Journal of Humanities and Social Sciences, Volume 12 No. 2, 2023: 79–97

The Role of Cooperatives and Farmer-Industry Linkages in the Evolution of Tanga's Dairy Innovation System

Hezron Makundi
University of Dar es Salaam
hmakundi@udsm.ac.tz

Heric Thomas
Science, Technology and Innovation Policy Research Organization (STIPRO)
heric.thomas@stipro.or.tz

Abstract

This study investigated the development of Tanga's dairy innovation system and its role in promoting and maintaining relationships between farmers, the industry, and cooperative unions; employing a case study approach. The main objective was to assess the role of cooperatives in forging farmer-industry linkages and in improving dairy industry innovations. 100 dairy producers in Tanga participated in the survey that led to the paper. A questionnaire was used to collect data from randomly selected farmers. Furthermore, 20 key informant interviews were conducted with various participants, including the Tanga Dairy Cooperative Union livestock extension service providers. Also, one Focus Group Discussion involving 12 participants from the aforementioned stakeholders was held. The findings revealed that over the last three decades, Tanga's dairy innovation has evolved into a competitive innovation system. It has gone through four phases: development of the capability of dairy farming (1985–1992), the formation of the Dairy Cooperative Union (1993), the development of milk-processing capability (1996–1997–2007), and the phase of improving the innovation capability of the whole system (2008–present). The formal and informal contractual arrangements of the Tanga Dairy Cooperative Union were found to be the primary means for sustaining close ties between dairy farmers and the Tanga Fresh Ltd. These agreements have enhanced collaboration and mutual learning that have contributed to a significant increase in farmers' milk production and Tanga Fresh Ltd's processing capacity. Based on the recorded achievements, this paper recommends for the adoption of the identified innovative contractual model to other cattle-rich zones. However, it is also imperative to address identified challenges such as fluctuation of trust between the farmers and the cooperative, and cases of deviation from contractual obligations.

Keywords: *dairy innovation system, linkage capability, cooperatives, dairy farming, Tanzania*

(Received: 30 January 2023. Accepted: 4 October 2023; Revised: 21 December 2023)

1. Introduction

African countries, including Tanzania, lag far behind other countries in knowledge generation and technological advancement (Muchie et al., 2003). For instance, in many African countries, basic technologies and limited knowledge resources are still used in the productive sectors. This has resulted in their failure to adequately produce high quality products in huge quantities so that they can compete on the

local and international markets (Wangwe, Diyamett, & Komba, 2009). This phenomenon is driven by weak and underdeveloped linkages among key actors, each posing a significant threat to its competitiveness and growth (Lundvall & Borras, 1999). Research shows that the existing productive sectors and firms, for example, have a low level of interaction with universities and technology service providers (Coulson & Diyamett, 2012). Similarly, the informalities in business and the dominance of micro and small enterprises are among the salient features of Africa's production systems (World Bank, 2017).

The above observations are supported by the fact that, although 32.2m cattle were raised in Tanzania in 2020, the subsector contributed a mere 7.4% to the country's gross domestic product (GDP). Thirty percent of this contribution came from the dairy industry (Lunogelo et al., 2021). Furthermore, Tanzania imports a significant amount of dairy products. According to Rural Livelihood Development Company, NIRAS (2010), dairy imports rise by 9% per year, while the amount of locally processed milk has decreased by more than 80% during the last 15 years. Consequently, between 2008 and 2019, Tanzania imported around 116,650 metric tons of skimmed milk, condensed milk, evaporated milk, dried milk, and butter valued at USD154,372 (Lunogelo et al., 2021). This has largely been attributed to poor dairy innovation capacity, which is also caused by weak linkages between milk producers and processors (Nyaki, 2014).

Since 1980, efforts have been made to improve the linkages in question in order to boost the technological capabilities of small-scale dairy farmers and milk processors throughout Tanzania. The country has requested various development partners to support the sector with a range of investments and projects. For example, the Dutch government supported smallholder dairy development projects in Tanga and Kagera. The Lushoto Smallholder Dairy Development Project was funded by the German government, while the Southern Highlands Dairy Development Project benefited from enormous support from the Swiss government (Kago, 2015).

Most of the projects had only 'patchy' success stories, with the exception of the Tanga Dairy Development Project. It is the only effective innovation system that has developed over the years and produced favourable results in terms of farmer-processor relationships (Nell et al., 2014). Dairy farmers, farmer cooperatives, and dairy processors work together in three different ways to develop Tanga's unique dairy innovation system (Lunogelo et al., 2021). In the other locations that received comparable support, this was not the case. Furthermore, research reveals that the development of the milk sector in Iringa Region is far lower than that of Tanga Region, despite the presence of dairy farmers and a processing firm, namely M/s ASAS Ltd.[1] This is the only milk processor in Iringa Municipality; and it was established as a result of the founders' determination to integrate vertically by establishing their own dairy farm. Analysis shows that this source (M/s ASAS Ltd) provides over 30% of

[1] A private owned large milk processing company in Iringa Region.

the dairy products produced in Tanzania (Kilima, 2021). In addition to the milk ASAS itself produces, milk is also sourced from Njombe (10%), Kitulo (5%), and municipal dairy farmers (10%) (Kilima, 2021).

Data suggest that the dairy producers in Kagera and Southern Highlands are more dispersed than their counterparts in the northern regions. They rely on informal markets and small dairy processing factories. Farmers' groups are weak, and non-existent in some cases. Furthermore, data shows that Tanga Fresh Ltd. has increased its processing capacity up to 150,000 lt/day. It is followed by ASAS Dairies Ltd. (100,000 lt/day), Njombe Milk Factory (20,000 lt/day), and International Dairy in Arusha (10,000 lt/day) (Lunogelo et al., 2021). Four factories with up to 5,000 lt/day capacity are in Pwani (2), Ruvuma (1), and Kilimanjaro (1) (ibid., 2021).

