed production, and lack of space for milk shop construction and further farm expansion **Knowledge infrastructure problem**: lack of veterinary diagnostic services and infrastructures; absence of functional milk and feed quality assessment laboratory services; poor access to tailor-made dairy knowledge resources **Financial infrastructure problem**: lack of favourable credit schemes for purchase of input and facilities for farm development **Soft institutional problems:** hesitant behaviours to promoted technical interventions; lack of motivation on the part of some farmers to form cooperatives; too risk aversive tendencies that could stifle innovation; mistrust of each other; mistrust of government actors **Capability problem**: lack of competence to formulate their demand regarding the kind of support they need from policy makers; lack of awareness on input quality and associated risks; lock-in to traditional technologies; little competence to exploit existing feed and dairy related knowledge sources;
Entrepreneurial	**Feed suppliers**	**Physical infrastructure problem**: Lack of feed storage infrastructure (for mill house and oil extraction owners); feeder roads of poor standard to safely transport feed and other inputs from sources; **Soft institutional problem:** deceitful behaviours, for example admixing of feed ingredients with inedible waste materials; mistrust of each other; mistrust of government actors mainly revenue authorities; pervasive secretiveness **Capacity problem**: No awareness on feed quality standards; lack of skill in feed formulation **Missing actor problem**: no actor in the system formally engaged in commercial feed production and distribution; no vibrant forage seed and dairy heifers producer
Entrepreneurial	**Drug vendors**	**Knowledge infrastructure problem**: shortage of disease diagnostic facilities to adjust drug recommendations **Financial infrastructure problem**: Limited service delivery, for example services limited to drug vending in most cases induced by financial problems **Soft institutional problem**: deceptive behaviours in service delivery, for example sale of expired drugs; inaccurate drug recommendations, perhaps induced by lack of diagnostic facilities

Table 4: cont

Technology diffusion	**Livestock Agency**	**Hard institutional problem**: Lack of a clear regional policy on urban/peri-urban dairying; no functional feed and dairy product quality and safety regulations; insufficient market incentive mechanisms to encourage producers to adapt practices ensuring safe milk production **Soft institutional problem**: top-down and coercive inclinations; habit of covering up failures; bias of extension services against market oriented peri-urban dairy niche sector; some actors of the office de-legitimizing peri-urban dairying activities **Capability problem**: Lack of competence to quickly reconfigure to new niche systems and development paradigms; limited capacity to initiate flexible strategies to fix solutions to local problems; lack of awareness on veterinary drug and feed quality regulations crafted at federal level
Technology diffusion	**District Bureau of Agriculture**	**Hard institutional problem**: Lack of articulated regional policy on urban agriculture; no functional feed and dairy product quality and safety regulations; insufficient market incentive mechanisms to encourage producers to adapt practices ensuring safe and quality milk production **Soft institutional problem**: coercive and top-down tendencies; habit of covering up failures; bias of agricultural extension services against market oriented peri-urban dairy niches; some actors of the office de-legitimizing peri-urban dairying activities **Capability problem**: Lack of competence to quickly reconfigure to new production systems and paradigms; limited capacity to initiate flexible strategies to fix solutions to local problems; lack of awareness on veterinary drug and feed quality regulations promulgated at federal level
Technology diffusion	**Liquid N Centre**	**Capability problem:** competence problems in packaging superior and standard quality semen
Knowledge diffusion	**Development Projects** **AGP** **EAAP**	**Weak network problem**: poor interaction with peri-urban dairy producers; less understanding on local production and farming contexts; not built on previous experiences in the area leading to misalignment of interventions and duplication of efforts
Knowledge diffusion	**Non-government organizations**	**Weak network problem**: poorly aligned with public sector actors; weak linkage with urban dairy producers; **Soft institutional problem**: suspicious of public actors **Strong network problem**: strong compliance with donor interests and priorities
Knowledge development	**Bako Research Center**	**Physical infrastructure problem**: lack of vehicle resources to effectively implement on-farm technology piloting and innovation triggering activities; unfavourable road network system **Knowledge infrastructure problem:** No well functioning internet and URL resources; no functional feeds, health and dairy analytical laboratories **Financial infrastructure problem:** shortage of adequate budget to smoothly run innovation activities and train research staff **Hard institutional problem**: formal institutions reinforcing the 'publish more' culture is in place (presence); no regulation as to how to value on-farm learning and innovation activities in career development (absence); no well articulated forage and dairy research and innovation policy framework **Soft institutional problem**: "Publish or perish" mind-set; misalignment between implicit research program objectives and farmer technology needs; reluctant research tradition to non-technical issues in technology generation processes **Weak network problem**: communication modalities not favouring effective interaction with farmers, for example technological information communicated in scientific jargons, and not often translated to local language

Table 4: cont

Knowledge development	**International Research Centers** **ILRI,** **IWMI** **CIMMYT**	**Hard institutional problem**: actions and behaviours of actors conditioned by global research policies of these centers, leading to a focus on mega research themes than site-specific niche system priorities, often distancing them from local development issues **Weak network problem**: limited on-farm technology showcases to support interactive learning and innovation; research objectives poorly aligned with location specific peri-urban feed and dairy value chains problems
Market formation	**Consumers**	**Soft institutional problem**: Soft institutional barriers to market formation (milk demand); for example, customers behaviour remarkably conditioned by existing social norms and habits, like abstention from consumption of animal source food (milk or meat) during fasting periods as an act of religious ceremony.
Policy support services	**District administration**	**Hard institutional problem**: Lack of an articulated policy statement on urban agriculture; no functional feed and dairy product quality and safety regulations; lack of awareness on veterinary drug and feed quality regulations nationally promulgated; insufficient market incentive mechanisms to encourage producers to adapt practices ensuring safe milk production **Soft institutional problem**: pre-eminence attitude over the other actors in the innovation system; resistive attitudes of some authorities to introduced peri-urban dairy innovation systems; top-down inclinations in decision making **Capability problem**: low technical expertise to productively guide development efforts of local public organizations, 'rhetoric commitments' rather outweigh practical actions; insufficient facilitation and managerial skills **Missing actor problem**: no functional organ catering for peri-urban dairy development within the city administrative structure

Table 5: A summary of systemic problems, and a cluster of innovation system actors to be addressed by systemic policy tools

