

**Milk production and marketing channel decisions of smallholder farmers
in the Zambian milk value chain**

by

Tulumbe Cheelo

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DECLARATION

I, **Tulumbe Cheelo**, declare that the dissertation, which I hereby submit for the Master of Science degree in Agricultural Economics at the University of Pretoria, is my own work and has not previously been submitted by me for a degree at this or any other tertiary institution.

Signature.....

Date: 28th July 2019

DEDICATION

To my dear late parents, Mr Boniface Cheelo and Mrs Christine Namweemba Cheelo, and to my siblings.

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LIST OF ACRONYMS AND ABBREVIATIONS

ACF	Agriculture Consultative Forum
AI	Artificial Insemination
CAADP	Comprehensive Africa Agriculture Development Programme
CFU	Conservation Farming Unit
CSO	Central Statistical Office
DAZ	Dairy Association of Zambia
DIDA	Dairy Industry Development Act
DPB	Dairy Produce Board
EU	European Union
FAO	Food and Agriculture Organization
FISP	Farmer Input Support programme
FRA	Food Reserve Agency
GDP	Gross Domestic Product
IAPRI	Indaba for Agricultural Policy Research Institute
ICA	Inter-locked Contractual Arrangements
IAs	Independence of Irrelevant Alternatives
MCC	Milk Collection Centre
NAIP	National Agriculture Investment Policy
NAP	National Agricultural Policy
NDP	National Development Plan
NYP	National Youth Policy
OLS	Ordinary Least Squares
RALS	Rural Agricultural Livelihoods Survey

SAPs	Structural Adjustment Programmes
SDG	Sustainable Development Goal
WHO	World Health Organization
ZDPA	Zambia Dairy Processors Association
ZNFU	Zambia National Farmers' Union
ZMW	Zambian Kwacha

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ABSTRACT

Dairy farming is a source of livelihood and a major income source for many of the rural Zambian farmers. The importance of the dairy sector cannot be overemphasised as its development has capacity to increase job creation and wealth generation. The sector makes insurmountable contributions to the nutrition status of the country and to the financial gains to the various value chain stakeholders. In an attempt to further develop these financial gains, several initiatives have been developed to encourage smallholder farmers' participation in the sector, and more so, for women and the youth. Nonetheless, there is still low participation by these interest groups. This study aims to understand the factors that influence smallholder farmers' decisions to participate in the Zambian dairy value chain, and particularly in terms of milk production and the selection of different marketing channels.

The objectives of the study are therefore to: (i) determine the factors that influence smallholder farmers' decisions to participate in milk production and the factors that influence milk volumes or milk production in Zambia, (ii) identify the factors influencing the choice of milk marketing channels among smallholder farmers in the Zambian milk value chain, and (iii) examine the characteristics of the youth and women in the milk production, as they compare with the characteristics of the control groups (non-youths and men).

To address the study objectives, quantitative cross-section secondary household data collected in 2015 by the Indaba for Agricultural Policy Research Institute (IAPRI) in the Rural Agricultural Livelihoods Survey (RALS) was used. "The RALS was implemented to provide

policy-relevant information that is not practical to collect annually from the government's agricultural surveys" (IAPRI, 2016). The study used data from the RALS from five key milk producing provinces of Zambia, namely the Central, Southern, Eastern, Lusaka and Western provinces. These constituted a total sample of 3574 randomly selected farming households. The study made use of both descriptive statistics and econometric modelling to analyse the data and present the findings. Specifically, the Heckman selection model (HSM), multinomial logit models, and an independent t-test were utilised.

The HSM was run on 2477 valid observations to address the first objective: to determine the factors that influence smallholder farmers' decisions to participate in milk production and the factors that influence milk production in Zambia. The HSM is used in order to account for potential biases in the sample selection of milk producers. The model results show that demographic factors, age, gender and education level of the household head, and the household size, affect the participation of farmers in milk production. Other variables were found to influence participation in milk production, such as landholding size, off-farm income, value of productive assets, access to market information, access to extension services, distance to markets and veterinary centres, mobile phone access, and geographical location.

Similarly, herd size, education level and access to extension services, grazing system used, and geographical location were found to be significant predictors of milk production. Results show that these factors have a positive impact on the amount of milk produced by farmers, except for landholding which has a negative influence on milk production.

To investigate the factors that influence the choice of a marketing channel among smallholder farmers, a multinomial logit model is used. Three milk marketing channels were identified, namely direct milk sales, and traditional and modern marketing channels. The valid sample for this model comprised 172 households, being households that both produced milk and participated in milk marketing. According to the multinomial logit model results, choice to participate in the traditional market is positively influenced by gender of the household head and milk yield. Off-farm income and distance to the nearest established market, however, have a negative influence on the selection of the traditional market. Gender of household head has a negative impact on participation in the modern marketing channel, yet education level, distance to major markets and amount of milk yield have a positive influence on choosing a modern marketing channel.

Finally, independent t-tests are used to test whether or not there were statistically significant differences between the characteristics of the women and the youth, against those of other participants in milk production. The sample of milk-producing households comprised 742 households. The study concluded that there are statistically significant differences between the attributes of women and youth farmers, relative to the reference groups (male and non-youth farmers) in the study. This implies that men and/or older farmers have an overarching advantage and capacity to produce milk over women and youth groups.

The study makes a significant contribution to the knowledge base of the Zambian dairy sector. The sector has limited literature to aid in informing policy. Based on the findings, there is a need for government intervention in the form of policy changes and value chain investments to improve milk production and participation in the modern marketing channel or more formal milk marketing channels. To encourage women and youth participation in the dairy sector, there is a need to increase accessibility to market information, support services and transparency in the dairy chain. There is a great need for affirmative action to be implemented towards achieving gender appreciation and empowerment to encourage involvement of women in milk production. For continuity and future development of the sector to materialise, there is need for widespread youth empowerment in areas of milk production.

Keywords: Milk production, milk-value chain, marketing channels, smallholder farmers, youth participation, female participation, Zambia

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CHAPTER ONE: INTRODUCTION

1.1 Background

Agriculture has been proved to play a critical role in the Zambian economy. The Zambian Government identified the agricultural sector as priority to drive the economy for national development in its 7th National Development Plan (7NDP, 2017). The sector caters for around 92% of the rural workforce and over 67% of the country's labour force (Mulemba, 2009; ZEFF et al., 2017). The dairy sector has been identified as a key sector in agriculture to spur development through job creation and to improve nutrition, among other things. The dairy sector offers potential for commercialisation that could lead to increased contribution to Gross Domestic Product (GDP) and has therefore been recognised as an important area for growth (Williams, 2016; World Bank, 2011).

Despite the Zambian dairy sector's potential to bring about economic development, it is faced with challenges. These challenges range from low productivity and limited participation in the available market structures to under-utilisation of the support services. From the time of market liberalisation (1991), the dairy sector saw a meteoric rise in milk production (FAOSTAT, 2018). In spite of this, productivity remains significantly low in most parts of the country, hence perpetuating the inability to meet the current national demand for milk and milk products. Several factors, such as limited access to inputs¹, market accessibility, productive assets and road infrastructure, affect milk productivity, thereby undermining the potential of the dairy sub-sector (Kawambwa et al., 2014; Lubungu et al., 2012). In addition, according to Lubungu (2016), the low milk productivity can be attributed to poor agriculture management practices; that is, poor herd health, among other things. This not only demonstrates the need for formal and informal market development, but also the need to improve infrastructure and access to inputs.

¹For example, access to livestock medicines, improved cattle breeds for milk production, quality feed and technologically advanced dairy equipment.

1.1.1 Overview of the dairy sector in Zambia

In Zambia, as in most developing countries (such as those in South Asia, sub-Saharan Africa and Latin America), the dairy sector can be separated into two major categories: the informal sector and the formal sector (Kumar and Staal, 2010). The informal sector accounts for over 80% of milk produced. In Zambia, the formal sector is made up of 3,000 to 4,000 smallholder and commercial farmers who have access to the formal markets (Houwens and van der Lee, 2018; Mumba et al., 2013; ZEF et al., 2017). On the other hand, the informal sector is made of over 300,000 traditional cattle-owning households who also produce milk, but have no or limited access to modern milk marketing channels for their milk (CSO, 2017; Houwens and van der Lee, 2018; ZEF et al., 2017). According to Kawambwa et al. (2014), in Zambia, at least 80% of milk produced is provided by smallholder farmers, which amounts to about USD 80 million per year in monetary terms. Of the 80% produced by the smallholder farmers, about 90% is traded informally, that is, it does not reach the formal sector. Because of poor access to formal marketing channels by smallholder farmers, Zambia's dairy sector makes a small contribution to the formal sector, a situation that has made Zambia a net importer of milk and milk products (ACF, 2012; Moll et al., 2007). The poor access to formal markets can be attributable to poor infrastructure (markets and roads), lack of access to finance to aid in business operations, and low milk yields, *inter alia* (Kawambwa et al., 2014).

In general, the dairy industry has shown an increasing trend in the production of milk as a result of an increase in human population and number of milking animals (Figure 1.1) (FAOSTAT, 2018; Namonje-Kapembwa and Hichaambwa, 2016). Despite this growth, productivity has remained low; thus, the sector has not been able to meet country demand, even when the country has lower than average consumption patterns (ACF, 2012; Sportel, 2017). According to ACF (2012), about 15% of the country's potential had been tapped into at the time of that report. This means that, with full exploitation of the available resources for the dairy sector, Zambia would be able produce enough milk for domestic consumption and surplus for export (Moll et al., 2007). There is, however, very limited documentation of the milk consumption trends in Zambia.

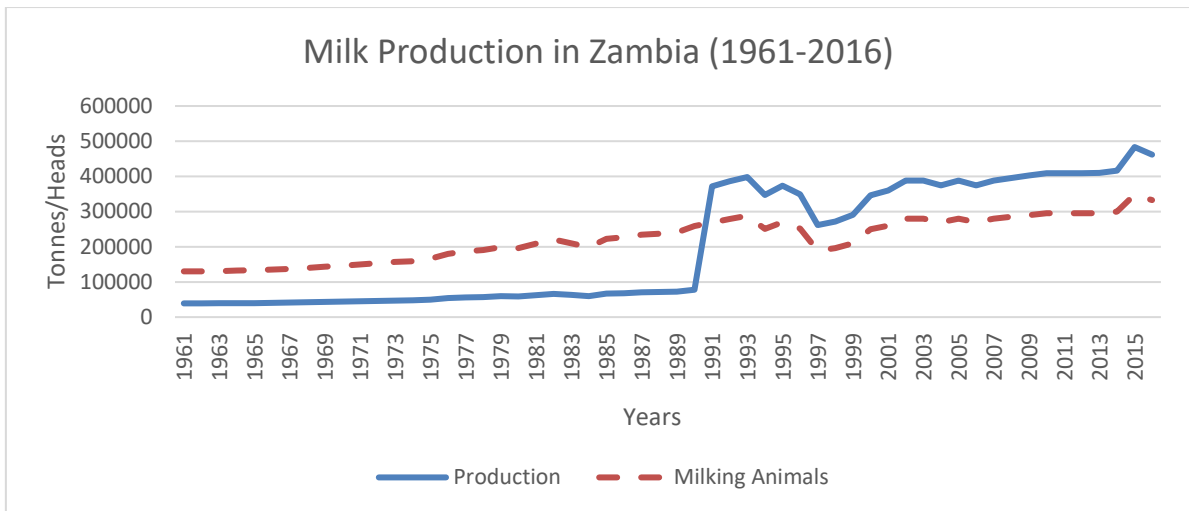


Figure 1.1: Milk Production in Zambia according to FAOSTAT (2018)

Source: Author’s own analysis from FAOSTAT (2018)

To mitigate some portions of this deficit, Zambia imports about 12 million litres of milk per year (Namonje-Kapembwa and Hichaambwa, 2016). In 2017, approximately 21% of the European Union’s (EU) agri-food exports to Zambia were made up of milk powders and whey (EU, 2018). Other milk products, such as yoghurt, cheese, ice cream and milk powders, were also imported from South Africa, Ireland, and Brazil, among others (Kenny and Mather, 2008; Namonje-Kapembwa and Hichaambwa, 2016). Zambia makes exports to Malawi, Angola, Democratic Republic of Congo (DRC), Tanzania and Zimbabwe, (Namonje-Kapembwa and Hichaambwa, 2016). However, these exports contribute a negligible export balance to contribute to the much-needed foreign exchange.

Kawambwa et al. (2014) suggested the use of improved breeds, good management practices and better access to improved feed or fodder, as solutions for mitigating the milk deficit. They highlight the fact that the country has a favourable climate, and sufficient grazing land for even double the current cattle population. Taking advantage of this potential would transform the sector to a net exporter of milk and milk products, thus gaining from the resulting foreign exchange earnings. In addition, a better-performing dairy sector is expected to lead to the improved food security and poverty status of the country. According to Sportel (2017), the dairy sector is under-performing due to poor collaboration in the value chain. Hence, there is a need for investment in the milk value chains and market development by all key players in order to encourage competition and growth through value addition activities (Kawambwa et al., 2014). Increased investment by both private and public sectors

in market development in the chain would stimulate milk participation and production, and ultimately reduce transaction costs incurred in accessing the formal markets by smallholder farmers. This will aid in harnessing the potential, enhancing performance of the sector, and improving farmer profits by increasing the value that accrues to the farmers in the chain. Furthermore, improvement in profit margins stands to act as a pull factor for private sector investment and participation in the dairy markets, especially by the youth and women (Kawambwa et al., 2014; Namonje-Kapembwa and Hichaambwa, 2016).

The next section provides a policy overview of the dairy sector in Zambia. It highlights the policy environment and how it has had an influence on the dairy sector in Zambia. Furthermore, the importance of milk and milk products to the human diet, the farmers and the economy at large are discussed.

1.1.2 The agricultural policy context in Zambia

Prior to 1990, the Zambian dairy sector was dominated by large commercial farmers, mainly European settlers who had taken to farming (Kenny and Mather, 2008). According to Kenny and Mather (2008), these farmers either migrated to Southern Rhodesia (present Zimbabwe) or went back to Europe after Zambia's independence in 1964. During the years leading up to 1991, the formal dairy sector was dominated by a state-owned processor, called the Dairy Produce Board (DPB), that was supplied by parastatal farm establishments and smallholder farmers (Neven et al., 2006; Williams, 2016). This period saw a decline in the number of commercial farmers in dairy production and at the same an increased demand for milk in urban areas (Kenny and Mather, 2008; Williams, 2016). With the help of the IMF and the World bank, structural adjustment programmes (SAPs) were introduced in the 1980s with the aim of stimulating economic growth and transforming the sector. The Market liberalisation of 1991 and Structural Adjustment Programmes (SAPs) have led to the following:

- (i) Privatisation of the Dairy Produce Board (DPB) to Bonnita South Africa, which later sold it to Parmalat, an Italian multinational (Kenny and Mather, 2008). This meant that Parmalat would inherit all the existing infrastructure and has since

remained the largest processor, to date (Namonje-Kapembwa and Hichaambwa, 2016)

- (ii) Market deregulation that brought about new quality standards which saw high quality milk attracting premiums.
- (iii) Reduction of financial and government extension support to the dairy sector, and
- (iv) Trade liberalisation without any import quotas, which saw the market open to regional trade (Neven et al., 2017).

These changes, however, have had both positive and negative impacts. In the short-run, privatisation led to massive job losses from parastatals, and some small enterprises could not survive the new competition resulting from imports of milk and milk products (Neven et al., 2017; Williams, 2016). On the other hand, a slight rise in milk output was experienced during the years of the liberalisation policies in the 1990s, as seen Figure 1.1. In the long-run, however, these changes aided in improving the efficiency of the dairy sector, with private sector investment taking centre stage. For example, before 1990, there was only one processor (state-owned), while there are currently over 20 privately owned milk processors today (Kenny and Mather, 2008; Namonje-Kapembwa and Hichaambwa, 2016).

The reduction in government support to the dairy sector meant that enterprises that became dependent on governments financial and technical support could not survive the new era. This resulted in a demand-driven industry emerging, and the saw the entry of NGOs (such as Land'O Lakes² and SNV³) and the private sector self-organising by providing technical support to smallholder farmers (Houwens and van der Lee, 2018; Williams, 2016). For example, private sector processors, in collaboration with the public sector and NGOs, have been instrumental in establishing MCCs which they then hand over to cooperatives to run to assist in providing access by smallholder farmers to formal markets (Neven et al., 2017). These initiatives have seen a rise in the number of dairy smallholders accessing the formal sector, which has proved to be extremely important and presents viability for sector development (Kawambwa et al., 2014; Kumar and Staal, 2010).

²An NGO championing the combating of food insecurity in Africa, with support from United States of America. For more information, see link. (<https://www.landolakes.org/where-we-work/africa/zambia>).

³An NGO involved in agriculture development with a bias towards the dairy sector and smallholder farmers. It is supported and funded by the government of the Netherlands. For more information, see link (<http://www.snv.org/country/zambia>)

In 2010, Zambia enacted the Dairy Industry Development Act (DIDA) to coordinate activities in the dairy sector in an effort to harness the sector's potential and thus aid in poverty alleviation, creation of jobs and improvement of food security (Neven et al., 2017). In the same vein, a merger between the Zambia Dairy Processor Association (ZDPA) and the dairy committee of the Zambia National Farmers' Union (ZNFU) established the Dairy Association of Zambia (DAZ), which is tasked to represent the interests of all players (farm-to-fork) in the dairy value chain (Houwens and van der Lee, 2018; Neven et al., 2017). This has ensured that all the role players in the value chain have a voice, and that the position of every role player is fairly represented. The lessons learnt from these changes remain critical in establishing mid- and long-term policies for the agricultural sector. Currently, however, there exists no specific policy document that specifically addresses the needs and challenges of the dairy sector, other than those contained in the NAP and the DIDA, as are found elsewhere in countries like South Africa and the Netherlands with flourishing dairy sectors (ACF, 2012; Kawambwa et al., 2014).

More recently, the Zambian government has formulated several mid-term development plans in its pursuit of its commitment to achieve its development agenda for 2030 of becoming a 'prosperous middle-income country by 2030'. The most recent of these is the Seventh National Development Plan (7NDP)⁴ which takes an integrated approach to development. It incorporates the UN SDG agenda 2030 and the AU's 'The Africa we want' agenda for 2063 into a robust document for resilient economic growth. The envisaged outcomes of this plan include, but are not limited to, the reduction in poverty and developmental inequalities, and achieving diversified economic growth and reduced unemployment, and enhanced human development (7NDP, 2017). To achieve these development outcomes, government developed key policies that would guide the implementation process. Some policies in play (with a bias on agriculture) include the National Agriculture Policy (NAP), the National Agriculture Investment Plan (NAIP), the National Youth Policy 2015 (NYP), and the National Gender Policy 2014 (NGP).

Zambia's National Agricultural Policy (NAP) has seen several revisions since the policy was launched in 2004. The revisions to the current NAP 2012–2030 would be necessitated

⁴7NDP was formulated to guide the national agenda for the years 2017 to 2021.

by the need to involve wide stakeholder consultations to establish an inclusive implementation framework. The over-arching mission is ‘to facilitate the development of a competitive, diversified, equitable and sustainable agriculture sector’ (NAP, 2011). The contribution of the sector to national development would include real GDP growth and the alleviation of food insecurity, with government taking centre stage in providing an enabling environment for development. Such an environment would include provisions for the betterment of markets, both input and output markets, to reduce the costs of doing business. Furthermore, government policy should cater for the promotion of sustained cultivation of comparatively advantaged crops for export markets and facilitating equitable access to resources to key players (the youth and women). The NAIP, an elaborate action plan, was established to facilitate the implementation process towards the attaining the NAP objectives. With reference to the Comprehensive Africa Agriculture Programme (CAADP), the complying countries should allocate at least 10% of public expenditure to the agriculture sector and achieve at least 6% sector growth. These aspirations are yet to be realised in Zambia (Chapoto et al., 2018). According to the Africa Development Bank, investing in the agricultural sector is a more effective way to reduce poverty than investing in other sectors, by at least a factor of two⁵. This is because it offers several avenues for income generation and reduction of food insecurity. The NAIP is a map for agricultural development that highlights critical areas of investment and the respective finance needs. Subsequently, the dairy sector has been identified as a critical sub-sector in the agricultural sector to contribute to economic growth.

The NGP was first adopted in 2000 and revised in the 2014 policy document. The policy is aimed at achieving full participation by both women and men in the development agenda of the country at all levels, taking into account challenges faced by women (NGP, 2014). This is to achieve equitable and sustainable development through the contribution of both sexes. The policy takes cognisance of the changing socio-economic landscape and the persistent feminisation of poverty, and thus it has been aligned with the objectives of the NDP. In terms of agriculture, the policy identifies agriculture as a labour absorbing and a major source of livelihoods for over 85% (comprising 85% females and 87% males) of rural households (NDP, 2014). The women, however, are viewed to carry out work that is more

⁵Agriculture Sector Strategy 2010-2014, African Development Bank; World Development Report 2008: Agriculture for Development, World Bank.

reproductive, as opposed to productive work. As a result, little attention is paid to their access to, and control of, productive resources, such as credit, land, energy, extension services, and farm implements, when compared with men (NDP, 2014). The policy therefore aims to address these ills among others.

The NYP, as informed by the demographic trends and the NDP, recognises the importance of youth participation and involvement in national development. The youth in Zambia, as in sub-Saharan Africa, make up the majority of the population (NYP, 2015; Girard, 2017). The policy acts as a strategic document to effectively, efficiently and sustainably realise youth development that is relevant to the Zambian context. It specifically addresses emerging issues such as bridging gaps and tackling challenges in youth development through strategic policy interventions; defining youth and identifying sub-groups to ensure targeted interventions; and identifying and mitigating risk factors (NYP, 2015).

These policies are generally intertwined, and so achievements on some smaller objectives would also contribute to the achievement of the mission and vision of the sector and country's development agenda. This study therefore wishes to provide evidence-based analysis of needy areas in the dairy sector. By understanding these policies, the analysis herein can be used to make policy recommendations to assist with the achievement of the objectives in the NDP as set out by government. As a result, this would bring about the development of a sustainable and competitive dairy sector. Lack of evidence inhibits planning and implementation efforts of the relevant policies. The next section highlights the importance of the dairy sector.

1.1.3 Importance of the dairy sector

Globally, the dairy sector has been identified as a paramount sector with regard to rural development (Britt et al., 2018; Kawambwa et al., 2014). The relevance of milk and milk products cannot be overemphasised, both for the farmers and for the economy. As such, it has been identified as a key sub-sector to help stimulate economic growth in a country. The benefits of milk and milk products range from economic to social benefits, including GDP contribution through trade and job creation, and balanced nutrition, which ultimately aims to improve food security.

In sub-Saharan Africa (SSA), the dairy sector shows much potential for growth through the formalisation of the dairy sector (Kawambwa et al., 2014; Moll et al., 2007). The sector makes a contribution to GDP through the trade of milk and dairy products in the value chain and through jobs created in the chain (Namonje-Kapembwa and Hichaambwa, 2016). Employment opportunities in the dairy sector range from farm-level jobs, processor-level jobs, and retail jobs to a number of service or support jobs within the dairy value chain (Mumba et al., 2013). For example, according to Nyangito (2004), not less than four jobs are created every time 100 litres of raw milk is collected, processed and marketed. Similarly, each time a million litres of milk is supplied and distributed per year, about 200 new jobs are made available (Mumba, 2012). This ultimately leads to an increase in the economic growth or GDP of a country. For instance, countries like Kenya and Uganda receive substantial sector contributions from milk, of over 50%, towards agricultural GDP (Balirwa et al., 2016).

The westernisation of diets in Zambia, and the region, has led to an increase in the demand for milk and milk products (Kawambwa et al., 2014). In addition, the increase in demand for dairy products can be attributed to increasing country and regional populations, and to increased consumer awareness of the benefits of dairy products (Houwens and van der Lee, 2018).