According to the literature, Tanga's dairy innovation system has evolved into a robust production system. Several studies have investigated the factors for its success, using value chains and other kinds of framework (Baregu, 2017). Many of the studies, however, suggest that the success of the system is attributed to the use of improved technologies and techniques by dairy farmers, such as the adoption of zero-grazing; cross-breeding; access to inputs, such as minerals and improved feeding practices; and disease control practices. However, previous research has not examined the critical role of institutional arrangements in linkage building and disseminating improved technologies and innovations across the system.

Therefore, the current study investigated the enabling environment/institutional arrangement that facilitated the building of farmer-industry collaborations, and which contributed to the development of technological capabilities in Tanga's dairy innovation system. This paper provides a complete overview of the processes helpful in linking the actors in the system, which is one of the primary means of facilitating dairy farmer upgrading in Tanzania. The paper presents the mechanisms in the dairy industry that are based on innovation clusters so that specific lessons on technological and policy interventions can be drawn from the industry. The study aimed to address three main research questions: the evolution of Tanga's dairy agro-industrial innovation system; the key ingredients of the environment that stimulates and maintains linkages in the system; and the role of the linkages in the process of building the technological capability of Tanga's smallholder dairy farmers and Tanga Fresh Ltd.

This introductory section is followed by a review of the relevant literature. Section 3 describes the research methodology adopted in the study. Section 4 analyses the data and discusses the findings. The final section gives the conclusions and recommendations.

2. The Dairy Sub-Sector in Tanzania

The dairy farming industry in Tanzania grows at a rate of 6% per year (Swai & Kurimuribo, 2011). The sub-sector is made up of both large-scale and small-scale dairy

farmers, who are concentrated in the highland areas in Tanga, Arusha, Mbeya, Kagera, Iringa, and Morogoro. The industry has a great potential to boost economic development in Tanzania. It performs critical functions, such as job creation, food provision, raw material provision for industries, and income generation for smallholder farmers and traders (Njombe et al., 2011).

The need to enhance the dairy sub-sector is particularly emphasized by its current production performance relative to its potential and expectations under the comprehensive national development strategies. For example, the National Strategy for Growth and Reduction of Poverty (NSGRP I & II) recognizes the dairy sub-sector as one of the key vehicles for poverty reduction. Similarly, some of the goals of the Agricultural Sector Development Programme (ASDP) emphasize the creation of an enabling and conducive environment to improve the productivity and profitability of the livestock sector through its dairy industry sub-sector (ibid.). The concerted effort to rapidly develop the dairy sub-sector is also consistent with the government's goal of turning Tanzania into a semi-industrialized country by 2025.

2.1 Efforts to Develop the Dairy Sub-Sector in Tanzania: Trends and Challenges

The efforts to develop Tanzania's dairy sub-sector began during the colonial era (Njombe & Sanga, 2010). The British government in Tanganyika allowed settler dairy farmers to establish the Temeke dairy farm in Dar es Salaam in 1921 (Lunogelo et al., 2021). The farm aimed at supplying milk to the government's civil servants in Dar es Salaam (Kurwijila, 2010). Between 1920 and 1940, operations of the 'white highland' diary project covered the highlands of Arusha and Iringa. From 1932 to 1935, the Mpwapwa Livestock Research Station developed the Mpwapwa breed based on Indian, European, and Tanzanian breeds for semi-arid regions with a higher potential for milk production. Unfortunately, almost all of the animal breeds were kept within the research stations, with only limited efforts to disseminate them to local farmers being made (ibid.).

Following independence, the dairy sub-sector received greater government attention, and the Dairy Industry Ordinance (No. 61 Cap. 456 of Tanganyika's laws) was drafted in 1961 to regulate the industry. The law proposed the formation of zonal dairy boards so that they could regulate milk production and processing in areas that produced enough milk (Sumberg, 1997). Furthermore, the government recognized a growing gap between domestic milk production and the national demand for milk in 1965. In response, the Tanzanian Dairy Industry Act No. 32 of 1965 (Cap. 590) recommended the establishment of a government-controlled national dairy board (NDB) and emphasized the establishment of large-scale and medium dairy farms.

The persistent poor performance of state bodies triggered the transfer of production, marketing and processing, and other business-related functions from state institutions to private sector actors during the 1980s. Other partners, such as donors

and development agencies, were requested to provide assistance to the industry in the form of projects and technical assistance. During this time, the Dutch government agreed to support the Kagera Smallholder Dairy Development Project and the Tanga Smallholder Dairy Development Project. The Swiss government supported the Dairy Development Project in the Southern Highlands, and the German government supported the Smallholder Dairy Development Project in Lushoto (Kago, 2015). With the exception of the Tanga Dairy Development Project, most of the other projects do not seem to have made any great achievements.

2.2 Addressing the Challenges in the Dairy Industry: An Innovation System Perspective

The innovation systems theory/approach is an effective mechanism for analysing actors, networks/linkages, and institutions that influence innovation processes in an industrial sector. Because of its utility, the theory has been used in various economic areas, including agriculture (both crops and livestock) and manufacturing, as a framework for enhancing innovation in both raw input production and subsequent value-added product processing. The theory emphasizes the interaction of diverse actors during the generation, exchange, and use of agriculture-related knowledge for economic use (World Bank, 2006). According to Leeuwis, (2004), and Hidalgo and Albors (2008), the system influences innovation through an interactive learning process involving multiple actors who are networked and linked with the help of a supportive environment.

According to Jensen et al. (2007), knowledge acquisition is divided into two types of learning: science, technology, and innovation (STI); and doing, using, and interacting (DUI). The STI model focuses on codified knowledge, formal learning processes, and experiment-based learning. Formal training, interaction with science and research organizations (such as universities), and research and development (R&D) are almost always the source of STI modes of learning. By contrast, the DUI mode of learning refers to workplace learning, and the transfer of tacit knowledge as a result of interacting with users. However, in the African context, the nature and gaps between knowledge bases of the various actors involved may necessitate using an enabler, such as a formalized arrangement, to facilitate networking, skills transfer, and mutual capability building.