Identified systemic problems	Innovation system actors to be addressed
Physical infrastructure problems	Dairy farmers; feed suppliers; District Bureau of Agriculture
Knowledge infrastructure problems	Dairy farmers; veterinary drug vendors; District Bureau of Agriculture
Financial infrastructure problems	Dairy farmers; veterinary drug retailers; District Bureau of Agriculture
Soft institutional problems	Dairy farmers; feed suppliers; veterinary drug retailers; Livestock Development and health Agency; District Bureau of Agriculture NGOs; Agricultural Research Center; International Research Center: District administration;
Hard institutional problems	Livestock Development and health Agency; District Bureau of Agriculture; Bako Agricultural Research Center; International Research Centers; District Administration
Weak network (interaction) problems	Dairy farmers; development projects; NGOs; District Bureau of Agriculture; International Research Centers
Capability problems	Dairy producers; feed suppliers; Livestock Agency; District Bureau of Agriculture; Liquid N Center; Agricultural Research Center; District administration
'Missing actor' problems	Input suppliers (forage seed and heifers); district administration (no actor responsible for facilitating development issues related to urban/peri-urban agriculture)

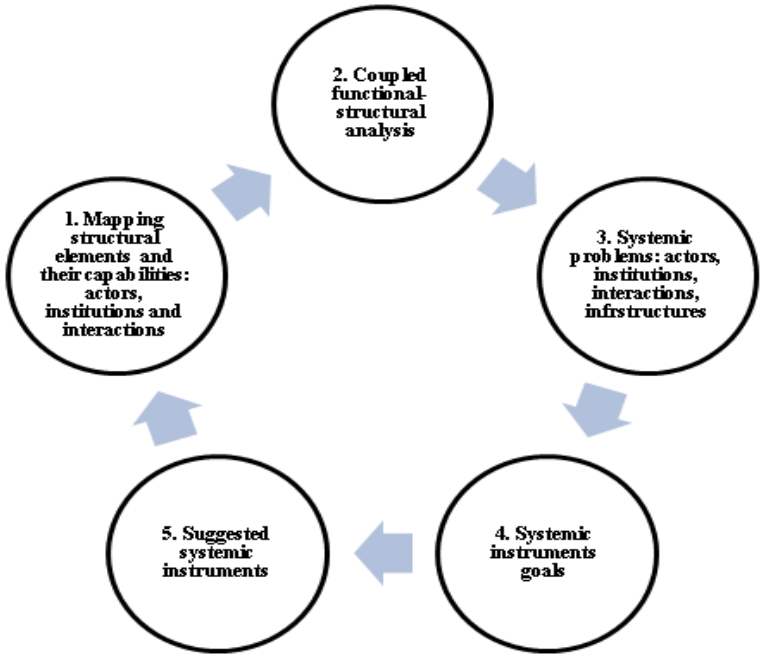

Figure 2: A systemic policy framework used to identify systemic problems, systemic instrument goals and possible systemic policy instruments

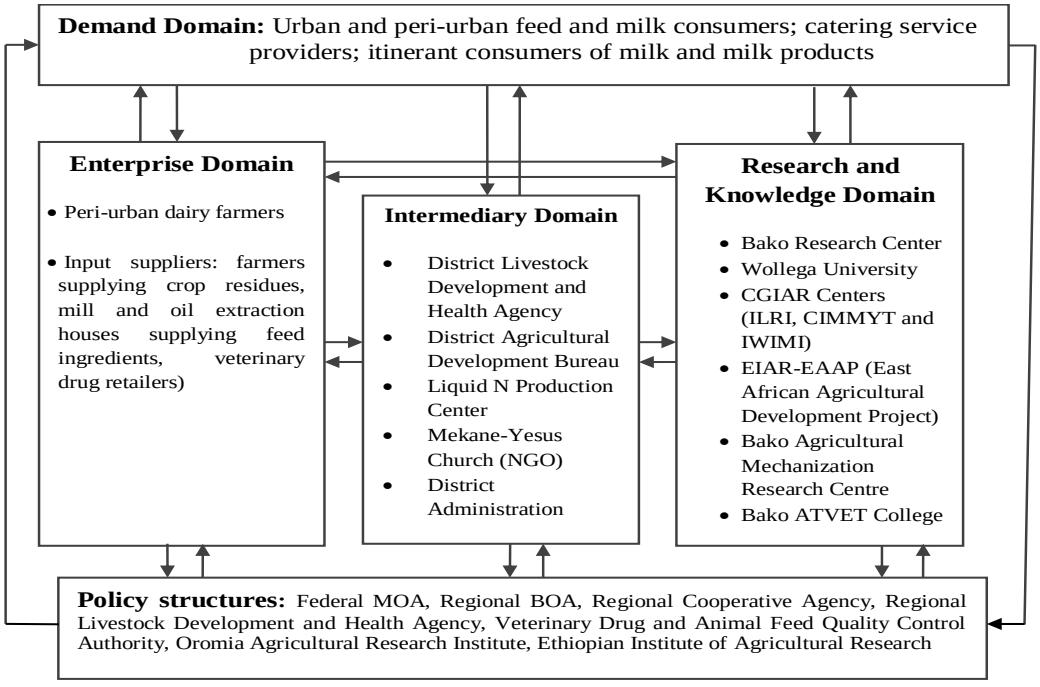

Figure 2: A Schematic diagram depicting the structural elements of the feed and peri-urban dairy technological innovation systems

innovation system and (6) Policy domain – actors involved in the formulation of policies related to feed and peri-urban dairy value chain development. A concise account of the functions of these actors is presented in the following section.

Table 2: Research actors and their functions

Research actors	Potential contributions made/could be made
BARC	Forage variety development; development of dairy feeding systems; on-farm evaluation of forage and dairy feeding systems; seed/planting material production and distribution; on-farm testing of the productivity and profitability of dairy technologies.
WU	Emergent research in the areas of feeds, breeding and health
Bako AMRC	Prototype development, and multiplication of milk processing equipments
Bako ATVET College	Training of development agents in animal science; maintenance and demonstration of well performing forage crops and dairy cattle breeds; technical support to districts in the areas of forage development and AI service delivery
ILRI	Germplasm supply; capacity building for researchers involved in forage and dairy research; promoting value chain development frameworks in the mandate areas of Bako Research Center; evaluation of feed technology suitability under specific farming system contexts
CIMMYT	On-station evaluation and on-farm testing of maize and forage legumes integrated fodder production options; capacity building for researchers in the livestock feed
IWMI	Enhancing livestock water productivity; evaluation and promotion of water efficient and environment friendly fodder options; capacity building for researchers
EAAP	On-farm testing of dairy feed options; financial support to regional fodder development initiatives

Note: BARC, Bako Agricultural Research Center; WU, Wollega University; ATVET, Agricultural Technical Vocational Education Training; ILRI, International Livestock Research Institute; CIMMYT, International Maize and Wheat Improvement Centre; IWMI, International water Management Institute; EAAP, East African Agricultural Productivity Project;

Enterprise Domain

The actors in this domain include: peri-urban dairy producers, crop and livestock mixed farmers, catering service providers (hotels, restaurants and cafes) and private actors involved in the production and supply of dairy feed and veterinary drugs. The peri-urban dairy farmers are involved in milk production and channel their produce to demand side actors (neighborhood customers and catering service providers in the urban centers). Crop farmers in the nearby rural sub-districts are involved in the supply of crop residues used as feed by dairy farmers. Urban and peri-urban dairy farmers generally have less access to compounded dairy feeds, but rely more on locally obtainable energy and protein supplements (mainly hulls of faba bean, field pea, lentil and chick pea and oil seed cakes, and scraps) sourced from mill houses operating in the two cities (Diriba *et al*., 2014). Catering service providers buy fluid milk from the peri-urban dairy farmers and (traditionally) process it into other milk derivatives for sale to final consumers. Private veterinary drug retailers prevailing in both sites were engaged in veterinary drug vending activities.

