

**EFFECTS OF PRACTICES OF INPUTS ENTREPRENEURS ON UPSTREAM  
MARKET PARTICIPATION BY SMALLHOLDER DAIRY FARMERS IN TANGA  
AND KILIMANJARO**

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the Master of Science Degree in Agri-Enterprise Development of Egerton University**

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## DECLARATION AND RECOMMENDATION

### Declaration

This thesis is my original work and has not been presented in this university or any other for the award of a degree

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## **DEDICATION**

To dreamers who need to advance in academia; one day, your path will light up, and wings will generously be extended for you to hold on and fly high; so, keep on dreaming and seeking, hugs all the way! And the smallholder dairy farmers in Tanga and Kilimanjaro regions who work hard to improve milk productivity and contribute to food and nutrition security; and my parents Mary Kundu and Henry Kundu who always made it clear that I am not welcome home until I complete this Master's journey, the times I wanted to quit; here we are, through the transition to PhD!

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## ABSTRACT

Tanzania has the fourth largest cattle herd in Africa with smallholder farmers as the majority. However, dairy productivity per cow has been consistently lower than the potential productivity. Yet, lower uptake of dairy input/service technologies by smallholder dairy farmers is evident. This study investigated the effects of market practices of inputs and services agri-entrepreneurs on market participation by smallholder dairy farmers in Tanga and Kilimanjaro. Specifically, the study characterized dairy inputs and services agri-entrepreneurs' business and technology dissemination practices, described the state of dairy inputs and services used by smallholder dairy farmers, and determined the effect of business practices by inputs and services agri-entrepreneurs on the uptake of inputs/services by smallholder dairy farmers. This study used secondary data collected in June 2021 by the International Livestock Research Institute under *Maziwa Zaidi II* project with a sample of 712 smallholder dairy farmers and 93 inputs and services agri-entrepreneurs. LCA characterized inputs and services agri-entrepreneurs. BIC revealed a 3-class model as the best fit (2153.071). The latent class membership of the input/service entrepreneurs for classes I, II, and III was 37.6% (35), 9.7% (9), and 52.7% (49) respectively. Item response probabilities revealed that class I provided animal health and extension services and maintained linkages with other POs while linking smallholder dairy farmers to AI, health, and extension services providers hence was named 'High business activities and business promotional practices'. Class II mainly provided genetic products (AI), delivering to clients on credit with milk as checkoff and genetic and extension services and linked smallholders to AI and extension service providers. It was named 'Low business activities, Medium business promotional activities'. Class III mainly sold feeds products and services while providing them on credit with milk as checkoff. This was named 'Medium business activities, Low business promotional activities'. Descriptive statistics showed that bull servicing was used more compared to AI. A mean of 2 cattle had been vaccinated, 3 dewormed, 2 tick controlled, and 1 treated while 2 types of feeds had been purchased. OLS Model analyzed the third objective. Latent classes I and II were significant at 1% while latent class III was significant at 5%. Education levels were negatively significant on expenditure on input meaning education did not affect decision to participate in input markets. Moshi Rural district had a negatively significant influence on input expenditure. Training inputs and service agri-

entrepreneurs on bundling relevant information alongside dairy inputs and services optimally is necessary to accelerate knowledge sharing with farmers.

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## **LIST OF ACRONYMS OF ABBREVIATIONS**

|               |   |
|---------------|---|
| <b>AF</b>     | Animal Feeds  |
| <b>AI</b>     | Artificial Insemination   |
| <b>AIC</b>    | Akaike's Information Criterion                                  |
| <b>BIC</b>    | Bayesian Information Criterion                                  |
| <b>BDS</b>    | Business Development Services                                   |
| <b>CGIAR</b>  | Consultative Group on International Agricultural Research       |
| <b>CIAT</b>   | International Centre for Tropical Agriculture                   |
| <b>CIYMMT</b> | International Maize and Wheat Improvement Centre                |
| <b>GDP</b>    | Gross Domestic Product  |
| <b>HBHBP</b>  | High Business activities and business promotional practices     |
| <b>ICC</b>    | Interclass Correlation Coefficient                              |
| <b>IITA</b>   | International Institute of Tropical Agriculture                 |
| <b>ILRI</b>   | International Livestock Research Institute                      |
| <b>LBMBP</b>  | Low Business practices, Medium business promotional activities  |
| <b>LCA</b>    | Latent Class Analysis   |
| <b>LPA</b>    | Latent Profile Analysis   |
| <b>MBLBP</b>  | Medium business activities, Low business promotional activities |
| <b>NGOs</b>   | Non-governmental Organizations                                  |
| <b>ODK</b>    | Open Data Kit   |
| <b>OLS</b>    | Ordinary Least Squares  |
| <b>PO</b>     | Producer Organizations  |
| <b>RHoMIS</b> | Rural Household Multiple Indicator Survey                       |

|             |   |
|-------------|---|
| <b>SDGs</b> | Sustainable Development Goals of the United Nations |
| <b>SSA</b>  | Sub-Saharan Africa                                  |
| <b>VCs</b>  | Value Chains  |
| <b>VIF</b>  | Variance Inflation Factors                          |
| <b>USD</b>  | United States Dollar                                |

## **CHAPTER ONE**

### **INTRODUCTION**

#### **1.1 Background of Study**

Dairy is a major sub-sector in most developing countries that are agriculture-based (Birhanu *et al.*, 2017) with smallholder farmers as dominant producers accounting for about 80% of total production (Food and Agriculture Organization - FAO, 2012). The dominant dairy animals are cows (FAO & Global Dairy Platform - GDP, 2019) and about 150 million farmers own 2 to 3 milking cows (Chawala *et al.*, 2019). This sub-sector contributes about 40% to the gross domestic product (GDP) of agriculture and is a source of livelihood for around 1 billion individuals worldwide through direct and indirect employment and food and nutrition security (Omondi *et al.*, 2017). More than half of the 1 billion people are from developing countries, and the average contribution of the dairy sub-sector to GDP is rising faster in these developing countries (International Livestock Research Institute - ILRI, 2019). India is the leading producer of milk globally as it produces about 22% of the global milk (Wankhade *et al.*, 2021), and is similarly characterized by smallholder dairy farmers as the majority (about 75%) (Janssen & Swinnen, 2019). Dairy subsectors across developing countries face relatively similar setbacks of lower productivity due to low adoption of input and service technologies (Chawala *et al.*, 2019; Janssen & Swinnen, 2019; Ngeno, 2018; Okello *et al.*, 2021; Rao *et al.*, 2019).

While dairy farming accounts for about 18% of Sub-Saharan Africa's (SSA) GDP (Kemboi *et al.*, 2020), milk productivity per cow remains low with the region contributing only 5.1% of global milk production (Kemboi *et al.*, 2020). These trends are linked to low uptake of innovative dairy inputs and service technologies (Omondi *et al.*, 2017). This is despite efforts from different stakeholders aimed at improving productivity (Adenle *et al.*, 2019). The low productivity and supply of milk is against the backdrop of a population of about 1 billion people, which is expected to exceed 1.2 billion by 2025, thus increasing demand for milk and dairy products (FAO & GDP, 2019). Currently, at least 80% of the global population consumes either milk or dairy products regularly.

In SSA, Tanzania has the fourth largest population of cattle after Ethiopia, Sudan and Chad respectively, and the leading in East Africa, with a herd of about 31 million kept for milk and meat (Bingi & Tondel, 2015). This herd accounts for 11% and 1.4% of the African and global cattle population respectively (Michael, *et al.*, 2018). Amongst this herd, 98.7% of cattle

are indigenous while 1.3% are improved cattle breeds with the small herd of improved breeds contributing about 70% of the milk quantity produced (Betsy *et al.*, 2020; Katjiuongua & Nelgen, 2014). The past 20 years has seen a 2.8% increase in milk production and this has been associated with an increase in cattle herd and not productivity per cow in Tanzania (Chawala *et al.*, 2019). According to Betsy *et al.* (2020) this lower productivity is attributed to traditional cattle breeds with lower productivity, poor management practices, and low uptake of innovative inputs and service technologies such as improved feeds, parasite controls, vaccines, diseases control and artificial insemination (AI).

Tanga and Kilimanjaro regions are among the high potential, cooler highland regions with subtropical climates of Tanzania where dairy farmers dominantly keep improved dairy cattle (Kurwijila *et al.*, 2012). Dairy farming ranks second after crops as economic activities and occupies about 15.3% of Kilimanjaro's land (United Republic of Tanzania, 2017). Tanga and Kilimanjaro regions are characterized by smallholder intensive and semi-intensive production dairy farming systems where farmers adopt improved inputs and services in diverse variations (Betsy *et al.*, 2021). Nonetheless, the portion of productivity enhancing improved dairy inputs and services are taken up in lower proportions which limits milk productivity (Bahta *et al.*, 2021; Betsy *et al.*, 2020).

Low adoption of improved inputs and services in developing countries has been associated with inability of smallholder farmers to afford respective inputs and services (Kebebe, 2019). Institutional factors such as limited knowledge of respective inputs and services among smallholder farmers, which is aggravated by inadequate extension services also limit uptake (Paloma *et al.*, 2020). Dar *et al.* (2021) outline that public extension agents are poorly funded and less motivated, and relay information to selected farmers hoping these farmers will diffuse similar information to other farmers. Mwambi *et al.* (2016) and Bahta *et al.* (2021) also point to limited multi-skilled public extensionists as a reason for the lower adoption of inputs and services. Dissemination approaches that largely depend on limitedly incentivized public extension systems have therefore failed to ensure sustainability in technology use. On the flip side, extension systems embedded in development projects are often tied to project cycles and uptake slow down as soon as respective projects close, sometimes leading to dis-adoption. Moreover, farmers often adopt inputs and/or services in singles, thus compromising the complementarity that would deliver greater productivity gains.

To bridge the gap, inputs and services agri-entrepreneurs are strengthening their role, motivated by their need for more profits and clientele (Kilelu *et al.*, 2018). Inputs and services agri-entrepreneurs provide farmers with relevant information to assist them to make informed purchase decisions (Dar *et al.*, 2021). Besides, these inputs and services agri-entrepreneurs apply innovative commercial practices and incentives in their businesses such as promotions, advertisements, discounts and field demonstrations to attract customers (Kilelu *et al.*, 2018). The business strategies leverage the existing transactional relationship between inputs and services agri-entrepreneurs and smallholder farmers (Kebebe, 2019), and can particularly be effective when inputs and services agri-entrepreneurs are empowered to offer accurate information concerning emerging inputs and services to farmers (Dar *et al.*, 2021; Okello *et al.*, 2021). Skilled inputs and services agri-entrepreneurs who possess creativity, innovativeness, and entrepreneurial drive provide solutions to market-oriented farmers interested in growth and exploring opportunities for productivity (Kilelu *et al.*, 2018). However, few studies have been done to determine the role of inputs and services agri-entrepreneurs in the uptake and use of inputs and services by smallholder dairy farmers.

Phase I of *Maziwa Zaidi* project that was implemented by ILRI in Tanzania found that direct dissemination of input and services technologies to farmers via research and public extension partners was a slower strategy for the adoption of input and service technologies (Omore *et al.*, 2021). Phase II of the project opted for a market systems approach involving inputs and services agri-entrepreneurs that is seen as catalysts of inputs and services uptake (ILRI, 2020). These actors are being empowered through agribusiness incubation to accompany improved inputs and services delivery with information provision among other business strategies (Omore *et al.*, 2021). This study aimed to understand the effects of business practices employed by inputs agri-entrepreneurs on input market participation by smallholder dairy farmers at the baseline of *Maziwa Zaidi II* project.

## **1.2 Statement of the Problem**

Dairy is a key sub-sector of Tanzania's agricultural sector in terms of GDP contribution, income generation, and food and nutrition security. However, the productivity of the sector remains low compared to the production potential and existing demand for milk and dairy products. An increase in milk production experienced has so far been associated with an increase

in herd size rather than productivity per cow. This is despite the efforts from different stakeholders over years to contribute towards boosting productivity. The public extension system has been the major avenue for the dissemination of improved dairy inputs and services technologies that boost milk productivity. However, this system is less motivated, funded, and incentivized, and hence the dissemination role has weakened over years. The research dissemination avenue is as well constrained such that dissemination stops as soon as the project is closed. An alternative improved dairy inputs and services dissemination avenue includes the market systems approach through private inputs and service agri-entrepreneurs' practices that inform and motivate smallholders to take up inputs and services. Previous studies focused more on the public sector dissemination avenues involving extension and research institutions rather than on the latter. This study sought to bridge this knowledge gap by determining the effects of dairy inputs and services agri-entrepreneurs' practices on the participation of smallholders in dairy input and service markets in Tanga and Kilimanjaro regions of Tanzania.

### **1.3 Objectives of the Study**

#### **1.3.1 General Objective**

To contribute to increased milk productivity in the dairy subsector through uptake of improved dairy input and service technologies by smallholder dairy farmers in Tanga and Kilimanjaro regions of Tanzania.

#### **1.3.2 Specific Objectives**

- i. To characterize dairy inputs and services agri-entrepreneurs' business and technology dissemination practices in Kilimanjaro and Tanga regions of Tanzania
- ii. To describe the state of dairy input and service use by smallholder dairy farmers in Kilimanjaro and Tanga regions
- iii. To determine the effect of business practices by inputs and services agri-entrepreneurs on the uptake of inputs by smallholder dairy farmers in Kilimanjaro and Tanga regions

#### **1.4 Research Questions**

- i. What are the characteristics of dairy inputs and services agri-entrepreneurs in Kilimanjaro and Tanga regions of Tanzania based on their business and technology dissemination practices?
- ii. What is the state of dairy input and services technologies use by smallholder dairy farmers in Kilimanjaro and Tanga regions?
- iii. What is the effect of business practices by inputs and services agri-entrepreneurs on the uptake and use of inputs by smallholder dairy farmers in Kilimanjaro and Tanga regions?

#### **1.5 Justification of the Study**

Tanzania has the fourth largest cattle herd in Africa, with about majority being indigenous breeds and only a few are exotic breeds. Yet, exotic breeds account for 30% and 70% of milk produced and marketed respectively. Despite being a key sub-sector in the agricultural sector, the dairy industry contributes just about 1.5 percent to the total GDP, unlike the neighbouring countries, Kenya, and Rwanda, where the sector contributes about 6 percent to the GDP. This is indicative of lower productivity per cow registered by the farmers in Tanzania. The low productivity is associated with lower adoption of inputs and service technologies such as improved animal feeds, AI services, vaccines and pests and disease control, and manure management. This is despite the efforts of different stakeholders aimed at enhancing technology uptake in different ways. This study focussed on assessing the relevance of input agri-enterprises on the uptake of innovative inputs and service technologies.

The study was in line with the National Livestock Policy developed by the Ministry of Livestock and Fisheries Development of the United Republic of Tanzania. The policy envisions to increase animal productivity and commercialize the livestock sector to ensure an improved household food security and income. The Tanzania Development Vision 2025 also aims to have a commercial, modern, and sustainable livestock sector through improved productive livestock for food and nutrition security, higher incomes, and environmental safety. These goals are also in line with Africa Union's Agenda 2063 priority which is focused on modern agriculture for increased productivity and production. Additionally, the 2014 Malabo declaration seeks to contribute to food and nutrition security by increasing agricultural productivity through various ways including quality and affordable inputs, and supply of appropriate knowledge, skills, and information to users. Findings from this study reveal the prevailing status of input use and

technologies adoption and therefore gives insight for policy alignment towards achieving improved productivity in the dairy sub-sector. The findings may also be useful for research institutions and other developmental partners focused on the dairy sub-sector since it generates evidence on alternative approaches to enhancing technology dissemination in developing countries. Finally, the study contributes towards the realization of sustainable development goals (SDGs) SDG 1: No poverty (end poverty in all its forms everywhere) and SDG 2: Zero hunger (end hunger, achieve food security and improved nutrition and promote sustainable agriculture. Particularly, this study contributes more on section 2.3 which aims to double the agricultural productivity and incomes of smallholder food producers, in particular... family farmers, pastoralists..., including through secure and equal access to land other productive resources and inputs, knowledge, financial services, markets and opportunities for value addition and non-farm employment.

## **1.6 Scope and Limitations of Study**

This study was limited to studying the effects of business practices by input entrepreneurs on input market participation by smallholder farmers in the Tanga and Kilimanjaro regions of Tanzania. Practices by inputs and services agri-entrepreneurs include non-commercial (such as bundling of complementary inputs and/or services). Possible technology bundling includes delivery of complementary technologies such as AI and East Coast Fever (ECF) vaccination services, that also happen to share cold chain infrastructure. Bundling could also involve inputs and services agri-entrepreneurs providing advisory services, either directly or in partnership with other extension service providers, as a strategy to grow demand for the inputs they offer. The commercial practices include aspects such as advertisement, discounting, after sales services, and promotion, done by these entrepreneurs to increase sales and profits. In turn, both commercial and non-commercial practices increase information about inputs and services to farmers. The study was limited to bundles of dairy inputs and services technologies in the study site under the framework of the *Maziwa Zaidi* Phase II Project being implemented by ILRI, International Centre for Tropical Agriculture (CIAT) and other partners. The study used a sample size of 712 smallholder dairy farmers and 93 input and service entrepreneurs for characterization and to determine how the practices of these entrepreneurs affect input market participation by these farmers. The third objective was limited to a sample size of only 152 out of the 712 smallholder

dairy farmers. This is because only the smallholder dairy farmers that identified with purchasing of dairy input and service technologies from the 93 inputs and services agri-entrepreneurs were useful to estimate the purchase of dairy inputs/services. The cumulative cost of these inputs and services was used as the dependent variable while the latent classes obtained from the first objective were collapsed into a categorical explanatory variable.

### **1.7 Definition of terms**

**Input and service technologies-** these are improved product or service inputs purposed to minimize costs and/or increase productivity in an agricultural enterprise. In this study, these included inputs/service technologies to increase milk yields at the lowest costs possible as well as service technologies like breeding, animal health and advisory services.

**Inputs and Services agri-entrepreneurs** – These are upstream agri-entrepreneurs in agricultural value chains who either produce and sell or source and sell dairy inputs and service technologies to farmers

**Input technology bundles** – These are sets of dairy inputs and service technologies that can be delivered together due to complementarity in their use and/or their ability to leverage common delivery systems and infrastructure. Common delivery was also expected to enhance joint adoption and hence greater productivity impacts of respective technologies. Examples of bundled technologies/services include artificial insemination and animal health services and input supply and extension services among others.

**Smallholder dairy Farmers** – These are dairy farmers with cattle below ten.

**Market participation** – Purchase/procurement of inputs and services by farmers which can be measured in terms of value of the inputs and services (Rather, total expenditure on inputs/services for each dairy farmer for the past 12 months prior to data collection).

## CHAPTER TWO

### LITERATURE REVIEW

#### **2.1 Input Use by Farmers in Developing Countries**

Enhanced use of agricultural inputs and service technologies has the potential to improve the livelihood of farmers by pushing them towards increased productivity and commercialization (Hornum & Bolwig, 2021). This can be crucial in developing countries, where agricultural production is largely smallholder-based, characterized by limited use of critical inputs and consequently low productivity (Dawa, 2015; Okello & Okello, 2021; Wossen *et al.*, 2017). Smallholder farmers in developing countries are about 500 million, with about 200 million engaging in formal markets along various value chains while about 300 million smallholders produce for subsistence and spot markets (Nelson, 2019). Whether farming for subsistence or farming as enterprises, productivity levels in developing countries have remained consistently low over years (Okello *et al.*, 2021). More so, those engaged in formal value chains are struggling and risk falling into poverty due to climate and economic shocks (Nelson, 2019). A major cause of the low productivity is the consistently low input use in developing countries across many agricultural VCs (Abay *et al.*, 2016; Janssen & Swinnen, 2019; Okello *et al.*, 2021). Bellemare (2015) argues that agricultural VCs in developing countries is characterized by the use of primitive technologies and spot market traditional forward and backward transactions, rather than vertically integrated value chains.

With the surge in human population, the reported low productivity has created a gap where demand exceeds supply (Rao *et al.*, 2018). This deficit is expected to grow, for instance, in the dairy sector, to about 5.8 million litres of milk in 15 years if strategies to increase productivity are not implemented (Michael, *et al.*, 2018; Nell *et al.*, 2014). The gap can be overcome if productivity increasing inputs and service technologies are embraced, possibly leading to surplus production of 1.5 million litres (Bahta *et al.*, 2021; Michael, *et al.*, 2018). This would result in increased returns, thus creating demand for more inputs and service technologies, and in turn furthering productivity increases (Rao *et al.*, 2018).

Even where farmers already use some agricultural inputs, these are applied in isolation or independently of each other, with limited complementarity that would deliver the productivity gains needed to transform smallholder agriculture (Abay *et al.*, 2016; Okello *et al.*, 2021). Indeed, many studies show that applying a combination of inputs is more beneficial. For

instance, Khonje *et al.* (2018) show that the adoption of multiple agricultural inputs was able to boost maize production in Zambia, leading to income increases and poverty alleviation. Ayele *et al.* (2012) and Maina *et al.* (2020) also acknowledge that despite the adoption of improved fodder by livestock farmers being relevant for productivity, it is only a single input, whose benefits can be enhanced by the adoption of complementary technologies. For instance, smallholder dairy farmers adopting improved dairy cattle would greatly benefit if they equally adopted improved practices such as deworming and use of improved forage varieties.

## **2.2 Hindrances to Input Market Participation by Farmers**

Several factors are responsible for the low and sometimes non-complementary use of appropriate technologies by farmers. First, most farmers barely access information concerning new inputs and service technologies in developing countries (Janssen & Swinnen, 2019; Ullah *et al.*, 2020). This limits their decision-making capability towards such inputs and technologies since these farmers are sceptical of the outcomes. As a result, many farmers stick to their traditional subsistence production devoid of modern technologies since investing in little known inputs and technologies is perceived as a risky venture. This reluctance to shift from subsistence to entrepreneurial production focus is evident among Ethiopia's smallholder dairy farmers as shown by Kebebe (2019).

Low use of relevant technologies by smallholder farmers can also be attributed to imperfections in input markets, which stem from the inadequate organizational capacity of farmers, extension providers and research institutions (Ullah *et al.*, 2020). While accounting for up to 80% of producers in developing countries, smallholder farmers are geographically dispersed over wide areas making it difficult for them to access inputs and services agri-entrepreneurs and extension services (Rao *et al.*, 2016). Smallholder farmers also exhibit a challenge of poor access to information and communication technologies and limited infrastructure, both of which increase transaction costs and limit access to structured input and output markets (Basurto *et al.*, 2020; Hornum & Bolwig, 2021; Rao *et al.*, 2016). Sheahan and Barrett (2017) posit that there exist variations in input use and input use intensity across developing countries due to varying input and output prices, market accessibility, and past investments in infrastructure and agricultural extension service by actors in the agricultural value chains. Indeed, agricultural supply chains and VCs in developing countries are poorly defined and integrated. This implies higher transaction costs such as the costs of seeking information,

sourcing inputs, identifying trading partners/VC actors, negotiating deals and enforcing contracts (Kebebe, 2019). This results in limited access to and affordability of inputs and service technologies, and hence slower adoption rates by farmers (Hornum & Bolwig, 2021).