Both STI and DUI occur in well-functioning innovation systems under a variety of agreements between producers and processors, thus leading to the acquisition of new knowledge and competencies that can be used in innovation. According to Zsogs (2010), the basic interactions in an innovation system are those that involve (a) producers and buyers; (b) multinationals (MNEs) and indigenous firms, typically small and medium-sized enterprises (SMEs); (c) SMEs; and (d) SMEs, universities, and other public and private business and technical knowledge providers. This paper focuses on the interaction between producers and processors. This model assumes that the interacting producers and processors/buyers have the capacity to absorb and benefit from the interactions happening across businesses or value chains (Fagerberg, 2004).

However, in Africa, producers and processors/buyers only interact when selling and buying products. It is only when a processor demand high quality inputs that they may influence improvements; and thus contributing to knowledge transfer towards their suppliers (Zsogs, 2010). As a result, the innovation system framework was used to examine actors, networks/linkages, and institutions that drive innovation processes in Tanga's dairy innovation system.

2.3 The Contractual Model and System Linkages

Contractual arrangements between a buyer and a producer (farmer) specify the conditions pertaining to the products supplied (Da Da Silva & Ranking, 2013). This also applies to contract farming involving vertical coordination of crop growers and a buyer: the buyer can specify or control the production conditions through contractual obligations towards their suppliers (Little & Watts, 1994). Contract farming systems give producers the responsibility to produce a specific quantity and quality of products that are sold to the contractor, usually at a predetermined price. These arrangements also oblige the contractor to provide input supplies, technical advice, credit, and market services to the producer (FAO, 2013). It is argued that many contractual arrangements create linkages that allow information, material, technical support and credits to flow between the two parties, while at the same time improving access to markets and skills among the actors in the system (ibid.).

A study by Mintenet et al. (2009) on the French bean innovation system in Madagascar revealed the importance of contractual arrangements in improving the performance of a farming system. The Lecofruit Company engaged Madagascan farmers to supply French beans to European supermarkets in accordance with international standards. To achieve this, Lecofruit trained the farmers on how to produce quality fruits and assigned extension officers to their farmer groups so that the farmers could meet the food safety and agricultural health standards of their markets. The farmers are visited more than once a week by one of the firm's representatives, who also engage in hands-on activities, such as best pesticide application practices. These arrangements have led to improvement of the quality of the beans produced by the Madagascan farmers.

3. Research Methods

This study used a set of methodological approaches to evaluate the innovation system perspective in light of the knowledge of the Tanzanian dairy subsector, specifically Tanga's dairy innovation system. The study used a combination of quantitative and qualitative approaches to make the findings more comprehensive. The population of the study constitutes dairy farmers, the Buhuri Livestock Training Centre, extension service providers, TDCU, Tanga Fresh Limited, Tanzania Livestock Research Institute (TALIRI), Agricare Enterprise and Marenga (input providers), credit providers (Farm Friends Tanzania, FINCA Micro Finance Bank[2]), non-

[2] Foundation for International Community Assistance (FINCA)

governmental organizations (NGOs), and development partners, such as Stichting Nederlandse Vrijwilligers (SNV[3]), Other participants included the Ministry of Livestock and the Dairy Milk Board.

Ten (10) organizations were selected from the above population for data collection purposes. The organizations were selected on the basis of the recommendations made by the TDCU during the planning process. As a result, two representatives from each organization were involved in data collection. Thus, 20 key informant interviews (KIIs) were conducted. Similarly, each organization was asked to provide one representative who could participate in one focus group discussion (FDG). Dairy farmers were represented by two farmers; hence, 12 dairy farmers participated in the FDG. The participants were selected following the TDCU's recommendations and their experience in Tanga's dairy farming.

One hundred (100) dairy farmers were randomly selected; the sample size being based on the resource capacity of researchers, in terms of finance and time. In this study, data were gathered between 2020 and 2021 using a structured questionnaire completed by the dairy farmers; and interviews with input suppliers, whole sellers, retailers, vendors, breeders, providers of artificial insemination and large-scale dairy farmers. The researchers filled out a questionnaire and participated in interviews. The questionnaire focused on the existing agreement between the dairy farmers, the TDCU and Tanga Fresh Ltd. The information gathered in relation to the third research question was on the farmers' ability to adopt and implement improved feeding practices, improved breeding practices, and improved dairy management processes. Furthermore, the survey assessed the farmers' access to information on market dynamics, extension services, veterinary medicine, other veterinary services; and milk collection, storage, and transportation technologies. Data on the dairy processors' (firm-level) ability to improve its product range, the shelf longevity of dairy products, marketing innovation, and processing and marketing capabilities were also collected. The study also used site visits, FGDs, and a thorough review of all relevant reports from the TDCU and Tanga Fresh Ltd. on production and processing trends, the number of registered dairy farmers, annual sales, and annual purchasing of inputs.

The data analysis used the following approaches. The KII and FGD notes were summarized through descriptions and narrations. This was a systematic and rigorous data analysis method aimed at identifying key evaluation findings, tally sheets and identify similar patterns of findings that emerged from the document review, focus groups, and KIIs. Responses from various stakeholder groups were cross-analysed with information from project documents. In addition, the information provided by the project staff was assessed against the information provided by the respondents (beneficiaries) to check for factual conformity across stakeholder groups. Quantitative data from the survey were analysed by creating frequency distributions,

[3] Netherlands Development Organisation

which were then processed and analysed using the Microsoft Excel software. The historical evolution of the system was examined through a narrative analysis of the personal stories captured through the interviews and document review.