Research domain

Regional, national and international research actors operating in the two peri-urban sites and the roles they play/could play are presented in Table 2. Bako Agricultural Research Center is the key actor undertaking research on feed and dairy subsectors in both sites. It has developed various technical options that can potentially be exploited for feed and peri-urban dairy development. It has generated information on milk handling and processing systems, and characterized the livestock production systems for tailoring interventions. Non-technical issues, however, received little attention in the past. The present study also revealed that such inclinations are still widespread though there were some evidences of progress from on-farm research endeavors conducted in collaboration with international research and development organizations. At present ILRI, CIMMYT and IWMI are also involved in on farm research activities but with more focus on rural smallholders.

Though at early stage, the Department of Animal Sciences of Wollega University has started research activities in the areas of feed resources, dairy and animal health. The Bako Agricultural Mechanization Research Centre is involved in the demand based production and distribution of milk processing and feed chopping equipments, though to a limited extent. The Bako Agricultural Technical Vocational Education Training College is involved in training of development agents in animal sciences. The International Livestock Research Institute was involved in forage germplasm supply, provision of technical and financial support for capacity building of researchers.

The International Wheat and Maize Improvement Center is involved in on-station evaluation and on-farm testing of integrated forage legumes and maize cropping systems, and capacity building for researchers working in

the livestock feed research and development program. The International Water Management Institute was observed to involve in activities associated with enhancement of livestock water productivity, assessment of feed sourcing options, evaluation and promotion of water efficient and environment friendly fodder options, feed resource assessment, feed balance determination and capacity building for researchers and development workers in the area. The East African Agricultural Productivity Project (EAAP), implemented by EIAR in collaboration with Bako Research Center was also involved in on-farm testing of promising fodder options targeting dairy value chain enhancement and provision of financial support for implementation of on-farm forage development initiatives at the two sites but the focus has mainly been on rural dairy system than the peri-urban fluid milk system.

Despite the existence of diverse research actors operating in the two peri-urban sites, their current role in enhancing the progress of peri-urban feed and fluid milk innovation system was not visible. Discussions made with the various actors along the value chains at both sites indicated that the linkage and interaction among the research actors was observed to be weak or non-existent, and the efforts of the various research actors was not well harmonized. Strengthening the interaction of research actors was found to be critical in facilitating innovation processes. Engaging research and development decision makers at national and regional levels in dialogues over priority national and regional research agenda in a particular production system was also suggested to be vital for improving synergy, and proper targeting of technological options to be tested on farm for improving selected livestock commodity value chains.

Intermediary domain

A large number of intermediary actors were observed to exist in the study sites but public actors dominate. Agricultural development offices at district level supervise the overall provision of agricultural development related inputs, with major focus on crop and natural resource subsector. The Livestock Development and Health Agency at district level focuses on promotion of livestock development packages, among which feed, breeding and animal health service delivery were the major ones, with their interventions mainly targeting the rural dairy production system, which is mainly of butter system. Appraisal of the 'as is' situation showed that both the District Agricultural Development Bureaus, and the Livestock Development and Health Agency were not giving significant attention to the peri-urban feed and dairy development, and were thus condemned by many peri-urban dairy farmers for neglecting most of their production related constraints: supply of technical inputs (feed, health and breeding services), land (for construction of milk retailing shops, dairy farm expansion and fodder production), structural problems such as electric power, road and water supply (mainly for relatively big farms where facilities are not fully operating due to power related problems for example) and lack of facilitation in organizing peri-urban dairy producers in to dairy cooperatives. At both peri-urban sites, there were no functioning peri-urban dairy cooperatives at the time of data collection for the present report.

Generally, failure to support the peri-urban dairy producers, ineffective AI and health service provision, and lack of district level intervention strategies tailored to the emerging peri-urban dairy niche sector were repeatedly indicated to critical problems in the course of the individual and group discussions held with the dairy farmers. It was apparent that lack of appropriate and realistic support scheme for emerging production niches like peri-urban dairy and limited knowledge on what is going on at lower level, and poor access to pertinent sources of knowledge is constraining the relevant actors from lucratively undertaking their expected roles.

Demand domain

These consist of consumers of milk and milk products, and dairy cattle feed and, include dairy farmers and urban and itinerant consumers. As previously outlined in a related peri-urban dairy value chain work (Diriba *et al*., 2014), fluid milk, and processed milk derivatives obtained from traditional processing are products consumed at both locations. At Nekemte, milk is primarily produced for market purpose, and the larger share is channeled to target consumers through informal outlets.

Policy domain

Development policies essentially crafted to fit regional development priorities within an overall national framework are vital for enabling innovation in a given technological innovation systems. Policies oriented to commercialization and poverty reduction and improvement in the allocation of public resources for the development of infrastructures is believed to create an environment that would enhance innovation capacity.

In the current setting, regional policies are formulated by the regional council; budget for livestock research and development is also allocated by the same. The overall political leadership to ensure effective implementation of regionally planned activities in a manner aligned with national and regional priorities is also provided by the same body. Bureaus of investment, and Trade and Industry deal with investment permits, and license private service providers. Regional Bureaus of Finance and Economic Development regulate budget use by public