Entrepreneurial knowledge and skills have also been shown to have greater impacts on the adoption of input technologies by smallholder farmers in developing countries. Farmers who receive training in business planning have an upper hand in making business and profitability focused decisions and are therefore more likely to adopt productivity enhancing input technologies (Okello *et al.*, 2021). Yet most smallholder farmers have less knowledge and lack an entrepreneurial drive. For instance, Kebebe (2019) relates smallholder dairy farmers' poor management of the Holstein-Horro heifers in Ethiopia, given to them by a local research organization, to poor enterprise capacities. Further, Hornum and Bolwig (2021) notes that small-scale farmers are less aware and technically limited in irrigation technologies, and this explains the low adoption of irrigation technologies in SSA. Enhancing the capacity of farmers therefore remains a critical avenue to enhancing the adoption of input technologies and innovations for accelerating this process are needed.

Finally, the non-complementary use of technologies by farmers has been attributed to the higher cost involved in adopting bundles of technologies (Abay *et al.*, 2016; Betsy *et al.*, 2020). For instance, dairy farmers in Tanzania are less involved in intensive farming systems since the adoption of exotic cattle breeds needs purchasing feeds, and animal healthcare inputs such as vaccines, triggering higher investment costs (Betsy *et al.*, 2021). Many smallholders are constrained by capital and credit that could enhance their ability to afford bundles of inputs (Kebebe, 2019). In other circumstances, farmers are either uninformed or have incomplete information about such input and service bundles, and as such fail to adopt them (Ullah *et al.*, 2020). Farmers view some input bundles as substitutes rather than complements in approaches that integrate inputs and service technologies aiming at sustainability. For instance, farmers perceive inorganic and organic fertilizers as substitutes yet they are intended to be complements in an integrated soil management system (Abraham *et al.*, 2020; Sheahan & Barrett, 2017)

### **2.3 Approaches Used by Stakeholders to Accelerate Access to Input Technologies by Farmers**

To intensify the use of appropriate input technology by smallholder farmers, several approaches have been used by stakeholders. Among these approaches is contractual farming arrangements promoted by public organizations, private actors, private-public partnerships, international aid organizations and non-governmental organizations (Azumah *et al.*, 2017; Rao & Qaim, 2011; Ton *et al.*, 2017). Input subsidies have also been promoted by governments of developing countries as steers of agricultural productivity (Jayne *et al.*, 2016). Some stakeholders such as research institutions have developed and promoted input technologies that improve productivity mainly through public extension systems (Adenle *et al.*, 2019). Increasingly, business-oriented approaches are emerging as an alternative avenue for enabling farmers to access inputs and increase productivity.

Contractual farming entails diverse arrangements before production on quantities, quality, price and timeliness of production, made formally or informally between farmers and buyers to purchase the farmers' produces (Mwambi *et al.*, 2016; Ton *et al.*, 2017). More often, these arrangements involve farmers receiving some form of support from buyers regarding the production process. This could include the provision of inputs and advisory services, the cost of which is checked off the product proceeds at the time of payment. Contractual arrangements have existed over years in agricultural value chains, where governments and developmental stakeholders encourage them as developmental policy incentives (Ton *et al.*, 2018). Such arrangements have been critical in enabling farmers to access credit, inputs for production, extension services and markets for their produce (Azumah *et al.*, 2017; Mwambi *et al.*, 2016; Ton *et al.*, 2017). However, there have been several concerns about buyers engaging farmers who are well off (Azumah *et al.*, 2017) and have more factors of production that enhance the quantity and ensure the quality of produce which most smallholders lack (Ton *et al.*, 2018).

Variations in the nature of contracts affect the impact of these arrangements on the welfare of farmers (Mwambi *et al.*, 2016). Poorly designed contracts that have unclear terms and conditions have also been shown to disadvantage farmers. Additionally, poor management of contracts, late provision of credit, inputs and payments could also result in lower incomes for farmers. Poorly designed contractual arrangements also empower firms to be monopsonies, with farmers losing their bargaining power while the buyers breach the contract terms to underpay or

delay payments to contractors (Bellemare, 2015; Mwambi *et al.*, 2016). As a coping strategy, farmers in such exploitative arrangements will resort to side-selling their produce in alternative markets where ready cash is offered even when it is lower than the contract price (Bellemare, 2015; Mwambi *et al.*, 2016). This means a loss especially when inputs that are meant to achieve a certain quality, as a competitive advantage, were used, and traceability value is lost as the produces mix with other produces in the informal markets.

The second approach to increasing input use by farmers involves input subsidies. Agricultural input subsidies have mostly been provided by ministries of agriculture in most developing countries over years to increase productivity (Abraham *et al.*, 2020; Mather & Jayne, 2018; Sheahan & Barrett, 2017). There have been success stories where some smallholder farmers' livelihoods have been improved through access to inputs, which they could otherwise not either access and/or afford (Paloma *et al.*, 2020). In Malawi for instance, subsidies have been shown to enhance the adoption of improved maize varieties by smallholders (Asfaw *et al.*, 2017). However, efficiency in the administration of subsidies can sometimes compromise the intended gains from such initiatives. In the case of fertilizer subsidies, late delivery and application of fertilizers negates intended productivity gains and nullify cost-effectiveness and sustainability in the long run (Paloma *et al.*, 2020). More so, subsidy programs can undermine complementarity in input use. This is evident where subsidized inorganic fertilizers are perceived by farmers as substitutes rather than complements in production (Sheahan & Barrett, 2017). Ragasa and Chapoto (2017) show that the use of organic manure for maize production ensured more yields than singly using inorganic fertilizer. Besides, subsidies on inputs such as fertilizer need complementary inputs such as improved seeds, management skills, labour, land, irrigation and credit to optimally achieve the goal of increased productivity (Liverpool-Tasie *et al.*, 2017; Ragasa & Chapoto, 2017). Input subsidies also need to be complemented by supportive infrastructure, which would further reduce access costs and increase the profitability of using inputs in production (Liverpool-Tasie *et al.*, 2017). Input subsidies should therefore be holistic in capturing other complementary inputs which are critical to the adoption of the subsidized input.

Additionally, there are concerns that the well-off tend to benefit from subsidies in place of the disadvantaged targeted beneficiaries, as has been witnessed in the case of input subsidy in Malawi (Basurto *et al.*, 2020). This is often the case when subsidy programs do not have adequately defined, standardized, and structured criteria for targeting beneficiaries, leaving room

for the subjective distribution of subsidized inputs (Abraham *et al.*, 2020; Asfaw *et al.*, 2017; Basurto *et al.*, 2020). Where subsidy programs are implemented exclusively through the public sector, there are also concerns that input subsidies could crowd out private inputs and services agri-entrepreneurs as subsidized inputs end up in the hands of able farmers who can access and afford such inputs even without subsidies (Asfaw *et al.*, 2017; Mather & Jayne, 2018). This has been the case with inorganic fertilizers in Kenya, Zambia and Malawi (Mather & Jayne, 2018), where poor smallholder farmers miss out on subsidized inputs as distributors allocate to farmers with productive efficiency (Abraham *et al.*, 2020; Asfaw *et al.*, 2017; Basurto *et al.*, 2020). In some cases, smallholder farmers access the subsidy vouchers and sell them to well-off farmers, to purchase basic needs (Asfaw *et al.*, 2017). In such a case, productivity cannot be attained since these farmers prioritize basic needs over farm productivity.

Another commonly used approach towards enhancing input use by poor smallholder farmers in developing countries involves direct promotion by research and developmental partners (Khonje *et al.*, 2018). Among the major players in this initiative are the national research organizations and the Consultative Group on International Agricultural Research (CGIAR) which brings together fifteen international research organizations. The organizations develop innovative technologies and work with public extension systems to disseminate such technologies as a means to improve productivity, value chain performance, and smallholder livelihoods (Adenle *et al.*, 2019). Research initiatives by CGIAR centres such as International Institute of Tropical Agriculture (IITA) and International Maize and Wheat Improvement Centre (CYMMYT) have, for instance, resulted in enhanced adoption of improved maize varieties, impacting at least 74,000 smallholders annually in West and Central Africa (Alene *et al.*, 2009). Improved bean varieties from CIAT, also led to tremendous improvement in productivity with at least 5.8 million smallholders benefiting from Southern Africa (Adenle *et al.*, 2019). ILRI has also been involved in the development and promotion of productivity enhancing technologies among smallholder dairy farmers (Dror, 2021). Continuity of uptake and use of inputs and services via research avenues may, however, be limited in that these initiatives run through projects that have a defined end and limited funding. This means that uptake by farmers may slow down as soon as a given project comes to an end, with implications being reduced productivity.

## **2.4 Role of Inputs and Services Agri-entrepreneurs on Inputs/Services Uptake and Use by Farmers**

Besides the three approaches outlined above, inputs and services agri-entrepreneurs are playing an increasing role in technology dissemination and promotion of input use among poor farmers. These entrepreneurs interact directly and more frequently with farmers in agricultural VCs and can therefore be useful in disseminating technologies (Kebebe, 2019). Their interaction with farmers provides them with intelligence on the needs and demand patterns of farmers. Through intelligence gathering, the inputs and services agri-entrepreneurs influence the kind of inputs that are made available by large agribusinesses involved in the manufacturing and distribution of inputs (Hornum & Bolwig, 2021). Courtesy of their profit orientation and understanding of market dynamics they also influence the rate at which such input and service technologies spread in their local regions. Indeed, Ullah *et al.* (2020) emphasize that adoption decisions on innovative input and service technologies for sustainable land use made by farmers mainly rely on the market connections between them and the suppliers of these inputs.

The increasing role of inputs and services agri-entrepreneurs in technology dissemination stems from information asymmetry that has become pervasive in developing countries due to the collapse of public extension systems. According to Khonje *et al.* (2018), among the factors limiting the adoption of multiple agricultural input technologies by smallholder farmers is accessibility to advisory services. In the absence therefore of effective extension services, inputs and services agri-entrepreneurs increasingly play the role of disseminating information about innovative input/service technologies (United States Agency for International Development-USAID, 2019). They play an active and vital role in both training and disseminating inputs and services technologies, thus enhancing the integration of smallholder farmers in agricultural VCs and boosting productivity (Kilelu *et al.*, 2018). Indeed, majority of farmers rely on traders and inputs and services agri-entrepreneurs to provide information and advice on inputs and service technologies since they are easily accessible (Ullah *et al.*, 2020). More often, inputs and services agri-entrepreneurs offer information on input and service technologies as a business strategy to enhance uptake and thereby maximize their returns (Dar *et al.*, 2021; USAID, 2019). Findings from Dar *et al.* (2021) indicate that a business-oriented approach of using inputs and services agri-entrepreneurs as disseminators of information on innovations in input and service

technologies increases the uptake rate and land use for the new varieties and increases the quantities of new varieties supplied among inputs and services agri-entrepreneurs.

Okello *et al.* (2021) underscore the need for enhanced capacity of smallholder farmers and stronger relationships with private service providers (inputs and services agri-entrepreneurs) to increase the uptake of input and service technologies. Inputs and services agri-entrepreneurs are well connected to different main and support actors across value chains, and this ensures efficiency in financial, knowledge and skills flow (Hornum & Bolwig, 2021). They also have a greater incentive to provide useful information to farmers given the returns to adoption that they accrue from more informed farmers (Dar *et al.*, 2020). Leveraging agricultural inputs and services agri-entrepreneurs to facilitate the dissemination of inputs and technologies in developing countries can therefore be significantly productive.

Input/service agri-enterprises also often supply inputs to farmers on credit terms, thus addressing the credit constraint that hinders input use. This is a kind of informal credit that is commonly used in developing countries such as Indonesia, Pakistan and Afghanistan, where farmers pay for the supplies after harvesting their produce (Moahid & Maharjan, 2020; Puspitasari *et al.*, 2020). Such innovation in VC financing saves smallholder farmers additional costs and restrictive collateral requirements associated with formal credit, thus accelerating the adoption of relevant agricultural inputs. Given their commercial nature and legal entity, input/service agri-enterprises can also link up with financial institutions to enable farmers to access inputs/services. The farmers and financial institutions reach a mutual agreement where the latter purchases necessary inputs for the former with an agreed manageable margin for the financiers. Farmers then pay for the financial services after the harvest have been sold.

#### **2.4.1 Inputs and Services Agri-entrepreneurs Commercial and Promotional Practices as Incentives to Increase Sales**

Inputs and services agri-entrepreneurs do several business promotional activities to attract more customers and expand their market base, and hence increasing profits and scales of operation. These activities include promotion, credit provision advertising, after-sale services like provision of transport, and discounts.

Raghubir (2004) results show that consumers gain more information about products that are promoted by giving the customers a gift to promote a given brand. From the value of the gift,

consumers can develop a perception of the promoted brand, and this may lead to more purchases (Raghubir, 2004). Discounting on the other hand attracts attention to the case product and makes customers view a product in terms of reduced costs, and increase purchases (Koo & Suk, 2020). According to Chiguvi (2020) study, after-sales services ensure customer satisfaction, customer loyalty, and customer retention. Advertisements in turn communicate information about products that convince, encourages, or manipulates customers to purchase products, and is very influential in increasing sales and growing the customer base (Karaxha *et al.*, 2016).

Despite the key roles of these commercial practices in increasing information to customers, there is a gap in agribusiness literature on the role of these incentives in increasing information on the case products. This study aims to fill this gap by assessing the effect of both commercial and non-commercial practices by inputs and services agri-entrepreneurs and how such practices affect farmers' decisions to use products.

#### **2.4.2 Caveat to Use of Inputs and Services Agri-entrepreneurs as Input and Service Technology Disseminators**

According to Dar *et al.* (2021) in as much as inputs and services agri-entrepreneurs spread input and service technologies information to expand their returns, some may provide sub-standard products instead, while others influence farmers into purchasing inputs that maximize the agro-dealer's profitability rather than the productivity of farmers. On the other hand, Ullah *et al.* (2020) show that malpractices by agri-entrepreneurs such as adulteration, inaccurate weighting, supply of alternate commodities, product imitations and supply of expired products may lead to lower adoption of agricultural input technologies. These concerns raise questions on the efficacy of agri-entrepreneurs in technology dissemination since such malpractices may discourage the uptake of recommended technology by farmers. However, if empowered from appropriate institutions, inputs and services agri-entrepreneurs can be technically equipped to strategically channel the right information alongside inputs and services technologies to better boost dairy productivity among smallholders.

#### **2.5 Theoretical Framework**

Several theories could be used to explain the decision of dairy farmers to purchase improved dairy inputs and services such as attribution theory and random utility theory. However, both theories do not consider all factors that will influence dairy productivity. More

so, random utility theory assumes that the dairy farmer has perfect discriminatory power, access to information and can consistently rank choices in a clearly defined manner under similar circumstances (Kjær, 2005). This study therefore anchored on the Utility Maximization theory (Fishburn, 1968).

Utility theory states that decisions and choices are based on the ability of economic agents to rank their choices depending on preferences (Fishburn, 1968). The decision to use specific inputs and/or services technologies is a choice process that depends on ranking the expected returns/utility from respective technologies (Asfaw *et al.*, 2012). The probability that farmers take up dairy inputs and technologies is thus determined by a comparison of the expected utility of the inputs and technology,  $I_1^*$ , against the expected utility of not using the technology,  $I_0^*$ .

While making this comparison the farmers evaluate both the benefits and costs of the decisions. Dairy farmers take and use the inputs and services technologies if the utility of using them,  $I_1^*$ , outweighs that of not utilizing the dairy inputs and technologies,  $I_0^*$ ; that is,  $I_1^* > I_0^*$ .  $I_1^*$  and  $I_0^*$  are latent variables since utility is unobservable. What is directly observed is the uptake of inputs and technologies  $I$ , such that  $I = 1$  if  $I_1^* > I_0^*$  and  $I = 0$  if  $I_1^* \leq I_0^*$ . Participation in the inputs and technologies market by smallholder farmers can therefore be represented in the equation below.

$$I = Z\alpha - u \dots\dots\dots (i)$$

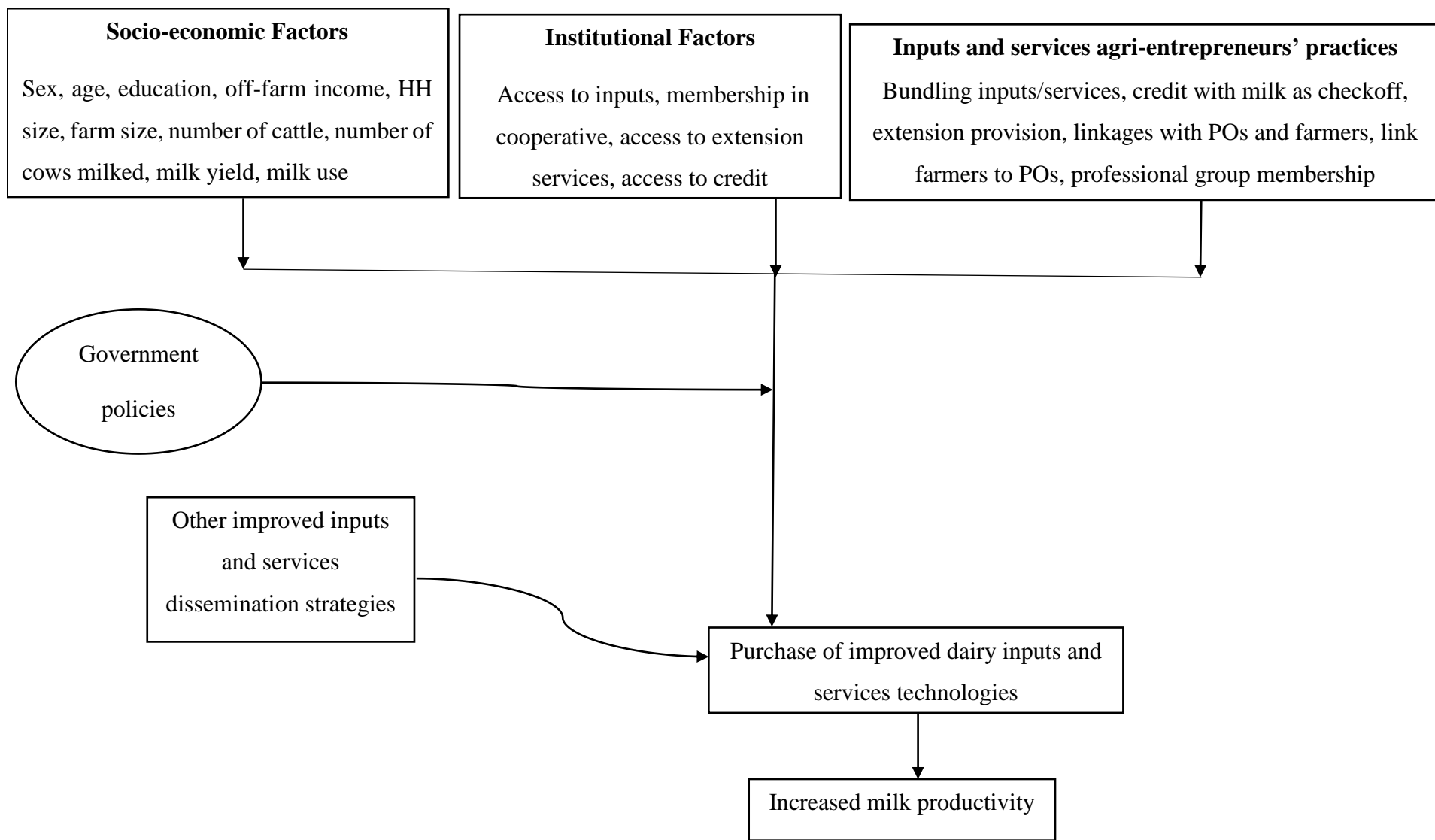
where  $\alpha$  represents a vector of parameters while  $u$  is the error term with a mean and variance of zero. The expected utility that a farmer derives from the technology/input choice is determined by a set of variables  $Z$ , which include the farmers' socio-economic characteristics (*education level, income sources, credit access, and other variables that affect the decision-making*), institutional structures, and technology characteristics. Variables in  $Z$  also determine the relative milk yield that a farmer can earn from using dairy inputs and technology bundles. These variables influence farmers' ability and the cost of uptake and use of dairy inputs and service technologies. Moreover, ranking the expected utility requires sufficient information about all the alternatives. The choice of technology is therefore determined by the level and quality of information the farmer has on respective technologies, hence the importance of extension services, which is part of the institutional environment affecting production by smallholders.

## 2.6 Conceptual Framework

The conceptual framework shows how dairy inputs and services used by smallholder dairy farmers are determined by factors that include interactions between key concepts identified from the literature review. The decision by smallholder dairy farmers to participate in the dairy inputs and services market measured in terms of purchase of the improved inputs and services and was determined by socio-economic, institutional, and inputs and services agri-entrepreneurs' practices. Socio-economic factors include characteristics of dairy households such as household demographics, income/wealth status and social networks. Institutional factors include sets of relationships, organizations and market/actor linkages that facilitate the exchange of information, goods, and services. These include farmer-based organizations such as cooperatives, extension service systems, and organizational set ups for access to credit among others. Dairy inputs and services agri-entrepreneurs' practices include business activities and business promotional activities. Business activities referred to the different bundles the dairy inputs and services sold by inputs and services agri-entrepreneurs in this study. The business promotional business activities include linkages with farmers and other inputs and services agri-entrepreneurs, sale of inputs/services with credit with milk as checkoff, delivering inputs and services to farmers, and belonging to professional groups. These practices were categorized into latent groups and included as a categorical independent variable in the OLS estimation. Smallholder farmers access information on dairy inputs and services either through the traditional extension system or from inputs and services agri-entrepreneurs, who are governed by government policies.

Inputs and services agri-entrepreneurs form part of the institutional landscape governing production systems since they play a critical role in linking farmers to technology developers. To the extent that they undertake business practices aimed at growing their sales through market enlargement, they play a critical link in input and service technology dissemination. To effectively perform their role as disseminators of input and service technologies, inputs and services agri-entrepreneurs possess some technical knowledge about different inputs and services technologies, and their benefits, and how to use the inputs/services to optimize yields. Input entrepreneurs avail inputs/service technologies with relevant information for their clientele (farmers) and have links with other dairy service providers who offer complimentary inputs/service technologies where they may refer farmers to acquire associated inputs/service technologies or facilitate the acquisition. Some inputs and services agri-entrepreneurs also hold

farmer field days, teaching, and demonstration plots, or have model farmers as avenues to provide information and practical scenarios to smallholder dairy farmers and positively influence their decisions to participate in inputs and technologies markets. These agri-entrepreneurs also apply commercial incentives such as advertising, discounting, and promotions among others, that aim to boost sales and profits. Given this role, it was expected that if the agri-entrepreneurs are empowered, their capabilities will increase, and this will possibly increase the uptake and use of inputs and services technologies by smallholder dairy farmers as they interact with empowered inputs and services agri-entrepreneurs. This can in turn increase milk productivity, and incomes of both the dairy farmers and inputs and services agri-entrepreneurs. *Maziwa Zaidi II* seeks to empower selected agri-entrepreneurs to better link with and serve the input and service technology needs of smallholders. This study employed the project's baseline data to determine existing practices of inputs and services agri-entrepreneurs that influence dairy farmers' purchase decision. Conceptualization is shown in figure 1.