4. Research Findings

4.1. Evolution of Tanga's Dairy Innovation System

The document review and interviews show that it took Tanga's dairy innovation system three decades to evolve into a solid system. Figure 1 depicts the evolution of the system in four major phases, from 1985 to 2019. Because of its distinct development trajectory, this section explains its evolution from 1985 to the time when the study was conducted, that is, in 2020 and 2021. It also explains the characteristics of the system in each phase. Furthermore, the section provides empirical data on the system, and the data that supplement the existing literature on Tanga's dairy innovation system. It illustrates the level of capabilities the system attained in each phase; capabilities not examined by previous studies.

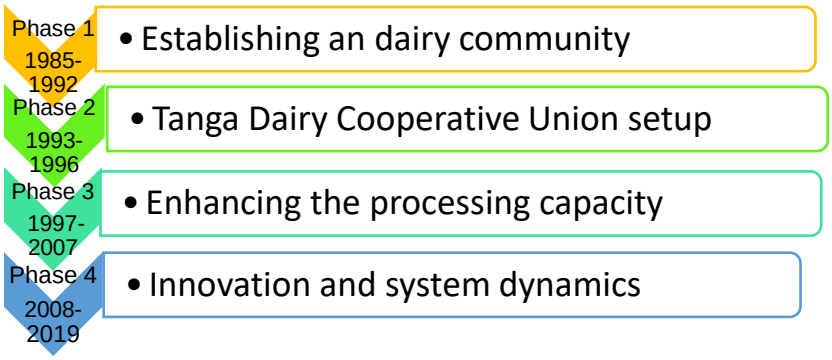

Figure 1: Evolution of Tanga's Dairy Innovation System
Source: Field survey, 2021

4.1.1 Phase 1: Establishing a Dairy Community (1985-1992)

Information shows that, like other coastal regions in Tanzania, Tanga is not a traditional pastoralist community. It was not until the late 1970s and early 1980s that some commercial dairy farms—including Azimio, Mgwisha, Buhuri Extension Centre, and Tanga Dairy—were established. The farms benefited a great deal from the Dutch government's assistance (interview with TDCU leaders, 2020). Nonetheless, by the mid- and late 1980s, support had shifted to small-scale dairy farmers, who were more effective in driving poverty reduction than the parastatal large-scale farmers. The Tanga Smallholder Dairy Development Programme (TSDDP) was introduced in 1985 with financial and technical support from the government of Tanzania and a Dutch Cooperative Society (FriZania Cooperation) from Friesland in the Netherlands. The BUHURI Livestock Institute was used to organize and train small-scale farmers in recommended dairy farming practices, as part of the programme (interview with TDCU Officers, 2020).

The TSDDP introduced artificial insemination to the small-scale farmers as a breeding service for improving the quality of livestock (interview with a former BUHURI Extension Officer, 2020). Furthermore, with financial assistance from the Netherlands, the programme established the cattle credit system in 1985 to enhance the engagement of smallholder farmers in dairy farming so that they could produce more milk. Some of the dairy farmers interviewed confirmed receiving credits as their initial investment in the industry (interview with farmers, 2020). The training and cattle credit system enabled the farmers to develop intermediate technological capabilities. It gave them the ability to produce milk for domestic consumption; and for sale to the surrounding communities, neighbouring schools, and hotels. Similarly, some of the refrigerated raw milk was transported as unprocessed fresh milk to Dar es Salaam.

4.1.2 Phase 2: Establishment of the Tanga Dairies Cooperative Union (1993-1996)

The data show that, in 1993 six (6) dairy farmers' primary cooperatives were turned into an apex organization called the Tanga Dairies Cooperative Union (TDCU). This organization sought to achieve the following goals: developing the dairy farmers' milk production skills and capabilities; protecting the benefits of primary cooperatives; ensuring a stable market for milk produced by the TDCU members; selling milk produced by the members; facilitating the availability of dairy input to farmers at a reasonable price; and negotiating the price of milk for the benefit of its members. During this phase, actors such as the Farm Friends Tanzania, TALIRI, and Buhuri Livestock Agency, initiated collaborations with the TDCU by supporting programmes relating to training, credit, research, and technology transfer for its member small-scale dairy farmers. Also, the TDCU oversaw the cattle credit system by implementing a new type of operational innovation. Under the new scheme, each registered farmer received one cow or heifer as a loan, with the obligation to care for the animal until it reached parturition. The payment for the 'credit' cattle was made by deducting 70% of the income generated from selling milk to the TDCU each month. Similarly, the TDCU became the primary buyer of the milk that the farmers produced, and the milk was collected through their primary cooperatives, which established and operated milk collection centres (MCCs). The TDCU sold the milk in Dar es Salaam as fresh milk and as traditionally cultured yogurt. This arrangement continued until 1997 when the Tanga Fresh Ltd. was formed. During this phase, the cooperative's membership grew, and five additional primary cooperatives were established. Unfortunately, there are no records on the total amount of milk produced and collected by the TDCU during this time period.

4.1.3 Phase 3: Processing Capability Building (1997–2007)

The data show that, in 1996, TDCU collaborated with Dutch-based Friesian Cooperative Society to establish a milk-processing plant; the plant was registered as Tanga Fresh Ltd. Tanga Dairies benefited from the support provided by the society and several non-governmental organizations in the dairy sub-sector. In 1997, Tanga Fresh Ltd. became the main buyer of the milk from TDCU. The milk was processed to

produce dairy products, such as fresh milk, cultured milk, butter, cream milk, plain yogurt, and flavoured yogurt. At the beginning, the plant had a processing capacity of 15,000 litres of milk per day. The processed products from Tanga Dairies were primarily sold in Dar es Salaam. In terms of ownership, TDCU owned 35% of the company, Friesian Investment Cooperatives 55%, and Tanga Fresh Ltd. Directors Alnoor and Ruty owned 10% (TDCU, 2019). With the help of industrial innovation and a larger market, the amount of milk collected by TDCU gradually increased from 2m litres in 1999 to 7.5m litres in 2007. This was influenced by the rise in the dairy farmers' population, which resulted in the establishment of new local cooperatives and Milk Collection Centres (MCCs). This situation shows that the system's capabilities grew on to a value addition level (AECF[4], 2011).