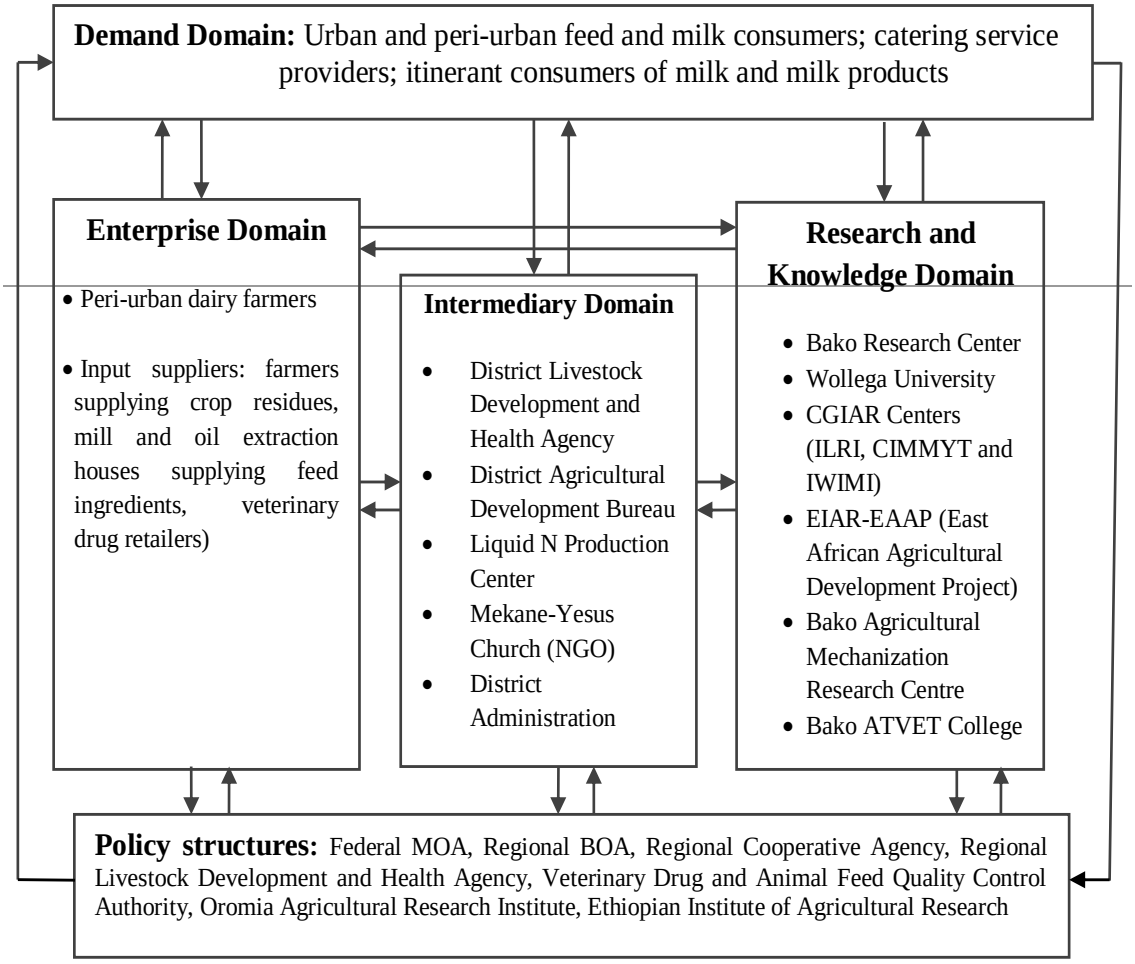

Figure 3: A Schematic diagram depicting the structural elements of the feed and peri-urban dairy technological innovation systems

organizations, and coordinate activities of NGOs. Bureau of Health at both zonal and district level was observed to have no visible role in relation to dairy development currently, but its future involvement is expected to be crucial in addressing public health concerns related to intensive peri-urban dairy development. Issues associated with public health concerns and suggested way outs to alleviate the prevailing challenges have been reported earlier in a related study (Diriba *et al*., 2014). The overall regional policy guidance for district level dairy (livestock) productivity improvement is provided by Regional Livestock Production and Health Agency.

The Federal Government has recently instituted independent executive body within the MOA led by State Ministry and catering for livestock development. There are three directorates under this department; (1) Animal Production and Feed Directorate, focusing on dissemination of inputs for livestock production and feed resources development; (2) Animal Health Directorate, focusing on health and quarantine service provision, and regulatory services; (3) Pastoralist Directorate, mandated for the pastoral areas, and dealing with animal health and production issues in the pastoral areas of the country. A new positive move also was the establishment of Animal Feed and Drug Administration and Control Authority. This focuses on policy issues related to regulation of feed and drug quality, and their production processes.

Interactive relationships between actors

The general patterns of interactive relationships between the main actors in the diagnosed feed and dairy innovation system are illustrated in Figure 3. The linkage patterns observed include: two way strong interactions with comparable influence; two way interactions but weak and episodic in nature, and two way interactions with unequal influence.

Accordingly, the interaction that was observed to exist between the regular public extension service providers

(District Bureau of Agriculture, District Livestock Development and Health Agency and Liquid N Production Center) and the District Administration office was of two way direction but with the latter actor having more influence. It was also indicated that these linkages are more of communication on livestock, crop and natural resource development related policy and regulatory issues. The function of this linkage as perceived by many informants was not more on learning and innovation except in cases where technical advisory issues are brought on board.

The linkages existing between NGOs and the District Administration office was indicated to be weak and intermittent. Similarly, NGOs were observed to have rare knowledge sharing links with public research centers. In Nekemte area, the Development and Social Services Commission of the Ethiopian Evangelical Church was reported to have occasional linkages with BARC where the feed and nutrition and dairy research staff of BARC partake in the training of the development agents. Linkages existing between public extension service providers were judged to be of two way type and strong, and to have a routine resource and knowledge sharing functions.

The linkage between BARC and District Administration was reported to be feeble and periodic. The BARC and the International Research Institutes were indicated to be of two directions and strong with resource and knowledge sharing functions, with strong partnership in a range of innovation piloting activities with a potential of enabling learning and innovation activities.

Linkages existing between International Research Institutes and the district administration office were indicated to be weak limited only to facilitation role of the latter in the organization of meetings of the focal stakeholders working with the research institutes in the area. The agricultural development projects (mainly AGP) was indicated to have a strong resource and knowledge sharing link with district extension service providers in the livestock and crop subsectors.

The relationships existing between peri-urban dairy producers and district extension service providers were also weak. It has continuously been argued that services rendered by the regular extension actors are biased towards rural producers than the emerging market oriented peri-urban dairy niche. On the other hand, there was strong linkage between peri-urban dairy producers and dairy product consumers and informal feed ingredient suppliers but with limited role for learning and innovation as they are more of input and output market links. The links between the emerging private service providers (specifically the veterinary drug vendors) and district development offices (mainly with livestock development and health) are limited to regulatory (policing) functions.

In general, linkages existing between the majorities of actors in the diagnosed innovation system were observed to be weak and often episodic, and unfavorable for collective learning and innovation to take place. Hence there is a need to work towards changing attitudes and practices of actors so that lively and productive interactions creating opportunities for learning and innovation will arise.