**Figure 1: Conceptual Framework (Own Conceptualization)**

## **CHAPTER THREE**

### **METHODOLOGY**

#### **3.1 Study Area**

This study used secondary data that was collected from smallholder farmers and select input and service agr-entrepreneurs in the Kilimanjaro and Tanga regions of Tanzania in June 2021, where the *Maziwa Zaidi II* project is being implemented. The project is based in 4 districts in Kilimanjaro region and 2 in Tanga region. These are the regions where a sample size of 712 smallholder dairy farmers was obtained. The districts in Kilimanjaro regions are Hai, Siha, Moshi Rural, and Rombo. Districts in Tanga regions are Korogwe Rural and Muheza. The urban districts were inputs and services agri-entrepreneurs' main bases and were not included in household level activities. These districts are where 93 inputs and services agri-entrepreneurs were obtained. These districts are Korogwe Town and Tanga City in the Tanga region and Moshi Municipal in the Kilimanjaro region. Tanga and Kilimanjaro regions are shown in Figure 2.

Within each district, the project implementation areas are Wards that are geographically clustered around producer organizations (PO) including cooperatives (as shown in Figure 3), which are indicative of dairy-cattle keeping areas.

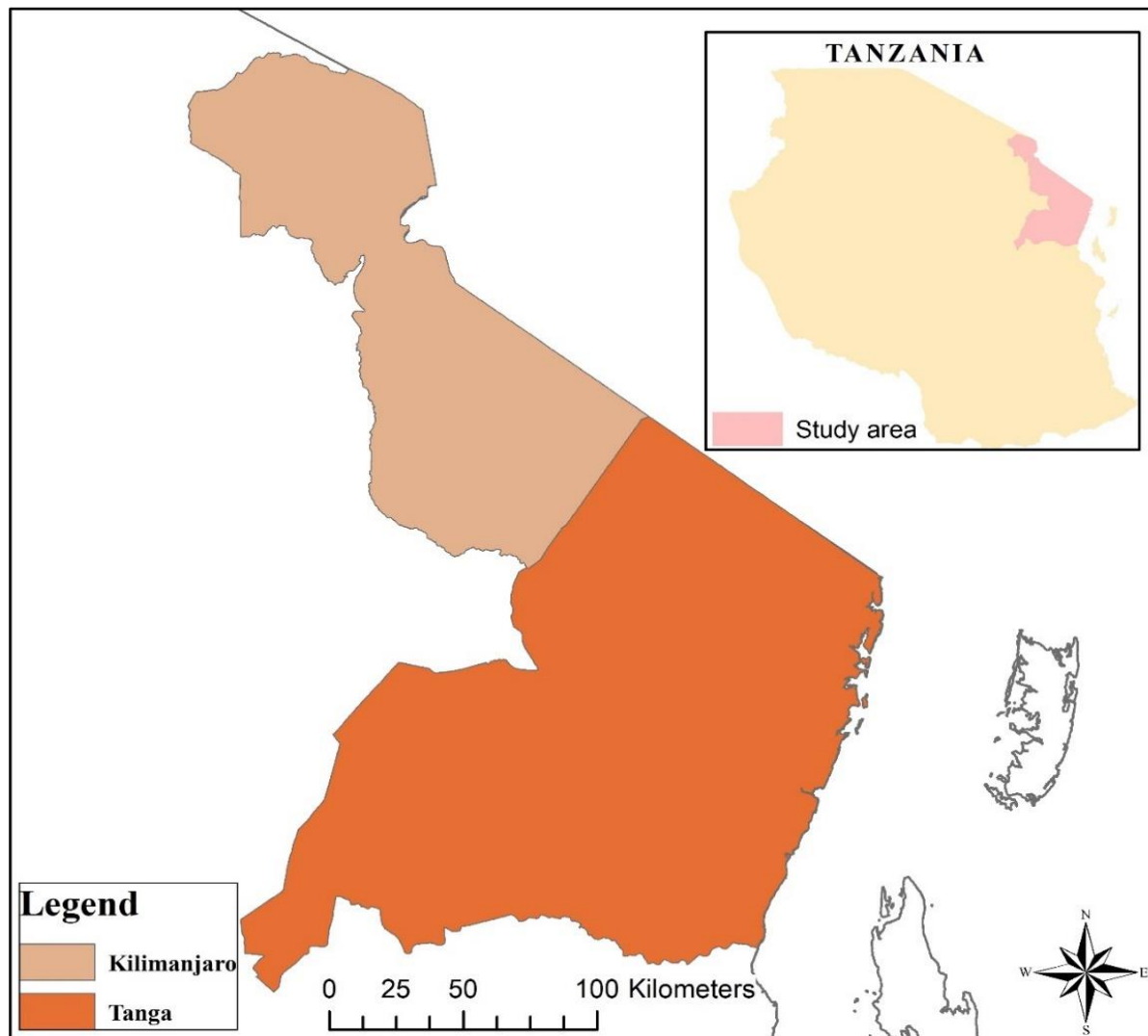
##### **3.1.1 Kilimanjaro Region**

Kilimanjaro region is one of the 31 administrative regions of the United Republic of Tanzania. This region is bordered by Kenya to the north and east, Tanga region to the south, the Arusha region to the west and the Manyara region to the southwest. According to the 2022 census, the Kilimanjaro region has a population of 1,861,934. Kilimanjaro has six districts which include Moshi, Hai, Siha, Rombo, Mwanza, and Seme, and one municipal, Moshi Municipal. Hai, Siha, Moshi municipal, Moshi rural and Rombo were the selected regions for this study.

##### **3.1.2 Tanga Region**

Tanga region is also among the 31 administrative regions of the United Republic of Tanzania. This region is bordered by Kenya and Kilimanjaro on the north and east, the Manyara region to the west, Morogoro and Pwani regions on the south and the Indian Ocean on the East. According to the 2022 census, the Tanga region has a population of 2,615,597. Tanga has ten districts which include Lushoto, Mkinga, Pangani, Handeni Rural, Handeni Town, Kilindi,

Korogwe Rural, Muheza, Korogwe Town, and Tanga City. Korogwe Rural, Muheza, Korogwe Town, and Tanga City were selected regions for this study.



**Figure 2:Map of Kilimanjaro and Tanga Regions**

**Source: GIS Section, Policy, Institutions, and Livelihood Programme, ILRI**

## **3.2 Research Design**

This study used secondary data from ILRI which was collected in June 2021 in Tanga and Kilimanjaro regions of the United Republic of Tanzania. While the *Maziwa Zaidi II* project applies a combination of with/without and before/after study design, the current study is based only on the baseline survey that was conducted in June 2021 in the two regions as part of that larger study design. This study used comparative analysis to assess the state of input market participation/input use based on business practices applied by the agri-entrepreneurs who were linked to smallholder farmers in the two regions.

### **3.2.1 Population of Study**

The population of the study was the smallholder dairy farmers and dairy inputs and services agri-entrepreneurs in Tanga and Kilimanjaro regions. Baseline data collected from 93 inputs and services agri-entrepreneurs was used to characterize agri-entrepreneurs based on applied business practices. The characterization helped in determining the effects of the business practices by input/service agri-entrepreneurs on input market participation by smallholder dairy farmers.

### **3.2.2 Sampling Unit**

The sampling unit for this study was smallholder dairy farmers within the selected Wards in the Tanga and Kilimanjaro regions of Tanzania and dairy inputs and services agri-entrepreneurs in these regions.

### **3.2.3 Sample size**

The study used the entire sample of farmers and inputs and services agri-entrepreneurs that were sampled by the *Maziwa Zaidi II* project, both drawn from known populations. *Maziwa Zaidi II* project purposes to implement interventions to enhance access to and use of dairy input and service technologies by smallholder dairy farmers in the Tanga and Kilimanjaro regions. The sample size was determined by key project impact indicators (productivity - lactation yield, farm income for cattle keeping households, milk revenue, and secondary indicators such as household consumption of milk), looking into impacts post 2021. While this study was based on the baseline survey, *Maziwa Zaidi II* project plans to undertake an evaluation way after the interventions will have been undertaken. The evaluation will be based on a difference-in-difference analysis following the 2-samples of before/after and with/without scenarios. Based on

these indicators and following the calculations that are summarized in Appendix A, *Maziwa Zaidi II* estimated a sample size of 780. However, 712 farmers were interviewed during the baseline survey as 68 farmers dropped out because of unwillingness to participate in the study.

The sample calculation formula is as below.

$$n = 2 \times \frac{\left( Z_{\frac{\alpha}{2}} + Z_{1-\beta} \right)^2}{d^2} \sigma^2$$

where n was the sample size to be determined,  $Z_{\frac{\alpha}{2}}$  is 5% level of significance ( $Z=1.96$ ), and  $Z_{1-\beta}$  is 80% power (0.84%). The distribution of the sample size across regions and districts is shown in Table 1.

**Table 1: Sample Size Distribution Across Districts**

| Region      | District                     | Sample size |
|-------------|------------------------------|-------------|
| Kilimanjaro |                              | (534)       |
|             | Hai District Council         | 105         |
|             | Moshi Rural District Council | 291         |
|             | Rombo District Council       | 86          |
| Tanga       | Siha District Council        | 52          |
|             |                              | (178)       |
|             | Korogwe Town Council         | 58          |
|             | Muheza District Council      | 120         |
| Total       |                              | 712         |

Analysis of objective 3 was based on 152 dairy farmers who purchased at least one dairy input/service from the 93 input/services agri-entrepreneurs interviewed at the baseline of this survey, as this was the key parameter of analysis (purchase if input/service from project input/service agri-entrepreneurs).

### 3.2.4 Sampling Procedure

The sampling process for the study followed several steps as outlined below.

*Step I: Identifying a list of inputs and services agri-entrepreneurs for the project*

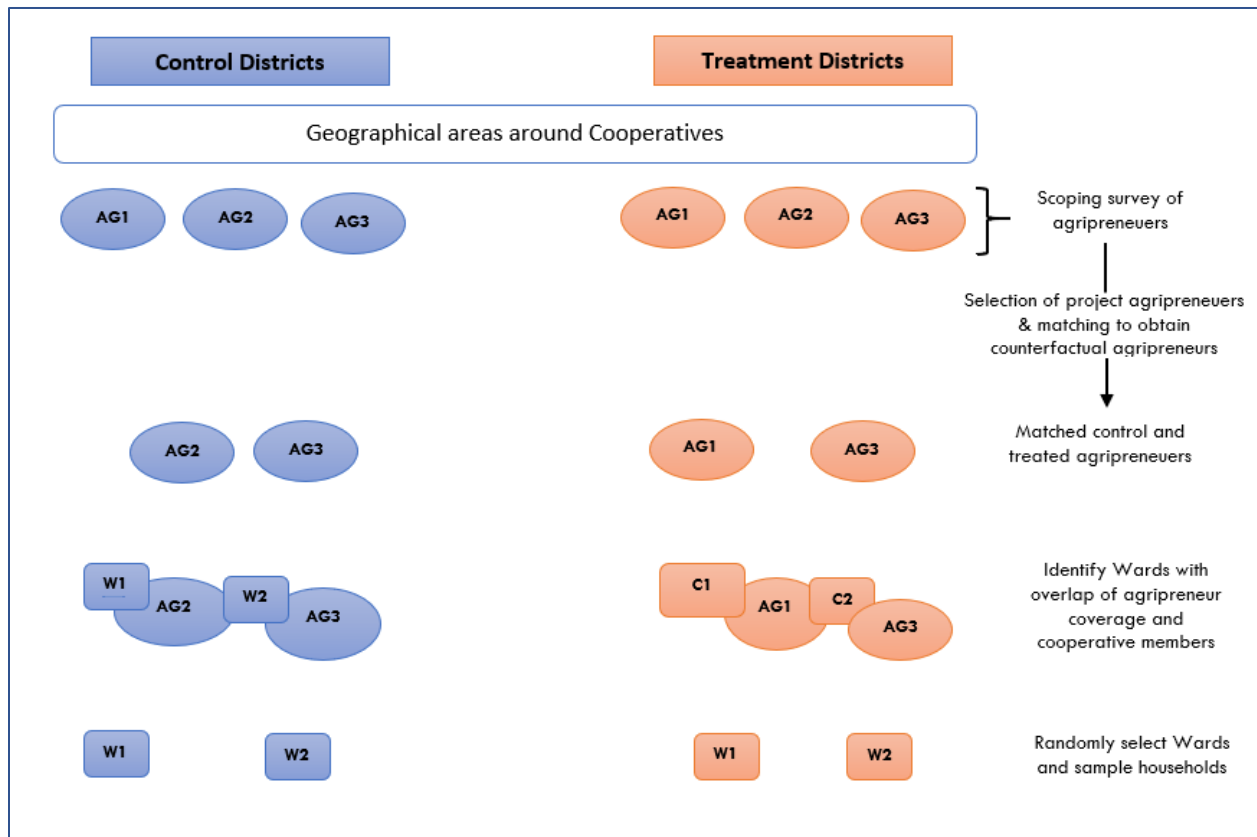
An initial long list of inputs and services agri-entrepreneurs was generated. This was obtained from both PO/cooperatives as they were asked to identify which input/service agri-entrepreneurs they work with and through key informant interviews with partners such as SNV and Solidaridad in project areas and major agri-entrepreneurs with wide networks in intervention and control areas. Most inputs and services agri-entrepreneurs were expected to be working with or through the PO/cooperatives. The PO/cooperatives were also asked for information about their members and which administrative wards their clients come from. This enabled selection of the wards with the highest numbers of farmers according to intraclass correlation coefficient (ICC) calculations.

*Stage II: Identification of target population households (smallholder dairy cattle keepers)*

After identification of the project input/service agri-entrepreneurs in both intervention and control areas, the PO/cooperatives linked to these were listed. Data on cooperative members and their geographical coverage (wards) was also obtained. It was expected that not all project input/service agri-entrepreneurs were linked to these PO/cooperatives, but probably that most were. However, the non-PO linked agri-entrepreneurs were likely working in the same geographical areas. Wards were identified around the PO/cooperatives which represent common areas of both project agri-entrepreneurs' coverage and cooperative members. From the list of wards with POs/cooperatives and agri-entrepreneurs overlap, a random selection of wards was drawn to become target wards for the study. Working with the local livestock extension officers at the ward level, a list of all dairy cattle keepers in the ward was then drawn to establish the target population for the study.

*Step III: Sampling of Smallholder Dairy households*

This list obtained from step II was then sorted into PO/Cooperative members and non-PO/Cooperative members with no further sorting beyond this category. Systematic random sampling was done for these lists by selecting every fifth household to obtain 780 households. Using this methodology maintained the randomness of sampling while ensuring that the final sample of households had the appropriate proportion of PO and non-PO members. A survey was then conducted for the sample dairy households. See Figure 3 for a graphic illustration of the sampling design.



**Figure 3: Sampling Approach of Wards**

### 3.4 Data Collection

The data was collected in selected administrative wards in Tanga and Kilimanjaro regions by ILRI and its partners. Data on households was collected using the Rural Household Multiple Indicator Survey (RHoMIS) questionnaire. The RHoMIS questionnaire entails carefully and expertly designed variables that capture farm and household characteristics, welfare, productivity, and economic performance, which were administered digitally using the Open Data Kit (ODK) platform (van Wijk *et al.*, 2020). Data collected on smallholder dairy households include household characteristics, livestock husbandry, access to and delivery by agri-enterprises of inputs and services technologies, the value of dairy inputs and services technologies in terms of cost, and agri-entrepreneurs' practices by agri-entrepreneurs. The inputs and services agri-entrepreneurs' practices were captured through a baseline survey of the entrepreneurs. This data on inputs and services agri-entrepreneurs was used in clustering the inputs and services agri-entrepreneurs into latent classes in objective one, and the resultant

groups were used as one of the explanatory variables in the econometric model in objective three to explain the uptake of inputs and services by smallholder dairy farmers.

### **3.5 Data Analysis**

R software and Stata software were used for descriptive, inferential, and econometric data management and analysis in this study.

#### **Objective one: To characterize dairy inputs and services agri-entrepreneurs' business and technology dissemination practices in the Kilimanjaro and Tanga regions of Tanzania**

This objective was analyzed by exploratory analysis methods. Descriptive statistics such as pie charts and tables were used to explore the characteristics of inputs and services agri-entrepreneurs and their business practices aimed to increase sales. Inputs and services agri-entrepreneurial practices in this study include business activities which mainly referred to the different bundles the dairy inputs and services sold by inputs and services agri-entrepreneurs. The business promotional business activities which include linkages with farmers and other inputs and services agri-entrepreneurs, sale of inputs/services with credit with milk as checkoff, delivering inputs and services to farmers, and belonging to professional groups. The study explored the use of latent class modeling to classify agri-entrepreneurs into homogenous groups. Latent class analysis (LCA) consists of a measurement model which determines the relationship between observed and fundamental latent (unobserved) variables, and a structural model that characterizes the distribution of latent variables and the impact of their antecedent variables (Charlier *et al.*, 2021; Masyn, 2013).

The outcome of LCA is subpopulations/latent classes according to similarity in patterns in a set of manifest variables/indicators among each subpopulation. LCA thus model relationships where discrete observed variables map onto discrete latent variables (Hasking *et al.*, 2011). Even though both LCA and factor analysis aim to group variables into smaller groups, factor analysis deals with continuous latent variables to group indicators together. More so, unlike factor analysis, LCA is a model which predicts goodness of fit, a criteria that determines a LCA with optimum groupings that parsimoniously represents latent characteristics of observations (Weller *et al.*, 2020). Best fit model can be determined by Bayesian Information Criterion (BIC), Akaike's Information Criterion – AIC, and the likelihood ratio (Bizimungu & Kabunga, 2016; Hasking *et al.*, 2011; Weller *et al.*, 2020). However, BIC is most common since

it is the most stable, and the model with the smallest BIC is usually selected. Factor analysis on the contrary categorises variables subjectively into clusters without an objective classification criterion. Furthermore, clustering can barely be performed in the case of missing data. Cluster analysis is as well limited for large variable range as the variables skew results given more weights, yet standardizing the variables results to adverse effects. Cluster analysis only measures limited similarities among the classes due to its subjectivity (De Roover *et al.*, 2017).

LCA uses a model-based grouping approach derived from the clustering method by estimating two sets of probabilities; posterior and outcome probabilities that describe the distribution of data and define probabilities of observed variables belonging to certain latent classes mutually exclusively and exhaustively (Statacorp, 2021). LCA builds an unconditional model basing on observable variables to explain the groupings of latent variables in latent classes. A given population is sub-divided into a specific number of sub-populations that accommodate variables with different multivariate probability density functions. Therefore, measurement of errors is possible (due to mutually exclusive and exhaustive latent classes).

These LCA model probabilities determine the weights of each variable that contribute to the occurrence, and this guides the researcher to identify priority attributes to concentrate on. A threshold of 0.5000 is then used to determine the significance of the weights of variables obtained (Bizimungu & Kabunga, 2016; Hasking *et al.*, 2011). A variable with a weight that is at least 0.5000 (50%) is considered to have a stronger magnitude and strength to influence the hypothesis. Else otherwise, the variables have weaker magnitude and strength to influence the hypothesis. Individuals are categorized into groups (latent classes) according to similarity in characteristics (according to the weights of each variable) (Statacorp, 2021; Weller *et al.*, 2020).

The shortcoming of LCA is that it does not exploit all possible combinations in its groupings (Merians *et al.*, 2019). However, sufficient latent classes are generated to represent data sufficiently, and therefore a large range of data set can be summarized economically. The LCA categorization is mutually exclusive and exhaustive such that a cumulative of 100% of the population is obtained, and this is a major advantage of LCA. Another shortcoming of LCA is that the researcher names the identified latent classes. However, both the LCA process and the resultant classes are complex (Merians *et al.*, 2019) and hence the researcher may assign a name to a group which does not reflect the class membership accurately (Weller *et al.*, 2020). Another alternative to LCA is Latent Profile Analysis (LPA). However, LPA uses continuous manifest

variables for the grouping of latent classes (Statacorp, 2021). LPA could therefore not be appropriate for this analysis whose manifest variables were categorical.

Using data on diverse practices by input/service agri-entrepreneurs that were collected during the baseline survey, LCA clustered inputs and services agri-entrepreneurs into homogenous latent groups with similar practices. Clustering the inputs and services agri-entrepreneurs' into fewer homogenous groups minimizes the number of variables to be included in the econometric model (Charlier *et al.*, 2021), and hence the efficiency of the resultant econometric model. Direct use of the many respective variables that characterize business practices by inputs and services agri-entrepreneurs would limit the degrees of freedom and minimize the power of the econometric model that is used to assess the effect of these practices on purchase of input by smallholder dairy farmers. The estimated latent classes were then included in the econometric model outlined in the third objective alongside other independent variables.

Assuming that sampled input/service agri-entrepreneurs belong to different categories the preference to belong is latent. The only observed is the non-commercial and commercial practices they do in their enterprises. A latent class model of  $M$  classes/groups is estimated from  $Q$  categorical variables. Vector  $Y_i = Y_{i1} \dots Y_{iQ}$  is a proxy of the entrepreneur  $i$ 's binary answer to the  $Q$  manifest variables, and  $Y_{iq}$  equals to 1...  $r_q$  values.  $C_i = 1,2 \dots M$ ;  $C_i = 1,2 \dots M$  is entrepreneur  $i$ 's latent class membership and  $I(y = k)$  is the relative size of every latent class which equals 1 if  $y = k$ , 0 otherwise. Assuming the last class is the reference, and  $x_i$  is entrepreneur  $i$ 's covariate value the  $x_i$  could be correlated with the probability of membership in each latent class  $r$ , but is assumed to be otherwise unrelated to  $Y_i$ . Therefore, the entrepreneur  $i$ 's contribution to the likelihood is:

$$P(Y_i = y | X_i = x) = \sum_{i=1}^M r_l(x) \prod_{q=1}^Q \prod_{k=1}^{r_q} \rho_{qk|l}^{I(y_q=k)} \dots\dots\dots(ii)$$

The class assignments obtained through the latent class specification will be used alongside other explanatory variables in objective three to determine the effect of business practices by agri-entrepreneurs on the uptake of inputs by smallholder dairy farmers in Kilimanjaro and Tanga regions.

**Objective two: To describe the state of dairy input/service technologies use by smallholder dairy farmers in Kilimanjaro and Tanga regions**

In this objective, descriptive statistics including means, standard deviation, and percentages were used to describe the socio-economic and demographic characteristics of smallholder dairy farmers. Analysis of these characteristics was relevant to understand whether they influence smallholder dairy farmers' expenditure on improved inputs and services. The t-test and chi-square tests were used for continuous and categorical variables respectively to show whether the averages/proportional characteristics of the smallholder dairy farmers between Kilimanjaro and Tanga regions differed or not. A non-significant t-test/chi-square value implied no statistically significant difference in characteristics among the means/proportions between farmers in Kilimanjaro and Tanga. Else otherwise, (significant t-test/chi-square values) there was a statistically significant difference between dairy farmers' characteristics between Tanga and Kilimanjaro regions. Farmers' demographic characteristics, milk production, inputs costs and use were analyzed.

**Objective Three: To determine the effect of business practices by inputs and services agri-entrepreneurs on the uptake of inputs/services by smallholder dairy farmers in Kilimanjaro and Tanga regions**

Input entrepreneurship practices include bundling of inputs and services technologies, provision of technical capacity (extension), conducting farmer field days, and setting up demonstration plots. Commercial practices include advertising, promotion, discounting, provision of input on credit arrangements, and transportation provision of inputs after the sale. Inputs and services agri-entrepreneurs apply these practices to change the perception of farmers and thereby increase their sales, grow their market base, and earn more profits. Uptake of the input and service technologies offered by inputs and services agri-entrepreneurs implies participation in the inputs and services market and this can be measured in terms of the value of money spent by these farmers to purchase respective inputs or services. The third objective focused on assessing whether these practices are effective in changing farmers' perception towards participation in inputs and services markets.