4.1.4 Phase 4: Improvement of the System's Innovation Capability (2008 to 2020)

The data show that the Dutch Oak Tree Foundation from the Netherlands purchased the shares of Friesian Invest Cooperatives in 2007; thus, it entered a joint venture with the TDCU in the ownership of Tanga Fresh Ltd. On the basis of the 'newly' injected capital, TDCU's shares in Tanga Fresh Ltd. increased to 42.5%; DOB acquired 52.5% of the shares; and the management (directors), Alnoor, and Ruty's shares decreased to 5% from 10%. The new investor (DOB) purchased a significant portion of the milk plant and invested three million euros in it to refurbish the factory, and purchase and install new equipment. Furthermore, the investor purchased cooling facilities for MCCs, such as cooling tanks, standby generators, trained personnel, and refrigerated milk transporting trucks. Also, the funds from the injected capital were used to purchase additional transport vehicles for collecting milk and transporting it to Dar es Salaam for sale and distribution (interview with TDCU officers, 2020).

During this phase, the volume of milk collected was estimated to have risen from 7.5m to 14m litres per annum. This increase was attributed to the increase in the number of members, new primary cooperatives, and MCCs. With approximately 4,500 farmers concentrated in one area, the TDCU recorded 26 primary cooperatives in 2020, thereby making Tanga Region a major player in the dairy industry in Tanzania (interview with TDCU officers, 2020).

The Tanga Fresh Ltd. increased its daily processing capacity from 15,000 to 31,000 litres in 2010. Between 2012 and 2019, its milk processing capacity increased to 50,000 litres per day. The installed processing machines with a daily capacity of 150,000 litres were coupled with a growing production capacity of dairy farmers. Tanga Fresh Ltd. sells only 25% of its products to other regions, such as Arusha, Kilimanjaro Dodoma, and Zanzibar (Field data, 2020). The study confirmed that Dar es Salaam was the main market for the milk from Tanga Fresh Ltd. and other dairy products in all four phases of the system's development.

[4] Africa Enterprise Challenge Fund (AECF) – this is an African development funder that supports innovative commercial businesses with the aim of reducing rural poverty, promoting resilient.

4.2 Backward and Forward Linkages under Tanga's Dairy Innovation System

The study found that Tanga's dairy innovation system had evolved into a well-organized and competitive system, and that it had maintained strong institutional cooperation and linkages among the key system actors. Small-scale dairy farmers, Buhuri Training Centres, extension service providers, TDCU, Tanga Fresh Ltd., TALIRI Research institute, Agricare Enterprise and Marenga (input providers), credit providers (FARM Friends Tanzania, FINCA Bank), NGOs (MEDA), and development partners (SNV): these were among the actors. Therefore, the study looked at how the actors' linkages were formed and being managed in the system. It was found that the linkages were formed, coordinated, and managed by the key system actors through contractual arrangements (both formal and informal). The TDCU played the 'leading operator' role in the networked system, and it was the 'caretaker' responsible for ensuring the integrity of the network of actors and their functions in the system (TDCU & Tanga Fresh Ltd., 2021).

During the FDGs, it was revealed that the contractual arrangements under TDCU influence linkage building through 'market specification', 'resource provision', and 'production management'. Under market specification, Tanga Fresh Ltd. requires dairy farmers to produce a certain quantity of quality milk that is usually processed at a predetermined price. Regarding resource provision, the company has to provide the necessary inputs to farmers. The contractual arrangements create linkages that allow information, material, technical support, and credits to flow between the two parties, while access to markets and skills among the system actors is improved. The linkages comprised the horizontal and vertical coordination. Horizontal coordination was accomplished through the TDCU and its affiliated primary cooperative societies, such as the Ushirika wa Wauza Maziwa Tanga (UWATA), which were contracted to supply milk to Tanga Fresh Ltd.

Tanga Fresh Ltd. is also in charge of settling dairy farmers' bills through the TDCU. The TDCU receives raw milk from smallholder dairy producers via MMCs, and Tanga Fresh Ltd. carries it to the facility so that it is processed into various products. Tanga Fresh Ltd. pays TDCU upon delivery of a specified quantity of milk to the factory, and the TDCU e-mails the payment information to each main cooperative leader. Such agreements oblige the TDCU and Tanga Fresh Ltd. to work together to guarantee that dairy producers receive training and inputs. Each MCC has a contract with milk cooperatives under the TDCU, and approximately 80–90% of the milk they collect goes through this channel. Tanga Fresh Ltd. has installed new equipment and cooling facilities in MCCs, including cooling tanks, backup generators, trained personnel, and refrigerated milk transporting trucks. The arrangement is consistent with the factory's ownership, as the TDCU holds 42.5% of the shares.

The study also found a contract between the TDCU and AGRICARE Enterprise for the latter to supply farmers with inputs, such as animal feeds and veterinary drugs. Other

institutions, including the Farm Friends Tanzania and FINCA Bank, entered into various contractual arrangements with the TDCU to provide farmers with cattle credit and other financial services; with the money for repaying the loans being deducted from the money earned from milk sales. Furthermore, the TDCU reported on informal arrangements that enable various stakeholders to offer capacity-building services to its member dairy farmers.

4.3 The Role of Linkages in the Dairy Farmers' Technological Capability Building

This section assesses the role of the linkages in building the technological competence of smallholder dairy farmers through access to various services, such as training, extension services, seminars, exhibitions, and field demonstrations. It was clear that the TDCU and Tanga Fresh Ltd. improved the system's linkages through contractual arrangements (both formal and informal). The linkages facilitated technology transfer and the imparting of skills to farmers, and improved access to inputs by dairy farmers. The services provided to farmers across the innovation system are summarized in Table 1.