Competencies of key actors as perceived by respondents

Information on the characteristics of the various actors (in terms of strengths) and how these attributes condition their interactive relationships is crucial (Hall *et al*., 2006). Such information would facilitate the identification of appropriate systemic policy instruments for enhancing the functioning of the innovation system. Table 3 summarizes the strengths of the key stakeholders involved in the surveyed feed and dairy innovation system based on the perceptions of the different informants consulted. Generally, it was apparent that there are considerable infrastructural, institutional and capability potential for the actors to complement each other for enhancing innovation activities provided that effective interaction and knowledge sharing and innovation practices take place.

Identification of systemic problems

Five systemic problem typologies were observed to embed in the feed and dairy innovation system diagnosed: (1) Infrastructural problems (physical, knowledge and financial); (2) institutional problems (hard and soft); (3) weak network problems; (4) capability problems, and (5) ‘missing actor’ problems. Matrix of the system function, actor and systemic problem developed based on the field data is summarized in Table 4. Each of the problems identified is elucidated further in the following subsections.

Infrastructural problems

Access to infrastructures is vital for an innovation system to sustainably evolve. Peri-urban dairy farms, mainly those which are relatively big, were observed to lack infrastructures such as reliable electric power supply, unfavorable feeder roads for input and output transport and lack of reliable water supply system. Lack of feed and milk quality assessment and veterinary diagnostic facilities were observed to be the key problems of the actors involved in research and health related functions.

These problems were indicated to impair the evolution of the diagnosed innovation system in one way or another. Informal feed ingredient suppliers (mill house and oil extraction owners) were also observed to lack

Table 3: Strengths of the different various in the innovation system

Actor	Strengths
District Livestock Agency; District Bureau of Agriculture	Fairly educated staff; perceptible presence at grass roots level; political capital.
Liquid N Production Center	Better endowed with physical infrastructural capacity
BARC	Better competence to find solutions to the technological needs of emerging niche sectors; significant technical and structural capability; better connection to diverse knowledge sources; emergent on farm technology piloting endeavours.
International Research Centers (ILRI, IWMI, CIMMYT)	Enhanced structural and technical capability; better connected to diverse knowledge sources; organized knowledge management system; emerging innovation focused initiatives; well articulated innovation generating strategies; well organized forage diversity gene bank; better financial capability.
Development Projects (AGP and EAAP)	Better financial capability; connected to diverse knowledge sources; interest to closely work with existing government structures.
Non-government organizations	Better financial capability; growing participatory traditions; strong financial capability for social sectors (education, health, poverty and gender); structural and financial flexibilities for enabling service and approach innovations.
Private veterinary drug vendors	Quick response to customer needs compared to existing public veterinary actors.
Peri-urban dairy farmers	Apparent enthusiasm to continue dairying business; propensity of some to innovate in the face of challenges; motivation of some to advance cooperative culture.
Feed ingredient suppliers	Noticeable interest in feed related entrepreneurial activities.
Consumers	Passionate to pay for milk and products; zealous about feeding milk to their infants.
District administration	Passionate to see the livelihood of the community improved; enthusiasm to respond to community development needs; political capital, and thus capability to mobilize the community and non-public actors.

feed storage infrastructures. The BARC was observed to lack vital knowledge infrastructures such as internet resources, and functional laboratories for animal nutrition, health and dairy product quality testing (Table 4). Shortage of physical infrastructures such as vehicles and financial resources for undertaking on-farm technology piloting activities has also been indicated to be critical. Indeed, some of the indicated physical infrastructures are characterized by their very large size and long term horizon of operation and high initial investment costs. This suggests the difficulty of generating returns for private actors to invest in them (Woolthuis e*t al*. 2005). Thus, innovation policy makers are responsible to intervene through appropriate systemic policy instruments.

Hard institutional problems

Institutions may condition economic behaviour and interaction and can thus encourage or hamper innovation (Woolthuis *et al*., 2005) and these institutional systemic problems have been named in different ways. Carlsson and Jacobsson (1997) refer to hard and soft institutional problems, while Edquist *et al*. (1998) described them as deliberately crafted vs. spontaneously evolved institutions. Johnson and Gregersen (1994) also discriminate between formal and informal institutions. In this work, the 'hard' and 'soft' institutional classification will be used (Carlsson and Jacobsson, 1997; Woolthuis *et al*., 2005). Hard institutions are the formal, written, consciously crafted ones while soft institutions are the informal ones that often evolve spontaneously (North, 1991; Woolthuis *et al*., 2005).

One of the observed hard institutional problems in the innovation system diagnosed was the lack of a clear regional policy on urban/peri-urban livestock development. Inventory of related existing policies and strategies at sectoral level and programs developed thereof revealed that the overall objective of the policies and strategies do essentially address the basic principles of livestock development. It was evident that the feed and

Table 6: Suggested policy tools that can contribute to achieving the goals of systemic instruments

Goals for systemic instruments	Suggested systemic policy instruments to achieve the goals
Stimulate physical infrastructures	Strengthen public investment in electricity, road and water supply systems; enhance responsive capacity of staff of these organizations through customer service oriented capacity enhancement training; ensure provision of adequate grant for vehicle purchase to strengthen on-farm technical innovation piloting activities by research centers; improve feed storage capacity of informal feed suppliers through strengthening and facilitating their linkage with financial support rendering organizations.
Stimulate knowledge infrastructures	Strengthening poorly functioning public research labs (for health, nutrition and milk quality) available at research organizations and universities in the study areas through improved research and development grant; improve the access of knowledge domain actors to diverse knowledge sources by improving financial support; public sector actors need to design mechanisms to encourage emerging market oriented peri-urban dairy niche sub-sectors with a level playing field; livestock development staff need to have access to knowledge sources on continuous basis; electronically, in printed form or through other media.
Stimulate financial infrastructures	Appropriate loan and other financial services need to be sought for supporting peri-urban dairy farmers and feed producers.
Secure presence of required hard institution	Formulate policy instruments favouring urban/peri-urban dairying and agriculture; formulate regional feed and dairy product quality and safety regulations; create awareness on the drug and feed quality regulation promulgated at national level; create sufficient market incentive mechanisms for dairy farmers to ensure production of quality and safe dairy products; develop regulations on how to value on-farm innovation piloting and knowledge brokering activities in research staff promotion; stringent hard intuitions such as staff promotion regulations disfavouring participatory and knowledge brokering initiatives need to be revised.
Secure presence of soft institutions	Priorities, contexts and needs of actors continually change; thus reorienting the roles of actors, and individual and organizational cultures and processes is required; development of incentive and accountability system to reinforce the culture of inter-organizational collaboration could be considered; there is a need to give a stop to embedding deceptive and dishonest tendencies through training and crafting formal institutional mechanisms to regulate such barriers to innovation; coercive and top-down tendencies stifle innovation progress, suggesting the need for adopting participatory and interactive paradigms to development.

peri-urban dairy sub-sector appraised was impaired not by the lack of general policy directions at both national and regional levels but by limitations associated with their implementation at niche sub-sector level. Successful innovation of the system thus requires the formulation of appropriate policy frameworks conforming to the overall national/regional livestock policy directions (Table 6).