Milk and other dairy products are good sources of high-quality protein and other micronutrients that are important to human diet. They have been identified to provide essential nutrients more efficiently than other foods do (Britt et al., 2018). According to Peters et al., (2016), diets that are primarily based on dairy products are superior to other diets. For instance, they are more nutritious than vegan-, omnivore-, and egg-based diets, and they maximise the use of croplands (Peters et al., 2016). This is because dairy products are a high source of quality protein and essential micronutrients. Therefore, strides made in improving the dairy sector will enable increased access to high-quality protein and micronutrients sources and thus contribute to the attainment of Sustainable Development Goal (SDG) Number 2: End hunger, achieve food security and improved nutrition and promote sustainable agriculture (Nilson, 2017).

Britt et al. (2018) forecast that the development of the dairy sector in terms of access to better information, technology and breeds would help to meet the future challenges of feeding the world's population with nutritious food. They propose the intensification and adoption of sustainable production practices as solutions to boost milk output. An increase in production volumes of milk in the country through the increased participation of farmers in the dairy sector is expected to lead to increased access to nutritious foods at affordable prices for the rural majority (Jodlowski et al., 2016).

The above sections have discussed a general overview of the dairy sector in Zambia and the policy environment that has helped shape it to what it is today. It has also taken cognisance of the need for a tailored dairy policy to guide and propel the sector into its projected potential of becoming a net exporter of milk and dairy products. For a better appreciation of the dairy sector in Zambia, the following section provides a contextualised value chain map of the sector. It gives a brief analysis of the Zambian milk value chain, emphasising the value chain map, the players and their respective activities.

1.2 The dairy value chain in Zambia

In Zambia, the production and marketing of dairy products involves a significant number of players in the dairy value chain. The dairy value chain is composed of activities by farmers, traders and collection centres, processors and distributors, and finally, the consumers (Figure 1.2).

As illustrated in the value chain map (Figure 1.2), three major types of milk marketing channel exist for the smallholder farmers, that is, the traditional (informal), modern (formal), and direct (informal) marketing channels (Kiwanuka and Machethe, 2016; Neven et al., 2017). The traditional marketing channel comprises selling milk to local traders, including restaurants, retail stores and others. The direct channel involves the sale of milk directly to individual consumers, mainly neighbours and friends. Modern marketing channels include formalised market structures, such as processors and Milk Collection Centres (MCCs) which are essentially dairy cooperatives. MCCs are among the most accessible forms of formal channels to the smallholder farmers as they are more widely spread in the country, with the majority being in Southern province (Neven et al., 2017). In addition, the volume

requirement is not as strict as when supplying directly to the processors that demand higher volumes. The modern marketing channel falls under the formal marketing channel which represents the major outlet of milk to the formal sector in Zambia. The traditional and direct marketing channels are both examples of informal marketing channels. To avoid the blanket approach of only comparing formal and informal channels, and risk losing detail of the characteristics of specific channel users, this study split the informal sub-marketing channel into traditional and direct marketing channels for a richer analysis.

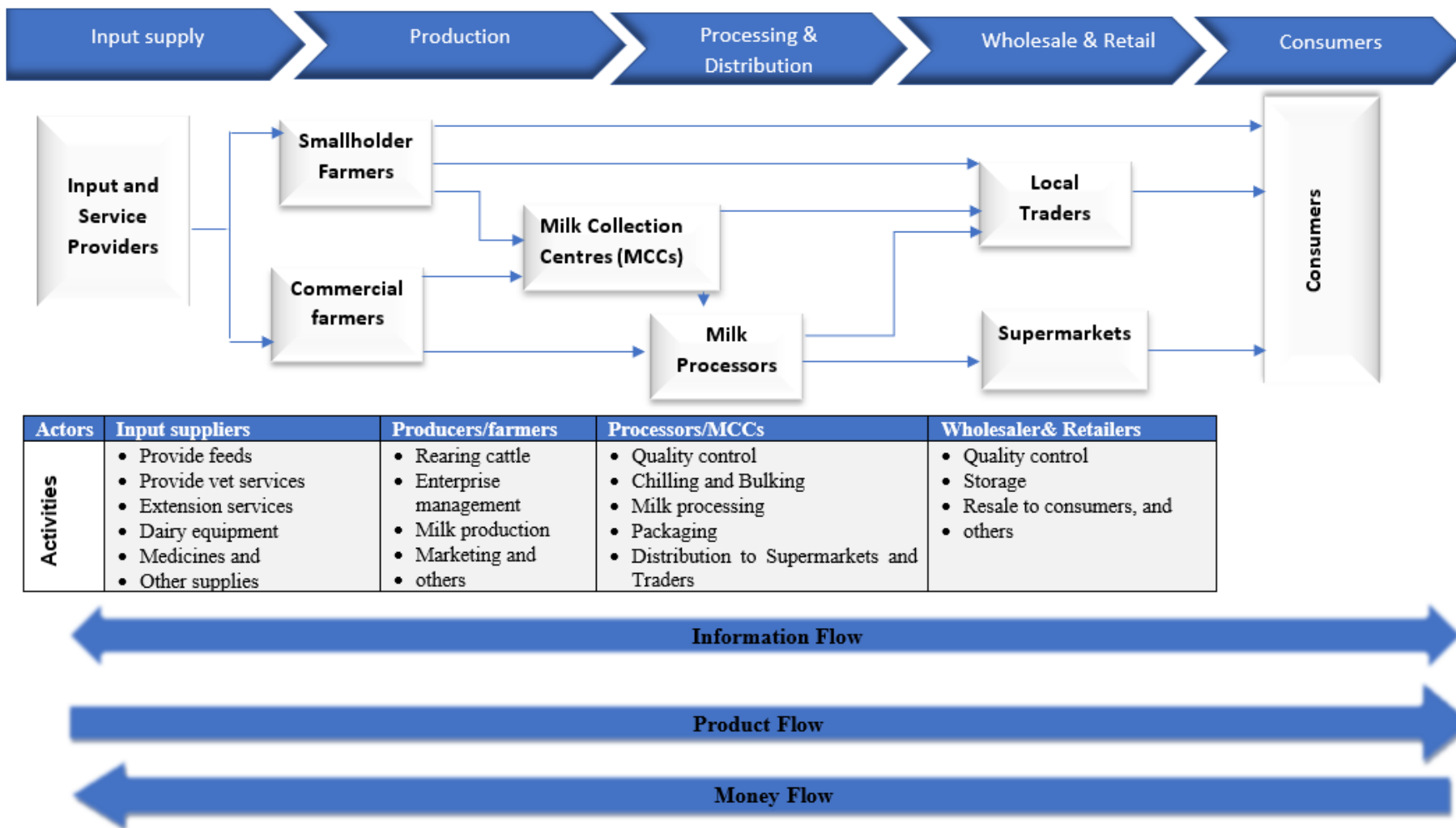


Figure 1.2: The Zambian Dairy Value Chain Map

Source: Partly adopted from Namonje-Kapembwa and Hichaambwa, 2016 and Author's own analysis

1.2.1 Input and Service suppliers

The major input suppliers in the dairy value chain range from the government, private companies and non-governmental organisations (NGOs) to cooperatives. These provide a combination of inputs such as feeds, financial services, medicines and other medical supplies, market information, and extension services.

Several feed companies provide feed supplements for dairy animals, including Novatek Animal Feeds, Tigers Feeds, and National Milling as the major suppliers. Commercial farmers and emergent farmers make up the largest clientele for these feed companies. On the other hand, the majority of the smallholder farmers practice semi-extensive grazing, where most feeding and water is provided for by communal pastures, and dams and rivers (Namonje-Kapembwa and Hichaambwa, 2016).

Another important aspect of proper animal husbandry and good herd management is the following of sound animal health practices (Ndandula, 2011). Farmers can access animal health services from the Veterinary Department of the government, private firms, and cooperatives. Commercial farmer have access to both local private and international input markets for dealing with animal health challenges. However, smallholder farmers usually access these services from government departments or from small local outlets. Animal health services from these sources include medical supplies, artificial insemination (AI) services, and technical knowledge through extension services (Kawambwa et al., 2014).

Another critical input for dairy production is access to water, although water is not supplied by the abovementioned input suppliers. For smallholder farmers, water sources are mainly taken from communal water dams, water streams and/or rivers. In extreme cases, farmers are forced to draw water from boreholes and other sources for their cattle (Namonje-Kapembwa and Hichaambwa, 2016). Water plays a critical role in the quantity of milk produced per cow (Teshager et al., 2013). For commercial dairy farmers, however, the case is different, as they usually have their own water sources for their livestock.

1.2.2 Producers

There are basically three categories of producers in the dairy value chain in Zambia, classified according to herd size, namely smallholder farmers, emergent farmers and large-scale or commercial farmers (Kawambwa et al., 2014; Namonje-Kapembwa and Hichaambwa, 2016). Smallholder farmers supply 80% of the milk production in Zambia, with approximately 17% of the milk reaching the formal sector (processors, retailers and general consumers at large). However, commercial and emergent farmers make up 20% of milk output, yet they also make up over 75% of the formal sector milk supply (Namonje-Kapembwa and Hichaambwa, 2016). Producers are responsible for rearing dairy cattle, animal husbandry practices, and general enterprise management to ensure sufficient production, and, depending on the volumes produced, also the marketing of the milk volumes produced.

Smallholder farmers are widely spread across the country (over 300 000 households) and predominantly own less than 20 animals per household. They mainly produce milk for subsistence, that is, for consumption. In the rare case where there is a surplus, it would be sold either directly to neighbours or at the local markets (CSO, 2017; Houwers and van der Lee, 2018). Seventy percent of the smallholder farmers practised solely extensive grazing (Kawambwa et al., 2014), which is attributable to their limited access to financial resources for purchasing improved feeds and fodder. In addition, they access communal water sources and have very limited access to support services, that is extension and veterinary services, among others (Lubungu, 2016).

Commercial farmers are generally those with a cattle herd size larger than 50, and produce large quantities of milk for the formal marketing channel and for commercial purposes. They are generally located along the line of rail that spans from the Southern province through to Lusaka and the Central provinces. Historically, development seemed to be concentrated along the line of rail, as it provided easy access to transport and market facilities. This could explain why the majority farmers are located along the line of rail. In addition to the smallholder and commercial farmers, an intermediate group of emergent farmers exists, with herd sizes ranging between 20 and 50, and are said to be in a transition phase, moving from small-scale production towards large-scale production and operating as commercial farmers (Sitko and Jayne, 2014). This group is assumed to have better access to key resources and

support services than typical smallholder farmers do, and more importantly, is market oriented (Sitko and Jayne, 2014).

1.2.3 Processors

In the dairy value chain, there are over 20 milk processing companies, albeit with different sizes, including cooperatives (Namonje-Kapembwa and Hichaambwa, 2016). However, the processing node in Zambia is dominated by two major processors, namely Parmalat and Zam-milk, which accordingly possess substantial bargaining power in the chain, thus allowing them to dictate the price of raw milk, which reduces farmers' profit potentials (Girma and Marco, 2014; Kawambwa et al., 2014). Smaller processors either source their raw milk directly from farmers or are organised into MCCs that supply raw milk at either prevailing prices or agreed-upon prices, as the case may be. Common practice for an MCC is to set a price for the given quality criterion, or as dictated by the processor that is sourcing milk from them. Accordingly, there seem to be only two courses: your milk either passes the quality test or it fails. You make a sale if your milk passes the quality test, or you do not if it fails.

Processors are responsible for adding value to the raw milk when processing finished products, that is, pasteurised liquid milk, sour milk, cheese, yoghurt, and butter, among others. They generally source their raw milk directly from farmers and/or through intermediaries, such as the MCC (Namonje-Kapembwa and Hichaambwa, 2016; Sportel, 2017)⁶.

1.2.4 Milk Collection Centres

MCCs are cooperatively owned as producer organisations and are run by smallholder farmers. Generally, they play a collaborative role in enhancing farmers' access to better markets and play a lobbying function for farmer groups (Namonje-Kapembwa and Hichaambwa, 2016). They play a significant role in the value chain, mainly collecting raw

⁶Studies seem to bundle the emergent farmers either together with smallholder farmers or sometimes as commercial farmers because of the vaguely defined classification criteria. As a result, little is found in the literature addressing emergent farmers, especially in the dairy sector. The dairy sector in Zambia has received very little attention in terms of research. Much attention has been rather placed on crops, chiefly Maize.

milk from smallholder farmers, chilling, and storing the milk before supplying to processors. In addition to collecting and marketing milk, some MCCs are also involved in the processing stage, after which it is sold directly to end-users (Sportel, 2017). For example, Mpima and Choma dairy cooperatives process some of their milk into yoghurt and sour milk, which is then sold directly to consumers. They act as a hub through which smallholder farmers can access the formal sector and they are generally widespread in the country, with the majority of them being in the Southern province of Zambia (Neven et al., 2017). As a result, they are also responsible for enforcing quality measures by ensuring that milk supplied meets the necessary quality requirements demanded by processors (Sportel, 2017; Alemu 2017). This is achieved by inspecting every delivery of milk made to the MCC as it comes in. According to Namonje-Kapembwa and Hichaambwa (2016), MCCs pay the farmers on a monthly basis, as opposed to on-the-spot cash payment. In addition, MCCs deduct a small percentage of the proceeds as service fees to cover operations costs. This, however necessary, eats into the smallholder farmers' already low profits.

The MCC model is gaining popularity in the country because it is seen as a tool for modernising the dairy value chain (Neven et al., 2017). According to Neven et al. (2017), participating in the MCC model is dependent on one's training in dairy activities, and the farmer's location in relation to the MCC. Ideally, MCCs should provide artificial insemination (AI), training, and processing, in addition to bulking, chilling, and marketing of raw milk, to support participation in the sector and ultimately increased milk volumes.

1.2.5 Wholesalers and retailers

Retailers play a 'last mile' function in the dairy value chain. They are responsible for making milk and dairy products available to the end-users at the consumers' convenience, without compromising quality. Retailers are generally composed of small-scale local traders and independent supermarkets that stock milk and dairy products, although in Zambia, farmers also fulfil a retail function by selling milk directly to consumers (Namonje-Kapembwa and Hichaambwa, 2016).

Local traders sell both processed milk products from processors and unprocessed milk sourced from smallholder farmers. They are part of the traditional marketing channel (a type of informal marketing channel) through which smallholder farmers sell their raw milk and

mainly operate on a spot-cash basis. They are made up of small stores, restaurants, and other individual resellers of milk. The traditional marketing channel has its advantages over other channels in that it has relatively higher milk prices and low operational costs, compared with formal channels. Formal channels often require operational licences and sometimes market contracts (Ishaq et al., 2017). Therefore, the relevance of this marketing channel cannot be belaboured. Traditional marketing channels, though underdeveloped, are among the most preferred by smallholder farmers.

In contrast, supermarkets stock and sell only processed dairy products that are sourced through credible processors. Needless to mention, Shoprite is the largest supermarket through which milk products are distributed, with a network of outlets in all provinces of Zambia (Namonje-Kapembwa and Hichaambwa, 2016). Furthermore, major processors have established wholesale and retail shops around the country to aid in the distribution to both smaller retailers and consumers (Namonje-Kapembwa and Hichaambwa, 2016). For example, Zambeef, through its cold chains, has established wholesale outlets (called macro-outlets) and retail stores for Zambeef products, including Zam-milk dairy products. Parmalat, on the other hand, has two-in-one distribution centres around the country that perform both the wholesale and retail functions.

Building on the context above, the following section presents the problem statement and the related objectives the study aims to address.

1.3 Problem statement

Dairy farming is a source of livelihoods and a major income source for many of the rural Zambian farmers (Neven et al., 2017). The importance of the dairy sector cannot be overemphasised as its development has capacity to increase job creation and wealth generation. Agriculture in many countries in Africa is mainly restricted to crop production. Several studies (Bowen et al., 2011; Namonje-Kapembwa and Hichaambwa, 2016; Resti et al., 2017) show that milk production has been increasing due to an increase in demand that is a result of population growth. Moreover, a budding and growing dairy industry promises to boost the agricultural sector due to the increasing demand and consumer preferences for dairy products, such as butter and cheese (Britt et al., 2018). Urbanisation, the growing

middle class and the associated rise in incomes have also contributed to the rising demand for dairy products (Neven et al., 2017).

The increasing demand for dairy products outstrips the production of these products in Zambia, despite a rising trend in production volumes (FAOSTAT, 2018). This has resulted in a national deficit for milk and dairy products; a situation that has made Zambia a net importer of dairy products (ACF, 2012). This is despite the vast resources the country enjoys; that is, land, water and labour resources, and a conducive climatic environment sufficient to produce even triple Zambia's current milk volumes (Moll et al., 2007). Studies by Kawambwa et al. (2014) and Ndandula (2011), *inter alia*, have shown that the Zambian dairy sector is profitable. Despite this profitability, the productivity and market participation in the dairy sector remain low due to a myriad challenges that hinder participation, production and marketing (Kawambwa et al., 2014).

A combination of large-scale commercial farmers, emerging farmers and smallholder farmers are responsible for milk production in Zambia. Smallholder farmers produce over 80% of milk produced in Zambia. However, only about 17% of this milk reaches the formal markets, which include formal processors, retailers, and ultimately, the consumers at large (Neven et al., 2017; Mumba, 2013). This demonstrates the limited utilisation of the formal marketing channels by smallholder farmers, which might point to challenges related to market access faced by the smallholder farmers. Neven et al. (2017) showed that urban milk consumers demonstrably purchased and ultimately consumed more milk which they sourced through formal outlets. This further demonstrates that the higher market potential of the formal marketing channel, as a single consumer, will purchase relatively more than in the informal sector does. Therefore, understanding the marketing challenges the smallholder farmers face, and how they make the decision on which marketing channel to use, becomes paramount.

In addition, several studies (ACF, 2012; Kawambwa et al., 2014; Neven et al., 2017) have shown that participation by women and the youth in the dairy sector is low. This includes participation in both milk production and milk marketing. For instance, Kawambwa et al. (2014) and Neven et al. (2017) show that less than 30% of women and only 3% of the youth participated in milk production, respectively. This is despite women and the youth making up most of the country's population (CSO, 2016). The utilisation of these demographic

dividends would stand to boost the sector's growth and development. The youth have pertinent attributes, that is, they are energetic, young and forward looking (Dekker and Hollander, 2017); hence, enhancing their participation in the dairy sector, and agriculture in general, would result in reduced instances of unemployment, rural poverty, crime, and deficient nutrition, *inter alia*.

This study aims to examine the factors that influence the farmers' decisions to participate in milk production and the determinants of milk yields in Zambia. The study also seeks to understand the factors that influence the choice of a marketing channel at the milk producer level. It is the view of this study that understanding the factors that influence participation in the informal channels (direct channel and/or traditional channel) would enable the tailoring of policy to enhance the transition from informal to formal and/or the formalisation of the existing structures in the informal sector. Finally, the study examines the demographic and socio-economic variables of the youth and women in milk production. This is undertaken to understand their limitations, motivations and needs, according to which policy can be formulated to ease their participation and growth in milk production and marketing. This study makes a significant difference in filling the apparent dearth in literature on the Zambian dairy sector and in informing policy. It is expected that the results and conclusions drawn from this study and recommendations thereof would feed into the National Agriculture Policy (NAP), the National Agriculture Investment Plan (NAIP), THE National Gender Policy 2014 (NGP), and the National Youth Policy 2015 (NYP).

1.4 Research objectives

The overall objective of this study is to understand the factors that influence milk production and marketing channel decisions of smallholder farmers in the Zambian dairy value chain.

More specifically, the study aims to:

- Determine the factors that influence smallholder farmers' decisions to participate in milk production and factors that influence milk production or volumes in Zambia.

- Identify the factors influencing the choice of milk marketing channels among smallholder farmers in the Zambian milk value chain.
- Examine the characteristics of the youth and women in the milk production as they compare with the characteristics of the control groups (non-youths and men).

1.5 Conceptual framework

However, in order to address the general and specific objectives of this study, it is important to take cognisance of the economic theories associated with economic decision-making to understand how smallholder farmers make production and marketing decisions. According to classical theories of economics, human subjects are rational and utility maximisers (Aleskerov et al., 2007). Theory on utility assumes that humans are methodical and consistent in their choices (Simon, 1990). According to Becker (1962), rationality seems to “imply some consistent maximisation of a well-ordered function, such as a utility or profit function.” However, in reality, rationality and maximisation seem to be too demanding on human decision makers as they present some computational burden. Decisions are therefore not always consistent with economic theory of rationality and maximisation (Simon, 1972). Behavioural economics comes to the aid with the concept of ‘bounded rationality’. Bounded rationality assumes that human subjects do not always have all the necessary information and cognitive abilities to make decisions consistent with economic theory (Simon, 1990). The theory of bounded rationality therefore aims to understand the decision processes in the presence of these limitations. According to Coase (1992), transactions always occur in some environment in which some level of friction is present. Transaction costs are, therefore, the costs incurred in gathering information relevant to the decision, contacting, contracting and controlling of the transaction (de Bruyn et al., 2001; North, 1990). According to Williamson (1991), bounded rational decision makers will choose an arrangement that minimises transaction cost given the attributes of the transaction, inclusive of both present and future potential risks and benefits.

This study employed these theories to understand the decision processes of smallholder farmers in Zambia, not only from a behavioural point of view, but also taking cognisance of transaction costs involved in the production and marketing of milk. When making the

enterprising decision in agriculture, farmers have several alternatives of what agricultural enterprises to venture into, such as crops and livestock production. These decisions are influenced by a myriad of factors, both innate and exogenous to the decision maker. Literature suggests that household characteristics, demographic variables, and socio-economic variables are key determinants of the participation decision, and also of milk yields (Ishaq et al., 2017; Kiwanuka and Machethe, 2016; Moturi et al., 2015). In addition to household characteristics, exogenous factors, ranging from existing government policies, prices, and access to support infrastructure and facilities, play a major role in the farmers' decisions to produce milk, and also when selecting milk marketing channels (Ishaq et al., 2017; Kiwanuka and Machethe, 2016; Mburu et al., 2007; Neven et al., 2017).

However, farmers will choose an enterprise that maximises their utility and minimises transaction costs, with the available information. Informational and computational limitations present themselves during the decision-making process made when deciding to participate in milk production. For example, in the Zambian context, until recently, the Farmer Input Support Programme (FISP) conducted by the government had a strong bias towards crop production, and chiefly maize (Kuteya et al., 2016; Mason and Tembo, 2015). At the same time, government also provided a ready market for maize through the Food Reserve Agency (FRA) for its strategic reserves. These were incentives that were not applicable to dairy farmers, thus increasing the transaction costs of opting for dairy production. Therefore, understanding the decision variables that influence these decisions is

paramount in understanding the needs of these farmers and thereby informs policy and strategic decisions.

Figure 1.3 shows some of the key decision variables that influence farmers' decisions in milk production and choice of milk marketing channels.