Assuming input/service market participation is measured in terms of value of expenditure on respective inputs and service technologies, Ordinary Least Squares (OLS) regression was

used to analyze this objective. Participation in inputs market is gauged through the expenditures that farmers allocate to the various inputs/services. Expenditure on inputs market is a continuous variable with a linear relationship between this dependent variable and the independent variables, and therefore OLS regression was appropriate where market participation (Y) is a linear function of explanatory variables X.

Several models can be used to analyse data with continuous dependent variables. General Least Squares Model can be used instead of the OLS model in the case of presence of heteroscedasticity and/or correlation of error terms to provide more efficient estimates (Gujarati, 2003). However, these assumptions were proved through test statistics. Instrumental variable regression could also be possible in the case explanatory variables are correlated with the error terms, generating biased and inconsistent estimates if OLS is used. However, this case was not detected for this analysis. On the other hand, Polynomial regression models non-linear relationships by including polynomial terms in the independent variables while Poisson regression is used in the case of count data, which was not the case for this study.

OLS mainly relies on assumptions of linearity, no collinearity in the explanatory variables, independence of errors, homoscedasticity, and normality which if not met, the results may be biased or inefficient (Greene, 2003; Gujarati, 2003). To account for this, test statistics were run for linearity, collinearity and heteroskedasticity to validate these assumptions. The OLS is as well sensitive to outliers as the model squares the residuals in its calculation. In the presence of outliers therefore, estimates are skewed, and this potentially leads to misleading conclusions (Greene, 2003; Gujarati, 2003). To account for this, the data used was carefully checked for any outlier and only after this was overruled was the analysis conducted.

The expenditure on inputs (Y) was generated from STATA computer program by summing the costs spent on purchasing dairy inputs/services by dairy farmers. These inputs/services included artificial insemination, animal vaccines, deworming, tick control, animal treatment, and animal feeds. The cumulative costs were then converted to USD at a rate of 2,334 Tanzania Shillings per 1 USD.

Several tests were conducted to check whether the model satisfies the Gaus-Makov Assumptions. The VIF factors were generated after implementing the model to check for collinearity among explanatory variables. More so, a scatter graph was plotted to check for

whether there was a linear functional relationship between the dependent and independent variables.

OLS revealed the relationship between market participation (uptake of inputs and services) and explanatory variables, which include socio-economic and institutional household characteristics, alongside business practices by inputs and services agri-entrepreneurs, which is typified through the latent classes (Kuwornu & Owusu-Nantwi, 2011).

Input entrepreneurs’ practices, grouped into latent classes in objective one, were adopted in the OLS model alongside the farmers’ socio-economic and institutional factors as explanatory variables. These latent classes were obtained from the input entrepreneurs’ dataset collected from the entrepreneurs. The socio-economic and institutional variables, and the dependent variable (expenditure on inputs and services) were captured in the farmers’ dataset collected from the farmers. In this farmers’ survey, farmers were asked to identify the entrepreneurs they purchased their dairy inputs/services from in the past 12 months prior to the survey. For the project entrepreneurs who were identified by farmers across the seven inputs/services (AI, Vaccine, Deworming, Tick control, Animal Treatment, Animal Feeds, and extension), their codes were replaced by the latent classes in which they were classified in in objective one. Therefore, farmers who did not identify with any project entrepreneur were dropped, resulting to a sample size of 152 for this objective. Categorical variables were then generated for each latent class across the inputs/services, such that 1 represented the entrepreneur belonging to a given class, 0 otherwise. The latent classes were then included in the model alongside other explanatory variables.

The OLS regression model can be represented empirically as below.

$$Y = \beta_0 + \beta_1 X_1 + \dots + \beta_n X_n + \beta_3 LC_n + \varepsilon \dots\dots\dots(iii)$$

where:

$Y$  is the dependent variable and represents the value of input or service uptake by smallholder dairy farmers.

$X_1 \dots X_n$  represent a vector of independent variables and include the farmers’ socio-economic, institutional, and technological variables.

$LC_n$  are the latent classes of inputs and services agri-entrepreneurs estimated from objective 1 and which describes homogenous groups of inputs and services agri-entrepreneurs with similar business practices.

$\beta_0$  is the constant while  $\beta_1 \dots \beta_n$  represent the unknown coefficients to be estimated.

$\varepsilon$  represents the error term and is assumed to be independently and normally distributed with a mean of zero and a constant variance (Greene, 2003).

The estimated coefficients portray the change in the outcome (input/service expenditure) variable as a result of unit change in the independent variables (Leeper, 2018), such that the coefficient  $\beta_3$  measured the change in value of inputs and service technology use that can be attributed to interaction with agri-entrepreneurs of different latent classes.

### **Input Expenditure equation (OLS)**

The functional relationship for the linear regression equation entailed in the OLS model is therefore as below.

$$InUp_i = f(HH\ size, HH\ age, landown, Animcount, Cattle\ No, edu, Gender, HH\ wky, Animstab, LC_n) + \varepsilon$$

where  $InUp_i$  represent row total costs of AI, Vaccine, Deworming, Tick control, Animal Treatment, and Animal Feeds inputs/services spent on dairy inputs/services by smallholder dairy farmers.

Interpretation of both the outcome and independent variables is as in Table 2 below while appendix B shows the questionnaire for data collection.

**Table 2: Description of Variables and Expected Signs that were used in the OLS Model**

| <b>Variable</b>              | <b>Description</b>  | <b>Expected outcome</b> |
|------------------------------|---|-------------------------|
| <b>dependent variable</b>    |   |                         |
| $InUp_i$                     | Total value of inputs/services purchased by dairy farmer in terms of cost (summed costs of AI, Vaccine, Deworming, Tick control, Animal Treatment, and Animal Feeds (USD) | +/-                     |
| <b>Independent variables</b> |   |                         |
| HH age                       | Age of household head (years)   | +/-                     |
| Gender                       | Gender of household head (male=1, female=0)   | +/-                     |
| edu                          | Education level of the household head (primeedu, secedu, postsecedu, adultedu are primary, secondary,   | +/-                     |

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|                               |  |     |
|-------------------------------|--|-----|
|                               | postsecondary, and adult education levels respectively.)   |     |
| Pastureland use               | Pastureland use (Yes=1, No=0)  |     |
| Marital status                | (couple=1, single=0)   |     |
| Grows crops                   | Household grows crops (Yes=1, No=0)  |     |
| HH size                       | Household size   | +/- |
| landown                       | Land size owned by dairy farmer  | +/- |
| Cattle No                     | Number of cattle owned by a household  | +/- |
| HH wky                        | HH works away from the household   | +/- |
| Anim No                       | Total count of dairy animal species owned  | +/- |
| Animstab                      | Animals stabled (Yes=1, No=0)  | +/- |
| No of anim milked bad season  | Number of cows milked during bad (dry) season  | +/- |
| No of anim milked good season | Number of cows milked during good (wet) season   | +/- |
| Milk amount good season       | Amount of milk during good season  | +/- |
| Milk amount bad season        | Amount of milk during bad season   | +/- |
| Districts                     | The district which the dairy farmer resides. Hai=1, Moshi Rural=2, Rombo=3, Siha=4, Korogwe Town=5, Muheza=6                         |     |
| <i>LC<sub>n</sub></i>         | Latent groups of Input/service providers; agri-entrepreneur who sells input/Services products/services (1= LC I, 2= LC II, 3=LC III) | +/- |

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\*LC represent the latent classes where the input/services agri-entrepreneurs will be categorized according to their commercial and non-commercial (bundling) practices

## **CHAPTER FOUR**

### **RESULTS AND DISCUSSION**

#### **4.1 Characteristics of Dairy Inputs and Services Agri-entrepreneurs' Business and Technology Dissemination Practices**

##### **4.1.1 Introduction**

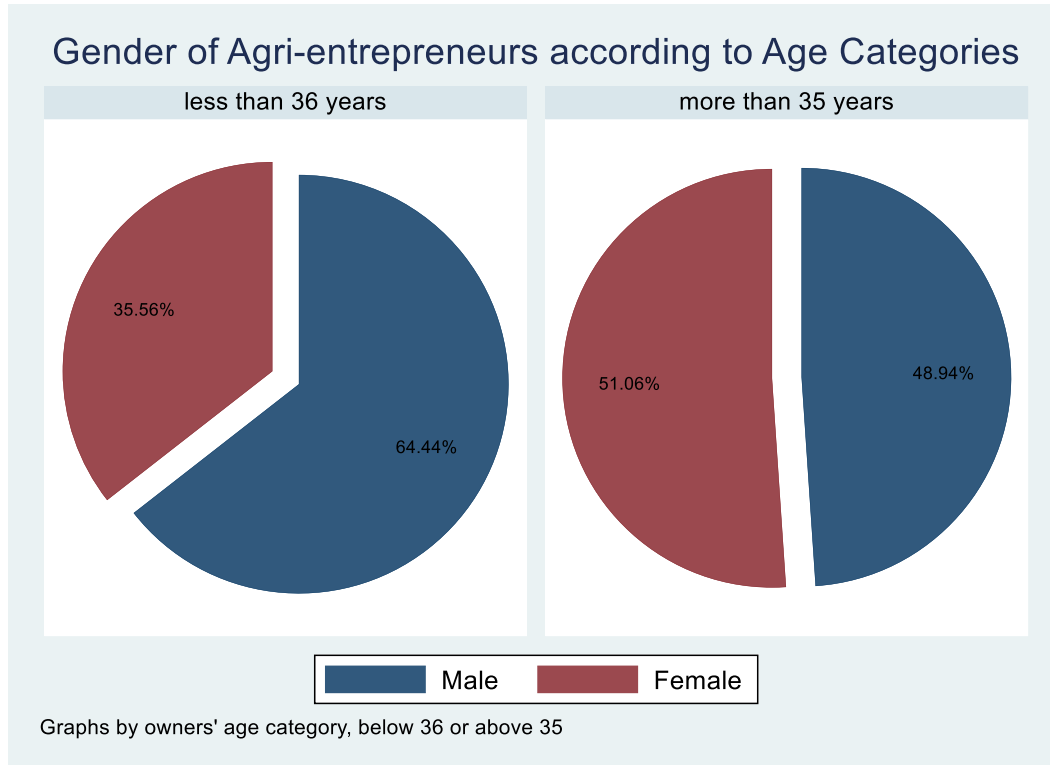
The targeted respondents were 93 inputs and services agri-entrepreneurs distributed in Tanga (21%) and Kilimanjaro (79%) regions. Distribution among districts in the Kilimanjaro region includes Hai (22%), Siha (12%), Rombo (27%), Moshi Rural (13%), and Moshi Municipal (5%). Inputs and services agri-entrepreneurs from the Tanga region include Tanga City (1%), Korogwe Town (5%), Korogwe Rural (6%), and Muheza (9%). These agri-entrepreneurs were situated across Wards where majority of the smallholder dairy farmers were or could easily access the entrepreneurs. Surveyed farmers were also sampled from the same Wards.

##### **4.1.2 Socio-Economic Characteristics of the Inputs and Services Agri-entrepreneurs**

The mean age of inputs and services agri-entrepreneurs was 43 years with a range of 18 to 73 years as shown in Table 3. Mean age findings are consistent with Odame and Muange (2011) and Adam (2018) studies on inputs and services agri-entrepreneurs in Kenya and Nigeria respectively. The findings are however contrary to Bamigboye and Bolaji (2022) study who found the mean age of inputs and services agri-entrepreneurs was 49 years in Nigeria. This average age of the respondents showed that most of them were in their active years, and this could be a positive indication of engagement in more business growth-centered incentives. Age was further categorized as less than 36 years old to describe the youth agri-entrepreneurs (18 to 35 years), and more than 35 years old represented the older inputs and services agri-entrepreneurs.

In terms of gender, 56.5% of the inputs and services agri-entrepreneurs were male while 43.5% of them were female. The gender of input and services agri-entrepreneurs according to the age categories is shown in Figure 4. Among the age categories, male youths were 64.4% while female youths were 35.6%. More males are involved in the dairy input and services businesses than women in both the general and youth category. These findings are similar to Bamigboye and Bolaji (2022) and Odame and Muange (2011). However, the males above the youth bracket were 48.9% while the female was 51.1%. Generally, the proportion of youths among the inputs

and service agri-entrepreneurs sampled was 49.5% while that of those above the youth bracket was 50.5%. This is relatively a high representation, almost halfway. This finding is similar to Adam (2018) whose study found that most inputs and services agri-entrepreneurs were of age 31-41 years. This could be due to projects that encourage youth entrepreneurship in the agricultural input supply sector like in Kenya (Kilelu *et al.*, 2022).



**Figure 4: Gender of Agri-entrepreneurs and Age Categories**

The average level of education attained by the sampled inputs and services agri-entrepreneurs was 13 years of formal schooling. This shows that most input/service agri-entrepreneurs had completed the advanced secondary school level of Tanzania. This corroborates with Ogutu *et al.* (2022) findings in Kenya. Therefore, majority of input/service agri-entrepreneurs were literate enough to read, write, and understand any information pertaining to inputs and services technologies and dairy farming and productivity. However, an average of secondary schooling means that majority of these entrepreneurs did not have tertiary education. According to Staudacher *et al.* (2021) findings on inputs and services agri-entrepreneurs in Uganda, knowledge of input/service agri-entrepreneurs increases with every additional year of education. Tertiary education specifically in agricultural domains can empower inputs and

services agri-entrepreneurs to give dairy farmers sufficient and accurate information about the inputs. Such an agri-entrepreneur can easily search for relevant information about a specific input/service and channel it to the farmer and this boosts effectiveness (Bamigboye & Bolaji, 2022). More educated entrepreneurs have more information and stock the latest improved inputs which they sell to customers on the strategic basis of information they provide on how best to use the inputs to maximize output. Interpretation of labels on some inputs such as veterinary pharmaceutical products (for instance pests and disease control inputs) is possible for more educated individuals, especially those who have tertiary agricultural qualifications or have received relevant training about inputs (Staudacher *et al.*, 2021). The sampled entrepreneurs could therefore possibly perform better if they receive some technical training to boost their knowledge of the inputs/services they offer.

The mean age of businesses was 9 years (the number of years the inputs/services business had existed since the owner started the enterprise) with a range of 1 to 37 years. Input/services businesses average years of existence could be indicative of input/service agri-entrepreneurs having some knowledge about the inputs/services that they trade in and more so about the latest improved inputs. The average number of years in which the owners of the inputs and service agri-entrepreneurs were engaged directly in their respective businesses was 9 years with a range of 1 to 39 years. This is contrary to Etyang *et al.* (2014) and Ogutu *et al.* (2022) whose studies recorded an average of 5 years of experience in Kenya. The years of experience indicate that majority of these owners had some experience in the businesses they were running and therefore had gained some knowledge of dairy inputs and services. Moreso, for them to stay in business for averagely that long means they have mastered how to attract and/or maintain their customers (smallholder dairy farmers) to keep making economic sense. Experienced input/service entrepreneurs are likely more informed and could have business skills to influence customers into purchasing their products and/or services (Bamigboye & Bolaji, 2022).

**Table 3: Socio-economic Characteristics of Inputs and Services Entrepreneurs**

| Variable                         | N  | Mean     | SD       | Min | Max |
|----------------------------------|----|----------|----------|-----|-----|
| Age of agri-entrepreneur (years) | 93 | 42.86022 | 12.30464 | 18  | 73  |
| Level of Education (years)       | 93 | 12.76344 | 3.958616 | 0   | 18  |

|                             |    |          |          |   |    |
|-----------------------------|----|----------|----------|---|----|
| Working in business (years) | 93 | 8.935484 | 8.559011 | 1 | 38 |
| Age of business (years)     | 93 | 9.236559 | 8.736975 | 1 | 37 |

### 4.1.3 Institutional Characteristics of the Inputs and Services Agri-entrepreneurs

Table 4 presents the institutional characteristics of continuous variables. The inputs and services entrepreneurs had a mean of 1 branch (number of outlets a single business owns and runs, where it offers the goods/services they deal with to dairy farmers) where they undertook their operations with a range of 0 to 10 branches. The business branches had a leptokurtic distribution of 29, and a positive skewness of 4, meaning that majority of the input and services enterprises had at least one branch in operation, hence above the sample average number of branches. The mean bundling of inputs/services, (these are defined as the different types of dairy inputs and/or services the business provided to generate revenue) provided by the input and services agri-entrepreneurs was 4 with a range of 1 to 7 inputs/services. The number of inputs/services sold by entrepreneurs had a negative skewness of -0.5 and a platykurtic distribution of 2.5, meaning the total number of enterprises run per agri-entrepreneur among the sample was below the sample average number of enterprises.

**Table 4: Number of Branches and Enterprises Owned by Inputs and Services Agri-entrepreneurs**

| Variable              | N  | Mean     | SD       | Min | Max | Skewness  | Kurtosis |
|-----------------------|----|----------|----------|-----|-----|-----------|----------|
| Number of Branches    | 93 | .9892473 | 1.272575 | 0   | 10  | 4.31549   | 29.17599 |
| Number of inputs sold | 93 | 3.892473 | 1.386757 | 1   | 7   | -.2491995 | 2.482462 |

The institutional categorical variables are represented in Table 5. Of these enterprises, 82.8% were registered while 17.2% were unregistered. Among the agri-entrepreneurs, 78.5% were directly involved in the management of their businesses. Input and services agri-entrepreneurs who were dairy farmers as well were 72%. Being involved as a farmer could mean more knowledge on what needs improvement at the farm level and hence performance of practices that enable other farmers to take up improved dairy inputs or services. The entrepreneur can therefore use their farm as a model/demonstration farm to offer training to other farmers. More so, input/service agri-entrepreneurs who are farmers are users of inputs/services and can

give reliable information to their clients (farmers) (Bamigboye & Bolaji, 2022). These entrepreneurs could also be cautious of the expiry dates of inputs they deal with and can put them into use before expiring, in case not bought in time and thus reducing sale of expired products. Of these input enterprises, 35.5% had permanent employees while 13% had casual employees. The lower average proportion of businesses with both full-time and casual employees could be because of the size of the enterprises, or the lower number of inputs/services sold by most of the entrepreneurs surveyed. More so, some enterprises used either unpaid labour from either family members or interns and/or volunteers (21.5%). A lower number of businesses that had employees could also be because most entrepreneurs (78.5%) are directly involved in their businesses and therefore offer labour themselves, especially since they are in their active years. In the case of a service enterprise, the owner could be undertaking the activities solely because of the technical know-how involved (for instance offering health intervention services like AI).

**Table 5: Institutional Characteristics of Sampled Inputs and Services Agri-entrepreneurs**

| Variable                                   | Binary option | (N=93)<br>% |
|--|---------------|-------------|
| Input/Service business registered          | Yes           | 82.80       |
|  | No            | 17.20       |
| Agri-entrepreneur directly involved        | Yes           | 78.49       |
|  | No            | 21.51       |
| Agri-entrepreneur is also a farmer         | Yes           | 72.04       |
|  | No            | 27.96       |
| Fulltime employees                         | Yes           | 35.48       |
|  | No            | 64.52       |
| Casual employees                           | Yes           | 12.90       |
|  | No            | 87.10       |
| Family members/Interns/volunteers involved | Yes           | 21.51       |
|  | No            | 78.49       |

#### 4.1.4 Entrepreneurial Characteristics and Perceptions of Inputs and Services Agri-entrepreneurs

Input/service agri-entrepreneurs were asked whether they have linkages with dairy POs and with other dairy input and service agri-enterprises, keep records/registers of their business promotional activities, and whether they belong to a professional body. Those with linkages with POs were 33.3% while 15.1% had linkages with other dairy inputs/services agri-entrepreneurs. Record keeping was practiced by 90.3% of the sampled enterprises majority of which maintained written registers (92.5%) while the remaining kept both written and computerized records. Record keeping in businesses is key in facilitating entrepreneurs to access loans from financial lending institutions. Only 17.2% belonged to professional bodies. This is represented in Table 6. Linkages with stakeholders is an avenue of information sharing and hence can contribute to the improvement of the performance of businesses as they improve in technical skills (Staudacher *et al.*, 2021). Such social and professional networks are key avenues for the creation of awareness and information sharing about new inputs (Ogutu *et al.*, 2022). Of the sampled entrepreneurs, 25.8% had benefited from developmental programmes either through capacity development in their business promotional activities or through receiving resources useful for business growth. Relevant institutions have been keen on projects with incentives to improve the input supply sectors and better their performance to enhance agricultural productivity (Kilelu *et al.*, 2022).

**Table 6: Linkages of Inputs and Services Agri-entrepreneurs with Dairy Stakeholders**

| Variable                               | Binary outcome | (N=93)<br>% |
|--|----------------|-------------|
| Linkage with Pos                       | Yes            | 33.33       |
|  | No             | 66.67       |
| Link with other dairy enterprises      | Yes            | 15.05       |
|  | No             | 84.95       |
| Keeps business Records                 | Yes            | 90.32       |
|  | No             | 9.68        |
| Belong to professional body            | Yes            | 17.20       |
|  | No             | 82.80       |
| Benefited from developmental programme | Yes            | 25.81       |

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No

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74.19

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Inputs and services entrepreneurs' support for dairy farmers (customers) to facilitate access to feeds, genetics (AI), health interventions (such as vaccines and disease controls), and extension services was assessed by this study. Entrepreneurs facilitating access to feeds were 39.8%, genetics 40.9%, health interventions 58.1%, and extension services 58.1%, shown in Table 7. More linkages among inputs and services agri-entrepreneurs, such as through associations can be opportune for inputs and services agri-entrepreneurs recommending the dairy farmers to other input/service providers who offer inputs that they do not offer (Ogutu *et al.*, 2022) and further improve complementarity in inputs/services use among smallholder dairy farmers. Indeed, this can boost farmers' trust in the suppliers of respective inputs and cause them to recommend the suppliers to their fellow farmers.