The survey has also indicated that there is a lack of functional product quality and safety regulation mechanisms. Lack of awareness on some existing national policies and regulations by some lower executive officers was also found to be widespread. For example, veterinary drugs and feed quality regulation was promulgated at national level, but it was observed that there is no awareness even about the existence of such proclamation by the lower executive bodies. Similarly, there is lack of functional dairy product quality and safety regulations, and insufficient market incentive mechanisms to encourage producers to adapt practices that would ensure production of safe and quality milk. As a result of such deficiencies, poor dairy products quality and unhygienic handling were observed to be widespread as products are normally channeled through informal market channels. While informal channels seem to work better for poor dairy farmers and consumers, the associated unhygienic farming practices and products, however, could raise serious public health concerns.

Technology generating actors such as BARC and Wollega University were also observed to have stringent formal institutions that reinforce the ‘publish or perish’

tendencies of researchers. On the contrary, there was no appropriate regulation as to how to consider technology transfer and on-farm technology piloting activities in staff career promotion. The research actors were also observed to lack well articulated forage and dairy related research and innovation policies guiding their activities.

Soft institutional problem

Soft institutions are those that evolve spontaneously and are the implicit 'rules of the game'. In this study, a top-down and coercive attitudes of village development workers, hesitant attitudes of farmers in experimenting the introduced technical innovations; innovation de-legitimizing tendencies of some actors in the system; deceptive behaviors of private entrepreneurs (informal feed supplies and veterinary drug vendors); habits of covering up failures by actors in the public extension service; mistrusts prevailing among actors, and cultural barriers to milk demand were identified to embed in the diagnosed innovation system (Table 4). The soft institutional problems observed to be critical as captured during the field study are further elaborated as follows.

Top-down attitudes of the development agents

Peri-urban dairy farms mainly located in the rural-urban fringe were observed to be supervised by village level development agents. It was claimed that there are times when the development agents tend to incline to top-down and coercive approaches to ensure that on-farm technology intervention activities are undertaken as formulated in the package manuals. From the stance of innovation systems perspective, this may rather stifle innovative activities and learning, which is in contrast to approaches leading to consensus building, collaborations and advisory activities which are rather in favour of healthier on-farm learning and innovation. In this regard, a statement by one farmer, noted during an interview, which could more or less be translated as: "...dairy farming is mighty easy for experts 'farming' between two lines of a clean paper..." is worth mentioning. This evidently reflects the perception of a mildly discontented farmer with the top-down and coercive inclinations of technical experts. This justifies the need for further coaching of the actors involved with soft system skills for enhancing facilitation capacity in on-farm technical innovation piloting activities.

Farmers' hesitant attitudes to the introduced technical innovations

In the system studied, innovation progress was observed to be slow in both peri-urban sites. Farmers were observed to be hesitant to sustainably experiment the introduced interventions. Interventions could perhaps face such disfavor due to their poor on-farm performance than expected and lack of competent and sustained technical support by experts, among others. For instance, it was observed that farmers often backslide from innovating with introduced forages and AI breeding system (Diriba *et al*., 2014). In case of improved forages, the causative factors for such attitudes were: low productivity and longevity of the introduced forages which, in turn, were indicated to be linked with poor management system. In the latter case, the low conception rate of cows induced by the low competence level of the AI technicians and the poor quality of semen used were indicated to be important.

These situations were observed to lead to erosion of farmers' confidence and gradually resulting in farmers' hesitant inclinations. Farmers were observed to make a new path of their own instead, for example, through opting for other alternative feeds obtainable from other sources like crop residues, native pastures, and hulls and byproducts from mill houses (Diriba *et al*., 2014). In case of animal breeding interventions, it was observed that they often fall back on natural mating; using both local and cross-bred bulls (Gizaw *et al*., 2011).

Innovation de-legitimizing tendencies of other actors in the system

Resistive and de-legitimizing opinions from the urban inhabitants and authorities, and organizational actors concerned with environmental sanitary issues were also noted to be the major impediment to sustainable innovation of the peri-urban dairy innovation systems. This situation was observed to be very critical for those farmers closer to the urban centers. Farmers were observed to be forced to shut off their farms despite the apparent contribution of such livelihood activities to the wellbeing of their family. It is thus vital that transparent communication about the potential economic benefits, threats and opportunities associated with certain technological intervention is made with relevant actors for the technology to gain legitimacy through time and sustainably evolve.

Misalignment between implicit research objectives and farmer technology needs

The present study also revealed the persisting tradition of designing forage and livestock research projects to achieve the implicit motive of publishing more research papers than on striving to solve critical problems of the peri-urban dairy subsector. This apparently resulted in the accumulation of less beneficial research information. Further, due to the technical jargons used to conform to

publication guidelines, the information generated is often not well communicated to livestock keepers. Personal academic interests were also observed to implicitly take priority while designing research programs over the significance of research results to solving priority needs of peri-urban dairy producers.

This tradition has terribly been reinforced by an existing stringent regulation of staff promotion, which is based mainly on the number of published research papers. Close observation and discussion with the research staff in BARC and academic staff of Wollega University revealed that the interest to have more published papers is highly perceptible. Publishing research information may not be a problem by itself, but it could hinder successful innovation when it becomes an implicit 'rule of the game' conditioning research program formulation and implementation. Currently, there are some efforts in strengthening on-farm technology piloting activities by BARC (Table 3) through farmers' research group approach. But such on-farm piloting and knowledge brokerage activities do not result in the generation of research data qualifying for publication in journals. This situation might discourage the successful evolution of such positive steps. There is thus a need for crafting appropriate institutional mechanisms facilitating how these efforts can be considered in research staff promotion (Table 4).

Extension service providers' bias against peri-urban dairy innovation system

Historically, rural livestock keepers have been the focal clientele for regular public extension service providers. Traditionally, these actors have been promoting livestock development interventions through a 'transfer of technology' model to rural farmers. Niche sectors such as peri-urban dairy farmers have not been on the agenda. The existing extension system has not yet been reconfigured to engage itself in support of such emerging market oriented actors operating under urban and peri-urban setting. Even research organizations seem not to be very serious in this regard, except some efforts made through short lived project activities in collaboration with other development partners.