Table 1: Improvement of the Farmer's Technological Capabilities (Multiple Responses)

Activities to Improve Capabilities	Response	
	N	*Percent*
Training	86	34.0%
Extension services	62	24.5%
Demonstration farm	24	9.5%
Seminars	78	30.8%
Exhibitions	3	1.2%
Total	**253**	**100.0%**

Source: Field survey, 2021

The multiple responses from the respondents summarized in Table 1 indicate that 34% of dairy farmers received training; 24% were contacted by extension officers; 9.5% had an opportunity to visit a demonstration farm; 30.8% had attended seminars; and that 1.2 % had attended exhibitions. In most cases, a training course is delivered in a two weeks' classroom programme at the Buhari Training Centre, and is embedded with a farming demonstration manual. The farmers interviewed reported that illustrative training manuals were more useful, and that they enabled most of them to follow the instructions given.

The farmers' capacity-building initiatives benefited the strong linkages among the various collaborating actors within the innovation system. The survey showed that 36% of the training received involved collaboration between the TDCU and Tanga Fresh Ltd. 64% of the training services were provided by TDCU and other actors, such as TALIRI, Buhuri Training Centre, Tanga Fresh Farms, SNV, Farm Friends Tanzania, MEDA, Agricare Enterprises, and Marenga Animal Feeds. These collaborations

enabled the farmers to access improved cattle breeds, improved feeding techniques, and enhanced management capacity. As a result, these links have increased smallholders' capacity. The following are some of the notable indicators.

- ***Frequency of milk rejection:***

Acceptance of the milk that meets the standards of Tanga Fresh Ltd. showed improvement of farmers' capabilities. About 20% of the respondents reported to have not experienced any rejection, while 60% said their milk was rarely rejected. Another 20% said their milk was rejected only once during the early days of doing business with Tanga Fresh Ltd. Tanga Fresh Ltd. and the TDCU acknowledged that, in general, the quality of the milk produced had improved over time. This is because many farmers have acquired the capabilities to produce milk that meets their standards. The thorough testing mechanism at the MCCs also contributed to the improvement of the quality of milk.

- ***Increase in milk production over the years:***

Improvement of the dairy farming techniques has led to an increase in milk productivity and production quantities. Information obtained from the TDCU showed that milk production had increased from 8,055,308 litres in 2011, to 14,000,000 litres in 2015 (see Figure 2).

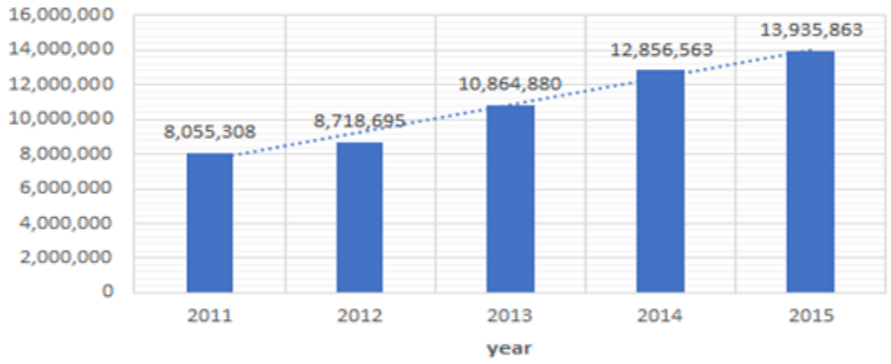

Figure 2: Tanga Fresh Ltd. Milk Production Trends
Source: Field data, 2021

- ***Increase in milk processing in a day:***

The study found that the plant of Tanga Fresh Ltd. had expanded its milk-processing capacity from 15,000 litres when it was launched, to 31,000 litres in 2010. Between 2012 and 2021, its processing capacity reached 120,000 litres of milk a day.

- ***Use of improved milk-storage facilities:***

The study found that 64% of the farmers were using aluminium storage cans for storing milk, and that 36% were still using plastic containers.

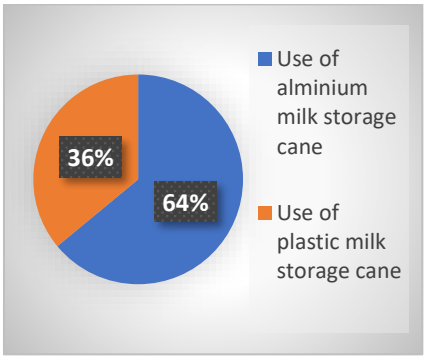

Figure 3: The Use of Aluminium Cane for Storing Milk
Source: Field Data 2021

Photo 1: Milk Collection Centre Process in Muheza
Source: Fieldwork, 2020

- ***Use of AI by farmers:***

Most of the farmers were still using natural mating as the main breeding practice, but few were using artificial insemination (AI) for breeding purposes; and appropriate timing for calving, pregnancy diagnosis, and checking of cattle during pregnancy.

4.4 Challenges Facing Tanga's Dairy Innovation System

The study uncovered a number of challenges confronting the system and threatening its continuity and sustainability. These challenges related to the nature and position of engagement among Tanga Fresh Ltd., small dairy farmers, and the TDCU

It was found that the dairy farmers, TDCU, and Tanga Fresh Ltd. did not have the same expectations; which caused several challenges. For instance, the farmers reported that the TDCU was offering them a low and exploitative price for the high-quality milk they produced. In Muheza, where the Chama Wafugaji Muheza

(CHAWAMU) is based, milk is purchased at TZS723 per litre from farmers. To the farmers, this price cannot enable them expand their dairy farms given the rising feeding and disease-treatment costs. As a result, some of the farmers defied their primary cooperative and sold their milk to individual buyers and small businesses, including the hotels and cafeterias in the town, who bought the milk at TZS1200–1500 per litre. Some farmers produced 60 litres of milk a day but sold only 20 litres to the TDCU just to maintain their membership in the organization.