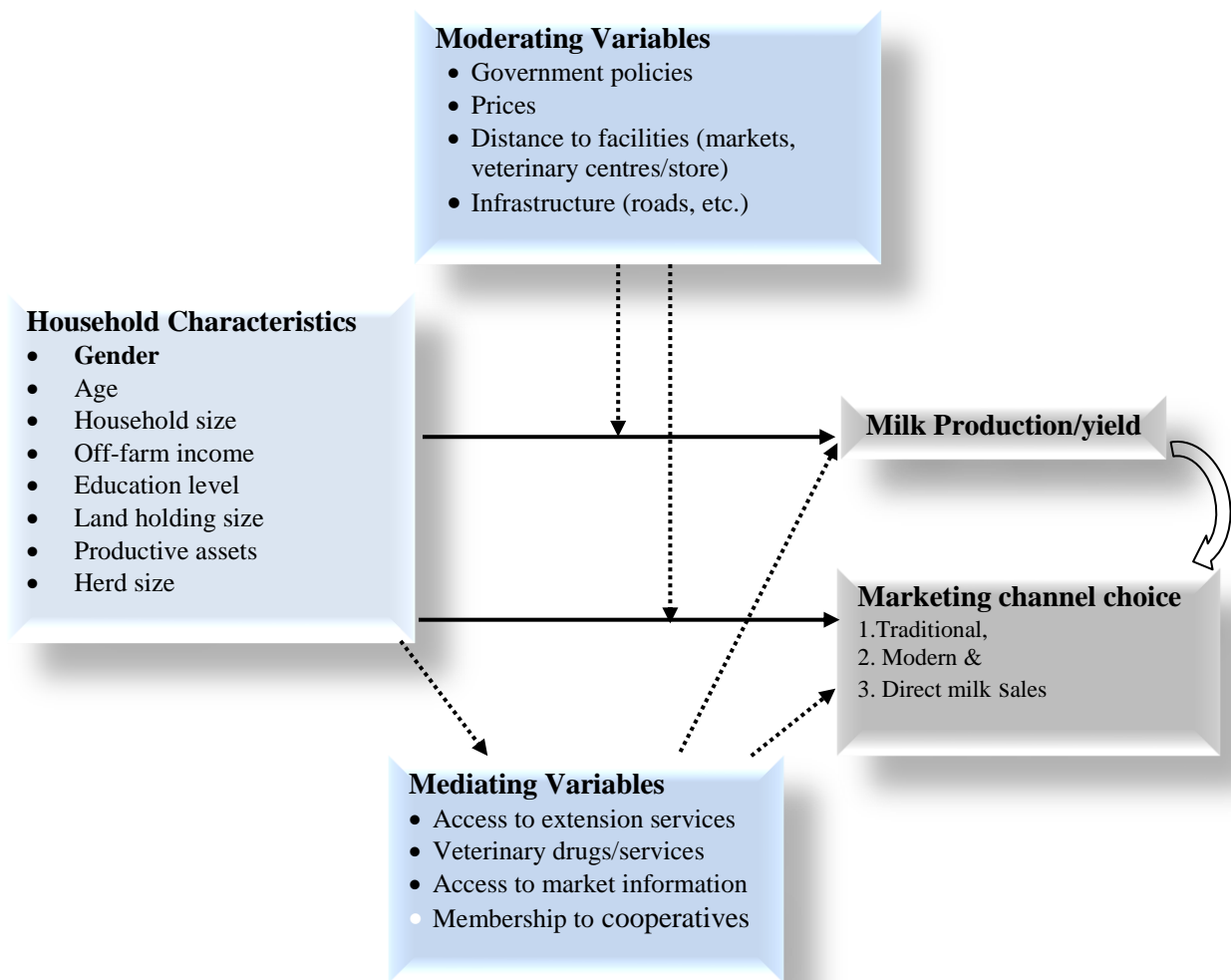


Figure 1.3: Conceptual Framework

Source: Author's own analysis

From those reflected in Figure 1.3 above, certain variables were selected and used in formulating hypotheses to guide this study. These include some of the common variables found in literature and are presented in the following section.

1.6 Hypotheses

From the conceptual framework, the following hypotheses can be derived.

H1: *Demographic variables have a critical influence on milk production and choice of a milk marketing channel.*

The rationale for hypothesis H1 is that the characteristics of a household head, in context of the environment, influence the attitudes and abilities, and thus the decision to participate in milk production and marketing (Chilonda et al., 2000; Neven et al., 2017). For instance, experience in milk production and therefore age of the smallholder farmer increases the farmer's efficiency, and therefore, milk production. In a similar manner, male-headed households are more likely to participate in milk production than female-headed households are. In addition to age and gender, formal as well as informal education, through contact with extension agents, positively influences milk production (Ishaq et al., 2017; Neven et al., 2017).

H1a: Females are less likely to participate in milk production than males are

H1b: Older farmers are more likely to participate in milk production than younger ones are

H1c: Education has a positive influence on milk production and choice of a modern marketing channel.

H2: *Socio-economic factors have an influence on milk production and marketing channel choice.*

The rationale for hypothesis H2 is that variables, such as off-farm income and herd size, represent some level of economic status of the household. As such, these factors will affect how the household decides to participate in milk production and milk marketing (Kiwanuka and Machethe, 2016; Namonje-Kapembwa and Hichaambwa, 2016). An increase in herd size, and therefore milk production, tends to decrease the likelihood of using direct milk sales and move the producer towards the modern channel, which tends to absorb high volumes (Ishaq et al., 2017).

H2a: Off-farm income has a negative impact of participation in milk production.

H2b: High milk production positively influences the use of the modern marketing channel.

H3: *Milk price increases the likelihood of participating in a traditional marketing channel.*

The rationale for hypothesis H3 is that prices in traditional channels are transparent and negotiable, whereas in modern channels, they are often fixed and based on quality grades (Ishaq et al., 2017). Therefore, smallholder farmers would prefer to receive a slightly higher price, without regard for quality.

H4: *Provincial geographical location and therefore cattle rearing culture influences likelihood of participating in milk production.*

The rationale for hypothesis H4 is that the existing culture in the locality where the farmers operate will influence the perceptions the farmers have about cattle and will likely influence the decision to participate in milk production.

1.7 Methodology

This section presents a summary of the data and methods used in addressing the study objectives. A more detailed discussion is provided in [Chapter Three](#).

1.7.1 Data and sample used

Quantitative cross-section household data that was collected in 2015 in Zambia as part of the Rural Agricultural Livelihoods Survey (RALS) was used. The survey was implemented by Indaba for Agricultural Policy Research Institute (IAPRI), in partnership with Zambia's Central Statistical office (CSO), to obtain a comprehensive picture of the Zambian farming sector. The RALS is nationally representative as it covers all the 10 provinces of Zambia. However, only the key milk producing provinces of Zambia were included in the study sample. These include the Central, Eastern, Lusaka, Western and Southern provinces, with a total sample population of 3 574 sampled households, inclusive of both participants and non-participants in milk production.

Depending on the model being implemented and its requirements, the sample size differed accordingly. For instance, for objective one, which includes both participants and non-participants in milk production, the HSM utilised 2 477 valid observations. In the second objective, the model requires only milk producers that sold some milk through some marketing channel, and the utilised sample is 172 households. Finally, in understanding the characteristics of women and the youth in milk production and comparing them with the rest of the other milk producers, a sample of 742 households is used. These include all households that recorded positive milk production in the reference period.

1.7.2 Data analysis

Data analysis was carried out in Microsoft Excel and STATA, using cross-section econometric tools. Descriptive statistics in terms of tables, graphs and regression models were used to analyse the data. In addressing the study objectives, three model strategies are used. The Heckman selection model is used to address the first objective. The multinomial logit model is used to address the second objective. And finally, the independent t-test is used to address the third objective.

1.8 Dissertation outline

The first chapter has discussed the overall study background, and mapped and unpacked a contextualised milk value chain. The chapter also highlighted the Zambian policy context, research problem, the study objectives, the conceptual framework, and hypotheses. The following chapter reviews the existing literature setting by providing an empirical review of factors that influence participation and yields in milk production. The chapter further contextualises the definitions of the milk marketing channels available to smallholder farmers, coupled with a discussion on factors influencing the choice of participating in these channels. Chapter Three highlights the data and methodological processes the study utilises to arrive at the findings. This is followed by the fourth chapter, which discusses the results of the descriptive analysis that highlights the exact profiles of the smallholder farmers sampled in the study. Chapter Five presents the econometric outputs of the model strategies that influence the milk production and marketing channel decisions, showing inferential results on factors and their respective magnitudes. The chapter also discusses the

characteristics of women and the youth in the milk value chain. In closing, the final chapter presents a summary of the study findings and provides an evidence-based recommendation.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This chapter presents a synthesis of literature deemed relevant to the study of milk production and milk marketing choices among smallholder farmers. The literature offers support and guidance, and indicates the scope of what has been done; thus, it serves to identify potential literature gaps and offers a point of departure for this study. Critical contextualised definitions are provided in this chapter. Section 2.2 below presents an empirical review of factors affecting the participation decision and milk production. Section 2.3 presents the determinants of marketing channel choice in the dairy sector, as made by smallholder farmers. This is followed by a brief discussion of participation by the youth and women and of their roles in agricultural and the dairy sector development. Finally, the last section presents a summary of the chapter to bring it all home.

Set out below are some key definitions that are used in the context of this study.

Participation in milk production: this is defined as any farming household that was raising cattle (at least one cow) in the reference period (2014–2015).

Milk production refers to the actual milk output produced and recorded by the household. In perspective, this means that a household can be said to participate in the sector by owning or raising at least one cow, but will only be said to be producing when they have physical quantities of milk being produced.

Milk Marketing Channel: Several definitions of a marketing channel have been put forward. However, all of them seem to agree with the basic idea that it involves the movement of goods from the producer to the consumer. According to Pelton et al. (2016), “a marketing channel can be defined as an array of exchange relationships that create customer value in the acquisition, consumption, and disposition of products and services”. In context, *a milk marketing channel* is a set of structures, people, organisations and activities that support the transfer of milk from the producer to the consumer (farm-to-fork).

A *value chain* describes “the full range of activities which are required to bring a product or service from conception to the different phases of production, delivery to final consumers and final disposal after use” (Kapslinky & Morris,2000). More specifically an “Agricultural Value chain is a full range of activities and participants involved in moving agricultural products from input suppliers to farmers’ fields and ultimately to consumers” (Miller & Jones,2010).

2.2 Participation decisions and milk production of smallholder farmers in the milk value chain

This section presents an empirical review of the factors that influence the smallholder farmers’ decisions to participate in milk production. It also discusses the factors that influence smallholder farmers’ milk production in the Zambian value chain.

2.2.1 Participation of smallholder farmers in milk production

Demographics and socio-economic factors are postulated to influence decisions to participate in milk production (Balirwa et al., 2016; Kiwanuka and Machethe, 2016). For example, age, education level, gender of household head, and household composition (size) are key variables in the decision to participate. Most studies have focused on the profitability of the dairy sector and marketing of milk (Ishaq et al., 2017; Kawambwa et al., 2014; Moturi et al., 2015; Neutzling et al., 2017). However, based on the findings of the studies and characteristics of smallholder farmers in the dairy sector, we can make inferences about the factors that influence the participation decision. These inferences are made by reviewing the characteristics of those who participated in milk production and marketing, and on whom the studies were based.

Kawambwa et al. (2014) and Namonje-Kapembwa and Hichaambwa (2016) opine that, for achieving a fully effective and sustainable dairy sector, the participation of women and the youth is key. This highlights the importance of the variables regarding gender and age in influencing the decision to participate in milk production. Kawambwa et al. (2014) suggested that women contribute time, energy, creativity and knowledge to milk production, which are attributes that are not inherently common in men. In addition, Namonje-Kapembwa and Hichaambwa (2016) highlight the point that the youth have limited access to resources, hence their participation in the dairy sector is limited.

According to Namonje-Kapembwa and Hichaambwa (2016), in a study on youth employment in the Zambian milk value chain, the limited access to funding for starting up enterprises in the sector attenuated participation in the milk value chain. This is because it is relatively capital intensive to establish a dairy enterprise at production level. For example, a farmer will need technical knowledge on how to run a dairy farm (husbandry practices), dairy cows (more specifically, those with improved genetics) for producing milk, land, and chillers or cold storage facilities (mainly imported) for keeping milk fresh (Kawambwa et al., 2014; Namonje-Kapembwa and Hichaambwa, 2016). Therefore, the need to have access to finance or credit to fund these operations cannot be over-emphasised. Similarly, gaining access to improved and cheaper sources of feeds, veterinary services and other facilities requires sound financial muscle. These all add up to the fact that finance has a huge role to play in a farmer's decision to participate in dairy production.

Another key factor that influences the decision to participate in milk production is the existing cattle-rearing culture of the local community in which the farmer lives. In Zambia, for example, the Southern, Eastern, Western and Central provinces have a very strong cattle-rearing culture and account for over 80% of the cattle-rearing households in the country (CSO, 2017; Namonje-Kapembwa and Hichaambwa, 2016). As such, these tend to be the highest milk producing provinces in the country, which further highlights the importance of the cultural norms in forming a farmers' decision to participate in dairying. It is expected, therefore, that a farming household that is in any of these provinces is more likely to participate in milk production than a farming household in the other provinces is.

In addition to the cattle-rearing culture, access to input and output markets, extension services, and land all influence the smallholder farmers' decisions to participate in dairy production. Lubungu et al. (2012), in a study undertaken to understand the participation of smallholder farmers in livestock markets in Zambia, found that limited access to (and high costs of) inputs and output markets would limit the participation of smallholder farmers in livestock production. Moll et al. (2007) observed that the milk markets form a pull factor that also induces smallholder farmers to invest in milk-production-enhancing resources, such as improved breeds. The availability of output markets for milk is paramount for the participation decision in milk production. Kawambwa et al. (2014) further suggest that the high costs of feed in Zambia hindered profitability, and therefore participation, in the sector.

The study also suggested implementing a ban on exports of maize bran that could be used as feed supplement at dairy farm level.

Some of these factors not only influence the decision to participate in milk production, but also impact on milk production. The next sub-section discusses the factors that influence milk production, as found in literature.

2.2.2 Factors affecting milk production

Demographics, such as age, gender and education level of the household head, have been shown to have a key impact on milk production. According to Gitau (2013) in a study aimed at understanding factors that influence milk production in Kenya, age, gender and education level have an influence on milk production. The study showed that the majority of the farmers involved in milk production were above the youthful stage (over 35 years of age) and had over ten years of experience in milk production. In the same study, it was established that males dominated the sector. These factors of age, gender and experience, together, influenced milk production. In a similar study by Neutzling et al. (2017) in Brazil, milk production was also found to be affected by education, household size and composition, as these influence the household's labour endowment. Composition refers to the number, gender and ages of the household members, which, according to Machina and Lubungu (2018), also influence livestock ownership. Household size seems to influence the labour available to the household, and as such, a larger household is expected to have sufficient labour to operate a milk enterprise, in addition to other on-farm enterprises. Moll et al. (2007) in a comparative study of production systems in Zambia, Kenya and Sri-Lanka, identified labour as a key factor of production. The study further found that Zambia had the lowest opportunity cost of labour among the three countries, implying a relatively more disposable labour resource in the Zambian context. This seems to suggest that the availability of family labour in dairy farming households plays a key role in rural agricultural systems, as noted by Girma and Marco (2014) in a study conducted in the Oromia regional state of Ethiopia.

Another important factor in milk production is access to water. Water accounts for over 60% of the animal's body and is therefore also the major constituent of milk (Teshager et al., 2013). Namonje-Kapembwa and Hichaambwa (2016) found that having limited access to

water significantly impedes milk production. The lack of access to sufficient and quality water supplies can therefore be a limiting factor in milk production.

Access to veterinary services includes having access to drugs that both treat and prevent disease. Faizal and Kwasi (2015), in a study conducted in Ghana, show that poor access to veterinary services affects animal health management. The same study also showed that access to veterinary services is influenced by factors such as age, education level, herd size and the costs of the veterinary services. This study further highlighted how demographic factors have a bearing on access to support services. According to Kawambwa et al. (2014), having limited access to veterinary services by smallholder farmers in Zambia has had a negative impact on milk productivity. For example, having poor access to veterinary services increases instances of disease outbreaks, and poor milk yields as a result.

Extension services serve as a form of training that provides technical support to farmers. Gitau (2013) highlights the point that the need for extension services in providing expert assistance, raising awareness about herd management, pests⁷ and disease management, among others, cannot be over-emphasised. As is the case with education, extension services ultimately improve milk yields as the farmers put into practice proper management practices (Girma and Marco, 2014). Such management practices include the use of improved breeds, effective and routine disease management, and the use of supplementary feed rations. Kawambwa et al. (2014) add that access to dairy extension services, with respect to Artificial Insemination (AI) and strategic breeding practices, would greatly improve milk production over time. To reduce costs associated with the process, continuous F₁ heifer replacement and cross breeding practices were suggested, especially for low-management smallholder farms.

Other critical variables that impact on milk production and which have a directly proportional impact on milk yield are herd size and cattle breed. It is expected that the more cattle, and therefore the more milking animals, the household has, the more milk it is likely to produce, all things equal. Several studies have shown that herd size influences milk production positively (Gitau, 2013; Neutzling et al., 2017; Wambugu et al., 2011). Equally important in determining milk yield is the breed of milking animals that the farmer owns. The majority of cattle-owning households in Zambia own indigenous breeds, which are not

⁷Examples include Face fly, Horn fly, Tick, Lice, and Cattle grubs.

ideally suited for milk production. These indigenous breeds yield between 3 and 5 litres of milk per cow per day, while improved dairy breeds produce between 10 and 20 litres per day (Kawambwa et al., 2014; Namonje-Kapembwa and Hichaambwa, 2016). Kawambwa et al. (2014) highlight the need to have access to improved breeds (which can produce above 10 litres of milk per day, per cow) in order for smallholder farmers to boost milk production. Wambugu et al. (2011) add that the use of improved breeds had a significant impact on milk production in a study conducted in Kenya to measure productivity and performance factors. A similar finding was made by Girma and Marco (2011) in Ethiopia and Neutzling et al. (2017) in Brazil, who noted that the use of improved breeds significantly improved milk production.

Another factor of production that impacts on milk yield, and ultimately milk production, is feed. In Zambia, many smallholder farmers practise extensive grazing. This means that animals are left to graze on communal pastures, with no or little supplemental feeding (Lubungu, 2016). As a result, milk production tends to fluctuate with the seasons and the availability of good quality grass. There is a significant decrease in milk yields during dry, hot seasons and during cold seasons when communal grasslands dry out. In a study conducted by Neutzling et al. (2017) in Brazil, it was found that milk production was highly influenced by the feeding system used. The study established that the use of an improved feeding system or cultivated fodders positively impacted on milk production. Similarly, Kawambwa et al. (2014) opined that the lack of, or limited access to, improved fodders and fodder management training has contributed to the perpetual low milk volumes produced by smallholder farmers.

Several other factors have been identified to have a potential influence on milk production. These include (i) involvement in crop-production activities and other livestock activities; (ii) the specific milk marketing strategy utilised; (iii) the extent of off-farm employment; (iv) the availability of price information; (v) the distance to milk collection centres (MCCs); and (vi) whether or not farmers are members of cooperatives (Girma and Marco, 2014; Kawambwa et al., 2014; Neutzling et al., 2017). These, however, have more of a supporting role, as opposed to a direct impact on milk production. For example, access to market and price information may influence participation in the market, but with no direct impact on actual milk produced. The next section presents a discussion of factors that influence the choice of milk marketing channels.

2.3 Milk marketing channels in Zambia

Generally, milk channels can be broadly categorised into those that are formal and informal. The *formal channel* is highly formalised and structured, sometimes requiring formal contracts to be concluded between actors. Commercial farmers are the major suppliers in the formal marketing channel, usually directly to processors (Iskandarani and Ekanayake, 2013). In addition, some smallholder farmers access the formal channel, either through MCCs or directly to the processors. The *informal channel* involves non-sophisticated approaches to milk marketing, either directly to the consumer in the local community or to local traders, stores, restaurants, among others. With smallholders in mind, Neven et al. (2017) characterised the modern or formal channels in Zambia as being those marketing channels that are operated through MCCs and the others only as traditional marketing channels.

This study proposes that bracketing all possible channels in the informal channel as being simply informal would not help in comprehending the intrinsic characteristics of the households using them, considering that they are the most used by smallholder farmers. Therefore, in this study, the informal channel has been divided into (1) a direct marketing channel for the sale of milk to consumers, that is, the local community, and (2) a traditional marketing channel for the sale of milk to other informal players. Consequently, three milk marketing channels were utilised for analysis in this study, namely (1) the direct marketing channel, (2) the traditional marketing channel, and (3) the modern marketing channel. These definitions were partly adopted from a similar study conducted in Pakistan by Ishaq et al. (2017), who identified informal marketing channels, that is, direct milk sales; traditional marketing channels; and modern/formal marketing channels.

2.3.1 Determinants of milk marketing channels

Like most agricultural products, milk is a highly perishable dairy product and requires effective marketing channels (Ishaq et al., 2017). A study by Neven et al. (2017), carried out in Zambia to understand the factors influencing the participation of smallholder farmers in the modern marketing channel, found that demographics such as age and education positively influenced participation. This was echoed by Kumar and Staal (2010) in a study conducted in India, who found that age and education have similar effects on smallholders'

decisions to market milk through a modern marketing channel. Several studies have further echoed this finding in relation to the education level of smallholder farmers (Ishaq et al., 2017; Moturi et al., 2015; Neutzling et al., 2017). Ishaq et al. (2017), in a study carried out in Pakistan, suggested that the level of education considerably enhanced the understanding of market information, and thus participation in the best market alternative. Ishaq et al. (2017) also found that the age of the household head positively influenced the participation decision of smallholder farmers in the traditional marketing channel. At the same time, age had no significant effect on participation in the modern marketing channel, which is a result that contradicts those of Neven et al. (2017) and Kumar and Staal (2010).

In addition to the effects of age and education on the choice of marketing channel, Ishaq et al. (2017) found gender to have a positive influence on smallholder farmers' decisions to participate in the traditional marketing channel, with no effect on other marketing channels. For example, male-headed households were more likely to participate in the traditional channel than female-headed households were. Ishaq et al. (2017) suggested that male-headed households were more likely to be market oriented than female-headed households were as they possessed greater market information. They also postulated that female-headed households tend to prioritise home consumption of milk, as opposed to selling it, especially if the household had children below the age of six.

According to Neven et al. (2017), income also influences the choice of the marketing channel. In particular, it had a positive influence on the decision to participate in the modern marketing channel. It is expected that a higher income would mean having increased access to finance for marketing operations. This is in line with the findings by Kumar and Staal (2010) who found that off-farm income and the amount of initial capital were positive influencers on the decision to participate in the modern marketing channel. Conversely, a study by Kiwanuka and Machethe (2016) in Zambia, which investigated the participation of smallholder farmers in interlocked contract agreements⁸ (ICAs) (a form of a modern marketing channel), contradicted this finding. This showed that having high off-farm income or income from sources other than dairying meant less specialisation in the dairy sector. Therefore, less specialisation would result in low milk volumes, which would then reduce the likelihood of participating in the modern marketing channel that requires high volumes.

⁸A form of marketing channel operating through marketing contracts between the producer and the buyer, mainly processors or MCC.

This was in accord with the findings by Moturi et al. (2015), in a study conducted in Kenya, who suggested that off-farm income or having multiple on-farm enterprises had a negative effect on using a modern marketing channel. This further suggests that smallholder farmers that had more amounts of off-farm income were more likely to utilise the traditional and/or direct marketing channels.

Herd size and milk production are two intricately related variables, that is, an increase in herd size (assuming more milking animals) would result in increased milk production. As such, the literature seems to use them interchangeably, depending on the measured variable. In this study, a bias towards the use of milk production as a variable is taken. Ishaq et al. (2017) argue that a larger herd size increased the likelihood of using the modern marketing channel. The converse is true for traditional channels. They attributed this to the fact that modern marketing channels are volume absorbing, thus the larger the herd size, and therefore milk production, is, the more likely the farmer is to choose the modern marketing channel. A smallholder farmer with high milk production will be more likely to use the marketing channel that would absorb the produce, which in this case is the modern marketing channel. This is because the alternative marketing channels are predominantly made up of several smaller buyers who would not absorb high volumes at once.

Kiwanuka and Machethe (2016) argue that the value of productive assets⁹ is highly related to the ability of a smallholder farmer to deploy capital to generate positive cash flows. Additionally, a higher value of productive assets could mean that a farmer is invested in transaction-specific assets, which could increase production and productivity in order to participate in modern marketing channels. In other words, the value of productive assets increased the likelihood of participating in the modern marketing channel. For example, investment in special milk equipment, dairy breeds, milk chillers and some transport facilities would render the smallholder farmer more efficient. This would result in high milk production, which ultimately influences the choice of the modern marketing channel.

Literature also shows that several other variables, such as access to extension services (specifically related to dairy farming), membership in farmer groups and/or cooperatives,

⁹Productive assets represented both farm implements and non-farm assets that the household owned during the reference period. These included ploughs, wheelbarrows, sprayers, bicycles, motor vehicles, cell phones, solar panel equipment, and water pumps.

and access to dairy market information, also influence the choice of a marketing channel (Ishaq et al., 2017; Moturi et al., 2015; Neven et al., 2017). According to Kiwanuka and Machethe (2016), access to dairy information increased the likelihood of participation in the modern marketing channel. They postulate that access to information, such as that regarding prices, quantity and quality requirements, and the marketing channels, created higher levels of awareness of the opportunities and risks involved.