Consumption cultures conditioning consumers' behaviour

Seasonal variations in demand for milk and milk products were indicated to pose milk demand problems in the study areas. Christians from some denominations were indicated to refrain from consuming dairy products on selected days of the week and during major traditional fasting months of the year. Some respondent farmers have indicated the incidence of low demand for milk and milk products during the fasting periods. Such established traditional institutions constrain consumers through normative processes which guide their consumption behavior.

Weak network (interaction) problems

Interactions between actors of an innovation system could condition innovation processes. In this regard, both weak and strong interaction could lead to negative results (Woolthuis *et al*., 2005).

In the present study, interviewed dairy farmers indicated that their linkage with district livestock development actors, research and academic organizations and commercial compound feed producers is weak. Had the linkage been strong, it could have enhanced information and knowledge flow between the actors. Such weak interaction between relevant stakeholders that can potentially complement each other has been referred to as weak network failure (Carlsson and Jacobsson, 1997), which is also analogous with the notion of "dynamic complementarity failure" articulated by Malerba (1997). As a result of weak inter-actor linkages, possibilities for interactive learning and innovation could be underexploited and producers may fall short of adapting to new technologies (Table 4). In addition, if interaction between actors in a given innovation system is weak, this might lead to a lack of shared vision in future technology development trajectories, which in turn could result in mismatch of technology generation endeavors and the needs of farmers.

Capability problems

The present study revealed that there is lack of competence on the side of peri-urban dairy producers to formulate their demand regarding the kind of support they need from policy makers. Similarly, lack of awareness on input quality and associated risks, and a situation of being locked-in into traditional technologies were pervasive (Diriba *et al*., 2014). Furthermore, informal dairy feed ingredient suppliers have indicated to lack awareness on feed quality standards. The regular extension service providers were observed to lack competence to quickly reconfigure to new production systems and paradigms and to be short of capacity to design flexible approaches to fix solutions to local problems.

Lack of awareness on veterinary drug and feed quality regulations promulgated at federal level was also observed by various feed and health related stakeholders. The district administrators were also viewed as lacking adequate technical expertise to lucratively lead development efforts of public organizations and to be short of facilitation and

Table 6: Suggested policy tools that can contribute to achieving the goals of systemic instruments continued...

Stimulate occurrence of interactions favouring learning and innovation	Strengthen innovation capacity enhancement efforts; encourage trustworthy interactive learning processes for better technological innovation; promote institutional innovation and build the habits of working together to bring about innovation; establish innovative linkage and interaction mechanisms to improve linkage strength; develop functional institutional arrangements for facilitating collective experiential learning.
Enhance actors capability	Innovative practices, competencies and incentives and accountability systems were generally meagre in the public organizations of the system diagnosed; thus there is a need to enhance knowledge capacity through training; the ability of public organizations to sufficiently reconfigure to shifts in policy, emergence of new actors and innovations of different nature need to be enhanced; need to trigger mindset and behavioural change for both individual and organizational actors through provision of platforms to give producers a voice to enable them influence policy and demand services.
Stimulate participation of existing actors or create relevant functional actors	Establish and strengthen stakeholder platforms that encompass diverse actors so that they could function effectively to contribute to the innovation system; facilitate the creation of relevant actors in the system if required.

managerial skills, which in one way or another could negatively affect innovation processes. Innovation system actors can just lack the competences, capabilities or resources to make the leap from an old to a new technology. Such capability problems have also been reported in the literature by various authors (Afuah and Utterback, 1997; Anderson and Tushman, 1990; Woolthuis *et al*., 2005).

In this regard, Smith (1999) has reported that actors often have problems of adapting to new technologies, a situation that could happen due to their inclination to technologies in which they have long experience and operational competencies. Such specialized focus could hinder innovation at farm or system level if the required capabilities to adopt technologies lie outside of the competencies of actors though it could allow them to 'do their things right'. In the literature, problems of such type have also been expressed as 'transition failure' (Smith, 1999). Equally, Malerba (1997) has described the phenomenon as 'learning failure' and explained that such situations prevent producers from learning rapidly and effectively, the result of which could be a lock-in into already existing (traditional) technological trajectories.

Systemic policy instruments suggested to alleviate the identified systemic problems

The matrix of the main systemic problems identified and clusters of various actors affected by the specific problem is provided in Table 5. This template gives a plain perception as to which innovation system actors need to be focused when the interventions proposed (as outlined in Table 6) are introduced for moderating the pinpointed systemic problems.

Suggested goals of recommended policy instruments together with possible systemic tools to achieve the set goals are presented in Table 6. Goals of the systemic instruments outlined are prescriptive and are meant to facilitate the design of appropriate policies and selection of instruments that can address the problems in an integrated way. Linking the set goals with the structural elements is useful in targeting specific elements in a way that improves the functioning of the system as a whole. The goals described (Table 6) illustrate what the suggested instruments should do to create the circumstances needed for the innovation system to successfully progress.

CONCLUSION

The present study identified five systemic problems embedding in the feed and dairy integrated innovation systems at the two case study sites. These were: infrastructural problems (physical, knowledge and financial); institutional problems (hard and soft); weak network problems; capability problems, and missing actor problems. Policy instruments that can potentially alleviate these systemic problems were also suggested.

REFERENCES

Afuah AN, Utterback JM (1997). Responding to structural industry changes: a technological evolution perspective. Industrial and Corporate Change 6, 183-202.

Amlaku Asres Zewde (2012). Innovation capacity in dairy production systems: A study in the Northwest of Ethiopia. A PhD Thesis submitted to the University of Natural Resources and Life Sciences Vienna, Austria.

Anderson P, Tushman ML (1990). Technological Discontinuities and Dominant Designs: A Cyclical Model of Technological Change. Adm. Sci. Q. 35.

BARC (Bako Agricultural Research Center), 2003. Genetic improvement of indigenous breeds and performance of cross-bred animals. Bulletin No. 2. February 2003, Bako, Oromia, Ethiopia.

Beyene Seboka, Abera Deressa (1995). The emerging learning paradigm in extension intervention: towards participatory enquiry. In: Proceedings of 25th Anniversary of Nazreth Research centre, Melkassa, Ethiopia.

Birhanu Z, M Matthew, S Bharat, W Abeyou (2011). Integrated Rain Water Management Strategies in the Blue Nile Basin of the Ethiopian Highlands, International Journal of Water Resources and Environmental Engineering 3: 220-232.

Carlsson B, Jacobsson S (1997). In search of useful public policies: key lessons and issues for policy makers. In: Carlsson, B., (Ed.), Technological Systems and Industrial Dynamics, Kluwer Academic Publishers, Dordrecht.