The farmers also complained about the high interest rates and tough conditions attached to the repayment of loans provided by the FINCA Bank. They argued that although the loan repayment modalities were simple, the TDCU and Tanga Fresh Ltd. did not pay them on time: there delays of up to 10 days, which affected their loan-servicing capacity. Furthermore, the farmers reported that when the system was established in 1985 there was a cattle credit system that encouraged farmers to do dairy farming. However, this programme was terminated in 2005, and there were no plans to reintroduce it through the TDCU or Tanga Fresh Ltd. As result, some farmers abandoned dairy production for other industries/activities.

Similarly, the TDCU and Tanga Fresh Ltd. were equally unhappy with the lack of trust among farmers, given that, despite offering them training, inputs, seminars, and other types of capacity building, they still did not keep their word and sold only 35% of their milk to Tanga Fresh Ltd. This threatened the performance and sustainability of the factory, and contributed to a decline in milk production. The factory management indicated that, with an installation capacity of processing 150,000 litres of milk a day, it processes between 50,000-120,000 litres a day, which is a gross underutilisation. In addition, the New City Master Plan, which restricts the amount of cattle that may be kept in the city, is seen as a challenge to Tanga's dairy industry. The TDCU, Tanga Fresh Ltd., and the farmers see the Plan as a threat to the peri-urban dairy farming system in Tanga. The system managers and urban planners have been involved disputes, since the development of the system was first left out of the regional development plans. To comply with the New City Master Plan, several dairy producers have started to reduce the number of the dairy cows they keep.

The rise in the number of small-scale milk dairies like Ammy Dairy, which rival Tanga Fresh Ltd., is yet another challenge facing the company. According to the research, Tanga Fesh Ltd. buys milk at TZS723 per litre, and has a more thorough testing process. On it part the Dairy buys it at TZS800 per litre, and with relatively less strict standards and test requirements. The study found that Ammy Dairy accepts a significant amount of the milk that Tanga Fresh Ltd. rejects through the TDCU.

5. Discussion

The purpose of this study was to provide an overview of the mechanisms utilized to develop and maintain linkages in Tanga's dairy innovation system. The study findings

have revealed that the contractual arrangement (both formal and informal) under the TDCU played a key role in coordinating the various actors and their functions in the system. The TDCU acts as an intermediary broker which, according to Winch and Courtney (2007) is "… an organization acting as a member of a network of actors focused not only on the generation nor the implementation of innovations but also on enabling other actors to innovate." The farmers benefited a great deal from the role TDCU plays in arranging the actors so that there is knowledge flow between or among them. For instance, by being the main player in Tanga's dairy innovation system, the TDCU entered into contractual arrangements with potential, supporting institutions like milk processors, input supplies, and training and research institutions. These institutions allow TDCU and its dairy farming members to access various value-added services.

With regard to access to information, critical inputs, business support services, and novel ideas, the study discovered that well-established and managed cooperatives were an excellent way of building trust and collaboration among the actors in the system. The TDCU provided evidence of the vital role cooperatives played in fostering horizontal coordination between the dairy farmers. Because collective purchases of goods and services, as well as milk marketing reduce transaction costs for individual dairy farmers, this coordination mechanism improved the farmers' economic stability. According to reports, these collective agreements have also strengthened the position of weaker players in the system, increased the variety of market outlets available, and improved the quality of milk by providing effective knowledge, governance, and monitoring support, as well as clear penalties for non-compliance.

These results align with the results of other studies on the production of milk in East Africa. For instance, a hybrid strategy combining input and service bundling by cooperatives and milk processors with the privatization of input and service delivery has enabled Kenya to achieve horizontal integration (van der Lee et al., 2016). Tanga's dairy milk co-operatives have an integrated approach including small dairy producers, milk processors, and service providers. Similarly, Kenya Co-operative Creameries Ltd. has been the most remarkable co-operative in Kenya in terms of building linkages among dairy actors in the system (Kilima & Kurwijila, 2020). Similar examples abound in Uganda and Rwanda, where dairy co-operatives have had similar growth and linkages (Kilima, 2021).

6. Conclusion, Recommendations, and the Way Forward

The study concludes that formal and informal contractual arrangements are the dominant approaches used in building linkages among actors in Tanga's dairy innovation system. The arrangements stimulated back-and-forth interactions between smallholder dairy farmers and Tanga Fresh Ltd., which created a strong dairy production system that enabled farmers to supply the needed quality and quantity of milk to Tanga Fresh Ltd. for processing (forward linkages), in return for technical support and credit. While considering the diverse cultural and historical attributes of

the diary sub-sector's actors across Tanzania, the study proposes that the policy lessons from Tanga's 'dairy model' should inform the plans of other cattle-rich zones, including Arusha, Manyara, Kilimanjaro, Mbeya, Mara, and Bukoba. A similar model of contractual arrangements and of engaging cooperatives could be tested in these areas.

The policy interventions and theoretical advancements in the field of innovation system research in Tanzania, and Africa in general, have been dealt with by the current study. The study helps to conceptualize the mechanisms for creating connections within the Tanzanian dairy innovation systems using a theoretical standpoint. With regard to policy, this research introduced a novel farmer-industry linkages approach to address the ever-growing difficulties facing Tanzania's dairy industry. For the systems to be managed sustainably, a plan for addressing them, such as inclusive planning, has to be developed and implemented.

Acknowledgement
The authors would like to thank REPOA for sponsoring this study. Nonetheless, the authors accept full responsibility for any errors or other shortcomings in this paper.

References

AECF. 2011. Tanga Fresh, Nairobi, AECF (Africa Enterprise Challenge Fund). Https: //assets. publishing.service.gov.uk/media/57a08acbe5274a31e00007a0/Tanga-fresh-AECF-case-study. pdf: retrieved on 5th, December 2020.