According to Neven et al. (2017), membership in a cooperative or MCC had a positive influence on using the marketing channel. Farmers belonging to MCCs, almost by default were more likely to use the modern marketing channel. According to Moturi et al. (2015), membership in a dairy cooperative gave smallholder farmers some level of bargaining power and economies of scale, and acted as a social capital variable. Smallholder farmers belonging to MCCs were able to share information and this increased their likelihood of using the modern marketing channel.

In addition, distance to MCC and local major markets positively influenced participation in the modern marketing channel (Moturi et al., 2015; Neven et al., 2017). According to Moturi et al. (2015), the possible explanation is that utilising the traditional marketing channel incurred transaction costs, such as time of looking for buyers, transport costs, and risks of not selling all milk. Therefore, the farther away the traditional markets were from the farmers, the more likely they were to use the modern marketing channel (however far away) to reduce the transaction costs incurred in using the traditional marketing channel. This contradicts the findings by Kiwanuka and Machethe (2016) who observed that distance to the MCC negatively influenced participation in the modern marketing channel. They suggested that distance to MCCs decreased the likelihood of using the modern channel, as distance made it difficult to meet the tight delivery schedules required, together with the increased transport costs involved. This simply suggests mixed results for distance to MCC, depending on the context in which the particular study was carried out.

Other relevant variables found to influence the choice of a marketing channel include milk price, quality inspection (at point of sale), speed of payment, and social relationship with the buyer. Price is a key decision variable in marketing channel choice. It has been found to have a positive influence on smallholder farmers' decisions to participate in the traditional marketing channel where prices are usually higher than those at MCCs (the commonly

accessed modern marketing channel by smallholders) (Ishaq et al., 2017; Kiwanuka and Machethe, 2016; Tsourgiannis et al., 2008). Traditional marketing channels seem to have a competitive edge on price (as they sell to local traders and restaurants), but they cannot absorb large milk volumes as the modern marketing channels do. Therefore, farmers with higher milk production are more likely to forfeit on price for volumes by using the modern marketing channel.

Similarly, the lack of quality inspection in the traditional marketing channel transactions positively influences participation in the traditional marketing channel (Balirwa et al., 2017; Ishaq et al., 2017). Quality inspection seems to be non-existent in alternative marketing channels, except in the modern marketing channel. Therefore, small-volume milk producers will opt for these alternatives to reduce the transactions cost, time and transport costs that are involved in delivering milk to modern marketing channels.

Because traditional marketing channels involve local buyers, long-term social relationships are often forged. These social relationships increase the likelihood of using the traditional marketing channels, as suggested by Ishaq et al. (2017) and Balirwa et al. (2017), as buyers in the traditional marketing channel tend to have social relationships with the milk producers from whom they purchase milk. These relationships increase the trust and continuity of business among the actors. On the other hand, transactions in the formal marketing channel are strict, often involving quality inspections on delivery and written contracts.

Furthermore, the speed of payment in the milk marketing transaction was found to positively influence the utilisation of a marketing channel by smallholder farmers (Ishaq et al., 2017; Tsourgiannis et al., 2008). The traditional marketing channel operates predominantly on a cash basis, and sometimes give advance payments to secure milk (Ishaq et al., 2017; Namonje-Kapembwa and Hichaambwa, 2016). Because social relationships are forged in the traditional marketing channel, buyers might also make advance payments for the produce that they are yet to receive, to ensure some level of trust and continued business. Modern marketing channels, on the other hand, operate on monthly payment schedules, which is a phenomenon that decreases the likelihood of smallholder farmers participating in the channel (Namonje-Kapembwa and Hichaambwa, 2016). Smallholder farmers are cash poor and would be more likely to appreciate cash payments, which sustain their families and farming

operations. Therefore, it is expected that farmers, with additional sources of income other than from dairy production, would be more likely to use the modern channel.

A dearth of empirical evidence exists on direct milk sales as a marketing channel. However, it seems to be implied that the majority of the milk producers participate in this market in Zambia (Mumba et al., 2013). Hence, there is a need to understand the factors that influence participation in this type of market. Literature further suggests that the modern marketing channel is adopted by farmers with high levels of education, high household income, and large herd sizes (Neven et al., 2017, 2006; Tsourgiannis et al., 2008). This is because smallholder farmers with such a profile are more likely to produce higher volumes of milk, and as such would be more likely to use the modern marketing channel. In addition, the modern marketing channel absorbs higher milk volumes and reduces the transaction costs associated with the traditional marketing channel. The circumstances of farmers with low household incomes, small herd sizes, and low levels of education compel them to choose to participate in traditional marketing channels and direct milk sales. As would be expected, these farmers would be more likely to produce low volumes of milk, and as such would more likely use the traditional and direct marketing channels, which are also cash-based marketing channels.

There seems to be a bias in literature towards analysing the formal marketing channels against the informal marketing channels, and using the informal marketing channel as the base¹⁰ in analysis. However, according to Kumar and Staal (2010), the formalisation of the informal sector offers great potential for sector development. Formalisation would be achieved by increasing the flow of milk from the informal sector to the formal sector. This could be achieved while keeping the market outlets available to the smallholder farmers relatively informal, for example through smaller intermediaries. This is suggested with due consideration of the fact that there is a bias in smallholder farmers' preferences towards the use of informal channels, given the incentive structures. This study aims to establish the factors that influence the choice of a marketing channel on a neutral ground, for both formal and informal marketing channels.

¹⁰As a result, most research output shows greater numbers of results on modern marketing channels, thus effectively suppressing the informal marketing channel in research.

From the above sections, several variables have been established to have an influence on decisions to participate in milk production and milk volumes. Similarly, several other variables influence the choice of a marketing channel. Common among these are the effects of gender and age on participation in the dairy sector. A full section has been dedicated below to gaining an understanding of the decision factors for the youth and women in participating milk production.

2.4 Participation of Women and the Youth in Milk Production in Zambia

Several studies have shown that women and the youth have less access to critical productive resources and services than do men and/or older farmers, respectively (Kawambwa et al., 2014; Namonje-Kapembwa and Hichaambwa, 2016; Neven et al., 2006). This not only hinders their participation in agriculture, and the dairy sector in particular, but also has critical effects on their yields and marketing abilities. Women and the youth usually have limited access to credit, input and output markets, extension information, and sometimes even to control of land rights (Lambrou, 2004; Namonje-Kapembwa and Hichaambwa, 2016).

In dairy production, studies have further shown that women and the youth constitute a major minority in Zambia, accounting for less than 40% of milk producers, and this is in spite of women and the youth making up the majority of the country's population (CSO, 2016; Kawambwa et al., 2014; Neven et al., 2017). According to Njenga et al. (2011), women, the youth, and the underutilised land potential provide some opportunities that could spur the growth of vibrant enterprises in the smallholder agricultural sector. Women and the youth comprise the demographic groups that are the least involved in agricultural production in sub-Saharan Africa (Njenga et al., 2011), and in Zambia in particular. Therefore, comprehending the roles that each has to play in the dairy value chain is key for an effective and productive value chain. This is in addition to understanding the specific challenges faced by each group, and thus the incentive structures of each individual group that could be utilised to stimulate participation in the sector.

Women have pertinent attributes in agriculture and have proved to be resourceful and productive, even with limited access to productive resources. A study by Koirala et al (2015) in the Philippines on rice production found that women produced more rice than the men did

and were better at controlling costs, despite their limited access to resources. The study further suggested that there was no significant difference between male- and female-headed household farm incomes, although women had higher fixed costs, resulting in reduced profit earnings. As the case is no different for the dairy sector, this further highlights the need to make the sector more accessible for women to reduce inefficiencies in the chain and to improve on profits. Some sources of these inefficiencies include the lack of access to credit due to lack of adequate collateral, and low access to education and extension services (Fletschner, 2008). Machina and Lubungu, (2018), in a study in Zambia aimed at understanding the gender dynamics in livestock ownership, showed that households with a male adult were more likely to have cattle than those without such a male adult were. This showed how a patriarchal society still hinders the participation of women in the livestock sector. Ayoade et al. (2009) reiterated the point that women have limited access to technology, education resources and land, which further perpetuates hunger and untimely deaths to a higher degree among women and girls, than among men. The study found such factors as education, access to credit and cooperative participation to be key factors for enabling women to participate in livestock production. Despite these and other challenges, women are an important part of the agricultural labour force, and at the same time, agriculture and the agricultural value chain are an important source of employment (Team and Doss, 2011).

Like women, the youth in agriculture also exhibit similar attributes. That is, they are energetic and future-oriented, yet they have limited access to productive resources, compared with their older counterparts (Dekker and Hollander, 2017). These limitations range from finance and capital resources, and access to extension services, to access to markets both for inputs and for outputs (Namonje-Kapembwa and Hichaambwa, 2016). This has resulted in the youth being the worst hit by high unemployment rates and poverty in sub-Saharan Africa, which is a situation that is projected to deteriorate further if no pragmatic steps are taken to address it (Girard, 2017). Their participation in agricultural value chains, including dairy, would make them employers and thereby stimulate more participants and continuity of the sector, resulting in a reduction in unemployment levels. According to Njenga et al. (2011), many of the youth in rural farming areas lack business skills, are poverty stricken, and are often involved in instances of alcohol abuse.

This section takes cognisance of the various challenges that women and the youth face in the dairy sector, and proposes to gain an understanding of these challenges separately, for each

group. The proposed separate analyses would help in developing specific policies for each group for effective operations of the value chain.

2.5 Summary

The chapter has established that there is poor participation in milk production by smallholder farmers, especially by the youth and women. Factors, such as age, gender, culture, access to economic resources, and extension education, are seen as contributing factors in making participation decisions. In a similar manner, a number of factors seem to affect milk production, ranging from age, gender and education level of household head, household size and composition, extension training, herd size, and grazing systems to breeds of cows used. From these points, as disclosed in the studies reviewed, it can be established that several factors affect milk production. The magnitude of their impacts may differ according to context, that is, regarding the available technology, culture, marketing strategies available to the farmer, and the time when and location where the study was conducted.

Several factors were also identified that influence farmers' decisions to participate in milk marketing channels. However, these studies disclose no common cross-cutting factors that influence participation in one channel. It would appear that education level, access to training or dairy extension, and milk yields outright influence the choice of the modern marketing channel. Other variables, however, seem to have mixed influences on the farmers' decisions; hence, there is the need to understand the *Zambian* context, as set out in this study. This study therefore aims to identify some of these factors in the context relevant to *Zambia* and to make some contribution to the existing body of knowledge.

Therefore, while agreeing with the results of the studies referred to, it is paramount to note that some variables that could be utilised in the *Zambian* context might not have been measured in the existing literature. Therefore, it becomes important to prescribe contextualised variables that are relevant in the *Zambian* setting, as there is a clear dearth in the literature regarding the *Zambian* dairy sector that might inform policy. Additionally, there are very few studies on the *Zambian* dairy sector that might offer guidance on the operations of the *Zambian* dairy sector, especially with regard to participation, milk production, and milk marketing by smallholder farmers. This study, therefore, stands to

make a critical contribution to the Zambian dairy sector's body of knowledge. The next chapters present the econometric strategies that the study used.

CHAPTER THREE: RESEARCH METHODS AND PROCEDURES

3.1 Introduction

This chapter presents the methods and modelling strategies employed in the study. It starts by describing the data and sample used, followed by the tools of analysis and the respective statistical packages utilised. The chapter highlights the econometric tools used to address the objectives of the study: (i) to determine the factors that influence smallholder farmers' decisions to participate, and the extent of participation, in milk production in Zambia; (ii) to identify the factors influencing the choice of milk marketing channels among smallholder farmers in the Zambian milk value chain; and (iii) to examine the characteristics of the youth and women in the dairy sector, as they compare with the attributes of other participants. The first objective is addressed by using the Heckman Selection Model, the second objective is addressed by using the multinomial logit regression model, and the third objective is addressed by using the independent t-test. These tools are described in detail in Section 3 of this chapter.

3.2 Data and sampling method

Quantitative cross-section¹¹ household data, which was collected in 2015 in Zambia as part of the Rural Agricultural Livelihoods Survey (RALS), was used in this study. The survey was implemented by Indaba for Agricultural Policy Research Institute (IAPRI), in partnership with the Zambia's Central Statistical office (CSO), to obtain a comprehensive picture of the Zambian farming sector. "The purpose of the RALS is to provide policy relevant information that is not practical to collect annually from the government's agricultural surveys" (IAPRI, 2016). The RALS is nationally representative as it covers all the 10 provinces of Zambia, and the data represents events in relation to agriculture for the 2014/2015 agricultural production and corresponding marketing seasons (IAPRI, 2016). The sample constitutes representative rural farm households, as a unit of analysis, engaged in

¹¹ Data collected from households at one point in time, without consideration on the effect of the passing of time.

agricultural production activities (crop and livestock production). The survey targeted small- and medium-scale farmers, cultivating between 0 and 20 hectares of farming land.

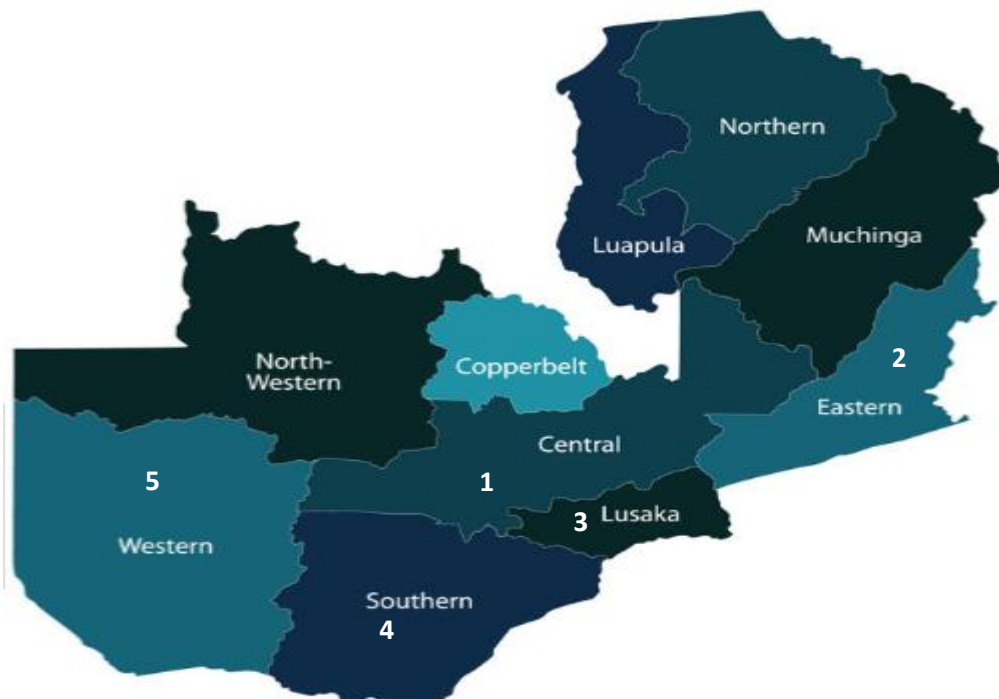


Figure 3.1: Map showing the Provinces of Zambia

The 2015 survey captured information from 7934 households from all 10 provinces of Zambia (Figure 3.1). However, only five provinces (marked on the map) were utilised in this study, as they represented both the largest number of milk producers and highest milk producing areas (CSO, 2017; IAPRI, 2016; Namonje-Kapembwa and Hichaambwa, 2016). The provinces comprise the Central, Eastern, Lusaka, Southern and Western provinces (Figure 3.1 and Table 3.1).

Table 3.1: Cattle owning households and Cattle population by province in Zambia

Province	Cattle owning Households		Cattle population	
	Number	Percent	Number	Percent
Central	50,954	14.6	826,322	22.6
Copperbelt	8,297	2.4	98,644	2.7
Eastern	105,950	30.4	598,455	16.4
Luapula	1,972	0.6	12,359	0.3
Lusaka	13,230	3.8	167,822	4.6
Muchinga	10,315	3	83,286	2.3
Northern	10,651	3.1	48,241	1.3
North Western	11,482	3.3	96,681	2.6
Southern	104,513	29.9	1,293,715	35.4
Western	31,646	9.1	429,142	11.7
Total	348,966	100	3,654,668	100

Source: Central Statistical Office (CSO) Preliminary Livestock Census Report (2017)

The five provinces (highlighted in Table 3.1) constituted 3 574 sampled households, inclusive of both participant (1,718) and non-participants (1,856) in milk production. It is expected that the lessons learnt from the analysis of these households can be inferred as also applying to the low milk producing provinces.

It is important to note that, depending on the model being implemented and its requirements, the sample size differed accordingly. For instance, for objective one, which included both participants and non-participant in milk production, the HSM utilised 2477 valid observations. In the second objective, the model required only milk producers who sold some milk through some marketing channel, and the sample utilised comprised 172 households.

Finally, for gaining an understanding of the characteristics of women and the youth in milk production, and comparing them with the other milk producers, a sample of 742 households

were used. These included all households that recorded positive milk production in the reference period.

3.3 Data analysis

Data analysis was carried out in Microsoft Excel and STATA by using cross-section econometric tools. Descriptive statistics in terms of tables, graphs and regression models were used to analyse the data to gain a better understanding of variables in the dataset. Descriptive statistics tend to be exact and do not require any underlying assumptions for them to be valid. To that effect, tables and graphics were used to describe the characteristics of the sampled households.

On the other hand, regression models require some underlying distribution assumptions for the results to be credible and generalisable for inference purposes. Therefore, in the sections that follow, each regression model used, together with the respective underlying assumptions, are discussed.

3.3.1 Variables used in the model strategies

In this study, cross-sectional secondary data was used to address the research questions. As the household was the main unit of analysis, household head (the person whom the household regarded as the overall head and makes most of the major decisions) and household characteristics were analysed. The following variables (typical household characteristics) were used in the models: age of household head (AGEHH), sex of household head (SEXHH), household head education level (EDUC), household income (INCHH), herd size (HRDSZ), cooperative membership (MEMBR), milk price (PRICE), distance to market (DISTMKT), access to phone (PHN), access to extension services (EXT), land holding size (LND), ownership of motor vehicle(s) (VEHCL), average milk production (MILKPROD), access to veterinary services (VET), and location or province (PROV). In the following section, the model strategies are explained, and the variables used and their expected signs are tabulated.

3.3.2 Model for determining factors for participation in milk production and level of milk production

The maximum likelihood Heckman Selection Model (HSM) was used to identify the factors that affect smallholder farmers' decisions to participate in dairy farming and the factors that influence the levels of production. The HSM requires that the data be normally distributed and homoscedastic for it to be consistent and efficient. Firstly, the distribution assumption requires that the error terms of the selection and outcome equations are independently and identically distributed with zero mean and constant variance (Vella, 1998). The assumption therefore requires that the joint distribution of the errors be normally distributed. Running the HSM with maximum likelihood produces the joint error, which is diagnosed for normality. Relaxation of this assumption results in efficiency loss in the model (Vella, 1998). However, with survey data, normality is rarely achieved, and the central limit theorem is rather invoked. The central limit theorem states that the sampling distribution of the sample means approaches a normal distribution with the increase in the sample size (holds true for sample sizes larger than 30 observations).

The HSM has two sets of equations, namely the selection equation and the outcome equation. In context, the selection equation uses a probit model to isolate factors that influence the decision to participate in milk production. The outcome equation then will identify the factors that had an impact on the level of milk produced by the participating households as would be in a typical ordinary least squares (OLS) regression. The maximum-likelihood HSM gave both results in one run, without having to run two separate models as is the case with two-stage HSM (Bushway et al., 2007). In addition, because the data was not collected specifically for milk producers, running OLS directly would result in selectivity bias, as the observations would be non-random. Running the HSM accounted for the confounding factors that could have had an influence on the decision to participate in milk production (Heckman, 1979; Vella, 1998). Another advantage of using the HSM is that the results from the outcome equation can be generalised to the whole sample for both participants and non-participants (Heckman, 1979; Schwiebert, 2015). Because of its wide applicability, the HSM has been applied in several areas of research, including labour studies (Heckman, 1979), criminology (Bushway et al., 2007), safety studies (Xu et al., 2017), and agriculture (Benjamin et al., 2015; Ibrahim et al., 2012; Tilahun and Bedemo, 2014). The agriculture studies have mainly shown how the HSM has been applied in agriculture mainly

in measuring participation and the extent or level of participation. These studies range from those on climate change adaptation (Tilahun and Bedemo, 2014) to crop varieties adaptation (Ibrahim et al., 2012), to access to agricultural microcredit (Benjamin et al., 2015), as examples. In this study, participation in milk production is measured, and extent of participation is also measured through the milk production variable in the outcome equation, as discussed below.

In this study, the households under consideration had a discrete choice whether or not to participate in milk production, notwithstanding that all were involved in agricultural activities. Borrowing from the behavioural economics' theory of bounded rationality and classical theory of utility maximisation, a household was considered to choose the utility maximising alternative, given the available information and their cognitive abilities. The standard maximum likelihood HSM follows a random utility model, and is specified (Vella, 1998) as:

$$\begin{aligned}
 1) \quad & y_i^* = x_i' \beta + \varepsilon_i; & i=1, \dots, N \\
 2) \quad & d_i^* = z_i' \gamma + v_i; & i= 1, \dots, N \\
 3) \quad & d_i = 1 \text{ if } d_i^* > 0; & d_i = 0 \text{ otherwise} \\
 4) \quad & y_i = y_i^* * d_i;
 \end{aligned}$$

where y_i^* , is a latent endogenous variable with observed counterpart y_i , d_i^* , is a latent variable with associated indicator function d_i reflecting whether the primary dependent variable is observed, and where the relationships between d_i and d_i^* and y_i and y_i^* , respectively, are shown in Equations (3) and (4). Equation (1) is the one of primary interest and (2) is the reduced form for the latent variable capturing sample selection; x_i and z_i are vectors of exogenous variables; β and γ are vectors of unknown parameter, and ε_i and v_i are zero mean error terms with $E[\varepsilon_i|v_i] \neq 0$. Let N denote the entire sample size and use n to denote the subsample for which $d_i=1$ (Vella, 1998).

Likewise, milk production was modelled as a function of demographic, socio-economic, and business support variables, as illustrated below. Specifically, the HSM is used to address the first objective, with the selection equation addressing the participation problem and the outcome equation addressing the determinant of milk yield problem.

$$Y(d=1) = x'\beta + \varepsilon, \quad \text{and} \quad \varepsilon_i|x \sim N(0, 1).$$

where, y^* is a latent (unobservable) variable representing a household's decision whether to participate in milk production or not; x is a vector of independent variables hypothesised to affect a household's decision to participate; ε_i is a normally distributed error term with mean 0 and variance 1; and d is an indicator variable which takes on the value 1 if a household participates in milk production, and 0 if otherwise.

Empirically, the following variables were analysed, as informed by literature, and their expected signs are as shown in Table 3.2 below.

Table 3.2: The Heckman selection model variables and expected signs

Variable	Variable type	Selection Equation	Outcome Equation
Participation	Dummy (1=Yes, 0. No)	+/-	
Milk Production/yield (Litres)	Continuous		
Age of household head	Continuous	+	+/-
Age squared		-	-/+
Gender of household head	Dummy (1=Female)	-	-
Household size	Continuous	+	+
Education level (years of schooling)	Continuous	+/-	+
Land Size (ha)	Continuous	+	+/-
Off-farm Income	Continuous	+/-	+/-
Productive assets	Continuous	+	+
Distance to nearest market (km)	Continuous	-	
Distance to Nearest Supplier of Veterinary products (km)	Continuous	-	-
Access to Extension Services	Dummy (1=Yes)	+/-	+
Herd size (number of cattle)	Continuous		+
Access to veterinary services	Dummy (1=Yes)		+
Grazing system	Categorical: 1. Communal, 2. Own pasture, 3. Both		+/-
Province	1. Central, 2. Eastern, 3. Lusaka, 4. Southern, 5. Western	+/-	+/-

Source: Author's own analysis

In Table 3.2, participation represents the dummy variable for the selection equation, where a response of 1 means that the household was participating in milk production, and 0 means they were not. Similarly, milk production represents the dependent variable for the outcome variable used to measure milk volumes. The rest of the other variables are independent

variables that were measured against the dependent variables in the respective equations and the expected signs are as shown.

In addition to understanding the participation and production, it is important to understand the characteristics that influence marketing channel choices made by smallholder farmers. The following section delves into this discussion.