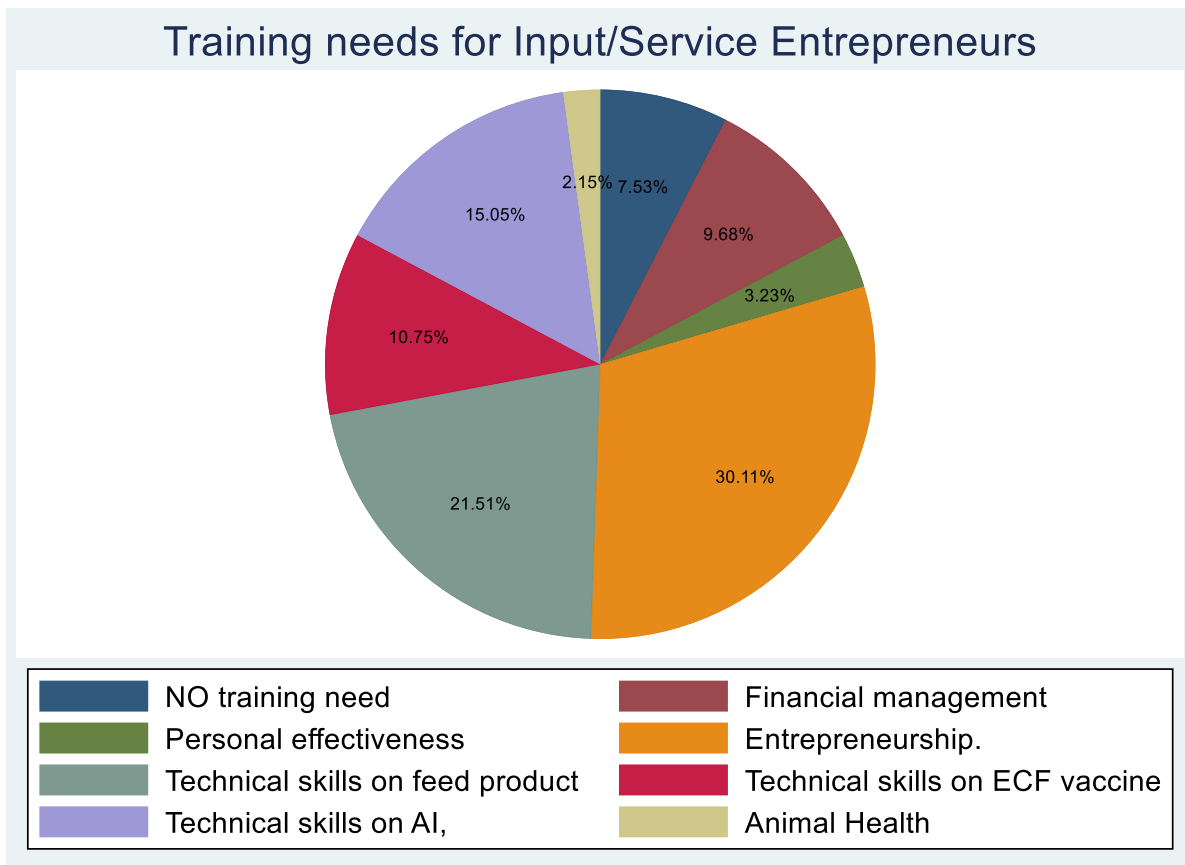
**Table 7: Relationship of Input and Service Entrepreneurs with Dairy Farmers**

| <b>Variable</b>                        | <b>Binary outcome</b> | <b>(N=93)<br/>%</b> |
|--|-----------------------|---------------------|
| Linking farmers (feeds)                | Yes                   | 39.78               |
|  | No                    | 60.22               |
| Linking farmers (genetics)             | Yes                   | 40.86               |
|  | No                    | 59.14               |
| Linking farmers (health interventions) | Yes                   | 58.06               |
|  | No                    | 41.94               |
| Linking farmers (Extension)            | Yes                   | 58.06               |
|  | No                    | 41.94               |

Dairy inputs and services agri-entrepreneurs were asked to identify the business development services (BDS) they require to better their businesses' performance. Of the BDS options, 39.8% of the entrepreneurs identified their priority needs as advice on business continuity planning, 36.6% as access to cash/short-term finance, 12.9% as business advice on diversification of products and sales channels and 3.2% as online business management training. The rest (7.5%) had no priority preference among these options. This could be because they are

either developed enough or have inadequate information about the relevance of BDS in their businesses.

Input and service entrepreneurs also identified their training needs. Results show that sampled entrepreneurs needed training in three priority areas including entrepreneurship (30.1%), technical skills for feed products (21.5%), and artificial insemination (15.1%). The rest of the training needs are represented in Figure 5. However, 7.5% of the entrepreneurs needed no training at all. Equally to BDS, the businesses could either be developed or unaware of the benefits of training on performance of a business.



**Figure 5: Training Needs Identified by Input/Service Agri-entrepreneurs**

#### 4.2 Latent Class Analysis of Practices by Input and Service Entrepreneurs

Table 8 shows the fit statistics for the models tested. Through Latent class analysis (LCA) a two-class model was tested to determine the response pattern. Three and four class models were then run progressively to compare the fitness of the models and determine the best model that parsimoniously fits the input and services entrepreneurs into classes according to their

homogeneous characteristics (business activities and business promotional activities). According to Weller *et al.* (2020), lower values for the fit statistics indicate better model fit in LCA. The Bayesian Information Criterion (BIC) was used to select the best fit model among the three since it is the most efficient and robust compared to the other tests of fit (Akaike’s Information Criterion – AIC and the likelihood ratio) (Bizimungu & Kabunga, 2016; Hasking *et al.*, 2011; Weller *et al.*, 2020). According to this criterion therefore, the 2-class and 3-class latent groups can be identified in the input and services entrepreneurs’ dataset according to the various commercial and business activities these entrepreneurs do to attract their customers (dairy farmers). However, a two-class model does not exploitatively categorize the input and service entrepreneurs since both the AIC and BIC are higher than those of a 3-class model. The BIC value (2153.071) of the 3-class model qualified this model as the most parsimonious and best fit.

The 4-class model recorded a shrinking AIC and likelihood ratio while the BIC (2165.361) value was higher than that of the 3-class model (2153.071). This is expected since inconsistency among these tests of fit in LCA models is usually experienced (Weller *et al.*, 2020); more reason why BIC is the most used measure of fit as it is the most reliable (Nylund-Gibson & Choi, 2018). The best fit model is defined by an “optimum point” wherein beyond the k+1 classes, more unnecessary classes with fewer class indicators are achieved, having fewer individuals allocated to the classes, hence weak identifiability (Dziak *et al.*, 2014; Hasking *et al.*, 2011; Weller *et al.*, 2020). This demeans the quality of the model and can influence the estimation of item probabilities. Recoding fit results for a 5-class LCA was impossible since the model had negative degrees of freedom and hence was unstable.

**Table 8: Fit Statistics from Latent Class Analyses**

| <b>Number of Classes</b> | <b>Likelihood Ratio</b> | <b>AIC</b>      | <b>BIC</b>      |
|--------------------------|-------------------------|-----------------|-----------------|
| 2-Latent classes         | 1190.507                | 2096.524        | 2210.491        |
| <b>3-Latent classes</b>  | <b>1028.837</b>         | <b>1980.854</b> | <b>2153.071</b> |
| 4-Latent classes         | 936.8769                | 1934.894        | 2165.361        |

The predicted posterior probabilities of the 3-class model indicated that majority of the input and service entrepreneurs belonged to class III (52.69%) followed by class I (37.63%). Class II had the lowest proportion of entrepreneurs (9.68%). From these posterior probabilities

and estimated population share, 49 entrepreneurs belonged to latent group III, 35 to group I and 9 entrepreneurs to group II. Indeed, these results prove the LCA assumption that latent groups are mutually exclusive and exhaustive and therefore individuals belong to only one group strictly (Lanza *et al.*, 2013). These results are shown in Table 9.

Table 9 shows the parameter estimates for the most parsimonious and best fit latent class model (3-class model). Conditional item response probabilities in Table 9 indicate the probability of a ‘yes’ response to the manifest variables given class membership. The probability values of observable variables that were at least 0.5000 were bolded and used for interpretation. This is because probabilities equalling 0.5000 and above are considered adequate to influence classification (Bizimungu & Kabunga, 2016; Lanza *et al.*, 2013) as this value signifies that at least half of the population proportion of the class responded ‘yes’ to practicing the specific activity. Precisely, the probabilities showed the strength of items that determined whether inputs and services agri-entrepreneurs would belong to their respective classes. Therefore, these bolded probabilities provided the rationale for assigning labels to the three latent classes.

**Table 9: Latent Class Membership and Item Response Probabilities for a Three Class Model of Inputs and Services Agri-entrepreneurs’ practices**

|   | Latent Class  |               |               |
|---|---------------|---------------|---------------|
|   | I             | II            | III           |
|   | HBHBP         | LBMBP         | MBLBP         |
| Latent Class Membership (%)                                     | 37.63         | 9.68          | 52.69         |
| Outcome Variables (Probability of ‘yes’ response)               |               |               |               |
| <b>Business Activities</b>                                      |               |               |               |
| Trade in animal feeds products                                  | 0.4191        | 0.0000        | <b>0.9191</b> |
| Trade in genetics products (e.g Semen)                          | 0.2347        | <b>1.0000</b> | 0.0000        |
| Trade in health products  | 0.4494        | 0.1128        | 0.4331        |
| Trade in Feed services  | 0.2460        | 0.0000        | <b>0.6968</b> |
| Trade in genetics services (e.g AI)                             | 0.4944        | <b>1.0000</b> | 0.0000        |
| Trade in health services e.g curative and preventive treatments | <b>0.9703</b> | 0.3232        | 0.2730        |
| Trade in extension services                                     | <b>1.0000</b> | <b>0.8872</b> | <b>0.5553</b> |

| <b>Business promotional activities</b>   |               |               |               |
|--|---------------|---------------|---------------|
| Farmer pays later for products/services  | 0.4623        | <b>0.9020</b> | <b>0.5453</b> |
| Business delivers products to its clients  | 0.0933        | <b>1.0000</b> | 0.0789        |
| Business allows clients to pay later for delivery service  | 0.0274        | 0.2256        | 0.1021        |
| Business offers call to deliver services on feeds  | 0.0000        | 0.0000        | 0.2223        |
| Business offers call to deliver services on AI   | 0.0616        | <b>0.8872</b> | 0.0000        |
| Business offers call to deliver services on health products  | <b>1.0000</b> | 0.4360        | 0.2117        |
| Business provides goods and services with payment as checkoff (payments deducted during milk delivery) | 0.4897        | <b>0.7892</b> | <b>0.5261</b> |
| Business has linkages with the dairy producer organizations  | <b>0.6041</b> | 0.2256        | 0.1630        |
| Business has linkages with other dairy enterprises in the area   | 0.3157        | 0.1128        | 0.0416        |
| Maintain records of business activities  | <b>0.9709</b> | <b>1.0000</b> | <b>0.8385</b> |
| Business is a member of professional association of input/service agri-entrepreneurs                   | 0.3173        | 0.0000        | 0.1011        |
| Business links customers to feeds providers/business providers   | 0.4184        | 0.0000        | 0.4548        |
| Business links customers to breeding service (AI) providers  | <b>0.7842</b> | <b>0.6616</b> | 0.1002        |
| Business links customers to animal health services providers   | <b>0.9688</b> | 0.2104        | 0.3751        |
| Business links customers to extension service providers  | <b>0.9661</b> | <b>0.5488</b> | 0.3163        |
| N  | 35            | 9             | 49            |

\* Conditional Item response probabilities that are  $\geq 0.5000$  are **bolded** to enable interpretation

Class I represents APs who are involved more in offering health services (0.97). These APs also bundle extension services (1.00) and are significantly engaged in business promotional activities including linkages with dairy POs (0.60) and other service providers such as AI (0.78) and animal health (0.97) services agri-entrepreneurs and extension service providers (0.97). Other business activities had relatively low (below 0.5000) item probabilities in this class including trade in animal feeds products (0.41), AI (0.23), health products (0.45), feed services

(0.25), and genetics services (0.49). From the pattern of these other (non-bolded) business activities, however, it is clear that a good number of APs belonging to this latent class bundled inputs/services in their enterprises. Other business promotional details included farmers paying for goods/services later (0.46) selling goods/services with milk as checkoff (0.48), maintaining links with other APs in the region (0.31) membership in professional associations (0.31) and linking customers to feeds providers (0.41). Characteristic details of significant and other (non-significant) business promotional activities (the strength of their item response probabilities) indicate that APs in class I averagely conducted an above average number of these activities, which can increase the performance of internal activities and customer share in the inputs markets. Particularly, this group mainly provided animal health and extension services and maintained linkages with other POs while linking smallholder dairy farmers to AI, health, and extension services providers. This latent class was therefore labeled ‘High Business activities and Business Promotional activities (HBHBP).

Members of latent class II significantly traded in genetics products (semen and AI service kits) (1.00), genetics services (1.00), and extension services (0.89). APs in this class had response probabilities of 0.11 and 0.32 for trading in health and health services manifest variables respectively. Despite being relatively low, these probabilities alongside the significant business promotional activities indicate that some input/service agri-entrepreneurs belonging to class II bundled genetics and genetics services with health products and health services. Compared to class III, the strength of these other business promotional activities was weaker. Significant business promotional activities were paying later for goods/services obtained (0.90), delivery of products/services to clients (1.00), offering ‘call to deliver’ services on breeding services (0.89), selling goods/services with milk as checkoff (0.79), maintaining business records (1.00), linking customers to breeding service providers (0.66), and linking customers to extension service providers (0.55). Other business promotional activities with relatively low item response probabilities included allowing customers to pay later for delivery services of inputs purchased (0.23), offering ‘call to deliver’ services on health products (0.44), having linkages with POs (0.23) and other agri-entrepreneurs in the region (0.11), and linking customers to animal health service providers (0.21). These results show that input/service entrepreneurs in this class had diverse business promotional activities they indulged in. However, compared to classes I and III, class II had weaker probability values than class I and stronger probability values than

class III. Particularly, group II members mainly provided genetic products (AI and semen), delivering it to clients on credit with milk as checkoff and genetic and extension services and linked smallholders to AI and extension service providers. Therefore, this class was labeled ‘Low Business activities, medium business promotional activities (LBMBP).

Trading in feed products (0.92) and feed services (0.70), and extension services (0.56) were significant manifest variables (business activities) in class III. Trading in health products (0.43) and health services (0.27) had relatively low probabilities. However, these response probabilities of the latter were stronger compared to those of inputs and services agri-entrepreneurs in latent class II. Therefore, quite a reasonable number of members of class III bundled animal feed products and services with health products and services. Significant business promotional activities were customers payment of inputs/services procured later (0.55), selling goods/services with milk as checkoff (0.53), and maintaining business records (0.84). Other activities with meaningful yet below average response probabilities in this category were offering ‘call to deliver’ services on health products (0.21), business having linkages with other POs (0.16), linking customers to feeds providers (0.45), animal health services (0.38) and extension services (0.32). Compared to classes I and II, the strength of business promotional activities in class III was lower than in the former classes. Particularly, group III members mainly sold feeds products and services while providing them on credit with milk as checkoff. Therefore, this class was labeled ‘Medium business activities, Low business promotional activities (MBLBP).

Extension service provision was a consistently significant business activity across the three latent groups (1.0000, 0.8872, and 0.5553 for classes I, II, and III respectively). These results portrayed that input and services agri-entrepreneurs disseminate information on the various inputs and services they trade-in. These results are consistent with Dar *et al.* (2021) whose findings show that private inputs and services agri-entrepreneurs proactively disseminate newly gained information about improved inputs/services to customers and potential customers. They do this to increase returns from increased purchases, and more importantly to gain reputation and develop their businesses in the long run. Less informed farmers get difficulties to make choices in the inputs market and thereby end up adopting less (Ullah *et al.*, 2020). Birhanu *et al.* (2017) findings show that a unit increase in training farmers increases the intensity of adoption of improved inputs/services by 8.8%. Contrary to this study, Ullah *et al.* (2020) and

Ullah *et al.* (2020) recommended a massive education drive by public extension systems to make up for the information asymmetry created by traders (inputs and services agri-entrepreneurs), who also sell low-quality goods, and boost improved inputs uptake in Pakistan. However, other studies have shown that public extension systems have consistently failed to achieve this (Bahta *et al.*, 2021; Dar *et al.*, 2021; Kilelu *et al.*, 2022; Mwambi *et al.*, 2016; Paloma *et al.*, 2020). Several studies have outlined the importance of private inputs and services agri-entrepreneurs as information agents as they constantly interact with farmers (Bahta *et al.*, 2021; Dar *et al.*, 2021; Hornum & Bolwig, 2021; Kilelu *et al.*, 2022; Okello *et al.*, 2021; Rutsaert *et al.*, 2021). Rutsaert *et al.* (2021) study in Tanzania recommends that mobilization and incentivization are necessary for rural communities (where farming is done) for small input/service agri-entrepreneurship creation. This can catalyze the availability of improved inputs/services, information access, and adoption of these by farmers, as well as create a competitive inputs/services market that minimizes the exploitation of farmers.

Members in class I recorded the highest magnitude of inputs and services bundling. Entrepreneurs in class II and III mainly performed specialized bundling of genetics products and services and health products and services (class II) and feed products and services and health products and services (class III). Class III had a higher magnitude of health products and services, however. Input bundling can be efficient for clients (dairy farmers), especially for inputs/services which yield higher productivity when used complementarily (Abay *et al.*, 2016; Khonje *et al.*, 2018; Rao *et al.*, 2018). Bundling is also useful to inputs and services agri-entrepreneurs in saving costs (for instance cold chain costs), and profits earned from purchasing complementary inputs and/or services by customers (Rao *et al.*, 2018). Adoption of one input/service creates the need of using the other to increase productivity in dairy. However, findings from Bamigboye and Bolaji (2022) study on inputs and services agri-entrepreneurs in Nigeria show that inputs and services agri-entrepreneurs mainly stock only the products/services highly demanded by their clients and less of the occasionally demanded. This minimizes their chances to incur losses as they regularly stock hence no products expire, and their capital is not consumed on less demanded products. This implies negating the bundling motive and deliberately relying on information from the farmers as per their demand regardless of information authenticity to sell inputs. This could be the case for below average bundling in class I and specialized bundling in classes II and III. Yet, information flow should majorly be vice

versa, from more informed inputs and services agri-entrepreneurs to mostly less informed farmers. Information flow can possibly be as well unidirectional, from the farmers to the inputs and services agri-entrepreneurs about the shortcomings farmers are facing in dairy production, and the vice versa on how to best combine inputs/services and when to best use which input to solve the production challenges and attain improved milk productivity.

Business promotional activities were diversely practiced across the groups in different magnitudes. Allowing farmers to pay later for products/services obtained was significant among groups II and III, and slightly below average in cluster I. The item probabilities recorded indicate that a significant number of members of the latter class and an average number of members in the former classes allowed their clients to pay later for the inputs/services they offered. Similar to this finding, Krause (2019) and Hornum and Bolwig (2021) show that inputs and services agri-entrepreneurs perform important roles such as facilitating credit provision and advisory services, apart from the input supply. Provision of credit incentives to clients (smallholder dairy farmers) is a crucial activity as it enables farmers to purchase inputs and services (Birhanu *et al.*, 2017). More so, such farmers access indirect credit without collateral, which is required by the lending institutions such as banks (Moahid & Maharjan, 2020; Puspitasari *et al.*, 2019).

The selling of products and services with milk as checkoff had a strong magnitude in classes II and III and was slightly below average in group I. This activity is a form of indirect provision of credit service and can incentivize dairy farmers to intensify improved inputs (Birhanu *et al.*, 2017) especially when they lack collateral to take other loan alternatives (Moahid & Maharjan, 2020). Record keeping was significant across the three groups. This means majority of entrepreneurs kept records of their business operations either manually or electronically. Only Entrepreneurs in class II significantly offered ‘call to deliver’ services to their customers. This is possibly since they were mainly trading in genetics products and services, while others were bundling with health products and services, which require a specialist to administer (for instance AI and East Cost Fever vaccine, respectively). However, very few entrepreneurs allowed later payment for the products/services that were delivered.

Below average class III entrepreneurs offered ‘call to deliver’ services on feed, while only class II recorded a strong magnitude in offering ‘call to deliver’ services on genetic products/services. All members of class I offered ‘call to deliver’ services on health products/services, while class II and III recorded below average magnitudes. While below

average entrepreneurs in class II and III had linkages with dairy farmers' POs, class I recorded a significant magnitude. Consistent linkages between input entrepreneurs and dairy farmers can boost the confidence of clients in price and quality as seen in Malak-Rawlikowska and Milczarek-Andrzejewska (2016) study in Poland's dairy value chain. More so, inputs and services agri-entrepreneurs can easily reach larger numbers of dairy farmers by maintaining linkages with POs (Krause, 2019). All three classes maintained minimal linkages with fellow input/service agri-entrepreneurs in their regions of operation. None of the entrepreneurs in class II belonged to a professional association or linked their customers to feed products providers, while a relatively low number in the remaining classes did these activities. Class I and II entrepreneurs significantly supported their customers by linking them to breeding and extension services, while only class I had a strong magnitude in linking customers to animal health service providers.

### **4.3 State of Dairy Input and Service Use by Smallholder Dairy Farmers**

#### **4.3.1 Introduction**

The smallholder dairy farmers sampled for the study were from the Kilimanjaro (75%) and Tanga (25%) regions of Tanzania. In terms of Districts, these farmers were from Hai (14.8%), Siha (7.3%), Moshi Rural (40.8%), Rombo (12.1%), Korogwe Town (8.2%), and Muheza (16.8%).

#### **4.3.2 Socio-economic Characteristics of Smallholder Dairy Farmers**

Table 10 shows the demographic and socio-economic characteristics of smallholder dairy farmers in the Kilimanjaro and Tanga regions. The average household size in both regions was 5 individuals. This household size is slightly below the estimated national average household size of 6 individuals (Katjiuongua & Nelgen, 2014). However, the average number of individuals per sampled household shows that the households have an average significant number of physical human capital for labour purposes in dairy activities. Findings of Kimani *et al.* (2019) show that the more the household size the more the labour for dairy farming activities. Dairy farming in Tanzania is labour intensive as it involves cut and carry system of fodder or crop remains for intensive farming, and catering for livestock as they graze for extensive farming, or both in the semi-intensive farming system (Chawala *et al.*, 2019).

Male household heads were 79% and 86% in Kilimanjaro and Tanga regions respectively. Majority of households in both regions therefore were male headed. This finding is consistent with Machina and Lubungu (2019) and Okello and Okello (2021) who attribute this to dominance of males in ownership and control of resources among farming households in Zambia and Kenya respectively. The head of the household therefore is highly likely to influence the decisions on uptake of dairy inputs and services technologies (Kimani *et al.*, 2019) and in what quantities/varieties. Couple households were 79% and 84% in Kilimanjaro and Tanga regions respectively. This could signify a higher probability of joint decision making on economic activities at household level. The average age of household heads was 63 years in Kilimanjaro while in Tanga it was 53 years. This finding corroborates with Mugumaarhahama *et al.* (2021) in Congo. Kilimanjaro had relatively older household heads compared to Tanga region. The age of heads in both regions is relatively higher and this could indicate having more experience with dairy farming hence these farmers were more likely to be vast in terms of dairy knowledge gained over farming years (Mugumaarhahama *et al.*, 2021).

Household heads had an average of primary schooling (primary schooling in Tanzania is between 2 to 9 years) in both Kilimanjaro (69%) and Tanga (72%). This finding is slightly below the national and global average educational level which is 9.2 years to 12.2 years respectively (United Nations Development Programme-UNDP & URT, 2014). The education level of these dairy household heads implies a low literacy level among the household heads surveyed. However, the head of households had at least basic technical human capital skills, as such reading and writing that could be useful to them as farm level dairy agri-entrepreneurs. The household heads who worked away from their homes at the time of this survey were 15% for Kilimanjaro and 16% for the Tanga region. This lower percentage could signify that most heads of households were actively present in their dairy enterprises since they were not far from the homesteads.

The average land owned by households was 2.50 acres in Kilimanjaro and 5.15 acres in Tanga regions. The near-half difference in the size of land owned between these regions could be due to the wider variation/spread in land size owned by the households in Tanga compared to Kilimanjaro region. Averagely, only 15% and 14% of the land was used as pastureland in Kilimanjaro and Tanga regions respectively. This could be due to the relatively small amounts of land owned by the farmers, wherein they practice both crop farming (99% and 94% of the

farmers in Kilimanjaro and Tanga respectively) and dairy farming. Regions with smaller sizes of land ownership in Tanzania are dominated by either semi-intensive or intensive livestock production system where less grazing is done and instead more of stabled feeding (67% overall in this study) is common (Mangesho *et al.*, 2021) where crop residues are commonly used as feeds (Maleko *et al.*, 2018).