Chaminade C, Edquist C (2006). From theory to practice. The use of the systems of innovation approach in innovation policy'. In: Hage, J., and DeMeeus, M.,(eds.) *Innovation, Learning and institutions*. Oxford: University Press.

Chencha Chebo, Zewdu Wuletaw, Workneh Ayalew (2012). Reproduction performance and milk off-take of indigenous cattle of Gamo Gofa zone, south-western Ethiopia. *Eth.J.Anim. Prod.* 12: 73-86.

Darnhofer I, Gibbon D, Dedieu B (eds). (2012). Farming systems research into the 21st century: The new dynamic. Dordrecht: Springer (in press).

Diriba Geleti, Mekonnen Hailemariam, Ashenafi Mengistu, Adugna Tolera (2014). Analysis of fluid milk value chains at two peri-urban sites in western Oromia, Ethiopia: current status and suggestions on how they might evolve. *Global Veterinaria* 12(1): 104-120.

Edquist C, Hommen L, Johnson B, Lemola T, Malerba F, Reiss T, Smith K (1998). The ISE Policy Statement - the Innovation Policy Implications of the 'Innovations Systems and European Integration' Research project funded by the TSER programme (DG XII). Linkoping University, Linkoping.

erbonne JF, Lentz R (2003). Rooted in grass: Challenging patterns of knowledge exchange as a means of fostering social change in a southeast Minnesota farm community. Agriculture and Human Values 20, 65-78

Farla J, Alkemade F, Suurs RAA (2010). Analysis of Barriers in the Transition toward Sustainable Mobility in the Netherlands. TFSC 77, 1260-1269.

Gizaw K, A Abera, S Eshetu, T Mediksa, T Gudeta, B Seboka (2011). Enhancing the productivity and profitability of crossbred and local cows in urban and peri-urban centers of Bako and Nekemte. In: In: Proceedings of the 19th Annual Conference of Ethiopian Society of Animal Production (ESAP) held December 15-17, 2011 in Addis Ababa, Ethiopia.

Hall A, Janssen W, Pehu E, Rajalahti R (2006). Enhancing Agricultural Innovation: How to Go Beyond the Strengthening of Research Systems. Washington: World Bank.

Hjorth P, Bagheri A (2006). Navigating towards sustainable development: A system dynamics approach. Futures 38: 74-92.

Jacobsson S, Johnson A (2000). The diffusion of renewable energy technology: an analytical framework and key issues for research. Energy Policy 28, 625-640.

Johnson B, Gregersen B (1994). System of innovation and economic integration. Journal of Industry Studies 2, 1–18.

Kebebe E, D Alan, A Adie, G Woldewahid, Z Ayele, B Gebremedhin, N Alemayehu (2010). Multi-stakeholder Platforms Strengthening Selection and use of Fodder Options in Ethiopia: Lessons and Challenges. In: ISDA (Innovation and Sustainable Development in Agriculture and Food), Montpellier, France.

Lamprinopoulou C, Renwick A, Klerk L, Hermans F, Islam MM, Roep D (2012). A systematic innovation policy framework: The case of Scotish and Dutch Agrifood innovation systems – Preliminary results. 131st EAAE seminar, Prague, Czech Republic, September 18-19, 212.

Leeuwis C (2000). Learning to be sustainable. The Journal of Agricultural Education and Extension 7, 79-92.

Leeuwis C (2004). Communication for Rural Innovation: Rethinking Agricultural Extension. Oxford: Blackwell.

Leeuwis C, Long N, Villareal M (1990). Equivocations on knowledge systems theory: An actor-oriented critique. Knowledge in Society: The International Journal of Knowledge Transfer 3, 19-27.

Lemma Gizachew, Diriba Geleti (1997). Research on feed Resources of Western Ethiopia: achievements and challenges. In: Proceedings of a workshop on review of applicable research results for western Ethiopian sub humid zones, Nekemte.

Megelata Oromia (2001). A proclamation to provide for the Establishment of the Oromia Agricultural Research Institute, Proclamation No. 44/2001, 9th year, No. 14, Addis Ababa.

Nill J, Kemp R, (2009). Evolutionary approaches for sustainable innovation policies: From niche to paradigm? Research Policy 38, 668-680.

North DC (1991). Institutions, institutional change and economic performance, Cambridge University Press, Cambridge.

OARI (Oromia Agricultural Research Institute). 2003. Strategic plan (2003/4-2005/6), Addis Ababa.

Rajalahti R et al., (2008). Agricultural Innovation Systems: from diagnostics toward operational practices. Agricultural and Rural Development, Discussion paper 38. The International Bank for Reconstruction and Development. The World Bank.

Rich KM, RB Ross, AD Baker, A Negassa (2011). Quantifying value chain analysis in the context of livestock systems in developing countries. Food Policy 36:214-22.

Rogers EM (2004). Diffusion of Innovations. NewYork: Free Press.

Roling N, Wagemakers MAE (eds). (1998). Facilitating Sustainable Agriculture: Participatory learning and adaptive management in times of environmental uncertainty. Cambridge: Cambridge University Press.

Schiere JB, Lyklema J, Schakel J, Rickert KG (1999). Evolution of Farming Systems and System Philosophy. Systems Research and Behavioral Science 16, 375–390.

Scoones I, Thompson J (eds).(1994). Beyond Farmer First. London: Intermediate Technology Publications.

Seife A, Alan D, Asamoah L, TK Truong (2012). Enhancing innovation in livestock value chains through networks: Lessons from fodder innovation case studies in developing countries. Available at: http://spp.oxfordjournals.org/content/39.

Smith K (1997). Economic infrastructures and innovation systems. In: Edquist, C., (Eds.) Systems of innovation: Technologies, Institutions and Organisations, London: Pinter.

Smith K (1999). Innovation as a systemic phenomenon: rethinking the role of policy. In: Bryant, K., Wells, A. (Eds.), A New Economic Paradigm? Innovation-Based Evolutionary Systems, Commonwealth of Australia, Department of Industry, Science and Resources, Science and Technology Policy Branch, Canberra, pp. 10–47.

Tesfaye Lemma Tefera, Puskur R, Hoekstra D, Azage Tegegn (2010). Commercialization of dairy and forage systems in Ethiopia; an innovation systems perspective. Working paper 17. ILRI, Nairobi, Kenya.

Van Mierlo B, Leeuwis C, Smits R, Klein Woolthuis R (2010). Learning towards system innovation: Evaluating a systemic instrument. Technological Forecasting and Social Change 77, 318-334.

Webber L (1995). Participatory rural appraisal design: Conceptual and process issues. Agricultural Systems 17, 107-131.

Woolthuis RK, Lankhuizen M, Gilsing V (2005). A system failure framework for innovation policy design. Technovation 25: 609-619.