3.3.3 Model for identifying factors influencing choice of a milk marketing channel

To establish the factors that determine the choice of a marketing channel, the multinomial logit model was employed. The multinomial logit model is an extension of the binary logit model, except that it has more than two choice dependent variables. The households have a discrete choice about which marketing channel they want to participate in. The multinomial logit regression uses a maximum likelihood estimation to evaluate the probability of a categorical choice (Greene, 2000). The probability that individual i chooses the j th alternative ($j=1,2,3$) for traditional marketing channels, modern marketing channels, and direct milk sales as a marketing channel can be expressed as follows:

$$P(Y_i=j|X) = G(\beta_0 + X\beta)$$

where:

$$X\beta = \beta_j X_{ij} + \dots + \beta_k X_{ik}.$$

β_{jis} is a parameter estimate for a market channel and X_{ij} is a vector of explanatory variables.

G is a cumulative distribution function (CDF) for a standard logistic random variable, which is expressed as:

$$G(z) = \exp(z) / [1 + \exp(z)] = \Lambda(z)$$

and strictly ranges between zero and one; $0 < G(z) < 1$ for all real numbers z (Wooldridge, 2016).

The probability for the choice of market j , given x_i covariates, is given as (Greene, 2000):

$$PROB(Y_i = j) = \frac{e^{\beta_j X_i}}{1 + \sum_{i=1}^n e^{\beta_j X_i}} \quad \forall j=1,2,3$$

where Y_i is the observed response for the i^{th} observation or household for choice of a marketing channel among the three channels ($j=1$ for direct milk sale, $j=2$ for traditional marketing channel and $j=3$ for modern marketing channel); x_i are the independent variables that influence the marketing channel choice; n is the sample size; and β_j are parameters to be estimated. Specifically:

$$PROB(Y_i = 1) = \frac{1}{1 + \sum_{i=1}^n e^{\beta_j X_i}}$$

The parameters can be estimated by maximum likelihood procedure as:

$$\ln \left[\frac{P_{ij}}{P_{i1}} \right] = \beta_j X_i$$

0

where the dependent variable is the log odds that the farmer will choose market j , relative to the base category (Ishaq et al., 2017; Moturi et al., 2015). The marginal effects of all explanatory variables for (X_{ji}) on the choice of milk marketing channels, with respect to X_{ji} , can be calculated by following equation:

$$\frac{\partial p}{\partial x_i} = \frac{\partial}{\partial x_i} [\exp(x, \beta) / (1 + \exp(x, \beta))] = p(1 - p) \frac{\partial x, \beta}{\partial x_i}$$

The multinomial logit model has the following advantages over other similar models in that it does not need the assumption of normality, linearity, and /or homoscedasticity (Greene, 2012). This makes the model more attractive and thus widely used in applied research (Greene, 2012). However, it makes an assumption about the independence of the dependent choice variable, called Independence of Irrelevant Alternatives (IIAs) (Greene, 2012). This assumption postulates that the choice of one alternative is not related to the choice of another. For example, to test for the IIA assumption, a test called the Hausman-McFadden test is used

(Greene, 2012). The model was therefore tested using STATA 15 and passed the IIA test, implying that the outcome choices were independent enough to warrant the use of the model.

The multinomial logit model was utilised to assess factors affecting smallholder participation in milk marketing channels. The multinomial logit model has gained popularity in market participation studies, when compared with models that could produce similar results, because of its attractive properties. For example, it has been used in many studies, ranging from participation in pineapple marketing channels in Kenya (Sigei et al., 2015); to participation in sheep and goat marketing channels in Macedonia (Tsourgiannis et al., 2008); to participation studies in the dairy milk marketing channels in Pakistan (Ishaq et al., 2017) in Kenya (Moturi et al., 2015).

Models such as the HSM (Balirwa et al., 2016) and the Categorical Principle Component Analysis (CATPCA) (Neutzling et al., 2017), among others, have been used to carry out similar studies. However, the computational ease and parsimonious nature of the multinomial logit model makes it a preferred model for this study, compared with others. It is also less restrictive than the alternative multinomial probit and linear probability models (LPMs) are, which require the normality and homoscedasticity assumptions (Woodridge, 2016).

The choice of the milk marketing channel was modelled as a function of household and household head characteristics; access to markets and transport infrastructure; access to support services; and access and ownership of factors of production (e.g. land and capital). Table 3.3 shows the variables used and the expected signs as informed by literature and available data.

Table 3.3: Multinomial logit model Variables and their expected signs

Variable	Variable type	Traditional	Modern	Direct Milk sales
Marketing channel	Dummies: 1.Direct milk sales, 2. Traditional, 3. Modern			
Age of household head	Continuous	+/-	+/-	+
Age squared				
Gender of household head	Dummy (1=Female)	+	-	+
Household Size	Continuous			
Highest level of formal education completed	Continuous	-	+	-
Land Size	Continuous	+/-	+	+/-
Off-farm Income	Continuous	-	+/-	-
Productive assets	Continuous	-	+	-
Membership to a Cooperative	Dummy (1=Yes)	+	+	-
Distance to nearest established market	Continuous	-	+	+
Distance to livestock market	Continuous	-	-	+
Distance to tarmacked road	Continuous	-	-	+
Milk Production (logged)	Continuous	-	+	-
Access to Market Information	Dummy (1=Yes)	+/-	+/-	-
Milk Price	Continuous	+	+	+

Source: Author's own analysis

The marketing channel variable represents the available marketing channel choices available to the smallholder farmer, from which one major choice is selected. The remaining variables are the factors that influence the choice of a marketing channel.

To make the computations even easier in multinomial logit, the model requires that one of the marketing channel choices be used as a base. Accordingly, the characteristics of the

remaining alternatives are determined against that base. The choice of a base is at the discretion of the researcher, or, the alternative with most observations is often used a reliable base. In this study, the direct milk sale had the most users, compared with the other alternatives. Therefore, the direct milk sales channel was used as the base category against which the traditional and the modern marketing channels were measured. For example, the likelihood of using the modern marketing channel was calculated relative to the direct milk sales marketing channel.

3.3.4 Independent t-tests

To conduct a comparative analysis of the characteristics of women against all men in the sample, and for the youth against all older farmers, the independent t-test was used. Selected variables were used for this analysis. Firstly, the means of a given variable are determined for each group (for example, male and female) and then these are compared for statistical difference. The independent group t-test¹² was used to address the third objective to test the statistical difference for the characteristics of women and the youth against the control groups (men and non-youths, respectively). The independent t-test hypothesises that the mean difference between the population groups is equal to zero. Therefore, a statistically significant difference in means, at alpha level 0.05, indicates a difference in the characteristics of the two groups in terms of the given variable.

$$t = \frac{\bar{x}_1 - \bar{x}_2}{s_p \sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$$

\bar{x}_1 = Mean of first sample

\bar{x}_2 = Mean of second sample

n_1 = Sample size (i.e., number of observations) of first sample

n_2 = Sample size (i.e., number of observations) of second sample

s_p = Pooled standard deviation

¹²For more information, see link: <https://stats.idre.ucla.edu/stata/output/t-test/> or <https://libguides.library.kent.edu/spss/independentttest>

In summary, this chapter has presented the methodological strategies used in this study to arrive at the findings. It highlighted the study area and sample sizes used for each model and the econometric tools used to address the objectives of the study. The Heckman selection model was used to determine the factors that influence smallholder farmers' decisions to participate, and the extent of their participation, in milk production in Zambia. The multinomial logit model was employed to identify the factors influencing the choice of milk marketing channels among smallholder farmers in the Zambian milk value chain. Finally, the independent t-test was used to examine the characteristics of the youth and women in the dairy sector, as they compare with the characteristics of the control or references groups. The following chapter presents the descriptive analysis of the results. This is then followed by a chapter presenting the results from the econometric models described above.

CHAPTER FOUR: RESULTS OF DESCRIPTIVE ANALYSIS

4.1 Introduction

This chapter presents a discussion of the findings of the study. It characterises and presents the descriptive statistics of the respondents of the study at household level to give a contextual feel of the data used. Sub-themes include demographics and socio-economic characteristics, access to business and support services, and social capital variables. Additionally, independent t-tests were carried out to test the difference in group means at marketing channel level to check the homogeneity status of the sampled households. This aided in understanding how similar or dissimilar the characteristics of the household are across the marketing channels to help tailor policy instruments accordingly.

4.2 Descriptive analysis

This section presents tables, figures and graphs that helped to gain an understanding of the data. It gives relevant understanding of what can be expected from the data and how the data can be modelled. It is also important to note that a pooled sample is referred in the text to mean the total sample size used in the study, consisting of both milk producers and non-milk producers. Additionally, sub-samples for specific marketing channel users are described. The modern marketing channel refers to formalised types of marketing channels, such as MCCs, interlocked contractual arrangements, and cooperatives. The direct sales marketing channel involves sales of milk directly to consumers, mainly neighbours, friends and others. The traditional marketing channel is the sale of milk to users and re-sellers, such as restaurants, local stores, and individual re-sellers, through unsophisticated means and with less formalisation. Under this section, sub-themes are discussed, including demographic and socio-economic variables, access to business support services, and social capital variables.

4.2.1 Demographic and socio-economic characteristics

The data showed that the sample was composed of active farmers with an average age of around 47.3 years, with over 75% being under 65 years of age. This is consistent with a CSO

labour force survey report that found that over 95% of the country’s population is under the age of 65 (CSO, 2018). The average age of the sample is important since age groups between the ages 15 and 65 are expected to be active, creative and energetic, and so actively participate in agricultural activities (Kawambwa et al., 2014; Staal et al., 2008). Table 4.1 below shows some statistics of household characteristics of the sample households.

Table 4.1: Characteristics of smallholder farmers in the study area

Variable	Mean	Standard deviation
Age of household head (years)	47.31	13.24
Gender of household head (1=Female)	0.17	0.37
Education level of household head in years	6.29	3.99
Household size (number)	6.50	2.80
Herd size(cattle)	11.44	18.82
Land holding (hectare)	4.76	8.37

n=3574

Source: Author's computation from RALS (2015)

Household sizes ranged between 1 and 24 persons per household, with an average of 7 persons per household. Cultural practices of polygamy and having traditionally extended families living as a single household contributed to the large household sizes. In this study, household size is used both as a proxy for labour endowment, representing a key factor of production, and as a push factor for participating in milk production activities (Kiwanuka and Machethe, 2016). Seventy percent of the sampled households comprised married persons, with only 1% being single, and approximately 29% making up the ‘other’¹³ group.

In a cross-tabulation of gender against highest level of education attained by the household head, proportionately more males had attended some formal education, across all categories, than females had. This was in agreement with the findings of the CSO’s Labour Force Survey Report (CSO, 2018). For example, around 45% of males had received primary education, compared with only 10% of females (see Table 4.1). In general, 55% of the sample had received primary education, with 28% and 4% receiving secondary and tertiary education, respectively. This entails that most farmers were literate, with only slightly less than 13% not having received any form of formal education. Education level is assumed to contribute to the decision-making process, as it is expected to enhance cognitive and business

¹³Not currently married, having been divorced, separated or widowed.

management skills (Ishaq et al., 2017). When compared across marketing channels, the average number of years spent in school was above seven years for all marketing channels, with no significant difference across the channels (Table 4.2).

Table 4.2: Cross tabulation of education level against gender

Gender of Household Head	Level of Education				Total
	No Education (%)	Primary (%)	Secondary (%)	Tertiary (%)	
Male	9.23	45.36	24.99	3.53	83.1
Female	3.58	10.07	2.69	0.56	16.9
Total	12.81	55.43	27.67	4.09	100

Source: Author's computations from RALS (2015)

Off-farm income, herd size, land size and value of productive assets, collectively, act as relevant factors in a farmer's milk production. Farmers held, on average, less than five hectares of land per household in the pooled sample (Table 4.1). However, land held by each household ranged between seven and ten¹⁴ hectares per household, across the marketing channels, with no significant difference (Table 4.3). Noticeably, users of the direct sales channel possessed greater areas of land than those in other channels did. Extreme cases were observed where households had large pieces of land that were unused and undisturbed by crop production, and are characterised as virgin land. In this study, the amount of land measured included land that was available to the household and had rights to use it. This included borrowed-in and rented-in land, cultivated fields, and virgin land. This was important, as in dairying, the land is usable by the household for grazing of the animals as opposed to only measuring cultivated field size. Therefore, it was not surprising that direct sales channel users had more land than other channels users did, as these tend to have greater areas of traditional land, some of which is virgin land. On the other hand, users of the modern channel, for example, tend to possess land owned under the civil tenure, and as such would have relatively smaller portions, with little virgin land.

To produce milk, one needs cows. Herd size comprised the number of cattle the household was rearing during the reference period, inclusive of milking animals (cows), bulls, oxen and calves. Modern marketing channel users had the most cattle (46) per household, compared

¹⁴ The difference between the pooled sample average and the marketing channel average arises because farmers who produce milk generally have more land than those that did not produce milk. Therefore, when the sample is pooled, the non-milk producers pulled the land size average down, as they made up the majority of the group.

with other market channel users. These findings are in agreement with those of Ishaq et al. (2017) and Moturi et al. (2015), where modern marketing channel users were found to have the most cattle, on average, compared with other marketing channel users. It follows, therefore, that those with greater numbers of cattle would produce more milk, all things being equal.

Table 4.3: Demographic and socio-economic characteristics of smallholder farmers per milk marketing channel

Variable	Traditional		Modern		Direct Milk Sales		t-test
	Mean	SD	Mean	SD	Mean	SD	
Age of household head	47.58	10.39	51.67	11.05	49.17	12.10	0.54
Youth farmers	0.13	0.33	0.00	0.00	0.13	0.13	0.69
Gender of household head (1=Female)	0.15	0.36	0.00	0.00	0.08	0.27	1.49
Education level of household head in years	7.88	3.65	7.78	2.68	7.34	3.53	0.43
Household size	7.85	3.21	9.89	5.71	7.97	3.25	1.47
Herd size (Cattle)	25.26	30.25	46.11	53.05	23.97	29.07	2.29*
Land holding	7.34	9.98	8.91	4.00	9.57	22.83	0.19
Off-farm income (ZMW)	11,455.38	31,644.42	5,459.67	6,930.50	9,968.74	2,1476.86	0.25
Productive assets (ZMW)	12,523.63	20,208.29	25,555.00	41,116.02	13,391.37	27,449.04	0.92
Sample Size	N=40		N=9		N=202		

*, **, ***: significant at 10%, 5% and 1% levels, respectively

Source: Author's computations from RALS (2015)

Off-farm income constitutes the income that the household made from other income generating activities outside the farm, including running businesses, and formal or informal employment. On average, off-farm income was over ZMW 8500 (USD 1130.32¹⁵) per household per annum for the pooled sample. This was higher than that of modern marketing channel users (ZMW 5500 or USD 731.38), but less than that of direct sales channel users (ZMW 9969 or USD 1325.66) and traditional marketing channel users (ZMW 11500 or USD 1529.26). Modern marketing channels users had the lowest off-farm income, as they were expected to have agriculture as their main business, thus making more income on-the-farm than off-the-farm. There was, however, no statistical difference across group means per

¹⁵Exchange rate USD1=ZMW7.52, as at June 2015; see link (<http://www.boz.zm/average-exchange-rates.htm>: Accessed 17th January, 2019: 12:27).

marketing channel. This was in line with Kiwanuka and Machethe (2016), who opined that a higher off-farm income meant less specialisation in the dairy sector, and as such, the modern marketing channel users would be expected to be more invested and specialised in dairy production, and so would have a lower off-farm income.

Like off-farm income, there was no significant statistical difference for value of productive assets across marketing channels. Productive assets represented both farm implements and non-farm assets that the household owned during the reference period. These included ploughs, wheelbarrows, sprayers, bicycles, motor vehicles, cell phones, solar panel equipment, and water pumps. These represented a myriad of applications in which these assets could prove useful to a farming household. Therefore, a higher productive asset value would be expected to have a positive influence on both milk production and marketing. The productive asset value among the marketing channels ranged between ZMW 12 500 (USD 1662.23) and ZMW 26 000 (USD 3457.45), with the modern marketing channel users having the highest average (ZMW 25 555 or USD 3398.27). As would be expected, the modern marketing channel users were more invested in agricultural activities, and as such, their higher productive asset value was no surprise (Kiwanuka and Machethe, 2016).

4.2.2 Access to business support services

Access to business support services by all actors in the marketing chain is pivotal in making the dairy chain competitive (Wambugu et al., 2011). Therefore, the availability of these services to producers, intermediaries and end-users of goods and services is paramount for sector development. This section discusses support services such as accessibility to markets and market information, access to extension, credit, veterinary services, and social capital variables in the milk value chain. The results are presented in Table 4.4.

Table 4.4: Access to business support services of smallholder farmers per marketing channels

Variable	Traditional		Modern		Direct Milk Sales	
	Mean	SD	Mean	SD	Mean	SD
Access to Market Information (1=Yes)	0.83	0.38	1.00	0.00	0.82	0.39
Access to a mobile phone	0.83	0.38	1.00	0.00	0.91	0.29
Access to veterinary services (1=Yes)	0.90	0.30	0.89	0.33	0.92	0.27
Member to Credit/Saving Society (1=Yes)	0.03	0.16	0.22	0.44	0.06	0.24
Access to Rural Credit/Loans (1=Yes)	0.18	0.38	0.22	0.44	0.19	0.40
Distance to nearest Tarmac	20.35	15.95	23.11	18.90	27.30	28.22
Distance to market	16.30	15.52	37.56	13.72	30.86	29.69
Distance to Livestock centre	17.84	14.74	22.78	19.10	27.83	25.55
Distance to Veterinary Product supplier	19.83	16.23	25.11	17.02	29.37	26.57
Sample Size	N=40		N=9		N=202	

Source: Author's computations from RALS (2015)

Distance to the market¹⁶ represented the transport costs involved in accessing the market. Table 4.4 shows that farmers had to travel distances of about 25 kilometres to the nearest established market that hosted many buyers and sellers, and where they could buy and sell commodities (agricultural or otherwise). Distances were slightly longer for those who used roadside markets to sell their products. A comparison of these distances showed that modern marketing channel users travelled the longest distances to the nearest market (38 km), followed by direct marketing channel users (31 km), and lastly, the traditional market users (16 km), with a 1% statistical difference. Users of the modern marketing channel were expected to travel longer distances to markets to meet contractual obligations and were able to do so because they had better access to means of transport, as evidenced by their large productive assets value. The distance to the nearest tarred roads, are sometimes used as market areas,¹⁷. Direct marketing channel users were found to live the farthest from tarred roads, followed by modern marketing channel users and traditional marketing channel users.

¹⁶Established markets that host greater numbers of buyers and sellers can be utilised as both input and output markets.

¹⁷In the absence of nearby established markets, smallholder farmers (especially women) would sell their produce by the roadsides, usually at a site where a good number of people pass by.

Generally, the majority of milk producers were located in rural areas and had sufficient grazing land and access to water, yet most of the above-mentioned key support facilities and services were located in or near urban centres. For this reason, it would appear that the farther away from towns the farmers were located, the more likely they would be to produce milk. In addition, this suggests that the majority of smallholder farmers live far away from the modern marketing channels, MCCs, which tend to be in or near urban centres. These smallholders, therefore, would be expected to use more of the traditional and/or the direct marketing channels.

In addition to distance, access to mobile phones and price information of agricultural commodities were examined. Over 80% of the farmers had access to mobile phones. Although this represents a medium through which farmers could access information, it was understood that having access to mobile phones alone did not exclusively mean that they accessed market information. Rather, it could partly represent having access to information, communication and technology.

Farmers accessed market information through several modes, including but not limited to, government extension officers, neighbours, and farmer groups. Generally, above 80% of farmers had access to market information, with no statistically significant difference across households choosing different marketing channels (Table 4.4). This could be attributable to the wide use of mass media platforms, such as television and radio, which were found to be a popular medium through which farmers accessed market information (see Figure 4.1). Fifty percent of the farmers had accessed price and market information through mass media platforms, while 25% did so through fellow farmers or neighbours, and 9.32% through non-governmental organisations (NGOs) and/or private firms (*inter alia*, churches, Lima links¹⁸, and the conservation farming unit (CFU)¹⁹). Not more than 7.75% of the farmers accessed market information through government extension agents, with 4% accessing information through farmer groups. The rest of the farmers accessed market information through channels such as workshops, field days, and the market place.

¹⁸Lima links is a Zambian social enterprise that provides farmers with agricultural commodity information through technology, predominantly cell phones (<http://www.limalinkszambia.com/>).

¹⁹The CFU works to provide farmers with training and skills in practices of conservation farming and other agricultural-related information (<https://conservationagriculture.org/work/>).

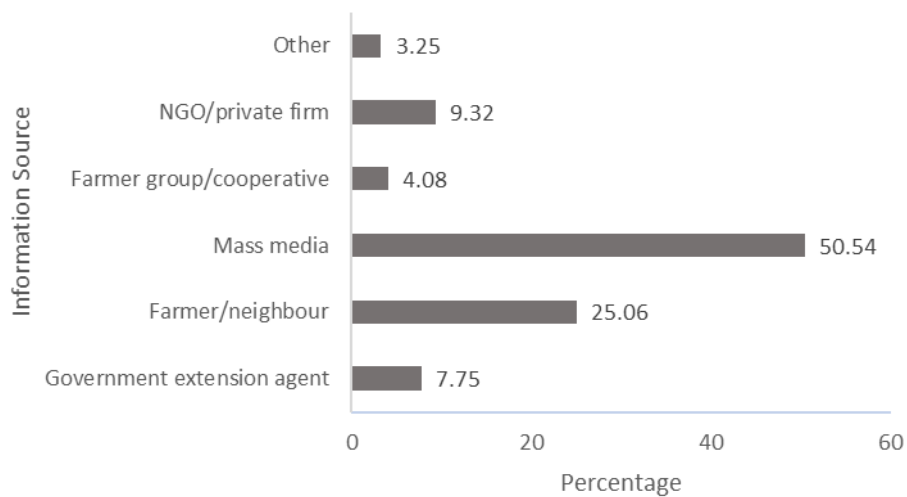


Figure 4.1: Sources of agricultural commodity price information

Source: Author's computation from RALS (2015)

In analysing accessibility to veterinary services, the farmers who had accessed these services from government departments or otherwise were accounted for. This measure was applied for all those who had accessed drugs for vaccination or treatment of their livestock during the reference period. It was discovered that above 90% had access to veterinary services, across the marketing channels. Direct marketing channel users accessed relatively more veterinary services than the other marketing channel users did, with the modern marketing channel users being lowest users. This seems to suggest that modern marketing channel users experience fewer instances of diseases that would warrant the need to access veterinary services. This could be attributable to better education and the resulting better herd management. Distances to the nearest livestock centres and other veterinary product suppliers ranged between 19 and 30 kilometres. This highlights the point that differences in accessing veterinary services were seen across the different marketing channel users.

Figure 4.2 below shows the major sources of veterinary services. It indicates that over 51% of the cattle-owning households accessed veterinary services from government departments, signifying the government's role in the sector. Forty-four percent of the remainder accessed the services from private firms and the rest would either self-diagnose and medicate or seek help from other farmers.

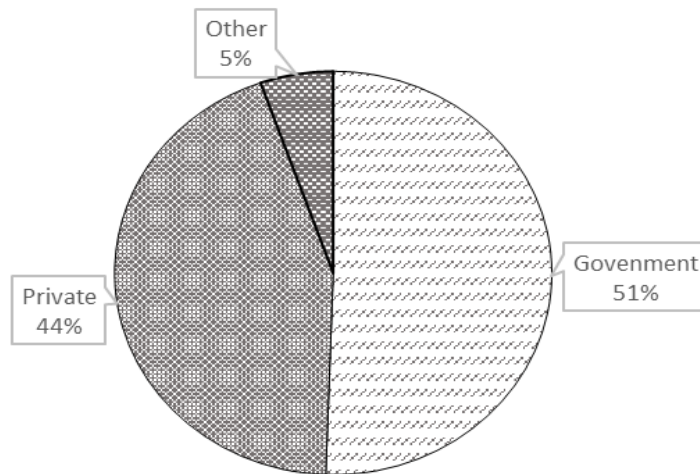


Figure 4.2: Sources of veterinary services

Source: Author's computation from RALS (2015)

Other business enablers that were examined include access to credit and membership of a local credit or savings society. This highlights the relevance of existing organisations in providing credit facilities to the local communities. The modern marketing channel had the highest number of participants, with 22% accessing rural credit or loans, followed by 19% of direct marketing channel users, and only 18% from the traditional marketing channel users, respectively. A possible reason for the high access to credit facilities enjoyed by the modern channel users is that they may be assumed to be more credit worthy and may have greater collateral for securing loans, as evidenced by the high value of their productive assets (ZMW 25 555 or USD 3398.27). Coincidentally, 22% of the modern marketing channel users were also members of credit or savings societies, which implies that they have access to credit or loans. Some 6% of direct milk sales users belonged to credit or savings societies and 3% of the traditional channel users, respectively, which suggests their limited access to rural credit or loans. This suggests that modern marketing channel users are more agile in seeking finance for their enterprises than the other marketing channel users are.