The mean number of animal species kept by farmers in Kilimanjaro was 3 while that kept in Tanga was 2 with at most 4 animal species in both regions. Cattle was owned by each household sampled in both regions. Majority of the dairy farmers (70% in Kilimanjaro and 56% in Tanga) identified with stabled livestock keeping. This implies that most of the surveyed farmers practiced either semi-intensive or intensive dairy farming systems. This finding is consistent with Chawala *et al.* (2019) study in the Southern and Eastern Coast regions of Tanzania where majority of the farmers from the Eastern Coast practiced an intensive dairy farming system. To boost cattle productivity (beef and milk), Mugumaarhahama *et al.* (2021) recommended the uptake of an intensive farming system in Congo.

**Table 10: Demographic and Socio-economic Characteristics of Smallholder Dairy Households in Tanga and Kilimanjaro Regions**

| Variable                             | Kilimanjaro<br>(n=534) |       | Tanga<br>(n=178) |       | Overall<br>(n=712) |       | t (2-tail) | $\chi^2$  |
|--------------------------------------|------------------------|-------|------------------|-------|--------------------|-------|------------|-----------|
|                                      | Mean                   | Std.D | Mean             | Std.D | Mean               | Std.D |            |           |
| <b>Socioeconomic Characteristics</b> |                        |       |                  |       |                    |       |            |           |
| Household size                       | 4.71                   | 2.00  | 5.42             | 2.26  | 4.89               | 2.09  | 3.950***   |           |
| Household head Education level       | 0.69                   | 0.75  | 0.72             | 0.82  | 0.70               | 0.77  | 1.526      |           |
| HH Head Gender (1=Male, 0=Female)    | 0.79                   | 0.41  | 0.86             | 0.35  | 0.80               | 0.40  |            | 4.532**   |
| Marital Status (1=Couple, 0=Other)   | 0.79                   | 0.78  | 0.84             | 0.64  | 0.80               | 0.75  |            | 8.410**   |
| Household head age (years)           | 59.91                  | 12.63 | 53.33            | 14.04 | 58.27              | 13.30 | 5.857***   |           |
| HH head works away (1=Yes, 0=No)     | 0.15                   | 0.36  | 0.16             | 0.37  | 0.15               | 0.36  |            | 0.092     |
| <b>Farm Characteristics</b>          |                        |       |                  |       |                    |       |            |           |
| Land owned by household (acres)      | 2.50                   | 2.83  | 5.15             | 7.12  | 3.16               | 4.46  | 7.093***   |           |
| Grows crops (1=Yes, 0=No)            | 0.99                   | 0.11  | 0.94             | 0.24  | 0.97               | 0.16  |            | 12.843*** |
| Pastureland use (1=Yes, 0=No)        | 0.15                   | 0.36  | 0.14             | 0.35  | 0.15               | 0.35  |            | 0.060     |
| Number of animal species owned       | 2.78                   | 0.90  | 2.19             | 0.74  | 2.63               | 0.90  | 7.926***   |           |
| Cattle stabled (1=Yes, 0=No)         | 0.70                   | 0.46  | 0.56             | 0.50  | 0.67               | 0.47  |            | 13.157*** |
| Number of Cattle owned               | 2.79                   | 1.71  | 4.53             | 5.00  | 3.22               | 3.00  | 6.929***   |           |
| Number of improved cattle breeds     | 2.50                   | 1.56  | 4.16             | 4.74  | 2.92               | 2.82  | 7.017***   |           |

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|  |             |       |             |       |             |       |          |       |
|--|-------------|-------|-------------|-------|-------------|-------|----------|-------|
| owned                                  |             |       |             |       |             |       |          |       |
| Number of local cattle breeds owned    | 0.29        | 1.05  | 0.37        | 1.81  | 0.31        | 1.28  | 0.759    |       |
| Number of improved breeds cows owned   | 1.11        | 0.79  | 1.66        | 1.83  | 1.25        | 1.16  | 5.543*** |       |
| Number of other improved cattle breeds | 1.39        | 1.18  | 2.50        | 3.22  | 1.67        | 1.96  | 6.721*** |       |
| <b>Milk Production</b>                 |             |       |             |       |             |       |          |       |
| Milk is harvested (1=Yes, 0=No)        | 0.79        | 0.41  | 0.78        | 0.42  | 0.78        | 0.41  |          | 0.011 |
| Number of cows milked in good season   | 1.00        | 0.72  | 1.40        | 1.30  | 1.11        | 0.92  | 5.098*** |       |
| Number of animals milked in bad season | 0.95        | 0.70  | 1.21        | 1.02  | 1.01        | 0.80  | 3.866*** |       |
| Milk amount good season                | 6.42        | 6.10  | 11.20       | 11.83 | 7.61        | 8.19  | 6.977*** |       |
| Milk amount bad season                 | 3.28        | 3.60  | 6.36        | 6.80  | 4.05        | 4.80  | 7.725*** |       |
| <b>Cost of Inputs</b>                  |             |       |             |       |             |       |          |       |
| AI                                     | 13.69 (163) | 9.02  | 16.66 (69)  | 12.37 | 14.57 (232) | 10.20 | 2.043**  |       |
| Bull Servicing                         | 3.97 (294)  | 12.72 | 6.76 (89)   | 5.72  | 4.62 (383)  | 11.53 | 2.008**  |       |
| Vaccine                                | 3.86 (362)  | 6.29  | 8.97 (84)   | 14.67 | 4.83 (446)  | 8.73  | 4.957*** |       |
| Deworm                                 | 5.73 (505)  | 6.34  | 6.86 (160)  | 8.79  | 6.00 (665)  | 7.02  | 1.779*   |       |
| Tick control                           | 8.13 (184)  | 12.09 | 10.50 (127) | 15.22 | 9.10 (311)  | 13.48 | 1.526    |       |
| Treatment                              | 12.18 (175) | 16.48 | 32.91 (67)  | 87.64 | 17.92 (242) | 48.85 | 3.004**  |       |
| Animal feeds                           | 16.87 (461) | 26.45 | 12.45 (140) | 12.57 | 15.84 (601) | 24.01 | 1.910*   |       |

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1=no formal, 2=adult, 3=primary, 4=secondary, 5=college, 6=university 'Other improved breeds' constitute of bulls and young animals combined. Figure in bracket is the cost of inputs section are the sample sizes for smallholder farmers who used the inputs. Cost is represented in USD currency \*\*\*, \*\*, and \* is significance at 1%, 5%, and 10% respectively

There was a slight variation on the mean number of cattle owned among the dairy households in Kilimanjaro (3 cattle) and Tanga (5 cattle) regions. Among this cattle herd, the local cattle breeds had insignificant averages. The mean number of improved cattle breeds owned by the dairy farmers was 3 cattle in Kilimanjaro and 4 cattle in Tanga regions. These averages are close to the mean cattle herd recorded and therefore majority of the cattle among the herd in both regions were of the improved variety. The number of cattle owned qualifies these farmers as smallholders. This finding concurs with Kurwijila *et al.* (2012) that improved dairy cattle farming is dominant in regions characterized as high potential, cooler highlands, with subtropical climates in Tanzania including Kilimanjaro, Tanga, Arusha, and Mbeya.

Of the surveyed households, averagely 1 lactating cow of the improved breed was owned in Kilimanjaro region while 2 lactating cows were owned in Tanga region. This shows that majority of households in the sample owned at least a milk producing cow of improved variety. Other improved cattle breeds (bulls and young animals) among the cattle herd were averagely 1 in Kilimanjaro and 3 in Tanga regions. The lower number of animals owned is characteristic of intensive and semi-intensive livestock farming systems in Tanzania (Mangesho *et al.*, 2021).

Milk harvesting from cows was done by 79% and 78% of households in Kilimanjaro and Tanga regions respectively within the past 12 months. During both good and bad milking seasons, averagely one cow was milked in sampled households. The average milk amount harvested during the good season in Kilimanjaro was 6.42 litres, while that harvested during the bad season was 3.28 litres per day. In Tanga, 11.83 litres were harvested per day during good season, while 6.36 litres during the bad season. These averages both in good and bad seasons are above those of (Twine *et al.*, 2018). The high variation between milk harvested per day between Tanga and Kilimanjaro regions may be due to the high deviation (as shown by standard deviations of 11.83 for the good season and 6.80 for bad season) of cattle herd recorded in Tanga region. This could have been caused by farmers in Tanga region taking up improved inputs/services from the influence of *Maziwa Zaidi I* project implemented in Tanga and Morogoro regions (Twine *et al.*, 2018). Good seasons (wet seasons) recorded higher amounts of milk harvested across the regions. This is probably due to the availability of feeds in plenty contrary to during the bad seasons (dry seasons) (Ndah *et al.*, 2017) where crop residues are mainly used (Ndah *et al.*, 2022).

The costs incurred in acquiring inputs/services is captured in Table 10 while Table 11 below shows the mean use/uptake of the inputs/services in the Tanga and Kilimanjaro regions. The averages of both the cost and number of inputs/services is obtained from the total cost/number of each smallholder mentioned during the survey. The cost section of Table 10 is discussed alongside the levels of input/service use captured in Table 11.

**Table 11: Average Levels of Input/Service Use**

| Input use<br>(1=Yes, 0=No) | Kilimanjaro<br>(n=534) |        | Tanga<br>(n=178) |        | Overall<br>(n=712) | $\chi^2$ |           |
|----------------------------|------------------------|--------|------------------|--------|--------------------|----------|-----------|
|                            | Mean                   | StdD   | Mean             | StdD   |                    | StdD     |           |
| AI use                     | 0.3127                 | 0.4640 | 0.3989           | 0.4910 | 0.3343             | 0.4721   | 4.4516**  |
| Cow served by<br>male bull | 0.6647                 | 0.7024 | 0.8652           | 1.1418 | 0.7148             | 0.8379   | 1.2727    |
| Animal vaccine             | 1.7266                 | 1.8950 | 1.8539           | 4.3193 | 1.7584             | 2.7092   | 24.2063** |
| Animal<br>Deworming        | 2.4326                 | 1.7070 | 3.7022           | 4.9100 | 2.75               | 2.9135   | 4.7459    |
| Animal tick                | 1.0581                 | 1.9921 | 3.3258           | 5.2179 | 1.625              | 3.2739   | 73.8561** |
| Animal treatment           | 0.4382                 | 0.8850 | 0.8596           | 2.1012 | 0.5435             | 1.3113   | 1.4106    |
| Feed products              | 1.9663                 | 0.9080 | 1.5955           | 0.7006 | 1.8736             | 0.8752   |           |

The specific sample of each input is as per that used in the costs of inputs section in Table 10, \*\* shows significance at 5%

Sampled households in both Kilimanjaro (31.2%) and Tanga (39.9%) regions had used AI within the past 12 months at the time of the survey. More so, at least one cattle owned by the dairy farmers was born of AI. Averagely 1 cow was served by an outside male among the cattle herd owned both in Kilimanjaro and Tanga regions. These results indicate that most households sampled owned at least 1 either crossbred or exotic breed among their cattle. The average amount spent on AI services in twelve months was higher (13.69 United States Dollar-USD and 16.66 USD) in both Kilimanjaro and Tanga regions respectively. This is compared to the average costs of servicing cows by bulls in (6.67 USD and 3.97 USD) in the Tanga and Kilimanjaro regions. This was reflected in the percentage of usage of these breeding inputs, where male servicing was higher as shown in Table 11. In terms of regions, Tanga had higher costs of using

both services compared to Kilimanjaro region. Even though bull servicing cost was significantly lower than that of AI, Tanga recorded the highest percentage in both use of bulls for servicing (86.5%) and AI (39.9%), but AI services had a lower percentage of less than half that of bull servicing. Therefore, farmers in Tanga invested more in improved animal breeding, with relatively higher cost of crossbreeding as evidence, compared to Kilimanjaro region. These findings concur with Twine *et al.* (2018) which show that dairy farmers in Tanga region are taking up more of improved dairy inputs such as genetics.

There was no significant difference between the number of animals vaccinated across both regions. Dairy farmers who invested in vaccinating their cattle averagely used 3.86 USD in Kilimanjaro and 8.97 USD in Tanga, however. On average, 2 cattle and 4 cattle had been dewormed in Kilimanjaro and Tanga regions per household respectively. While the cost of deworming in Kilimanjaro was 5.73 USD, that of the Tanga region was 6.86 USD. Tick control costs amounted to an average of 8.13 USD and 10.50 USD in the Kilimanjaro and Tanga regions, respectively with 1 and 3 cattle controlled of ticks in the former and later regions. Animal treatment costs was 12.18 USD in Kilimanjaro and 32.91 USD in Tanga with a mean of 1 animal in both regions. Tanga region had higher cost records across the animal health interventions used by the dairy farmers compared to Kilimanjaro region. This difference is because of more animals receiving these interventions in Tanga compared to Kilimanjaro. More so, findings from Bayiyana *et al.* (2019) proved allocative efficiency among dairy smallholders in Tanga region towards optimizing their milk production capacity. Embracing more improved inputs/services interventions in Tanga region is attributed to the benefit and exposure the region has had as a subject of several dairy developmental projects (Twine *et al.*, 2018). These projects, including the *Maziwa Zaidi I* project by ILRI and its partners (Mangesho *et al.*, 2021; Twine *et al.*, 2018), are rolled out by different stakeholders and target smallholder dairy farmers' improvement in productivity.

Both regions purchased a mean of 2 feed product varieties. The average cost of feed products purchased by dairy households in Kilimanjaro was 16.87 USD while that of Tanga was 12.45 USD. Contrary to the other inputs, Tanga's cost of feeds was lower than that of Kilimanjaro. The lower record in purchasing animal feed inputs could be because most smallholder dairy farmers in Tanzania use crop residues to feed their cattle in wet and dry seasons, while they also store the feed residues for later use (Maleko *et al.*, 2018). According to

Ndah *et al.* (2017), semi-intensive and intensive dairy feed systems in Tanzania are characterized by Napier grass and fodder trees during wet seasons and crop residues during dry seasons, where a ‘cut and carry’ system is common. This could also mean that some of the farmers grow some animal feeds on the small parcels of land.

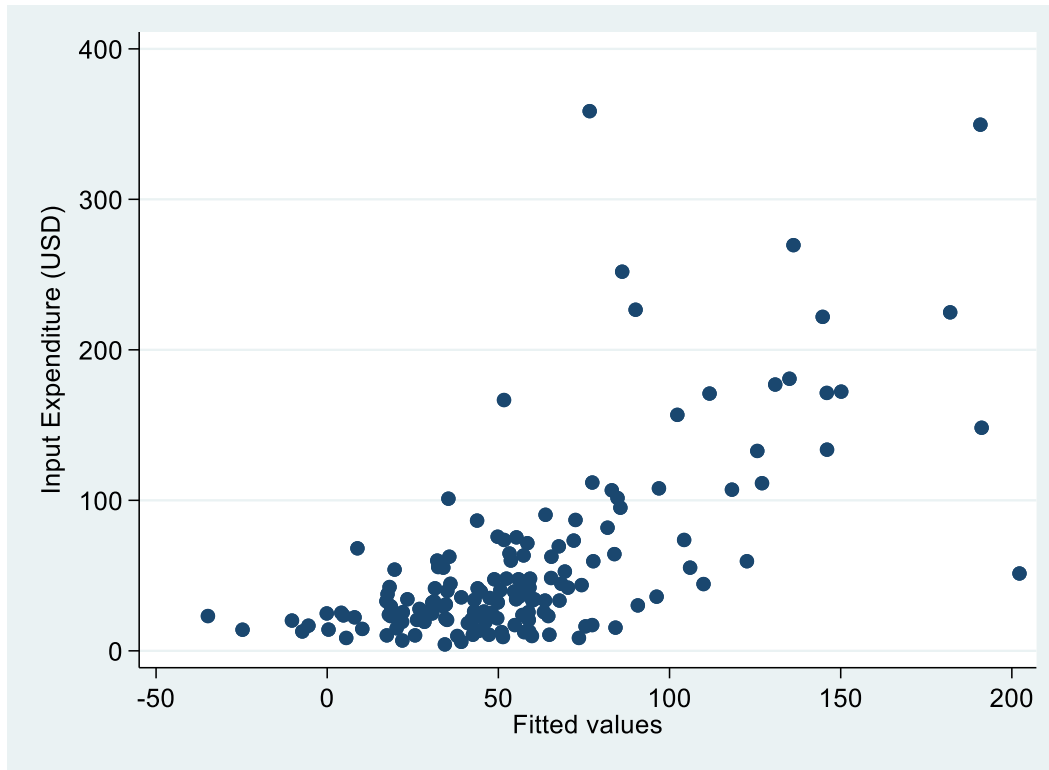
#### **4.4 Effects of Input/Service Entrepreneurs’ Practices on Input Market Participation by Smallholder Dairy Farmers**

The OLS regression was used to estimate market participation by smallholder dairy farmers in this study. The model fit test statistics for the OLS model are represented below.

##### **4.4.1 Results for Test of Linearity and Multicollinearity**

###### **Test for Linearity**

Linearity test determines whether the linear specifications in the OLS model are acceptable; that is whether there is a linear relationship between the dependent and independent variable (Hansen, 2022). A graph was plotted for the residuals against the fitted values to test for linearity in this study as represented in figure 6. The absence of a sequence/pattern in the graph proved linearity between the independent and dependent variable hence the data fulfilled linearity OLS requirement.



**Figure 6: Test for Linearity**

**Test for Multicollinearity**

Using the variance inflation factors (VIF) presence of multicollinearity was tested (Gujarati, 2003) among the explanatory variables. The average VIF was 3.14, way below 5.000 as per the recommended threshold. These results are shown in Table 12. Therefore, these values proved the absence of multicollinearity among the independent variables in the OLS model.

**Table 12: VIF Test Results for OLS Model**

| Variable        | VIF  | 1/VIF    |
|-----------------|------|----------|
| HH size         | 1.29 | 0.776072 |
| Pastureland use | 1.36 | 0.737153 |
| HH age          | 1.43 | 0.701589 |
| Landown         | 1.88 | 0.531918 |
| Anim No         | 1.49 | 0.671019 |

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|                      |       |          |
|----------------------|-------|----------|
| Cattle No            | 3.20  | 0.312196 |
| LC1                  | 4.03  | 0.247943 |
| LC2                  | 2.69  | 0.372228 |
| LC3                  | 2.85  | 0.350482 |
| Gender               | 2.94  | 0.339816 |
| HH wky               | 1.30  | 0.767592 |
| Animstab             | 1.33  | 0.751703 |
| Primedu              | 11.16 | 0.089588 |
| Secedu               | 10.04 | 0.099626 |
| Postsecedu           | 3.26  | 0.307068 |
| Adultedu             | 2.94  | 0.340371 |
| Harvest milk         | 2.20  | 0.455033 |
| Grow crops           | 1.32  | 0.760449 |
| HH marital status    | 2.77  | 0.361485 |
| No of animals milked | 5.72  | 0.174955 |
| good season          |       |          |
| Milk amount good     | 6.10  | 0.164061 |
| season               |       |          |
| No of animals milked | 3.13  | 0.318985 |
| bad season           |       |          |
| Milk amount bad      | 4.49  | 0.222656 |
| season               |       |          |
| Moshi rural district | 1.76  | 0.568323 |

|                       |             |          |
|-----------------------|-------------|----------|
| Rombo district        | 1.74        | 0.575900 |
| Siha district         | 1.71        | 0.584168 |
| Korogwe town district | 1.43        | 0.701725 |
| Muheza district       | 2.49        | 0.402066 |
| <b>Mean VIF</b>       | <b>3.14</b> |          |

#### 4.4.2 The OLS Results

The results are represented in table 13. The dependent variable was a continuous variable (expenditure on inputs) and was measured in USD (converted from Tanzanian shillings at 2334 Tanzanian shillings per 1 USD rate). Despite the level of education recording a high VIF value above the threshold, it was still included in the model as the overall VIF was below 0.5000.

Coefficients indicate the direction and magnitude of change in amount spent on dairy inputs/services because of change in the response variables. The OLS function was statistically significant at 1% (0.0000). OLS model explained 40.3% of the variation. This means that the rest of the variation (59.7%) in the market participation by dairy farmers was explained by other factors that were not included in the regression. Even though the variation explained by the model was lower than the average recommended (50%) (Greene, 2003), the  $R^2$  is a measure of linear association between variables and does not capture information about the causation (cause and effect) relationship between the regressors and regressed variables (Greene, 2003; Gujarati, 2003)

On average, smallholder dairy households spend 62.33 USD on purchasing improved dairy inputs/services from input/service providers. Several variables significantly influenced the market participation of smallholder dairy farmers in input market. Input and services agri-entrepreneurs belonging to latent class I, II, and II, stabled animals (zero grazing) , level of education, number of cows milked during good season, and dairy farmers from Moshi Rural district were statistically significant.

Results show that the effect of inputs and services agri-entrepreneurs belonging to latent classes I and II were statistically significant at 1%. These results show that smallholder dairy farmers' interaction with inputs and services agri-entrepreneurs in latent class I and II increases

farmers' expenditure on dairy inputs/services by 79.51 USD and 87.69 USD respectively. Inputs and services agri-entrepreneurs in class I mainly provided animal health and extension services. The also maintained linkages with other POs while linking smallholder dairy farmers to AI, health, and extension services providers. The provision of extension services, maintaining linkages with other POs, and linking smallholders to AI, health, and extension services providers could have increased expenditure on inputs/services by smallholder dairy farmers. On the other hand, class II mainly provided genetic products (AI and semen), delivering it to clients on credit with milk as checkoff, and genetic and extension services. These inputs and services agri-entrepreneurs also linked smallholders to AI and extension service providers. Class II inputs and services agri-entrepreneurs providing their inputs and services with milk as checkoff, extension services, and linking smallholder dairy farmers to AI and extension service providers could have increased expenditure on inputs/services by smallholder dairy farmers.

The effect of class III inputs and services agri-entrepreneurs was significant at 5%. Class III mainly sold feed products and services while providing them on credit with milk as checkoff. Smallholder dairy farmers' interaction with inputs and services entrepreneurs in latent class III increases expenditure on dairy inputs/services sold by 52.02 USD. Primary, secondary, postsecondary, and adult education had a negative significant relationship with the smallholder dairy farmers' expenditure on inputs at 5%. An increase in the level of education by 1 unit reduce expenditure on inputs by 91.38, 95.82, 71.29, and 109.95 units respectively. Therefore, the purchase of inputs/services by dairy farmers was less based on the literacy status and levels of individuals. A probable reason for this could be that dairy farmers make decisions based on the type and level of information they have about the use and relevance of improved input/services (Birhanu *et al.*, 2017; Ullah *et al.*, 2020). These findings could be indicative of the crucial role extension services can play in influencing inputs and services purchase by dairy farmers, regardless of their level of education.

Farmers' engagement in zero grazing increases expenditure on dairy inputs and services by 26.59 USD. This finding proves the findings from literature about the prevalence of semi-intensive and intensive farming systems among dairy farmers in Tanga, Kilimanjaro and Morogoro regions (Chawala *et al.*, 2019; Ndah *et al.*, 2017). Results also showed that a unit increase in the number of cows milked during the good season (wet season) increased expenditure on dairy inputs and services by 20.24 USD. However, this finding is contrary to

findings Chawala *et al.* (2019) on feeds, where in good season farmers cut and carry fodder and crop remains to animals in intensive and semi-intensive farming systems.