Baregu, S. 2017. Effects of Milk Imports on Competitiveness of Domestically Processed Milk in Tanzania. https://www.canr.msu.edu/news/3rd-annual-agricultural-policy-conference-march- 1-3-dar-es-salaam. retrieved on 15th, December 2021

Coulson, A. & Diyamett, B. 2012. Improving the Contribution of Agricultural Research to Economic Growth: Policy Implications of a Scoping Study in Tanzania. *International Growth Centre (IGC): Working Paper*.

Da Silva, C. A. & Ranking, M. 2013. *Contract Farming for Inclusive Market Access*. Food and Agriculture Organization of the United Nations (FAO).

Fagerberg, J. 2004. What Do we Know about Innovation? Lessons from the TEARI Project. *Centre for Technology, Innovation and Culture, University of Oslo TEARI Project, Report*, (1).

Hidalgo, A. & Albors, J. 2008. Innovation Management Techniques and Tools: A Review from Theory and Practice. *R&d Management*, 38(2): 113–127.

Jensen, M. B., Johnson, B., Lorenz, E., Lundvall, B. Å. & Lundvall, B. A. 2007): Forms of Knowledge and Modes of Innovation. The *Learning Economy* and the *Economics of Hope*, 155.

Kago, K. M. 2019. Impact of Innovation Platforms and Information Sharing on Nurturing of Smaller Innovation Platforms: A Case Study of Tanzania Dairy Development Forum. Doctoral dissertation, Egerton University.

Kilima, F. T. M. 2021): Integrating Smallholder Dairy Farmers Into Formal Milk Markets in Tanzania: Key Lessons and Policy Implications. *Tanzania Journal of Agricultural Sciences*, 20(1): 72–81.

Kilima F.T.M. & Kurwijila L.R. 2020. Integrating Smallholder Farmers to Commodity Value Chains in Sub-Saharan Africa: Challenges, Prospects and Policy Issues. In: Singh B., Safalaoh A., Amuri N., Eik L., Sitaula B., Lal R. (eds). *Climate Impacts on Agricultural and Natural Resource Sustainability in Africa*. Springer, Cham. 119–140 pp.

Kurwijila, L. R. 2010): An Overview of the Dairy Industry in Tanzania; Situation, Challenges and Expectations. In *Proceedings of the Agricultural Council of Tanzania (ACT) Dairy Stakeholders forum held at Mkonge Hotel, Tanga Tanzania,* 10*th December*.

Leeuwis, C. 2004. With Contributions by A. Van den Ban. *Communication for Rural Innovation–rethinking agricultural extension*.

Little, P. D. & Watts, M. (Eds.). 1994. *Living under Contract: Contract Farming* and *Agrarian Transformation in Sub-Saharan Africa*, Univ of Wisconsin Press.

Lundvall, B.-A. 1992. *National Systems of Innovation - Towards a Theory of Innovation and Interactive Learning*. London, Pinter.

Lunogelo, H. B., Makene, F. S., Patrick, M. J. A. L. M. & Kihenzile, T. 2021. *Innovation and Inclusive Industrialisation in Agro-processing*. https://iiap.info/wp-content/uploads/2022/03/IIAP _Tanzania_ Citrus_Working_Paper_December_2021v1.pdf retrieved on 20th, December 2022.

Muchie, M., Gammeltoft, P., and Lundvall, B.-A˚. (eds.). 2003. *Putting Africa First: The Making of African Innovation Systems.* Aalborg, Denmark: Aalborg University Press.

Nell, A. J., Schiere, H. & Bol, S. 2014. *Quick Scan Dairy Sector Tanzania*. Dutch Ministry of Economic Affairs.

NIRAS. 2010. *Rural Livelihood Development Company: Survey on Dairy Products Market in Tanzania.* Dar es Salaam.

Nyaki. 2014. Institutions and Efficiency of Milk Value Chains in Bagamoyo District. MA Dissertation.

Njombe, A. P., Msanga, Y., Mbwambo, N. & Makembe, N. 2011. The Tanzania Dairy Industry, Status and Prospects. The Tanzania Ministry of Livestock and Fisheries Development. a paper was presented during the 7th African Dairy Conference and Exhibition held at Movenpick Palm Hotel, Dar es Salaam. 25–27th pp22.

Szogs, A. 2010. *Technology Transfer* and *Technological Capability Building in Informal Firms in Tanzania*. Center for Innovation, Research and Competence in the Learning Economy (CIRCLE): Department of Design Sciences, Lund University.

Sumberg, J. 1997. Policy, Milk and the Dar es Salaam Peri-urban Zone: A New Future for an old Development Theme? *Land Use Policy*, 14(4): 277–293.

Swai, E. S. & Karimuribo, E. D. 2011. Smallholder Dairy Farming in Tanzania: Current Profiles and Prospects for Development. *Outlook on AGRICULTURE*, 40(1): 21–27.

Tanga Dairy Cooperative Union (TDCU). 2020. Interview Conducted on 10th December, 2020.

TDCU & Tanga Fresh Ltd. 202). Interview Conducted on 15th January, 2021.

TDCU. 2019. Ownership of Tanga Dairy Cooperative Union, *Annual Report*.

Van der Lee, J., Bebe, B. O. & Oosting, S. 2016. *Sustainable Intensification Pathways for Dairy Farming in Kenya: A case study for PROIntensAfrica WP*2, *Deliverable* 2.3 (No. 997). Wageningen Livestock Research.

Winch, G. M. & Courtney, R. 2007. The Organization of Innovation Brokers: An International Review. *Technology Analysis & Strategic Management*, 19(6): 747–763.

Wangwe, S. M., Diyamett, B. D. & Komba, A. 2003. Trends in R&D Activities in Tanzania: Funding Sources, Institutional Arrangements and Relevance. *Research on Knowledge Systems (RoKS): IDRC*.

World Bank. 2006. *Enhancing Agricultural Innovation: How to Go Beyond the Strengthening of Research Systems*. World Bank. Washington, DC.

World Bank. 2017. *Tech Start-up Ecosystem in Dar es Salaam: Findings and Recommendations*. World Bank.