4.2.3 Social capital variables

Social capital refers to the networks or relationships that exist in a community which enhance the efficiency and effectiveness of its functions or operations (Nahapiet and Ghoshal, 1998). Three variables (shown in Table 4.5) were utilised to explain social capital in the sampled

communities, which comprise access to the government’s Farmer Input Support Programme (FISP), membership of a cooperative or farmer group, and membership of a women’s group (Banda, 2017; Mburu et al., 2007).

Table 4.5: Access to social capital variables across marketing channels

Variable (1=Yes)	Traditional		Modern		Direct Milk Sales	
	Mean	SD	Mean	SD	Mean	SD
Access to FISP	0.68	0.47	0.89	0.33	0.60	0.49
Cooperative membership	0.60	0.50	0.89	0.33	0.63	0.48
Membership to Women's Group	0.35	0.48	0.44	0.53	0.34	0.47

Source: Author’s computations from RALS (2015)

The FISP programme is a government programme through which farmers can access subsidised inputs for the respective farming season, predominantly maize seed and fertiliser²⁰ (Kuteya et al., 2016). To achieve its objective, government required the would-be beneficiaries to belong to a cooperative as a pre-requisite for registration under the programme. According to Alemu (2017), cooperative provide a node through which smallholders farmer can access formal markets, information and dairy technology and extension. For instance, the access to FISP and membership of a cooperative were accessed by 53% and 55% farmers, respectively. Therefore, membership of a cooperative constituted the largest category through which some members accessed FISP. These two variables were found to be highly correlated as they measured related information. The results show that users of the modern marketing channel had the highest access to FISP and numbers of membership of farmer cooperatives (89%), compared with the other two channels (Table 4.5). This could be attributable the fact that modern marketing channel users had better access to information and are business oriented, with a bias towards agriculture, and thus took advantage of the reduced input costs available through the subsidised input regime. The results seem to suggest that the number of modern market users who belonged to farmer cooperatives did so solely to get access to the FISP.

²⁰At the time of writing, the FISP programme had been updated to an electronic-FISP that allowed farmers to diversify their input combination to accommodate other enterprise needs, such as livestock production and horticultural crops.

The farmers were asked if any household member(s) belonged to a women's group, and the results revealed that 24% of the sample had access to these groups. When disaggregated by marketing channel, users of the direct channel had the highest membership (47%) of women's groups, followed by the modern marketing channel (44%) and the traditional marketing channel (35%) users, respectively. As mentioned earlier in this study, no female- and youth-headed households used the modern marketing channel. This suggests that the majority membership of the women's group comes from the female- and youth-headed households.

4.2.4 Grazing Systems

As mentioned earlier, grazing systems are especially important to milk production and milk yield. Figure 4.3 summarises the main grazing systems that are practised in Zambia. As shown, the majority of farmers used communal pastures throughout the year, that is, from the rainy season when pastures are plentiful, through to the hot and cold seasons when pastures are scanty. About 3.9% of the farmers, however, exclusively used their own pastures to feed their cattle in the named three seasons. This includes those who grazed their animals exclusively on their own fields and/or harvested pasture to feed their animals. As can be seen from Figure 4.3, about 15% of the farmers practised both communal grazing and own pasture systems. Farmers would use communal grazing in the rainy season and supplement with their own harvested pastures in the dry and cold months of the year. It is therefore expected that the type of grazing system that a farmer uses could have an impact on the amount of milk that they produce in a year. As was expected, the majority of smallholder farmers in Zambia practise an extensive farming system, where a greater use of communal grazing and water resources is utilised. Better management, that is, the use of own harvested or improved pastures, would result in high milk yields. To minimise operation costs, farmers would opt for a combination of both communal and own pastures, with a minimal decrease in yields, if well managed. In a similar manner, utilising only the communal grazing system would drastically reduce feed cost, but at the same time, the yields suffer.

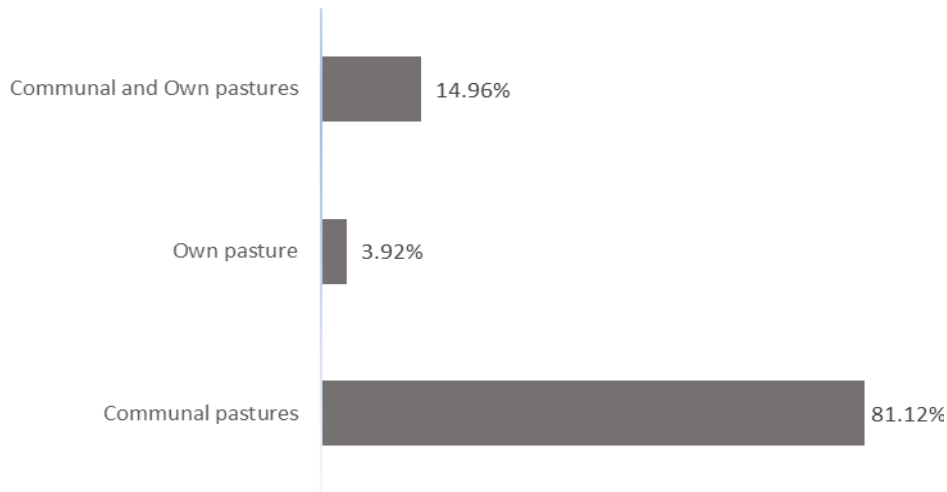


Figure 4.3: Grazing systems practised in Zambia by smallholder farmers

Source: Author's own computation from RALS (2015)

4.2.5 Milk production and sales by marketing channel

Milk production represents the amount of milk the household produced during the reference period of 12 months prior to the interview date. It included all the milk produced for consumption and for sale. Picking a farmer at random from the modern channel users, indicates that he or she would be producing an average of over 3 761 litres per year. Similarly, Table 4.6 shows that traditional marketing channel users and direct channel users produced 1 855 and 1 199 litres per year, respectively.

Table 4.6: Production and sales of milk by smallholder farmers per marketing channel

Variable	Traditional channel		Modern channel		Direct Milk Sales		t-test
	Mean	SD	Mean	SD	Mean	SD	
Milk production	1,854.50	1,570.51	3,761.11	3,826.37	1,198.61	1,296.04	14.99***
Milk Sales	1,250.73	1,260.54	2,627.72	3,126.55	7,47.86	990.15	13.4***
Milk price	4.62	3.84	2.74	0.72	4.17	3.20	1.24
Sample Size	N=40		N=9		N=202		

*, **, ***: significant at 10%, 5% and 1% levels, respectively

Source: Author's computations from RALS (2015)

Sales volumes proportionately followed the production trend (Figure 4.4). It follows that those with the highest production volumes also sold higher milk volumes. These results were expected, as it was assumed that participants in modern marketing channel would have more years of education and technical know-how, and thus would enjoy relatively easy access to factors of production and business support services. For the other channels, these attributes varied considerably. Production and sales volumes differed significantly across the marketing channels and were higher than the pooled sample volumes were, as this survey included non-milk producers as well.

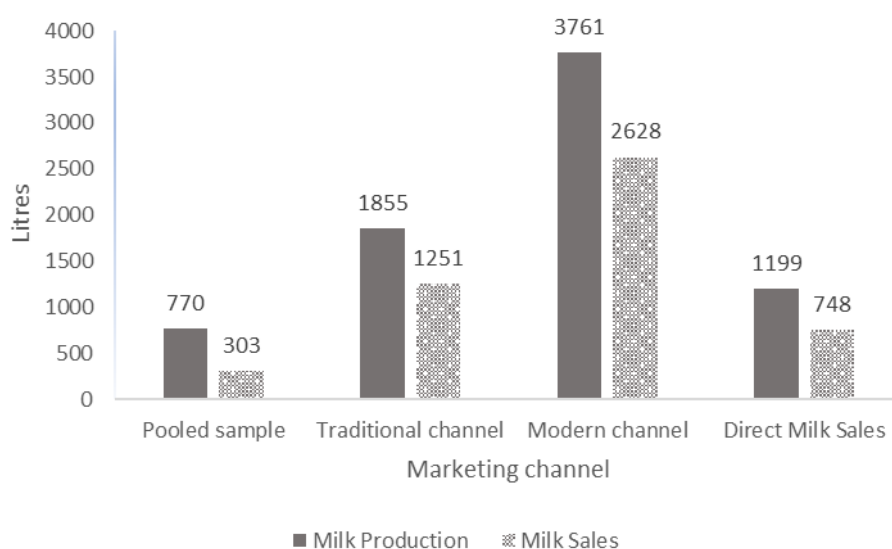


Figure 4.4: Milk production and sales volumes by marketing channel

Source: Author's computation from RALS (2015)

Price is a key decision factor in determining what marketing channel farmers use to sell their milk. This is because prices quantitatively show explicitly the benefits that would accrue to the farmer. Assuming that farmers are rational and utility maximisers, all things being equal, they will always choose the marketing channel that maximises their utility (Williamson, 1991). By extension, a marketing channel with a higher price would be a default channel of choice, *ceteris paribus*. The traditional marketing channel offered the highest price per litre of milk, at ZMW 4.62 (USD 0.61), followed by the direct marketing channel at ZMW 4.16 (USD 0.55), while the lowest price came from the modern marketing channel, at ZMW 2.74 (USD 0.36) (Table 4.6). In fact, this was not surprising for two reasons and was consistent with literature. Firstly, in the traditional marketing channel and direct channel, price is flexible and can be negotiated according to market forces, thus tending to be higher more

often than not (Ishaq et al., 2017; Moturi et al., 2015). For the modern marketing channel, however, price is fixed by the buyer or set through a contractual arrangement in cases of inter-locked contractual arrangements (ICAs)²¹. Secondly, seeing that users of the modern marketing channels were those with high milk production volumes, it follows that they needed a reliable and consistent market that would absorb all their milk sales volumes (Moturi et al., 2015). Because the traditional and direct marketing channels are small-volume marketing channels, with slightly higher prices, the bulk buying facilities made up for the price loss to the modern channel users. Despite the differences in milk prices across the marketing channels, price was not statistically significant across the channels.

4.3 Summary

The above discussion has thus far covered the descriptive analysis, describing the results, and the different tools available for contextual understanding. The findings showed that the majority (75%) of the smallholder farmers in the study were between the ages of 20 and 65 years, with an average of 47.3 years. The average household size was 7 members per household. Further, overall, only 17% of the farmers were females in the sampled areas. The average number of years of formal education received by the household head was around 6 years, with landholding size per household averaging around 4.7 hectares. These numbers are slightly higher when compared across marketing channel. This is because, generally, smallholder farmers with cattle tend to have better resources than those who only farm crops have. Machina and Lubungu (2018) suggest that the ownership of livestock also enhances the capacity for crop farming.

In terms of marketing channels, the majority (80%) of smallholder farmers in the sample utilised the direct milk sales channel. About 16% used the traditional marketing channel, and the remaining 4% used the modern marketing channel. Neither the youth nor women participated in the modern marketing channel, highlighting the fact that gender and age played a major role in market choice. Generally, users of the modern marketing channel had better access to factors of production than users of other channels did. They had better education, labour endowment, and more productive assets, and ultimately produced and sold more milk than other marketing channel users did (Neven et al., 2017, 2006).

²¹Some farmers participating in the modern marketing channel did so in terms of binding contracts with buyers or processors, as the case may be.

The sections that follow delve into the results from econometric models to address the specific objectives of the study.

CHAPTER FIVE:
ECONOMETRIC RESULTS FOR FACTORS AFFECTING SMALLHOLDER
FARMERS' PARTICIPATION DECISIONS IN MILK PRODUCTION AND MILK
MARKETING

5.1 Introduction

This chapter presents results from the econometric models to address the specific objectives. The findings derived from the econometric models regarding the factors that influence (i) smallholder farmers' decisions to participate in milk production and the levels of milk production in Zambia; (ii) smallholder farmers' choices of a marketing channel; and (iii) characteristics of women and the youth in milk production are discussed.

The Heckman Selection Model was employed to address objective one and the results are presented below. The second model (Multinomial logit) addressed the second objective by determining the decision factors in choosing a milk marketing channel. Then the hypotheses tested are revisited. The t-test was used to compare the characteristics of women and the youth against the control groups. Finally, a brief chapter summary of the findings is presented.

5.2 Smallholder farmers' participation in milk production

In the HSM, the selection equation was used to explain the participation problem, while the outcome equation addressed the milk production problem. The selection equation, as presented below.

$$\text{Milkp} = \beta_0 + \beta_1 \text{agehh} - \beta_2 \text{agehh}^2 + \beta_3 \text{sexhh} + \beta_4 \text{hhsiz} + \beta_5 \text{educhh} + \beta_6 \text{land} + \beta_7 \text{offinc} + \beta_8 \text{passet_valu} + \beta_9 \text{distmk} + \beta_{10} \text{dist-vet} + \beta_{11} \text{ext} + \beta_{12} \text{phone} + \beta_{13} \text{prov}$$

where participation (Milkp) in milk production is the dependent dummy variable (1=yes and 0=no) representing the decision to participate in milk production.

The results are presented in Table 4.8. The model was highly significant, with $prob > \chi^2$ (p-value=0.000), $athrho$ (-0.675, p-value=0.000) and $Insigma$ (7.022, p-value=0.000), signifying a proper model fit. The significance of $athrho$ and $Insigma$ showed that there was correlation between the selection and outcome error terms representing presence of sample selection bias.

The data included a subsample of farmers who produced milk and others who did not. If the characteristics of the milk producers and non-producers were similar, then selectivity bias would not be problematic. In this sample, however, an exploratory test to check the homogeneity of the sample showed that their characteristics were dissimilar. Hence, this warranted the use of HSM to correct for the selectivity bias. To correctly determine the influencers of milk production, the model checked whether some characteristics that influence participation would also affect levels of production. Sample selection occurs when some determinants of the participation decision are also relevant in determining the production levels (Vella, 1998).

In this study, the model identified the variables that influenced the farmers' decisions to participate in milk production as being: age (p-value=0.0531) and gender (p-value=0.0000) of household head; household size (p-value=0.0000); level of education (p-value=0.0007); landholding size (p-value=0.0000); and off-farm income (p-value=0.0227). Other determinants include the value of productive assets (p-value=0.0004), distance to nearest veterinary products supplier (p-value=0.0922), access to mobile phone (p-value=0.0067), and provincial location of the farmer. The effects and magnitudes of these variables on the farmers' decisions to participate in milk production are presented below (Table 5.1). Table 5.1 presents the coefficients and the respective marginal effects that each variable would have on the decision variable. The marginal effect represents the effect on the probability of the decision to participate as a result of a unit change in the independent variable, *ceteris Paribus*.

Table 5.1: Heckman selection model results

<i>Independent variables</i>	Selection Equation		Marginal Effect
	<i>Participation</i>	<i>P-value</i>	<i>dydx (psel)</i>
Age of household head	0.033* (0.017)	0.0531	0.008 (-0.004)
Age squared	-0.000* (0.000)	0.0974	-0.000 (0.000)
Gender of household head (1=female, 0=male)	-0.519*** (0.097)	0.0000	-0.130 (0.024)
Household Size	0.085*** (0.012)	0.0000	0.021 (0.003)
Highest level of formal education completed	-0.030*** (0.009)	0.0007	-0.007 (0.002)
Land Size	0.050*** (0.009)	0.0000	0.013 (0.002)
Off-farm Income	-0.000** (0.000)	0.0227	-0.000 (0.000)
Productive assets	0.000*** (0.000)	0.0004	0.000 (0.000)
Distance to nearest market	0.000 (0.001)	0.7236	0.000 (0.000)
Distance to Nearest Supplier of Veterinary products	-0.002* (0.001)	0.0922	-0.001 (0.000)
Access to Extension Services (1=yes, 0=No)	0.0338 (0.102)	0.7408	0.008 (0.026)
Access to mobile phone	0.231*** (0.085)	0.0067	0.058 (0.021)
Province			
Eastern	0.176* (0.090)	0.0504	0.043 (0.021)
Lusaka	-0.241* (0.137)	0.0779	-0.050 (0.027)
Southern	1.191*** (0.094)	0.0000	0.371 (0.027)
Western	-0.0654 (0.124)	0.5965	-0.015 (0.027)
Constant	-2.528*** (0.410)	0.0000	
Model fit			
athrho	-0.675***		
Insigma	7.022***		
Number of Observations	2,477		2,477
Log pseudolikelihood	-6908.50		
Wald Chi2 (19)	136.16		
Prob > chi2	0.0000		
Uncensored observations	697		

Robust standard errors in parentheses

*** p-value<0.01, ** p-value<0.05, * p-value<0.1

Source: Author's computations from RALs (2015)

Age of household head and age squared were significant at 10% probability level. Age was positively related to participation up to a certain age, after which the relationship becomes negative, as represented by the negative sign on age squared. This indicates that middle aged

farmers have a higher probability to participate in milk production, than younger and much older farmers. An increase in age by a year increased the likelihood of a farmer participating in milk production by about 0.82%, up to a certain age,²² after which the likelihood starts to decline. It is expected that after a certain age, the older a farmer gets, the less active he or she becomes in performing agricultural activities. Namonje-Kapembwa and Hichaambwa (2016) suggested that younger people tend to shun agricultural activities, as opposed to their older counterparts. Therefore, it would be more likely for older farmers to participate than it is for younger ones.

Likewise, female-headed households were less likely to participate in milk production than their male counterparts were. A female-headed household was less likely to participate in milk production by about 13%, compared with a male-headed household. This was in agreement with the findings by Gitau (2013) who showed that the sector was dominated by men. A possible reason for this is that cultural norms seem to hinder participation by women in dairying, as the owning and handling of cattle is seen as a man's job (Kumar and Staal, 2010). The gender of the household head was statistically significant at 1% as a participation variable.

Household size, landholding size, and education level of the household head were significant at 1%. Household size and landholding size had a positive influence on participation, while education had a negative influence. An increase in household size by one more person increased the likelihood of the household participating in milk production by 2.1%. Household size was expected to have a push-effect on participation, considering that the larger a household is, the greater the family labour force it will have at its disposal, thus enabling the household to afford to diversify away from crop production into livestock and milk production. In a similar manner, an increase in landholding size by one hectare increased the likelihood of participating by about 1.3%. Having sufficient land for crop production, and even some additional virgin land, would increase the likelihood of participating, as the household would have sufficient grazing fields for its livestock. On the contrary, education had a negative influence on participation. The results show that the higher the level of education a farmer has, the less likely (0.75%) he or she would be to

²²Age has a positive relationship with participation. However, age-squared shows that at a certain point, age tends to have a negative effect on participation as the farmer gets older. Determining this turning point, however, requires certain further mathematical computations that are not feasible to do for the requirements of this study.

participate in milk production. The more years that a person spends in school, the more employable he or she becomes. Therefore, an increase in the number of years spent in school leads to a higher probability of having a job, formal or otherwise, where that person can earn off-farm income.

Like education level, off-farm income reduced the likelihood (0.00016%) of a farmer participating in milk production. The results show that a farmer with substantial off-farm income, achieved through business activities, and/or other employment, is less likely take up milk production. Generally, with more off-farm income, the farmer has a biased incentive structure to continue in that income generating activity to minimise risk. The value of the productive assets, on the other hand, had a positively high influence on the farmers' decisions to participate in milk production. The more assets a farmer had, the higher the likelihood (0.0002%) of that farmer participating in milk production was. A farmer with greater extents of productive assets, especially with a bias towards agricultural or farm assets,²³ had a higher affinity for entering into other ventures to diversify his or her business portfolio. These results are in agreement with findings suggested by Kiwanuka and Machethe (2016).

Distance to input markets, specifically for veterinary products was significant at 10% probability level. As was expected, the farther away the veterinary products market or supplier was from the farmer's homestead, the likelihood of the farmer participating in livestock production, and later on milk production, declined by about 0.05%. All things equal, access to veterinary services are key in milk production as they help to control the spread of diseases, mortalities, and even the quality of livestock and milk produced (Faizal and Kwasi, 2015). For example, access to veterinary services helps to prevent diseases, like Mastitis, that have a bearing on milk quality and human health, if consumed. Therefore, the distance to where these services and products can be obtained, coupled with poor road infrastructure, the vagaries of weather, and the perishable nature of milk, represent a key influence on the farmers' participation decision. Against a priori expectation, the distance to an established market was found to have a positive influence on participation in milk production, although not significant. This implied that the further away the established market was from the farming household, the more likely that farmer was to participate in

²³ Productive assets represented both farm implements and non-farm assets that the household owned during the reference period. These included, ploughs, wheel barrows, sprayers, bicycles, motor vehicles, cell phones, solar panel equipment, and water pumps, among others

milk production. As mentioned earlier, most milk producers are located in remote rural areas, while most established markets are in urban areas. Nevertheless, the distance to these markets seemingly has a positive influence on the likelihood of participating in milk production.

Access to mobile phones was significant, at 1%. Those farmers with access to mobile phones were more likely to go into milk production than those without mobile phones were. Access to mobile phones strictly means that the household had access to a mobile phone in the reference period, regardless of whether it was owned by the household or not. Having access to mobile phone increased the likelihood of participating in milk production by 5.8%, which further highlights the need for having access to information, which is a key decision factor. According to Moturi et al. (2015), this can be premised on the fact that access to mobile phones increases the exploitation of price flexibility. Access to mobile phones, therefore, increases the likelihood to access market information, and therefore participation in milk production.

The provincial locations of the farmers were included in the model to represent the cattle rearing culture of the specific regions in the country (Kiwauka and Machethe, 2016; Namonje-Kapembwa and Hichaambwa, 2016). For example, smallholder farmers in the Southern, Central, Western and Eastern provinces are more likely to participate in milk production than the others are because of the strong cattle-rearing culture in these provinces. To avoid the dummy variable trap²⁴, one of the provinces (Central) was used as a base against which the others were measured. The model results show that being in Lusaka province (p-value=0.0779) reduced the likelihood of the farmer participating in milk production by 5.0%, relative to farmers in Central province. Conversely, farmers in the Eastern (p-value=0.0504) and Southern (p-value=0.0000) provinces were more likely to participate in milk production than those in Central province were, by 4.3% and 37.1%, respectively. This is in accord with prior expectations, since the Southern province has a strong livestock-rearing culture, and which constituted about 35% of the cattle population in the Zambian livestock census (CSO, 2017).

²⁴ A scenario where variables are highly correlated, thus introducing multicollinearity problems. In case of dummy variables, there exists perfect collinearity, thus one needs to be excluded and used as base.

Access to extension services did not show any significant effect on the decision to participate in milk production. However, it has had a positive influence on the smallholder farmers' decisions to participate in milk production.

5.3 Determinants of smallholder farmers' milk production in Zambia

In the outcome equation of the HSM, an OLS regression corrected for selection bias was used to determine the factors influencing milk production. Milk production was modelled as a function of demographic, socio-economic, and institutional variables, and the results are set out in Table 5.2. The outcome equation is presented here, with the independent variables and milk production (Milkprod) as the dependent variable.

$$\text{Milkprod} = \beta_0 + \beta_1 \text{agehh} - \beta_2 \text{agehh}^2 + \beta_3 \text{sexhh} + \beta_4 \text{hhsz} + \beta_5 \text{educhh} + \beta_6 \text{land} + \beta_7 \text{offinchh} + \beta_8 \text{asset_value} + \beta_9 \text{distmkt} + \beta_{10} \text{distvet_sup} + \beta_{11} \text{ext} + \beta_{12} \text{hrdsz} + \beta_{13} \text{vet} + \beta_{14} \text{grazin} + \beta_{15} \text{prov}$$

The model results showed that education level (p-value=0.0061), land holding size (p-value=0.00470), access to extension (p-value=0.0477), and herd size (p-value=0.0042) are critical factors in milk production. Other critical variables include grazing system, specifically using own pastures (p-value=0.0839), and provincial location of the farmer.