**Table 13: OLS Model Results**

| <b>Variables</b>  | <b>Coefficient</b> | <b>Std Error</b> | <b>T</b> | <b>P&gt;t</b> |
|-------------------|--------------------|------------------|----------|---------------|
| HH size           | -3.3738            | 2.6733           | -1.26    | 0.209         |
| Pastureland use   | 3.4082             | 12.8411          | 0.27     | 0.791         |
| HH age            | -0.2899            | 0.4261           | -0.68    | 0.498         |
| landown           | -0.7693            | 1.0135           | -0.76    | 0.449         |
| Anim No           | 1.9662             | 6.1965           | 0.32     | 0.752         |
| Cattle No         | 0.6523             | 2.0560           | 0.32     | 0.752         |
| HBHBP (LC I)      | 79.5116            | 21.8582          | 3.64     | 0.000***      |
| LBMBP (LC II)     | 87.6870            | 22.5288          | 3.89     | 0.000***      |
| MBLBP (LC III)    | 52.0205            | 22.1257          | 2.35     | 0.020**       |
| Gender            | 18.6854            | 20.3798          | 0.92     | 0.361         |
| HH wky            | 6.1856             | 13.1309          | 0.47     | 0.638         |
| Animstab          | 26.5905            | 11.2579          | 2.36     | 0.020**       |
| Primedu           | -91.3767           | 30.6522          | -2.98    | 0.003***      |
| Secedu            | -95.8151           | 32.6001          | -2.94    | 0.004***      |
| Postsecedu        | -71.2949           | 37.2977          | -1.91    | 0.058*        |
| Adultedu          | -109.9487          | 41.6307          | -2.64    | 0.009**       |
| Harvest milk      | -18.8123           | 16.5662          | -1.14    | 0.258         |
| Grows crops       | -30.6410           | 35.7145          | -0.86    | 0.393         |
| HH Marital status | 26.3289            | 20.4788          | 1.29     | 0.201         |
| No of anim milked | 20.2429            | 8.4431           | 2.40     | 0.018**       |
| good season       |                    |                  |          |               |
| Milk amount good  | 1.3049             | 1.0839           | 1.20     | 0.231         |
| season            |                    |                  |          |               |
| No of anim milked | -4.0216            | 7.7402           | -0.52    | 0.604         |
| bad season        |                    |                  |          |               |
| Milk amount bad   | -1.3570            | 1.5104           | -0.90    | 0.371         |

| season                |          |         |       |           |
|-----------------------|----------|---------|-------|-----------|
| Moshi rural district  | -34.3685 | 18.2324 | -1.89 | 0.062*    |
| Rombo district        | -9.5774  | 16.8872 | -0.57 | 0.572     |
| Siha district         | -20.2964 | 15.2895 | -1.33 | 0.187     |
| Korogwe town district | -14.4238 | 21.9109 | -0.66 | 0.512     |
| Muheza district       | -5.2178  | 15.9197 | -0.33 | 0.744     |
| Constant              | 62.3332  | 53.4505 | 1.17  | 0.246     |
| n                     |          |         |       | 152       |
| Prob > F              |          |         |       | 0.0000*** |
| R-squared             |          |         |       | 0.4027    |
| Adj R-squared         |          |         |       | 0.2667    |

**Note:** \*, \*\*, and \*\*\* represent significance levels at 10%, 5%, and 1% respectively.

If a household resides from Moshi Rural District, expenditure on dairy inputs and services will decrease by 34.37 USD. This finding could be because of the longer distance the farmers have to face to access inputs and services agri-entrepreneurs. Findings from Bamigboye and Bolaji (2022) and Rutsaert *et al.* (2021) show that most farmers located in rural areas, far away from input/service agri-entrepreneurs adopt less of improved inputs and services because of the distance and limited information about the improved inputs and services.

## CHAPTER FIVE

### CONCLUSIONS AND RECOMMENDATIONS

#### 5.1 Conclusions

This study aimed to find out the effects of inputs entrepreneurs' practices on inputs market participation by smallholder dairy farmers in the Tanga and Kilimanjaro regions of Tanzania. Specifically, the study focused on characterizing dairy inputs and services agri-entrepreneurs' business and technology dissemination practices, describing the state of dairy inputs and services use by smallholder dairy farmers, and determining the effect of business practices by inputs and services agri-entrepreneurs on the uptake of inputs and services by smallholder dairy farmers in Kilimanjaro and Tanga regions. This study used baseline data from ILRI's *Maziwa Zaidi II* (Moremilk IT) project which was collected in June 2021. Using exploratory, descriptive, and econometric data analysis techniques, the following conclusions are made from this study.

The first objective of this study was to characterize dairy inputs and services agri-entrepreneurs' business and technology dissemination practices in Tanga and Kilimanjaro regions. The objective employed descriptive statistics to explore the status of inputs and services entrepreneurs and exploratory study method; LCA to group inputs and services agri-entrepreneurs in these regions according to their similarities in business practices and business promotional practices that potentially motivate dairy farmers to purchase improved dairy input and service technologies. Descriptive statistics show that inputs and services agri-entrepreneurs who link farmers to their fellow suppliers include 39.8% to feed providers, 40.9% to AI providers, and 58.1% to health intervention providers and extension providers. More so, these suppliers identified their BDS needs as business continuity planning (39.8%), access to short-term financing (12.9%), and diversification of products and sales channels (3.2%). The training needs identified by input entrepreneurs include entrepreneurship (30.1%), technical skills for feed products (21.5%), and AI (15.1%). Using the BIC criteria, the optimally representative LCA model was a 3-class latent class model. Class I was composed of HBHBP and consisted of 35 entrepreneurs. These agri-entrepreneurs mainly provided animal health and extension services and maintained linkages with other POs while linking smallholder dairy farmers to AI, health, and extension services providers. Class II was composed of LBMBP and had 9 entrepreneurs, who majorly provided genetic products (AI and semen), delivering it to clients on credit with

milk as checkoff, and genetic and extension services, and linked smallholders to AI and extension service providers. Class III was composed of MBLBP entrepreneurs wherein 49 inputs and services agri-entrepreneurs of the survey belonged. Class III members mainly sold feeds products and services while providing them on credit with milk as checkoff.

The second objective of the study focused on describing the state of dairy inputs and services use by smallholder dairy farmers. Analysis of this objective entailed descriptive statistics including means, standard deviation, t-test statistics, and chi-square tests to describe the states of input use among smallholder farmers in Tanga and Kilimanjaro. Average cattle ownership was 3 with at least each household having a cow of improved variety in both Kilimanjaro and Tanga. About 79% and 78% of the population were harvesting milk at the time of the survey. Stabled dairy farming was identified among 67% of households, an indication of semi-intensive and intensive farming systems. While the use of AI was 31.2% and 39.9%, bull serving was used by 66.5% and 86.5%, with higher costs of AI (13.69 USD and 16.66 USD) compared to serving cows with bulls (6.67 USD and 3.97 USD) in Kilimanjaro and Tanga respectively. A mean of 2 cattle had been vaccinated with a mean cost of 3.86 USD in Kilimanjaro and 8.97 USD in Tanga. Yet, 2 and 4 cattle had been dewormed with 5.73 USD and 6.86 USD spent in Kilimanjaro and Tanga regions respectively. Tick control costs were 8.13 USD and 10.50 USD with 1 and 3 cattle controlled in Kilimanjaro and Tanga. Animal treatment costs were 12.18 USD and 32.91 USD in Kilimanjaro and Tanga with a mean of 1 animal in both regions. Generally, the Tanga region had higher cost records across all the animal health interventions used by dairy farmers compared to the Kilimanjaro region. On the contrary, the cost of purchasing feeds was lower in Tanga (12.45) compared to Kilimanjaro (16.87 USD) with averagely 2 feed products purchased by households across regions.

The third objective was to determine the effect of business practices by inputs and services agri-entrepreneurs on the uptake of inputs by smallholder dairy farmers. The OLS regression was used for analysis. Results show that the effect of inputs and services agri-entrepreneurs across latent classes I, II and III were statistically significant at 1% (I and II) and 5% (III). Smallholder dairy farmers' interaction with inputs and services agri-entrepreneurs in the three latent classes therefore increased farmers' expenditure on dairy inputs and services by 79.51 USD (Class I), 87.69 USD (Class II), and 52.02 USD (Class III). The primary, secondary, postsecondary, and adult levels of education had an inversely significant relationship with the

purchase of inputs and services. More so, there was a negative significant relationship between farmers residing from Moshi Rural district and expenditure on inputs. Zero grazing and number of cows milked during good season positively influenced expenditure on inputs.

Therefore, this study concludes that:

1. Inputs and services agri-entrepreneurs in *Maziwa Zaidi II* project sell their products in diverse bundles with no optimum bundling. Each of the three groups of entrepreneurs offer extension services to their customers. Smallholder dairy farmers diversely associate with inputs and services agri-entrepreneurs who reasonably bundle dairy inputs/services and besides promote their businesses with business promotional activities.
2. The higher cost incurred in Tanga for purchase of inputs and services may signify that smallholder dairy farmers in Tanga purchase more improved inputs/services compared to those in Tanga Region. The negatively significant relationship between Moshi Rural district and input expenditure is more reason for this conclusion.
3. This study concludes that the purchase decision of improved dairy inputs and services relies less on the level of education of dairy farmers and more on the type and amount of knowledge about the inputs/services.

## **5.2 Recommendations**

1. Findings from this study show that farmers can benefit from inputs and services agri-entrepreneurs who bundle improved dairy inputs and services for them to access as a one stop shop, and more so, inputs and services agri-entrepreneurs who promote their businesses through using business promotional activities such as providing inputs/services on credit with milk as checkoff. This study recommends the training of inputs and services agri-entrepreneurs of *Maziwa Zaidi II* project on optimum bundling of both business activities (dairy inputs and services) and business promotional activities to optimize their sales to boost purchase of improved dairy inputs and services by smallholder dairy farmers.
2. Secondly, findings show that purchase of improved inputs and services does not rely on the level of education, but rather on the technical information availed to the farmer for informed decision making. Extension services provision had a high magnitude across the three latent groups in objective one meaning that majority of inputs and services agri-entrepreneurs offered information related to the inputs and services during their

interaction with the dairy farmers. Extension services provision alongside inputs/services by the inputs and services agri-entrepreneurs gives the farmers the knowhow of dairy inputs and services and increases farmers' confidence in purchasing them. This can leverage a win-win situation with increased sales on the entrepreneurs' side and increased use of improved inputs on the farmers' side. More so, extension services can boost the complementary use of inputs/services. This study recommends the training of inputs and services agri-entrepreneurs about the dairy inputs and services they sell, and on how best they can be combined by farmers to maximize milk productivity so that they can bundle this information alongside their business promotional activities to boost complementary purchases of inputs and services by dairy households. Business activities such as model farms (more so those of input/service agri-entrepreneurs who also do dairy farming) can accelerate the dissemination of such information to farmers and hence farmers' trust in their input/service agri-entrepreneurs.

3. Networking among inputs and services agri-entrepreneurs and between the agri-entrepreneurs and dairy farmers needs to be fostered for adequacy in information sharing about farmers' needs. Inputs and services agri-entrepreneurs recommend other agri-entrepreneurs who have improved inputs/services the farmer need that are not sold in the farmers' shop. Farmers also learn and recommend fellow farmers to such efficient shops which avail inputs and relevant technical information alongside and link them to other inputs and services agri-entrepreneurs for the inputs not sold there. This also brings mutual trust between the seller and the customer.
4. Lastly, this study recommends that more efforts should be put in Kilimanjaro region to boost the purchase of inputs and services by smallholder dairy farmers. There is need for inputs and services agri-entrepreneurs to expand into rural areas so that farmers can easily reach them, access information about inputs/services and purchase them to improve their farm productivity.

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## APPENDICES

### Appendix A: Ethical Approval

# EGERTON



# UNIVERSITY

TEL: (051) 2217808 P. O. BOX  
2217942 EGERTON

536

FAX: 051-

## EGERTON UNIVERSITY INSTITUTIONAL SCIENTIFIC AND ETHICS REVIEW COMMITTEE

**EU/RE/DVC/009**

**Approval No. EUREC/APP/187/2022**

**27<sup>th</sup> July, 2022**

Ruth N Kundu  
Egerton University  
P O Box 536 – 20115  
Telephone: +254705495322  
E-mail: danielaruthkay6290@gmail.com

Dear Ruth,

**RE: ETHICAL APPROVAL: EFFECTS OF INPUT AND SERVICE ENTREPRENEURS' PRACTICES ON INPUT MARKET PARTICIPATION BY SMALLHOLDER DAIRY FARMERS. THE CASE OF TANZANIAN DAIRY SUB-SECTOR**

This is to inform you that *Egerton University Institutional Scientific and Ethics Review Committee* has reviewed and approved your above research proposal. Your application approval number is **EUREC/APP/187/2022**. The approval period is **27<sup>th</sup> July, 2022 –28<sup>th</sup> July, 2023**.

This approval is subject to compliance with the following requirements;

- i. Only approved documents including (informed consents, study instruments, MTA) will be used.
- ii. All changes including (amendments, deviations, and violations) are submitted for review and approval by *Egerton University Institutional Scientific and Ethics Review Committee*.

iii. Death and life-threatening problems and serious adverse events or unexpected adverse events whether related or unrelated to the study must be reported to *Egerton University*

*Institutional Scientific and Ethics Review Committee* within 72 hours of notification iv. Any changes anticipated or otherwise that may increase the risks or affected safety or welfare of study participants and others or affect the integrity of the research must be reported to *Egerton University Institutional Scientific and Ethics Review Committee* within 72 hours.

v. Clearance for Material Transfer of biological specimens must be obtained from relevant institutions.

***“Transforming Lives through Quality Education”***

vi. Submission of a request for renewal of approval at least 60 days prior to expiry of the approval period. Attach a comprehensive progress report to support the renewal. vii. Submission of an executive summary report within 90 days upon completion of the study to *Egerton University Institutional Scientific and Ethics Review Committee*.

Prior to commencing your study, you will be expected to obtain a research license from National Commission for Science, Technology and Innovation (NACOSTI) <https://oris.nacosti.go.ke> and also obtain other clearances needed.

Yours sincerely,








Prof. R. Ngure

**CHAIRMAN, EGERTON UNIVERSITY INSTITUTIONAL SCIENTIFIC AND ETHICS  
REVIEW CTTEE**

*RMN/BK/*

## Appendix B: NACOSTI Research Permit

|  |  |
|--|--|
| <br><b>REPUBLIC OF KENYA</b>  | <br><b>NATIONAL COMMISSION FOR<br/>SCIENCE, TECHNOLOGY &amp; INNOVATION</b>                           |
| Ref No: <b>890761</b>  | Date of Issue: <b>21/November/2022</b>   |
| <b>RESEARCH LICENSE</b>  |  |
|   |  |
| <b>This is to Certify that Ms. Ruth N Kundu of Egerton University, has been licensed to conduct research as per the provision of the Science, Technology, and Innovation Act, 2013 (Rev.2014) in Nairobi on the topic: Effects of Input Entrepreneurs' Practices on Inputs Market Participation by Smallholder Dairy Farmers in Tanga and Kilimanjaro for the period ending: 21/November/2023.</b> |  |
| License No: <b>NACOSTI/P/22/22213</b>  |  |
| <b>890761</b><br>Applicant Identification Number   | <br>Director General<br><b>NATIONAL COMMISSION FOR<br/>SCIENCE, TECHNOLOGY<br/>&amp; INNOVATION</b> |
|  | Verification QR Code<br>  |
| <b>NOTE: This is a computer generated License. To verify the authenticity of this document,<br/>Scan the QR Code using QR scanner application.</b>   |  |
| <b>See overleaf for conditions.</b>  |  |

## Appendix C: Ethical Approval: ILRI



18<sup>th</sup> May 2021

**Our Ref: ILRI-IREC2020-08/2**

International Livestock Research Institute  
P.O. Box 30709 00100 Nairobi, Kenya.

Dear Amos Omore, PhD

**Ref: Approval for minor amendment and renewal of approval for ‘Agri-entrepreneurship, technology uptake and inclusive dairy development in Tanzania’**

Thank you for submitting your request for minor amendment to the International Livestock Research Institute (ILRI) Institutional Research Ethics Committee (IREC). ILRI IREC is accredited by the National Commission for Science, Technology and Innovation (NACOSTI) in Kenya, and approved by the Federalwide Assurance (FWA) for the Protection of Human Subjects in the United States of America.

This is to let you know that ILRI IREC has reviewed and approved your request for minor amendment and renewal of approval as per IREC Form 3 and IREC Form 4 dated 1<sup>st</sup> April 2021. The approval for minor amendment is for ‘dairy producer baseline activity using RHoMIS survey tool’. The approval period is from 18<sup>th</sup> May 2021 to 17<sup>th</sup> May 2021. Note that all other approval conditions as per approval letters referenced ILRI-IREC2020-08 and ILRI-IREC2020-08/1 remain the same.

For further clarification or information you may require, call on ILRI IREC on [ILRIResearchcompliance@cgiar.org](mailto:ILRIResearchcompliance@cgiar.org).

Yours Sincerely,

**Elise Schieck, PhD**  
**Chair, ILRI Institutional Research Ethics Committee**

Documents received & reviewed:

- IREC Form 3 & IREC Form 4 dated 1<sup>st</sup> April 2021
- Consent Form, RHoMIS tool & sampling protocol

Patron: Professor Peter C Doherty AC, FAA, FRS

Animal scientist, Nobel Prize Laureate for Physiology or Medicine–1996

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Email ILRI-Ethiopia@cgiar.org

ILRI has offices in East Africa • South Asia • Southeast and East Asia • Southern Africa • West Africa

## Appendix D: Sample Size Calculation for Smallholder Dairy Households

| Indicator  | Change due  |                            | ICC<br>(within<br>Ward)<br>assumed | No.<br>/ Ward<br>Group | No.<br>Wards<br>per<br>Group | Total HH<br>per Group<br>(incl. 20%<br>drop-out) |
|--|---|----------------------------|------------------------------------|------------------------|------------------------------|--|
|  | to<br>intervention<br>vs. Change in<br>control<br>(%mean) | S.D.<br>assumed<br>(%mean) |                                    |                        |                              |  |
| Milk Revenue per year (for households keeping cows) 90% (USD)    |   | 300%                       | 0.03                               | 26                     | 12                           | 390  |
| Farm Income per year (households keeping cattle) 70% (USD)       |   | 230%                       | 0.03                               | 24                     | 12                           | 360  |
| Milk Lactation Yield (Local, Exotic, and cross combined) 60%     |   | 110%                       | 0.17                               | 15                     | 12                           | 225  |
| Food Consumption Score (cattle-keeping households only)          |   | 32%                        | 0.01                               | 16                     | 12                           | 240  |
| Food Consumption Score for MILK (cattle-keeping households only) |   | 42%                        | 0.05                               | 16                     | 12                           | 240  |

---

|  |       |            |
|--|-------|------------|
| Total households (2 groups) using highest Indicator requirement: | 24    | 780        |
|  | wards | households |

---

**Appendix E: Questionnaire: Smallholder Dairy Farmers**

**DAIRY INPUTS AND SERVICES, INPUT ENTREPRENEURS' PRACTICES AND  
SMALLHOLDER DAIRY FARMERS PARTICIPATION IN INPUT MARKETS  
QUESTIONNAIRE**

**General Information**

**SECTION C: HOUSEHOLD IDENTIFICATION**

|                      |      |        |
|----------------------|------|--------|
| Questionnaire number | Code | Name   |
| Interviewer's Name   |      |        |
| Starting time        |      |        |
| Region name          |      |        |
| District name        |      |        |
| Block/Ward name      |      |        |
| Village name         |      |        |
| Target species       |      | Cattle |
| Respondent name      |      |        |
| Telephone number     |      |        |

**Introduction and Consent**

My name is ..... I have been employed by ILRI, to conduct a survey on household livelihoods and farming practices. I would like to ask you some questions about your farming practices, other work you might do, foods that you eat in your household, and also who does what jobs. The interview will take about one hour. Everybody is asked the same questions. You will not be judged in any way, and your identity kept anonymous. If you don't want to answer something, that will not cause a problem. We will use the information which you give us to plan for more successful projects in your communities in the future. Do you have any questions?

Do you consent to provide information for this survey?

Yes..... No..... No answer.....

If you agree, please make a mark or signature here.....

**SECTION B: HOUSEHOLD DEMOGRAPHICS**

**Household Head Information**

What is the name of the household head? .....

What is the sex of the household head? 1=Male..... 0=Female.....

Is the household head married?

1=Has Partner – married or non-married 2=Woman – single, widowed, divorced etc., 3=Man – single, widowed, divorced etc., 4=No answer

What is the highest level of education the head person has completed?

1=No school, 2=Primary, 3=Secondary, 4=post-Secondary, 5=Adult education, literacy school or parish school, 6=No answer

What is the age of the household head?.....

Does this person often live or work away from home? 1=Yes..... 0=No.....

How many people live in your household?

| Number of adults in the household | Number of children in the household | Total household size |  |
|-----------------------------------|-------------------------------------|----------------------|--|
| Male.....Female.....              | Male.... Female.....                |                      |  |
| Total.....                        | Total.....                          |                      |  |

**LAND USE**

Does your household own land, rent land, use common land?

1=Own land, 2=rent land for own use, 3=rent out land to others, 4=use common land 5=No, don't use any land, 6=No answer

If own land, amount of land owned (in acres).....

Does your household grow any crops? 1=Yes..... 0=No.....

**SECTION C: LIVESTOCK PRODUCTION**

Which Livestock does your household keep?

Cattle.... Buffalo.... Goats..... sheep.... Pigs.....Chicken.... Turkeys.... Other birds....  
Rabbits.... Donkeys... Fishes... Bees... Others(mention)....

Indicate Livestock species count kept by household.....

How many head of cattle does your household own? .....

Does your household use any grazing land for your animals? 1=Yes..... 0=No.....

Does your household keep any of your livestock in stables or pens? 1=Yes.... 0=No.....

How many cattle do you have? .....

Among the total head of Cattle you are keeping, how many are of:

Local breeds?..... Improved breeds?.....

Does your household collect milk from the Cattle? 1=Yes..... 0=No.....

How many Cattle did you milk per day when they were milking well in the last 12 months?

.....

About how much milk did the Cattle produce when they were milking well during the last 12 months? .....

For how many months were you collecting this amount?.....

How many Cattle did you milk per day when they were NOT milking well during the last 12 months? .....

About how much milk did the Cattle produce when they were NOT milking well during the last 12 months?.....

For how many months were you collecting this amount?.....

## **LIVESTOCK PRODUCTIVITY: INPUT USE**

### **ARTIFICIAL INSEMINATION**

Have you used artificial insemination in the last 12 months? 1=Yes..... 0=No.....

Of the total animals in your herd of, how many were born by artificial insemination (AI)?

.....

How many have been serviced by AI in the last 12 months?.....

Who was the AI provider for in the last 12 months?

1=Private AI unit, 2=Public veterinarians or animal health workers, 3=Breeding farm, 4=Self-AI performance 5=others

How much did you spend on AI in the last 12 months?.....

Which private providers delivered the AI service to your cattle? (if project Inputs and service entrepreneur, write their code).....

What is the name of the private AI provider "other"?.....

How many have been serviced by an outside male animal in the last 12 months?

.....  
How much did you spend on the outside male service in the last 12 months?  
.....