Table 5.2: Heckman model regression results - milk production

<i>Independent variables</i>	<i>Coefficients</i>	<i>Standard errors</i>	<i>p-value</i>
Age of household head	14.023	(21.761)	0.5193
Age squared	-0.231	(0.201)	0.2506
Gender of household head (1=female, 2=Male)	157.430	(148.700)	0.2898
Household Size	-23.292	(19.412)	0.2302
Highest level of formal education completed	34.098***	(-12.437)	0.0061
Land holding size	-8.826***	(3.123)	0.0047
Off-farm Income	0.003	(0.002)	0.1484
Productive assets	-0.003	(0.003)	0.1705
Distance to nearest market	-1.180	(1.742)	0.4981
Distance to nearest supplier of veterinary products	0.894	(-1.854)	0.62964
Access to extension services (1=yes, 0=No)	205.291**	(103.679)	0.0477
Herd Size	18.280***	(6.391)	0.0042
Access to veterinary services (1=yes, 0=No)	57.958	(89.812)	0.5187
Grazing system			
Own pasture	400.367*	(231.641)	0.0839
Communal & own pastures	-42.468	(100.906)	0.6739
Province			
Eastern	-270.2***	(98.768)	0.0062
Lusaka	228.632	(242.711)	0.3462
Southern	45.400	(145.341)	0.7548
Western	577.281***	(182.405)	0.0016
Constant	718.115	(669.3)	0.2833
Model fit			
athrho	-0.675***		
Insigma	7.022***		
Number of Observations	2,477	2,477	
Log pseudolikelihood	-6908.50		
Wald Chi2 (19)	136.16		
Prob > chi2	0.0000		
Uncensored observations	697		

Robust standard errors in parentheses

*** p-value<0.01, ** p-value<0.05, * p-value<0.1

Source: Author's computations from RALs (2015)

The results show that the level of formal education attained by the household head highly impacted on the amount of milk produced. Education was statistically significant at 1% probability level with a positive magnitude of about 34.1. This implies that, all things being equal, an increase in the years of formal education by one year would increase milk production by about 34.1 litres per year. The positive sign makes economic sense, as it is expected that education greatly increases the utilisation and understanding of market information and skills adoption, and enhances the understanding of the management needs of the milk enterprise (Ishaq et al., 2017). Milk production, by its very nature, is knowledge intensive, implying that it demands an understanding of biology, animal physiology, and management, among other skills. Better educated farmers are more likely to have a better grasp of these relevant principles. The landholding size of the household was highly

consequential for milk production, at 1%. The model shows that a 1% increase in the amount of land that the household has will result in a decrease in milk production by not less than 8.8 litres, *ceteris paribus*. A negative sign was against the a priori expectations. However, an increase in the amount of land may have a negative impact on milk production as it may imply further diversification by the farmer into other enterprises, thereby reducing focus on the dairy enterprise. Consequently, an increase in the number of enterprises undertaken might increase management pressure on the household, thus resulting in a decrease in milk productivity. According to Lubungu (2016), most smallholder farmers practise extensive grazing, using communal lands. As such, additional land would not directly influence milk yields positively, unless the farmers used the extra land for grazing fields, fodder production, and husbandry pens.

Access to extension services was statistically significant, at 5% probability level. The results show that farmers who accessed extension services had increased milk production of above 200 litres per year more than those who did not access extension services. This finding echoed findings by Gitau (2013) and Girma and Marco (2014), who found that extension service indeed had a positive influence on milk yields. This shows that the need for extension services cannot be over-emphasised. Extension services signify relevant training that helps to understand and put into practice technical knowledge in areas of animal husbandry, proper dairy practices, and general farm management.

In milk production, the over-arching assumption is that, for a farmer to produce milk, he or she must have cows. It was therefore expected that the more cows or cattle a household had, the more milk it would produce. In the model, this effect is measured using the herd size covariate. The results show that an increase in the herd size by one unit will lead to an increase in milk production of about 18.3 litres per annum, *ceteris paribus*. Similarly, findings by Neutzling et al. (2017), Neutzling et al. (2017), and Wambugu et al. (2011) consistently show that an increase in the herd size had a positive impact on the milk yields.

Equally important in milk production, is the grazing or feeding system that the farmer practises. The grazing system was used as the exclusion criterion for participants in milk production as it was expected to influence milk production for participants. In this study, three systems were identified, i.e. communal pastures, own pastures, and a combination of both communal and own pastures. The majority of the farmers sampled used the communal

pasture systems; therefore, the communal pastures system was used in the model as the base against which the other systems were measured. The model (Table 4.9) showed that farmers who utilised their own pasture produced over 400 litres more milk per year than those that used the communal system did. Use of (own) cultivated pastures results in concentrated feeding and improved nutrition, which consistently results in high milk yields (Wambugu et al., 2011). This result was consistent with the findings of another study (Neutzling et al., 2017) where the use of fodder systems or the use of improved feeding strategies improved milk production. Farmers who practised a combination of communal and own pasture systems were found to produce about 42.5 litres less milk per year than those that used only the communal feeding system did. This was inconsistent with expectations; however, it was not statistically significant. A possible reason, however, is that those who practised both systems in effect introduced inefficiencies into their operations, which would result into reduced yields, which is a result also suggested by Wambugu et al. (2011).

The provincial variable was used to test if the geographical location influenced the quantity of milk a farmer produced. The model shows that farmers in the Eastern province (p-value=0.0062) produced less milk than farmers in the base Central province did, by approximately 270 litres less per annum. Consistently, farmers from the Western province (p-value=0.0016) produced significantly more milk than those in the Central province did, in excess of more than 550 litres per annum. Similarly, the Lusaka and Southern provinces produced more milk than the Central province, although the results did not show any statistical significance. This signifies that other areas with a strong cattle-rearing culture would produce more milk than those with a weaker culture would. This is consistent with the findings of Kiwanuka and Machethe (2016).

In summary, this section reported results on the factors that influence the farmers' decisions to participate in milk production and those factors that influence milk production using HSM. In both cases, several factors were found to significantly influence participation decisions and milk production. These include education level, landholding size, access to extension services, and the geographical location of the farmer. The next section further goes to determine the factors that influence the choice of a marketing channel for those farmers who accessed milk markets.

5.4 Milk marketing channels among smallholder farmers in Zambia

This section delves into the milk marketing discussion. It investigates and discusses the factors that influence the choices of a marketing channel among smallholder farmers. From the total sample, only farmers who produced milk and accessed the milk market through the named marketing channels were used in this analysis. Three milk marketing channels were identified, namely direct milk sales, traditional marketing channels, and modern marketing channels. The multinomial logit model was used to examine these factors.

The model was tested for Independence of Irrelevant Alternatives (IIAs) as presented below;

b = consistent under H_0 and H_a ; obtained from `mlogit`

B = inconsistent under H_a , efficient under H_0 ; obtained from `mlogit`

Test: H_0 : difference in coefficients not systematic

$$\chi^2(3) = (b-B)'[(V_b-V_B)^{-1}](b-B)$$

$$= 0.83$$

$$\text{Prob}>\chi^2 = 0.8434$$

(V_b-V_B is not positive definite)

From this result, we can accept the null of independence in the marketing channel alternatives.

The multinomial logit model was utilised to identify the determinants of smallholder farmers' choices of a milk marketing channel. The choice of the milk marketing channel was modelled as a function of age, gender and education; labour endowment (household size); off-farm income and productive assets; access to markets and market information; and access to business support services and milk price.

$$\text{Mktch}_j = \beta_0 + \beta_1 \text{agehh} + \beta_2 \text{agehh}^2 + \beta_3 \text{sexhh} + \beta_4 \text{educ} + \beta_5 \text{hhsz} + \beta_6 \text{offinc} + \beta_7 \text{asset_valu} + \beta_8 \text{membr} + \beta_9 \text{kmkt} + \beta_{10} \text{dlstkmt} + \beta_{11} \text{dtarmac} + \beta_{12} \text{milkprod} + \beta_{13} \text{mktinfo} + \beta_{14} \text{price}$$

where Mktch_i represents the marketing channel alternatives available to the farmer, that is, direct milk sales, traditional and modern marketing channel.

In this study, the direct milk sale channel was used as the base category against which the informal and the modern marketing channels were measured. Table 5.3 presents the results

for the multinomial logit model and the associated marginal effects regarding the determinants of milk marketing channels. The consequential determining factors for participating in the traditional marketing channel include gender of household head (p-value=0.045), off-farm income (p-value=0.070), distance to markets (p-value=0.039), and milk yield (p-value=0.003). For the modern marketing channel, such variables included gender of household head (p-value=0.0000), education (p-value=0.087), distance to markets (p-value=0.095), milk yield (p-value=0.064), and access to market information (0.0000).

Table 5.3: Multinomial logit model regression results

Independent variables	Estimate Coefficients						Marginal Effects (dy/dy)			
	Traditional			Modern			Traditional	Modern	Direct sales	milk
	Coefficients	Standard errors	P-value	Coefficients	Standard errors	P-value				
Age	0.060	(0.180)	0.739	0.315	(0.443)	0.477	0.006	0.008	-0.014	
Age squared	-0.001	(0.002)	0.628	-0.002	(0.004)	0.602	0.000	0.000	0.000	
Gender of Household Head (1=Female, 0=Male)	1.389***	(0.692)	0.045	-13.678***	(1.242)	0.000	0.250	-0.367	0.117	
Education level of household head (years)	-0.022	(0.067)	0.741	0.228*	(0.133)	0.087	-0.004	0.006	-0.002	
Household size	-0.031	(0.072)	0.667	0.044	(0.196)	0.821	-0.004	0.001	0.003	
Off-farm Income (logged)	-0.230*	(0.127)	0.070	-0.126	(0.257)	0.625	-0.029	-0.002	0.031	
Productive assets value (logged)	0.204	(0.199)	0.306	-1.245	(1.044)	0.233	0.033	-0.034	0.001	
Membership to a Cooperative (1=Yes, 0=No)	0.036	(0.458)	0.937	1.233	(1.127)	0.274	-0.002	0.032	-0.030	
Distance to Established Market	-0.026**	(0.013)	0.039	0.029*	(0.018)	0.095	-0.004	0.001	0.003	
Distance to livestock market	-0.018	(0.011)	0.103	-0.036	(0.035)	0.300	-0.002	-0.001	0.003	
Distance to tarmacked road	0.002	(0.011)	0.883	0.058	(0.049)	0.240	0.000	0.002	-0.001	
Milk Production (logged)	0.526***	(0.176)	0.003	1.398*	(0.756)	0.064	0.061	0.034	-0.095	
Access to Market Information (1=Yes, 0=No)	0.138	(0.619)	0.823	16.555***	(1.839)	0.000	-0.068	0.435	-0.367	
Milk Price	0.087	(0.070)	0.218	-0.776	(0.477)	0.104	0.015	-0.021	0.006	
Constant	-4.706	(4.422)	0.287	-29.642	(14.385)	0.039				
Model fit										
Log pseudolikelihood	-84.474									
Number of observations	172									
Wald chi2(28)	525.510									
Prob>chi2	0.000									
Pseudo R2	0.214									

Robust standard errors in parentheses *** p-value<0.01, ** p-value<0.05, * p-value<0.1

Source: Author's computations from RALs (2015)

The results show that the gender of the household head had a significant influence on the choice of the marketing channel. Gender was a dummy variable, with values 1 and 0 for female and otherwise, respectively. Gender was statistically significant at 5% for the traditional channel and 1% for the modern channel, respectively. Being female increased the likelihood of using the traditional market by 25%, although it decreased the likelihood of participation in the modern marketing channel by 36.7%, relative to the direct sales channel. This result was consistent with findings (Ishaq et al., 2017) which found that females were more likely to participate in traditional marketing channel due to familiarity with local buyers or collectors. It was expected that female-headed farming households would use the traditional markets, as they were more likely to sell milk at the local markets and/or through roadside markets²⁵.

The results further reveal that an increase in the number of years spent in school by one year increased the likelihood (0.6%) of using the modern marketing channel. On the contrary, an extra year in school decreased the likelihood of using the alternative marketing channels. This is in line with most research findings in the field where education has been found to have a positive impact on participation in the modern marketing channel (Ishaq et al., 2017; Moturi et al., 2015; Neven et al., 2017). It is expected that smallholder farmers with higher levels of education would have a better understanding of the market environment and optimise their choice of a marketing channel accordingly.

Relative to the direct sales channel, an increase in off-farm income decreased the likelihood of participating in the traditional marketing channel by 2.9%. Therefore, an increase in income by one Kwacha (USD 0.133) tends to increase the likelihood of switching from the traditional to the modern marketing channel. This is in line with findings by Mburu et al. (2007), where off-farm income was found to have a positive influence on participation in the modern marketing channel. Furthermore, Neven et al. (2017) have suggested that higher incomes increased the likelihood of using the modern channel. A possible reason is that higher incomes would help in purchasing high-value dairy equipment that would increase milk production, and consequently the likelihood of using the modern marketing channel to absorb the resulting volumes. This contrasts with the findings by Kiwanuka and Machethe (2016) who suggested that having more income outside the dairy enterprise decreases

²⁵ Selling of milk by the roadside to other resellers or directly to consumers.

likelihood of using the modern marketing channel. This is premised on the fact that having greater off-farm income means less specialisation in dairy production and decreases the likelihood of using the modern marketing channel.

Another key determinant of the marketing channel used is distance to the established market²⁶. Distance to the market had a mixed effect on its influence on the choices of a marketing channel. Relative to the direct marketing channel, an increase in distance to the market by one kilometre significantly increased the likelihood (0.1%) of using the modern marketing channel, but decreased the likelihood (0.4%) of using the traditional channel. These results are in contrast to the findings by Ishaq et al. (2017) who found that an increase in distance to the market increased the likelihood of participating in the traditional market, with no effect on modern marketing channel participation. These results show that users of the modern market may be well off, and so might have better access to transport facilities, as represented by their productive assets endowment (Neven et al., 2006). As a result, they could access markets even farther away, thus putting the other users at a disadvantage in terms of market access. As suggested by Tsourgiannis et al. (2008), access to own means of transport, such as vehicles, positively influences the likelihood of accessing urban markets. In the same vein, the result consistently show that the farther away the market is in terms of the traditional channel, the less likely the farmers are to travel to the named major markets to access customers, and instead the direct sale channel is utilised.

In accordance with *a priori* expectations, milk production had an impact on the choice of the marketing channel used by the farmers. An increase in milk production by one litre increased the likelihood of using the traditional or the modern marketing channels by 6.1% and 3.4%, respectively. These findings are in agreement with those of Moturi et al. (2015) and Ishaq et al. (2017) who used herd size as a proxy for milk yield, and found that higher milk production increased the likelihood of participating in the modern marketing channels. All things being equal, as milk production increases, the more a smallholder farmer is likely to switch from the direct marketing channel to the traditional, and finally to the modern marketing channel that captures higher volumes.

²⁶Common market with many buyers and sellers + with several goods and services.

According to Ishaq et al. (2017), price increased the likelihood of a dairy farmer using the informal marketing channels in Pakistan. However, in this study, price was not found to significantly influence the choice of the marketing channel. A probable explanation for this is that price was not significantly different across the marketing channels²⁷, which would leave the farmers indifferent about the marketing channel based on price, *ceteris paribus*. Price may not independently influence the decision, but when coupled with transaction costs, such as information access, transport, quality inspections, and contractual arrangements, it is likely to influence the choice of the milk marketing channel (North, 1990; Stephen. Mbogoh, 1992).

The results also show that access to market information increased the likelihood of using the modern marketing channel. Those with access to commodity market and price information were more likely to use the modern marketing channel. According to expectations, the users of the modern marketing channel had better education levels, and as such, had sufficient cognitive abilities to gather and utilise market information in the dairy sector. These findings resonate with those of Sigei et al., (2015) and Kiwanuka and Machethe (2016). The latter suggested that access to market information made the smallholder farmer aware of the available opportunities and risks involved in the marketing channel. As a result, they were more likely use the modern marketing channel than the other channel. Another possible explanation is that modern marketing channels have avenues for providing market information to their users, thereby encouraging the use of the channel. On the contrary, the traditional and direct marketing channels may have limited market information dissemination tools available.

Finally, the rest of the factors included in the model were not found to be significant in influencing the farmers' decisions to choose a milk marketing channel. However, the age of household head and the value of productive assets had positive influences on the choice of both traditional and modern marketing channels. Household size had a negative influence on the choice of using the traditional marketing channel and a positive influence on the modern marketing channel. In the following section, we revisit the hypotheses tested and establish the results thereof.

²⁷Average milk prices per litre per channel were as follows: Traditional channel ZMW 4.62(USD 0.61), modern channel ZMW 2.74 (USD 0.55), and direct channel ZMW 4.17 (USD 0.36).

5.5 Hypotheses tested

The hypotheses advanced by this study can be tested against the findings mentioned above. The hypothesis H1 was confirmed, with the demographic variables of age, gender and education level of the household head having critical influences on the decision to participate in milk production, with gender also impacting on milk production, and education level influencing the choice of a marketing channel. Additionally, a larger household size indeed increased the likelihood of participating in milk production. Therefore, the hypothesis H1 was confirmed.

By and large, H2 was confirmed, with socio-economic factors having an influence on milk production and marketing channel choices. Specifically, off-farm income had a negative influence on the decision to participate in milk production, and off-farm income had an influence on the milk marketing channel decision. Milk production had a positive influence on the decision to utilise the modern marketing channel.

Milk price was hypothesised to have a positive influence on participation in the traditional marketing channel. However, this study did not find this to be the case, as price was not a significant factor in determining a marketing channel. Therefore, H3 was not confirmed.

Finally, as was expected, the geographical location and the cattle-rearing culture indeed had an influence on the decisions to participate in milk production, thereby confirming H4. Table 5.4 tabulates a summary of these hypotheses.

Table 5.4: Table of Hypotheses tested

Hypothesis	Description	Result
H1	Demographic variables have a critical influence on milk production and choice of a milk marketing channel.	
H1a	Females are less likely to participate in milk production than males	Confirmed
H1b:	Older farmers are more likely to participate in milk production than younger ones	Confirmed
H1c:	Education has a positive influence on milk production and choice of a modern marketing channel	Confirmed
H2:	Socioeconomic factors have an influence on milk production and marketing channel choice.	
H2a:	Off-farm income has a negative impact of participation in the milk production.	Confirmed
H2b:	High milk production positively influences use of the modern marketing channel.	Confirmed
H3:	Milk price increases the likelihood to participate in a traditional marketing channel.	Not Confirmed
H4:	Provincial geographical location and therefore cattle rearing culture influences likelihood to participate in milk production.	Confirmed

5.6 Independent t-test

This section aims to present a discussion of the key variables found to have a significant effect on the participation decision and milk production. Mainly, the characteristics of women (female-headed households) and the youth (youth-headed households, 15–35 years of age) were compared against those of the reference or control group (male-headed and non-youth-headed households). In this effort, the study comparatively analysed critical factors in milk production to test for statistical differences in productive resources and services access among interest groups in order to provide evidence for policy tailoring. The section takes cognisance of the various challenges that women and the youth face in the dairy sector, and proposes to gain an understanding of these challenges separately, for each group. Thinking of farmers as a single group weakens the argument for empowerment, as the various categories of farmers have varying challenges, needs, and motivations. This over-generalisation undermines policy relevance, necessitating the need for further sound data and analysis. Performing this disaggregated analysis would help in developing specific policies for each group for effective operations within the value chain.

5.6.1 Women in milk production

As discussed earlier, women, like the youth, have pertinent attributes that make them suitable for the dairy sector, from milk production to retail. The sample had more male-headed households than female-headed households²⁸. Table 6.1 shows that, of the 742 milk producers used in this analysis, women made up only about 8.8%, and the rest were male-headed. The CSO (2018) has reported a 60.5% and 39.5% male and female participation in the agricultural sector, respectively. This is also in line with common research findings that show a higher participation in agricultural activities for male-headed households than for female-headed households (Girma and Marco, 2014; Ishaq et al., 2017; Kiwanuka and Machethe, 2016; Moturi et al., 2015).

Selected factors on participation and milk production were examined for women, against those of the reference group. The results showed significant differences between the attributes of men and women in milk production (see Table 5.5 below).

Table 5.5: Independent group t-tests, male against female sample population

Variable	Male-headed households	Female-headed households	difference	t-stat
	Mean(a)	Mean(b)	(a-b)	
Age of household head	48.09	53.48	-5.40	-3.29***
Education level of household head (years)	6.92	4.43	2.48	4.99***
Household size	7.77	6.10	1.67	3.76***
Herd size (Cattle)	18.27	13.53	4.74	1.43
Land holding	7.80	8.48	-0.67	-0.34
Off-farm income (ZMW)	8816.36	8066.33	750.03	0.23
Productive assets (ZMW)	15177.20	6440.50	8736.70	2.09**
Milk Production	805.27	365.75	439.52	2.83***
Sample Size	682	60	622	
Note: **, ***: significant at 5% and 1% levels, respectively				

Source: Author's computations from RALS (2015)

²⁸See Table A in the Appendix.

Table 5.5 shows that, of the 10 variables tested, 7 were significantly different from zero between the women and men in milk production. These comprise age of household head (p-value=0.0011), education level (p-value=0.0000), household size (p-value=0.0002), value of productive assets (p-value= 0.0366), and milk production (p-value=0.0048). Using the Pearson's Chi-square test categorical variable were also tested for independence, that is access to mobile phone ($\chi^2=6.0027$, p-value = 0.014), access to extension services ($\chi^2=4.4428$, p-value = 0.035). All the significantly different variables were in favour of male headed-households, except for one, namely, age of household head. These findings echo the findings by other researchers who have concluded that the underperformance of the agricultural sector is attributed, in part, to the fact that women's productivity is greatly hampered by virtue of them having limited access to productive resources (see Table 5.4) (Ayoade et al., 2009; Team and Doss, 2011).

As a point of departure, men²⁹ were, on average, much younger than women were, with about five year's difference from an average of 48 years for men. This is in line with the findings by Hill and Vigneri (2014) who used two case studies for coffee growers in Uganda and another for cocoa growers in Ghana, where in each case, women were found to be much older than their male counterparts were. This means that, despite their age and circumstances, women have little reservations about participating in agriculture, and by extension, in dairy production.

Men had better access to education, and both formal and informal forms of extension services. For example, men had received more years of formal schooling than women had, of at least 2.5 years more. This agrees with Ayoade et al. (2009) who found that formal education was a key variable in participation in livestock production. According to Ishaq et al (2017), education stands to better equip a farmer to successfully run a dairy enterprise, which is intellectually demanding. Likewise, gaining access to extension services, which represents access to informal education, showed that gender and access to extension are not independent of each other. These findings are further supported by Lambrou (2004) who found that the limited access to extension services by women hindered their participation and productive abilities. The need for women to access extension training and education cannot be over-emphasised, especially for milk production, as they tend to enhance the

²⁹Male-headed households.

cognitive productive capacities of the farmers. The fact that more numbers of men have better access than women do simply puts women milk producers at a disadvantage. This entails the consequence that women miss out on advice regarding issues of herd management, animal husbandry practices, milking practices and quality maintenance, which extension services may provide.

At the same time, men had better labour endowments, as indicated by the significantly larger household sizes (7.77), than those of the female-headed households (6.1). As mentioned earlier, household size represents the disposable labour that a household may utilise in its enterprises, including milk production. According to Hill and Vigneri (2014), female-headed households had smaller families, and as a result, less access to the required labour, and so they needed to hire labour, which placed a major constraint on their effectiveness, profitability and sustainability. This scenario only perpetuates the low participation of women in agriculture in general, and more specifically in milk production.