**ANIMAL HEALTH**

Which disease syndromes are the most significant for your cattle?.....

Did any of the cattle have clinical signs of these illnesses during the last 12 months?

1=Yes, 0=No

How many cattle had these conditions?.....

Did you use any medicines for your cattle in the last 12 months?

1=Yes, 0=No

Did you buy any vaccines for your cattle from a local vet or pharmacy?

1=Yes, 0=No

For which diseases has your household used the bought vaccines with cattle?.....

How many cattle have been vaccinated in the last 12 months?.....

How much did you spend on this vaccination in the last 12 months?.....

How many cattle have been dewormed in the last 12 months?.....

How much did you spend on the deworming in the last 12 months?.....

How many cattle have been tick-controlled in the last 12 months?.....

How much did you spend on the tick-control in the last 12 months?.....

How many cattle have been treated for sickness in the last 12 months?.....

How much did you spend on treatments for the last 12 months?.....

Who were your animal health providers for cattle in the last 12 months?

1=Public, 2=Private, 3=Others (mention)

Which private providers delivered health services to your cattle (if project Inputs and service entrepreneur, write their code)?

.....

### **LIVESTOCK FEEDING**

What do you feed the cattle?.....

Which feeding systems are you using for your cattle?

1=Grazing, free (incl. scavenging), 2=Grazing, herded, 3=Grazing in a fenced paddock, 4=Tethering, 5=Supplementary feeding, 6=Stall-feeding (incl. cut & carry)

Which feeds did you purchase?.....

In which months did you buy feeds for cattle in the last 12 months?.....

Who were your feed suppliers for cattle in the last 12 months?

1=Public, 2=Private, 3=Others (mention)

From which suppliers did you buy feeds (if project Inputs and service entrepreneur, write their code)?.....

What was the estimated cost of feeds you purchased in the last 12 months?.....

### **ADVISORY SERVICES**

If you need advice or information for your cattle on breeding matters, where do you get advice from?

If you need advice or information for your cattle because of its health, where do you get advice from?

If you need advice or information for your cattle for feeding and feed matters, where do you get advice from?

Choices for the 3 questions:

1=Public veterinarians or animal health workers, 2=Private veterinarians or animal health workers, 3=Agricultural and vet input supplier shop, 4=Extension worker (gov), 5=Local co-op,

6=NGO, 7=On-line sources, 8=Other farmers, 9=Own judgement, 10=Other (please specify),  
11=Never receive advice

Specific private extension providers that have provided extension to you (if project Inputs and service entrepreneur, write their code).....

Time finished.....

## **Appendix F: Questionnaire: Inputs and Services Agri-entrepreneurs**

### **Participant consent form**

I work for the International Livestock Research Institute (ILRI) or TALIRI (if applicable). ILRI is an international research organization on livestock development in developing countries. In Tanzania, ILRI is working towards to promoting proven technologies and innovations in the livestock sector. This study's results research will generate strategic evidence needed to inform the evolving environment of rural commercialization in dairying, thereby increasing smallholder competitiveness, household income and consumption of safe milk in Tanzania. The project is funded by the CGIAR research program on Livestock.

I will ask you questions, for example, about the structure, conduct and performance of your dairy-related businesses. However, any information that we collect about you as part of this activity will be kept confidential. Any information that identifies you will be kept safely in our computer and will not be shared with or given to anyone except used to generate averages by the researchers in this project. However, the findings from this research will be put in publicly accessible databases and used by researchers and others with aim to support and improve dairy industry in Tanzania – both within and outside of Africa – to help understand the impacts promoting proven dairy technologies and innovations. Participation in this research is entirely voluntary, and refusal to participate will not result in a penalty or a loss of benefits to which the research participant is otherwise entitled, and therefore, you may discontinue participation at any time on the process. However, it is our hope that findings from this study will provide lessons on how best agribusiness efficiency and profitability can be improved leading to smallholder dairy competitiveness in Tanzania.

No risks anticipated in this study, except for loss of your time during the interview. However, we hope to finish the interview in less than 2 hours. If you experience any discomfort during the interview do not hesitate to inform me (or other researchers in this study who shall advice you on the action to take). The results report will be shared with you as soon as it is ready in a simple form. The research study has been reviewed by the relevant authorities who have approved it.

**Certificate of Consent**

I have read/heard the foregoing information, or it has been read to me or translated to me. I have had the opportunity to ask questions . I consent voluntarily to participate in this research.

Name of Participant/respondent \_\_\_\_\_

Date\_\_\_\_\_

Signature/thumb print \_\_\_\_\_

Name of person/enumerator obtaining consent\_\_\_\_\_

Date\_\_\_\_\_

Signature \_\_\_\_\_

**Contact**

**Name of main researcher:** Dr. Amos Omore

**Institution:** International Livestock Research Institute

**Telephone:** XXXXXX; **Email address:** [a.omore@cgiar.org](mailto:a.omore@cgiar.org)

**Section A: Background information**

|                     |  |                   |            |
|---------------------|--|-------------------|------------|
| 1. Questionnaire ID |  |                   |            |
| 2. Region           |  |                   |            |
| 3. District         |  | 4. Village        |            |
| 5. Division         |  | 6. Date of Survey | --/--/---- |

|         |  |                      |  |
|---------|--|----------------------|--|
|         |  | [DD/MM/YYYY]         |  |
| 7. Ward |  | 8. Enumerator's name |  |

**GPS COORDINATES:** X \_\_\_\_\_ Y \_\_\_\_\_

**Location point of interview (tick)** [ ] = trader's premises [ ] = selling point [ ] = buying point

*interview the person in charge of the agribusiness activities (preferably the owner). Are you interviewing this person?* 1=YES; 0=NO [ ]

|  |               |
|--|---------------|
| 9. What is the <b>name of the respondent</b>   | [____<br>_]   |
| 10. What is the <b>Sex of the respondent</b> 1= Male 2 =Female   | [ ]           |
| 11. When was the respondent born (Age of respondent) - year of birth - YYYY  | [ _ _<br>_ _] |
| 12. Respondent's <b>highest level of formal education (schooling) completed [codes]</b>  | [ ]           |
| 13. Number of years working in this business   | [ ]           |
| 14. What is the respondent's ownership <b>position of respondent in the business [Code]</b><br>1= sole owner/proprietor; 2= joint owner/proprietor; 3= hh member of owner; 4=employee;<br>9=other (specify)  | [ ]           |
| 15. What is the respondent's Work position in business?<br>1= Investor (no direct involvement in running business) 2= Owner (directly involved<br>in running business)<br>3= executive (only strategic decisions, supervision of managers) 4= manager (daily<br>decisions and supervision of workers) 5= worker 9 =other specify____ |               |
| 16. If an employee, what business activities is s/he is in-charge of:<br>1. Buying; 2 = selling products; 6=Both buying and selling; 3 = providing services; 7=<br>buying, selling and providing services; 4 = processing products; 8= buying, processing and<br>selling 5 = administration; 9 = other specify _____                 |               |
| 17. What is the relation of respondent with owner of the business?   | [ ]           |

|  |  |
|--|--|
| 0=Owner; 1. spouse; 2. Son/daughter; 3= Other relative; 4. No blood relation; 9. Other specify |  |
|--|--|

**Section B: Nature of business entity and labor, transport costs**

|  |   |     |
|--|---|-----|
| 18. Name of the owner of the business ( <i>note: only ask if the respondent is not the owner</i> )   | [ ]   |     |
| 19. Sex of the owner of the business 1= Male 2 =Female ( <i>note: only ask if the respondent is not the owner</i> )  | [ ]   |     |
| 20. Owner's age ( <i>note: only ask if the respondent is not the owner</i> )   | [ ]   |     |
| 21. Owner's <b>highest level of formal education (schooling) completed</b> 88=Don't know ( <i>note: only ask if the respondent is not the owner</i> )  | [ ]   |     |
| 22. Owner's number of years working in this business 88=Don't know   | [ ]   |     |
| 23. Is the business owner also a farmer? 1 = YES 0= No   | [ ]   |     |
| 24. What is the name of the business? ( <i>if no name, use the name of the owner</i> )   | [ ]   |     |
| 25. When was the business started (Year)? – yyyy   | [ ]   |     |
| 26. What is the nature of your business entity? 1 = sole proprietorship (registered); 2 = partnership (registered); 3 = private company (registered); 4 = public company (registered) 6 = Government parastatal/corporation; 5 =Cooperative or Self/help; 7 = non-registered Sole proprietor; 8=non-registered partnership; 99 = other (specify) | [ ]   |     |
| 27. Does the business engage in this type of Business?<br>1 = YES<br>0= NO   | a. Trade in feed products   | [ ] |
|  | b. Trade in genetics (products)   | [ ] |
|  | c. Trade in health products   | [ ] |
|  | d. Provision of feed services (e.g. processing)                           | [ ] |
|  | e. Provision of genetics services (e.g. AI services)                      | [ ] |
|  | f. Provision of health services (e.g. curative and preventive treatments) | [ ] |
|  | g. Provision of Biogas/manure management products/services                | [ ] |
|  | h. Provision of extension (advisory services)                             | [ ] |
| j. credit provision e.g. loans, goods/services on credit, check-off, etc?  |   | [ ] |
| 28. On what species of livestock is your business mainly focusing? 1 = cattle; 2 = goats; 3 = sheep; 4 = donkey; 5 = poultry; 9 = other  | [ ][ ][ ]   |     |
| 29. Does the business employ workers on full-time basis? 1 = YES 0= NO   | [ ]   |     |

|  |         |
|--|---------|
| 30. Does the business employ casuals (i.e. temporary worker on a daily wage rate)? <b>1 = YES 0= NO</b>  | [_____] |
| 31. Is the business operated as a family business i.e. (run by spouse, children, relatives)/ employs interns and volunteers?<br><b>1 = YES 0= No</b>   | [_____] |
| 32. If Yes, is the family labor/interns and volunteers unpaid? 1=YES 0=NO  |         |
| 33. How many permanent branches/outlets does the business have?  | [_____] |
| 34. How many temporary branches/outlets did the business use in the last 12 months?  | [_____] |
| 35. How does the business deliver products to its clients?<br><b>1= pick up by buyer; 2 = deliver to buyer; 9 = Other (specify) _____</b>  | [_____] |
| 36. If you deliver, who pays for the cost of delivery?   | [_____] |
| <b>1 = Separate payment by buyer; 2 = included in the price; 3 = Free delivery within a certain radius; 4. Paid by seller 9= Other _____</b>   | [_____] |
| 37. What is the most common <b>payment method</b> used to receive payment for the products (milk, feed, medicines etc) and services sold by the business?<br><b>1 = buyer pays on delivery; 2 = arrears verbal contract (buyer pays in arrears e.g. end of the month); 3 = arrears written contract (buyer pays in arrears e.g. end of the month), 4 = advance verbal contract (buyer pays in advance); 5= advance written contract (buyer pays in advance); 9 = Other (specify) _____</b> | [_____] |

**Section C: Conduct and performance of providers of AI, VETERINARY PRODUCTS/SERVICES, and LIVESTOCK FEEDS**

|   |  | AI<br>(only) | Agrovets and animal<br>health products/<br>services (including AI<br>vaccines & feeds) | Vaccine<br>(Only) | Livestock<br>Feed<br>(Only) |
|---|--|--------------|--|-------------------|-----------------------------|
| 38. How do you trade in these products? <b>1 = yes (only) 2=Yes,combined with other products/services 0= no</b> |  | [ ]          | [ ]  | [ ]               | [ ]                         |
| 39. If yes  | a. Do you offer as a:<br>1=wholesaler 2=distributor 3= retailer 4= service provider? ( <i>all except milk traders</i> )<br>1= Mobile trader (producer) 2= Mobile trader (non-producer)<br>3=Transporter-trader 4=Milk bars 5=Milk dispensers 9=Other<br>specify ( <i>instruction: for milk traders</i> ) | [ ]          | [ ]  | [ ]               | [ ]                         |
|   | b. Do you offer call service and deliver to the farm? 1 = YES 0= NO  | [ ]          | [ ]  | [ ]               | [ ]                         |
| 40. Do you offer services for [ <i>product/service category</i> ] that are paid for? <b>1 = YES 0= NO</b>       |  | [ ]          | [ ]  | [ ]               | [ ]                         |
| 41.   | a. Of the total services offered, how many were ECF vaccination services?  |              |  |                   |                             |
|   | b. What describes the availability of equipment/ support services for delivering services?   | [ ]          | [ ]  | [ ]               | [ ]                         |

|   |   |                |             |             |             |
|---|---|----------------|-------------|-------------|-------------|
|   | <p><b>1= readily available throughout the year; 2= Available most of the time; 3= so-so (sometimes available, sometimes not available; 4 =Unavailable most of the time; 5. Not readily available – very difficult to find</b></p> |                |             |             |             |
| 42. Do you provide specialized advice on services in your area of trade? <b>YES</b> | <p><b>0= NO</b></p>   | [ ]            | [ ]         | [ ]         | [ ]         |
| 43. If yes, to who?   | <p><b>1=farmers; 2=fellow traders (peers); 3=traders (my clients); 4= both farmers and my clients;9=other specify</b></p>   | [ ]            | [ ]         | [ ]         | [ ]         |
| 44. What is the main media you use to deliver the advice?                           | <p><b>1=Brochure/documents;2= Face to face (individual); 3= Face to face (organized meetings); 4= Campaign in the congregation (church/market etc 5= Digital (phone/ website); 9= Other specify</b></p>                           | [ ]            | [ ]         | [ ]         | [ ]         |
| 45. What is nature of the advice do you give?                                       | <p><b>1 = determine product or service requirements; 2 = best use of products (how, when, frequency); 3 = Technical e.g. storage, equipment; 4 = Marketing/ sales 9 = other (specify) ___</b></p>                                 | [ ] [ ]<br>[ ] | [ ] [ ] [ ] | [ ] [ ] [ ] | [ ] [ ] [ ] |
| 46. What other arrangements do you have with your clients?                          | <p><b>0= No other arrangement; 1= Providing goods or services on credit; 2=Bundling products and services e.g. check-off; 3= Providing loans; 4= discount offers, 5=sales promotions; 9 = Other specify ___</b></p>               | [ ] [ ]<br>[ ] | [ ] [ ] [ ] | [ ] [ ] [ ] | [ ] [ ] [ ] |

|   |      |      |      |      |
|---|------|------|------|------|
| 47. Is the business required to obtain any regulatory permits/licenses to operate your business?<br>1 = YES 0= NO   | [__] | [__] | [__] | [__] |
| 48. If yes, did you obtain a business License to operate your business in the last 12 months ( <i>June 2020 to May 2021</i> )? 1 = YES 0= NO 3=NOT REQUIRED | [__] | [__] | [__] | [__] |

### Section F: General business trends

|   |                   |
|---|-------------------|
| 49. In the past months/ years, have you consulted any BDS (business development services) to improve your business performance?<br>Yes/No   |                   |
| 50. If yes, which one?<br>Business incubator model(S); 2= consultants 3=mentors 4= training programs 5= business advisors (on diversification of products and sales channels, on business continuity planning &/or access to cash / short-term finance etc) 6-Online business management training   |                   |
| 51. What training would you like to have to sustain or improve your business performance? 1= Financial management 2. Personal effectiveness; 3. Entrepreneurship. 4. Technical skills on feed production; 5= Technical skills on manure management; 6= Technical skills on ECF vaccine and disease management, 7= Technical skills on AI, 8= Technical skills on digital platforms 9= other specify | [__] [__]<br>[__] |
| 52. Do you have linkages with the dairy producer organization in the area 1 = YES 0= No   | [__]              |

|   |     |
|---|-----|
| 53. Do you have linkages/ networks with other dairy enterprises in the area                           | [ ] |
| 54. Do you maintain records of your business activities? Yes/ No                                      |     |
| 55. If yes, how? 1= written registers; 3= on a computer; 9= any other way (please specify)            |     |
| 56. Are you a member of any professional association of traders/ service providers? Yes/No            |     |
| 57. In the past months/years, have you benefitted from any development programme (government or NGO)? |     |
| 58. Do you link your customers (farmers) to feed products providers? 1=Yes 0=NO                       |     |
| 59. Do you link customers (farmers) to genetics (eg AI) providers? 1=YES 0=NO                         |     |
| 60. Do you link your customers (farmers) to animal health services eg vaccines, providers? 1=YES 0=NO |     |
| 61. Do you link customers (farmers) to extension service provider? 1=YES 0=NO                         |     |

**Appendix**

**G:**

**OLS**

**Regression**

**Raw**

**Output/Results**

```

. reg Input_Exp_USD HH_size i.Pastureland_Use HH_head_age landowned livestock_count cattle_Number i.
> LC1 i.LC2 i.LC3 i.HH_Gender i.HH_Workaway i.Livestock_Stabled i.HH_Educ_Lvl i.Milk_harvest i.Grow_C
> rops i.HH_type milk_number_animals_milked_good_milk_amount_good_season_1 milk_number_animals_milke
> d_bad_s milk_amount_bad_season_1 i.district

```

| Source   | SS         | df  | MS         | Number of obs | = | 152    |
|----------|------------|-----|------------|---------------|---|--------|
| Model    | 236510.43  | 28  | 8446.80108 | F(28, 123)    | = | 2.96   |
| Residual | 350854.622 | 123 | 2852.4766  | Prob > F      | = | 0.0000 |
|          |            |     |            | R-squared     | = | 0.4027 |
|          |            |     |            | Adj R-squared | = | 0.2667 |
| Total    | 587365.052 | 151 | 3889.83478 | Root MSE      | = | 53.409 |

| Input_Exp_USD                    | Coefficient | Std. err. | t     | P> t  | [95% conf. interval] |           |
|----------------------------------|-------------|-----------|-------|-------|----------------------|-----------|
| HH_size                          | -3.3738     | 2.673284  | -1.26 | 0.209 | -8.665401            | 1.917801  |
| Pastureland_Use                  |             |           |       |       |                      |           |
| Y                                | 3.408165    | 12.84111  | 0.27  | 0.791 | -22.01002            | 28.82635  |
| HH_head_age                      | -.2898669   | .4260758  | -0.68 | 0.498 | -1.133258            | .553524   |
| landowned                        | -.7692821   | 1.013515  | -0.76 | 0.449 | -2.775473            | 1.236908  |
| livestock_count                  | 1.966173    | 6.19654   | 0.32  | 0.752 | -10.2995             | 14.23184  |
| cattle_Number                    | .6523376    | 2.055997  | 0.32  | 0.752 | -3.417382            | 4.722057  |
| 1.LC1                            | 79.51162    | 21.85828  | 3.64  | 0.000 | 36.24449             | 122.7787  |
| 1.LC2                            | 87.68703    | 22.52875  | 3.89  | 0.000 | 43.09276             | 132.2813  |
| 1.LC3                            | 52.02051    | 22.12572  | 2.35  | 0.020 | 8.224008             | 95.817    |
| HH_Gender                        |             |           |       |       |                      |           |
| m                                | 18.68538    | 20.37982  | 0.92  | 0.361 | -21.65523            | 59.02599  |
| HH_Workaway                      |             |           |       |       |                      |           |
| Y                                | 6.185619    | 13.13094  | 0.47  | 0.638 | -19.80627            | 32.17751  |
| Livestock_Stabled                |             |           |       |       |                      |           |
| Y                                | 26.59045    | 11.25787  | 2.36  | 0.020 | 4.306188             | 48.87472  |
| HH_Educ_Lvl                      |             |           |       |       |                      |           |
| Primary                          | -91.37665   | 30.6522   | -2.98 | 0.003 | -152.0508            | -30.7025  |
| secondary                        | -95.81505   | 32.60013  | -2.94 | 0.004 | -160.345             | -31.2851  |
| postsecondary                    | -71.29492   | 37.29773  | -1.91 | 0.058 | -145.1235            | 2.533653  |
| adult_education                  | -109.9487   | 41.63065  | -2.64 | 0.009 | -192.354             | -27.54337 |
| Milk_harvest                     |             |           |       |       |                      |           |
| Y                                | -18.81232   | 16.56615  | -1.14 | 0.258 | -51.60399            | 13.97935  |
| Grow_Crops                       |             |           |       |       |                      |           |
| Y                                | -30.641     | 35.71446  | -0.86 | 0.393 | -101.3356            | 40.05359  |
| HH_type                          |             |           |       |       |                      |           |
| couple                           | 26.3289     | 20.4788   | 1.29  | 0.201 | -14.20762            | 66.86542  |
| milk_number_animals_milked_good_ | 20.24288    | 8.443144  | 2.40  | 0.018 | 3.530194             | 36.95557  |
| milk_amount_good_season_1        | 1.304878    | 1.083871  | 1.20  | 0.231 | -.8405795            | 3.450335  |
| milk_number_animals_milked_bad_s | -4.021605   | 7.740151  | -0.52 | 0.604 | -19.34276            | 11.29955  |
| milk_amount_bad_season_1         | -1.356966   | 1.510444  | -0.90 | 0.371 | -4.346796            | 1.632865  |
| district                         |             |           |       |       |                      |           |
| 1025                             | -34.36848   | 18.23239  | -1.89 | 0.062 | -70.45839            | 1.721423  |
| 1026                             | -9.577421   | 16.88719  | -0.57 | 0.572 | -43.00459            | 23.84974  |
| 1027                             | -20.29639   | 15.28946  | -1.33 | 0.187 | -50.56093            | 9.96816   |
| 1072                             | -14.42377   | 21.91089  | -0.66 | 0.512 | -57.79503            | 28.94749  |
| 1075                             | -5.217817   | 15.91969  | -0.33 | 0.744 | -36.72987            | 26.29423  |
| _cons                            | 62.33322    | 53.45054  | 1.17  | 0.246 | -43.46885            | 168.1353  |

## Appendix H: Publication

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### Dairy input agri-entrepreneurs' practices and their effect on inputs market participation by smallholder farmers in Tanzania

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#### ABSTRACT

Dairy productivity per cow remains lower than the production ability amid increasing population. Among major reasons for this is the lower uptake of improved dairy inputs by smallholder dairy farmers. We characterized dairy input providers' business practices using Latent class analysis (LCA) and determined the effect of these business practices on the uptake of inputs by smallholder dairy farmers in Tanga and Kilimanjaro regions using OLS. From LCA, Bayesian Information Criteria (BIC) revealed a 3-class model as the most parsimonious and best fit (2153.071). The latent class (LC) membership of the input/service entrepreneurs for classes I, II, and III was 37.6% (35), 9.7% (9), and 52.7% (49), respectively. Using item response probabilities, we classified class I, II and III as 'High business activities and business promotional practices', 'Low business activities, medium business promotional activities', and 'Medium business activities, Low business promotional activities'. Extension services provision was significant across all the classes with probability values greater than 0.5. The OLS model revealed that LC I and II were significant at 1% while LC III was significant at 5%. Education level and Moshi Rural District were negatively significant. Technical training of input entrepreneurs and capacity building on bundling relevant information alongside inputs is necessary for knowledge sharing with farmers. Networking, collaborations, and alliances among input/service entrepreneurs and between entrepreneurs and dairy farmers should be fostered for adequacy in technical information sharing and connecting farmers to other input suppliers. There is need for entrepreneurs to invest in rural areas and improve information and input access by the farmers. The study explored private dairy entrepreneurs as alternative extension services providers as a business strategy to enhance uptake of improved inputs by smallholder farmers. This study is relevant in making workable decisions towards implementing programmes geared towards increasing the improved input uptake in developing countries.