Another factor of production that is statistically significantly different from zero, at 5% level of significance, is value of productive assets, with males having higher values than females have. This shows that their male counterparts are better equipped, for example, with farm implements than women are. These include assets such as motor vehicles, bicycles, ploughs, planting equipment for crops, milking equipment, and boreholes. According to Simango (2015), having less access to productive assets has a negating impact on women's participation in agriculture. The same study identified capital, limited access to markets, and water resources as being limiting factors to participation by women. Hill and Vigneri, (2014) further suggested that better access to means of transport (such as bicycles) enjoyed by men meant they had better access to markets, even those that were far away, and men thus benefited from higher prices offered at the distant markets.

As a measure of the access to information and communication technology, the access to mobile phones was examined. It showed a statistically significant relationship between gender and access to mobile phones. Male-headed households' access to mobile phones was about 10% higher than that for female-headed households was. The lack of access to this form of technology could hinder gaining access to relevant market information, as a mobile phone is a key medium of information exchange, including information on extension

services. Kiwanuka and Machete (2016) suggested that having access to dairy information positively influenced the milk marketing participation decision.

This study was also interested to find out if there was a significant difference in the milk production volumes between the two groups. It was observed that male-headed households, on average, indeed produced significantly more quantities than female-headed households did. This was in accord with the results reported by Simango (2015), who observed low productivity by women, when compared with men. However, Quisumbing et al. (2014) suggested that if women had equal access to resources as men did, they could increase yields by over 20%. In a study on rice, it was observed that women, in fact, produced greater quantities than men did, despite their disadvantages (Koirala et al., 2015). Owing to the fact that men had more resources than women did, sales volumes also showed a similar trend, with men having sold more milk than females did. This was not, however, statistically different between the two groups. By extension, it can be said that, even though women produced significantly lower milk volumes than men did, they sold similar quantities as the men did. This further suggests that women-headed households face greater income needs, and thus women tend to be more enterprising than their male counterparts are, which is necessary for them to sustain their households.

Other variables analysed were found to be not significantly different, including herd size, land holding and off-farm income. This suggests that even though the means for the two groups were different, the difference was not large enough to warrant a statistical difference. Notably, however, most of these were variables also biased towards male-headed households. For example, on the income front, it is a positive development to observe that the incomes for both men and women derived from waged and salaried jobs were not significantly different. This showed that even though men received slightly higher off-farm incomes, the difference was not statistically different. Moreover, according to the recent CSO (2018) labour report in Zambia, females in paid employment earned slightly higher incomes than males did. This is a sign that progress is being made in closing and even toppling the gender gap in the formal employment sector.

This section contrasted several selected variables for men and women that influence milk production and participation into milk marketing. It has shown that male-headed households in most instances had better access to the factors of production than the female-headed

households did. For example, male-headed households had received more years of schooling than the females had, had more productive assets, and even had better access to extension services. The next section delves into a similar examination but comparing the youth and non-youth farmers.

5.6.2 The youth in milk production

In sub-Saharan Africa, over 60% of the population is under the age of 25 years, with about three-quarters living in rural areas. Agriculture is in fact the major employer of these young people, at sector level (Dekker and Hollander, 2017; Namonje-Kapembwa and Hichaambwa, 2016). Currently, Zambia has a youth unemployment level of 17.4% (16.2% and 19.1 % for male and females, respectively) (CSO, 2018). According to Girard (2017), the number of the youth who are unemployed in Zambia is projected to increase by more than 50% by 2030, owing to increasing rural population and stagnating economic development. He further suggested the integration of the rural youth into agriculture to facilitate and stimulate economic growth. Therefore, harnessing these demographic dividends of the youth is paramount in developing the agriculture sector (Kawambwa et al., 2014; Njenga et al., 2011). Generally, Zambia has seen a sustained decline in the number of people employed by the agricultural industry, from 73% in 2005 to about 48.9% in 2014. This is, in part, a result of youth migration from rural to urban areas, and partly due to the increasing population not being incorporated in job-creation (Namonje-Kapembwa and Hichaambwa, 2016; Pelzom and Katel, 2017). More recently, a labour report by the CSO showed that only 25.9% of the working population were involved in agricultural activities (CSO, 2018). The drop to 25.6% can also be attributable to the new computational procedures adopted from the 19th International Conference Labour Statisticians resolutions of 2013,³⁰ which substantially reduced the numbers of the labour force due to reclassification. For example, previously, production for own consumption was counted as employed work, but currently, people working at achieving own production are reclassified as underutilised labour force, with potential for employment. The report also pointed out the fact that youth participation in agricultural activities was at 25.6%, a result slightly higher than the 20%³¹ found in this

³⁰Implemented in Zambia in the 2017/18 Labour Report.

³¹See Table A in the Appendix.

study. The number was even lower (14%), when only farmers involved in milk production were considered.

Needless to mention, targeting policies that would attract the youth into milk production and other chain activities would not only guarantee increased incomes, but also improvement in nutritional status and welfare. Likewise, relevant variables were reviewed for the youth against the reference group (Table 5.6).

Table 5.6: Independent group t-tests: youth farmers against non-youth farmers

Variable	Non-Youth headed households	Youth-head households	difference	t-stat
	Mean(a)	Mean(b)	(a-b)	
Education level of household head (years)	6.66	7.09	-0.43	-1.09
Household size	7.90	6.03	1.87	5.45***
Herd size (Cattle)	18.74	12.84	5.89	2.29**
Land holding	8.14	6.16	1.98	1.27
Off-farm income (ZMW)	8397.01	10931.81	-2534.80	-1.06
Productive assets (ZMW)	15202.68	10030.19	5172.49	1.58
Milk Production	778.20	718.34	59.86	0.49
Sample Size	637	105	188	
<i>Note: **, ***: significant at 5% and 1% level respectively</i>				

Source: Author's computations from RALS (2015)

From Table 5.6, the following variables were found to be significantly different from zero between the two groups, namely household size (p-value=0.0000), and herd size (p-value=0.0221). The Pearson's test carried on categorical variable (access to mobile phone, access to veterinary services and access to extension services) showed only access to veterinary services ($\chi^2 = 4.6076$, p-value = 0.032).

Household size gave expected results in the sense that youth farmers had smaller household sizes (6.03) than that the older group did (7.90). The difference was statistically significantly different from zero. Youth farmers were not expected to have larger household sizes than the older farmers. To reiterate, a smaller household size represents a limited labour force

being available for the household to utilise. Therefore, youth farmers were disadvantaged in that regard. Household size has a push-factor influence on participation in the agricultural sector, and the dairy sector in particular, because a larger household has a higher level of family labour available, and the need for milk products, among other food products, will be higher (Ohene, 2013).

Another requisite for milk production was ownership of cattle, the average for which was found to be statistically different from zero. The group of older farmers was found to have a significantly larger mean herd size than the youth group did, at 1% significance level. It is expected that the more cattle one has, the more milk one will be able to produce, holding all other factors constant. Namonje-Kapembwa and Hichaambwa, (2016) suggested that the youth are less likely to own cattle due to financial constraints, and as a result, more numbers of the youth are involved in the dairy sector as employees, or otherwise in other activities of the farm in the value chain, with limited engagement in the production.

Additionally, non-youth farmers had high access to veterinary services, of about 88%, and youth farmers had an even higher access of about 95%. Although both groups had an impressive access to veterinary services, the results show that age played a key role in accessing veterinary services. Another impressive result was for the access to extension services, where both groups had over 80% access, with no statistically significant difference between the means of the two groups. These results suggest that, due to lack of experience by the youth in the sector, as compared with older farmers, they tend to use more of the business support services to enhance their productivity.

These results show an overarching bias towards the older farmer having better access to resources and services than the youthful farmers have. Except for access to veterinary services, where significantly more numbers of youth farmers accessed such services than older farmers did, the rest of the significant variables were biased towards the older farmers. Therefore, enhancing the existing support institutions would greatly attract the youth into the sector, including financial and technical support services (Kawambwa et al., 2014; Namonje-Kapembwa and Hichaambwa, 2016; Njenga et al., 2011).

The remaining variables tested did not show any significant difference. Of interest, however, were the outcomes for variables such as education and off-farm income. Although the

education levels of the household heads were not significantly different, it was observed that youth farmers had spent a slightly higher number of years in school than the older group did. This indicated that, although not statistically different, the youth in agriculture, on average, had higher levels of education than their older counterparts had.

Off-farm income, as a form of capital, showed that the youth farmers earned more off-farm income than did the older group of farmers. Although this was not statistically significant, it provides relevant insight that youth farmers had better diversified portfolios than the older farmers did, and they did not rely so much on on-the-farm incomes. Considering that youth farmers had somewhat better education, it can also be noted that they had better access to job opportunities off the farm.

Despite the differences between the characteristics of the youth and the non-youth groups, there was no significant difference in milk production. Non-youth farmers produced more milk than the youth farmers did. In spite of the disadvantages the youthful farmers face, they are able to statistically match the milk production of non-youth farmers. They can, therefore, be said to be more efficient, all things being equal. Empowering them in their lacking aspects would most likely increase their outputs.

5.6.3 Comprehensive summary

In this chapter, two overarching hypotheses were implied. (1) There is a statistical difference between the characteristics of women and men in milk production, and (2) there is a statistical difference between the characteristics of the youth and older farmers in milk production. Indeed, after reviewing the results for women and the youth independently, the results showed that the characteristics indeed differed significantly.

The results were, however, in agreement with several other studies, in that women had limited access to productive resources, which inhibited their participation in agriculture, and in dairy production and milk marketing (Hill and Vigneri, 2014; Koirala et al., 2015; Quisumbing et al., 2014; Simango, 2015). This further highlighted the presence of strong patriarchal societal norms that still regard cattle ownership and management as a business for men (Machina and Lubungu, 2018). Strides have to be made to improve women's

participation and productivity in the dairy sector, which would help to improve the nutrition status and incomes of women farmers, and would reduce instances of extreme poverty.

Similarly, youth farmers were found to face challenges of their own in the dairy sector, with key challenges being smaller herds and household sizes (available labour), which represent key factors of production. Literature shows that the way in which the youth perceive agriculture is key to their participation and productivity (Kising' u, 2016; Namonje-Kapembwa and Hichaambwa, 2016; Njenga et al., 2011). Therefore, having a profitable and viable sector is only one step in the right direction. More needs to be done in terms of increasing awareness so as to improve the perceptions that the youth have of dairying, and make it a lucrative career path (Kimaro et al., 2015; Njenga et al., 2011; Pelzom and Katel, 2017).

Finally, the results show that the characteristics of the youth and women indeed differed significantly, when compared with the reference group. By extension, the results highlight the fact that female-headed household faced more challenges than the youth-headed households did. The results were at best mixed, with only minor similarities. This makes the point that generalising farmers as one group when formulating policies would lead to policy misdiagnosis, which would undermine the relevance of those policies. Therefore, it is paramount to understand the needs of each group and therefore target policies for each group. The development of the dairy sub-sector would increase employment and incomes for farmers (Staal et al., 2008). It is expected that improvements in dairy sub-sector margins would render the industry more lucrative and appealing to the youth and women (Kawambwa, 2014).

5.7 Summary

In conclusion, this chapter has discussed the key findings in addressing the specific objectives of this study: (i) to determine the factors that influence smallholder farmers' decisions to participate in milk production and the levels of milk production in Zambia; (ii) to identify the factors influencing the choice of milk marketing channels among smallholder farmers in the Zambian milk value chain; and (iii) to examine the characteristics of the youth

and women in the milk production, as they compare with the characteristics of the control groups (non-youths and men).

Several factors have been found to influence the decision to participate in milk production and the choice of a milk marketing channel. Moreover, education, landholding, extension services, and herd size influenced milk production. This highlights the importance of demographic and socio-economic factors, not only in the decision to participate in milk production, but also in the impacts on milk production. They further influence the decision to participate in milk marketing and the choice of a milk marketing channel. Other notable factors are business and support services, including access to extension services, access to veterinary services, access to mobile phones and market information, and access to improved feeds. All these play critical roles in enabling the smooth operations in the dairy sector. Consequently, improvements in their provision and accessibility would greatly contribute to sector development.

The following chapter provides the summary of this study, the results and policy implications and limitations of the study.

CHAPTER SIX: CONCLUSION AND RECOMMENDATIONS

6.1 Introduction

This chapter presents the major findings of this study. It highlights the conclusions for both descriptive and econometric model results, and for women and youth participation in milk production. Additionally, the policy implications, limitations and further research recommendations are also presented.

Dairy production has been on the rise owing to several factors, including, on the demand side; increases in the demand for dairy products, increasing population and incomes, and access to export markets for dairy products. On the supply side, due to the increasing number of milking animals over the years and a stable political environment, milk production has been increasing albeit slowly. Despite these strides, Zambia still experiences challenges in the dairy sector, chief among which include low milk productivity, and limited participation in milk production by women and youth. In addition, poor participation by smallholder farmers is noticed in the marketing of milk, more so using the formal marketing channels. This study specifically sought to address three objectives: (i) to determine the factors that influence smallholder farmers' decisions to participate in milk production and milk volumes in Zambia; (ii) to identify the factors influencing the choice of milk marketing channels among smallholder farmers in the Zambian milk value chain; and (iii) to examine the characteristics of the youth and women in the dairy sector, as they compare with the characteristics of the control groups (non-youths and men).

In addressing these objectives, secondary data was used from the Rural Livelihood Survey (RALS) implemented in 2015 by the Indaba for Agricultural Policy Research Institute (IAPRI). Only the key milk producing provinces of Zambia were, however, included in the study sample. These comprise the Central, Eastern, Lusaka, Western and Southern provinces. In addressing the first objective, the Heckman selection model was used, with a sample size of 2477. This included both smallholder farmers in milk production and those who were not. To address the second objective, the multinomial logit model was used, with

a sample size of 172 smallholder farmers. This sample comprised smallholder farmers who both produced milk and sold some milk during the reference period. Finally, to address the third and last objective, the independent t-test was used. The t-test was carried out on smallholder farmers who actively produced milk in the reference period. This sample numbered 742 households.

6.2 Summary of key findings

The farmer's decision to establish a milk producing enterprise is a complex one. It was influenced by several factors, ranging from demographic, socio-economic, access to business or support services, to the location where the farmer lived. Demographic factors, such as age, gender, education level of household head, and household size, affected the participation in milk production. Socio-economic variables, such as land holding, off-farm income and value of productive assets, significantly influenced the participation decision.

The existing support services and infrastructure played a pivotal role in the participation decision, including distance to a veterinary products supplier, and access to mobile phones, representing access to market information. Gender, education and distance to livestock centres had a negative impact on the participation decision of the smallholder farmer to venture into milk production.

Milk production was also influenced by several variables, including education level, herd size, landholding size, and access to extension services, which were found to be significant predictors. In addition, the provincial location where the farmer lived and the grazing system employed also had a consequential impact on the amount of milk the farmer produced. The use of improved pastures or grazing systems increased the milk yields the farmers received (Neutzling et al., 2017; Neven et al., 2017). These factors had a positive impact on the amount of milk produced by farmers, with the exception of land holding size. This implies that efforts that aim to improve farmers' herd size, levels of formal education, and access to extension services would result in increased milk production. Notably, farmers in the Western province produced significant more milk than those in Central province did, whereas those in the Eastern province produced significantly lower milk volumes.

The multinomial logit model was used to identify the factors influencing the choice of a milk marketing channel among smallholder farmers in the Zambian milk value chain. The results indicate that the gender of the household head, education level, off-farm income, milk yield, access to market information, and distance to established markets significantly impacted on the selection of a milk marketing channel. The choice to participate in the traditional channel was positively influenced by the gender of the household head and milk yield (Ishaq et al., 2017). On the contrary, distance to the nearest established market and off-farm income influenced the selection of the traditional market negatively. The amount of milk produced and gender were significant, at 1% significance level, while distance to established markets and off-farm income were significant, at 5% and 10%, respectively.

The gender of the household head, education level, distance to established market, milk yield, and access to market information were found to influence participation in the modern marketing channel (Ishaq et al., 2017; Neven et al., 2017). These factors positively influenced the likelihood of using the modern marketing channel, except for gender. Being female reduced the likelihood of the farmer utilising the modern channel. The impacts of the covariates gender and access to market information were significant, at 1%, with the rest at 10%.

From this study's results, it can be inferred that the attributes of women and youth farmers, relative to the reference group and to each other, differed significantly. When the attributes of women and men were analysed using the student t-test, the differences in means for several variables were found to be statistically significant. These included age of household head, education level, household size, and value of productive assets owned. Also significant were access to mobile phone and extension services. Overall, male-headed households were more advantaged than the female-headed households were (Hill and Vigneri, 2014; Kawambwa et al., 2014; Koirala et al., 2015). This further led to significantly low levels of milk yields and sales by the female-headed households.

In a similar manner, covariates were tested for differences in means for non-youth-headed households against youth-headed households. As would be expected, the age of the household head was statistically and significantly different from zero. Also significant were household size, herd size, membership to farmer cooperatives, and access to FISP and veterinary services. Access to veterinary services by the youth was significantly higher than

that for non-youth farmers was. Overall, older farmers had better access to factors of production than the youth farmers did, which is similar to other research findings (Kising'u, 2016; Njenga et al., 2011; Pelzom and Katel, 2017). Finally, milk production and sales were not significantly different from zero, implying that even with older farmers' advantages in milk production, the youth farmers were relatively more efficient.

By addressing these objectives, the study sought to make a significant contribution in filling the apparent dearth in literature on the Zambian dairy sector and in informing policy. It was established that there is very little literature in the Zambian dairy sector, thus presenting a critical knowledge gap. Therefore, this study has laboured to highlight some of these critical areas and to help in filling this knowledge gap.

6.3 Policy recommendations

In order to encourage participation in milk production, a fair land distribution policy ought to be formulated and implemented. Improvements in information flow in the market should be encouraged, through extension services, mass media (radio and television), and other media platforms accessible to smallholder farmers through mobile phones. This would improve on the transparency and trust in the value chain. Additionally, there is need for improvement to be made in the services provided by agricultural groups and extension service providers in terms of livestock services, such as artificial insemination, training on animal health, and milking practices, which would also enhance the quality of milk delivered to MCCs.

Government needs to develop a deliberate investment policy for the dairy sector that targets achieving the reduction of input costs (medicines, pastures and dairy equipment), and increased access to improved breeds, quality feeds and improvements in enablers to facilitate better market access. In the same vein, investment in local communal water sources, such as dams in rural areas, would result in increased annual milk production. The water facilities could also be used to irrigate fodder, which could be used to supplement the cattle in the dry months of the year. Government could also subsidise the growing of fodder to encourage the growing of fodder and its management by smallholder farmers, either for own use or for sale to other farmers. Consequently, this would directly reduce the dependence of milk volumes on seasonal factors, thus allowing for sustained all-year milk production.

Likewise, increased investment (by both government and private stakeholders) in more numbers of processing plants, located in the local areas where milk is produced, would encourage participation by smallholder farmers in the formal sector, albeit in a local setting. Additionally, increasing the numbers of milk collection centres closer to the farmers would increase the flow of milk to the formal sector, and so utilise the existing and under-utilised processing capacity. These measures would act to reduce smallholder farmers' transport costs and provide a ready market for milk.

Lastly, based on the findings, the study recommends that affirmative action be implemented towards achieving greater gender appreciation, which would encourage the involvement of women in milk production. For continuity and the future development of the sector to materialise, there is need for steps to be taken to ensure widespread gender awareness and the empowerment of the youth in areas of milk production. Comprehensive incentive structures need to be formulated that would encourage the youth and women to participate in the sector. This would include the dissemination of widespread awareness messages regarding the relevance of milk, both for the human diet and as providing income-generating activities that the youth and women can tap in.

6.4 Limitations and opportunities for further research

This study was not without limitations. These include having to deal with limited information on milk production in Zambia and limited peer-reviewed literature, especially regarding the availability of robust data needed for verifying government statistics, which are mainly approximates and datasets with limitations. As mentioned earlier, secondary data was used to answer the research questions. Moreover, data regarding major useful variables, which would enhance modelling and statistical inference in this study, were missing. For example, there was no direct measure of cooperatives as milk-selling outlets, and by extension, of the distances between the households and the milk collection centres, which were identified as being key milk outlets to the formal sector. Measuring these variables would enhance the understanding of the influences that they have on market participation with some higher degree of accuracy.

Similarly, variables on the numbers of cows and cattle breeds that the farmers used in their milk production were not encapsulated in the available literature. These variables would have helped to control for access to improved breeds³² as a factor that would influence milk production volumes. The number of milk producing cows in the cattle herd would help to ascertain actual milk yield per cow, and to comprehend the influence this has on choice of a milk marketing channel.

Also missing were sources and distances to water sources that are utilised for livestock in general, and specifically for milk production. Water is a critical variable in livestock and dairy production. Understanding how it is accessed in the context of the study would help to understand its role in the participation decisions of the smallholder farmers in milk production. Finally, it would have been preferred to have a direct measure for access to livestock extension services, as opposed to the general access to extension services that seem more biased towards crop production.

These limitations warrant the need for further research to be undertaken that would capture data on milk production variables and the marketing options of dairy farmers. As a follow up, critical analysis of the perceptions of the youth and women regarding milk production could be undertaken in order to understand those motivational factors that would make it attractive for their participation. The findings from such research would provide stronger policy targets for improving youth and gender disparities in the sector and for improving the unemployment and poverty statistics.

³² Literature shows significantly different average milk yields for different cattle breeds, especially between indigenous breeds and improved breeds.

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APPENDIX

Table A: Characteristics of smallholder farmers in the study area and across milk marketing channels

Variable	Marketing Channel								t-test
	Pooled sample		Traditional channel		Modern channel		Direct Milk Sales		
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
Age of household head	47.31	13.24	47.58	10.39	51.67	11.05	49.17	12.10	0.54
Youth farmers	0.20	0.40	0.13	0.33	0.00	0.00	0.13	0.13	0.69
Gender of household head (1=Female)	0.17	0.37	0.15	0.36	0.00	0.00	0.08	0.27	1.49
Education level of household head (years)	6.29	3.99	7.88	3.65	7.78	2.68	7.34	3.53	0.43
Household size	6.50	2.80	7.85	3.21	9.89	5.71	7.97	3.25	1.47
Herd size(Cattle)	11.44	18.82	25.26	30.25	46.11	53.05	23.97	29.07	2.29
Land holding	4.76	8.37	7.34	9.98	8.91	4.00	9.57	22.83	0.19
FISP (1=YES)	0.53	0.50	0.68	0.47	0.89	0.33	0.60	0.49	1.75
Membership to a cooperative(1=Yes)	0.55	0.50	0.60	0.50	0.89	0.33	0.63	0.48	1.36
Access to Market Information (1=Yes)	0.80	0.40	0.83	0.38	1.00	0.00	0.82	0.39	1.00
Access to a Mobile phone	0.79	0.40	0.83	0.38	1.00	0.00	0.91	0.29	1.72
Membership to Women's Group (1=Yes)	0.24	0.43	0.35	0.48	0.44	0.53	0.34	0.47	0.23
Access to veterinary services (1=Yes)	0.41	0.49	0.90	0.30	0.89	0.33	0.92	0.27	0.14
Member to Credit/Saving Society (1=Yes)	0.06	0.24	0.03	0.16	0.22	0.44	0.06	0.24	2.57*
Access to Rural Credit/Loans (1=Yes)	0.27	0.45	0.18	0.38	0.22	0.44	0.19	0.40	0.06
Distance to nearest Tarmac	24.11	31.14	20.35	15.95	23.11	18.90	27.30	28.22	1.22
Distance to market	23.78	25.53	16.30	15.52	37.56	13.72	30.86	29.69	5.14***
Distance to Livestock centre	27.68	27.92	17.84	14.74	22.78	19.10	27.83	25.55	2.83*
Distance to Veterinary Product supplier	27.63	27.16	19.83	16.23	25.11	17.02	29.37	26.57	2.49*
Distance to Livestock/products market	24.18	28.26	19.13	16.76	29.89	17.93	31.07	28.44	3.36**
Milk Production	769.73	1158.57	1854.50	1570.51	3761.11	3826.37	1198.61	1296.04	14.99***
Milk Sales	302.89	827.05	1250.73	1260.54	2627.72	3126.55	747.86	990.15	13.4***
Milk price	4.19	3.27	4.62	3.84	2.74	0.72	4.17	3.20	1.24
Off-farm income (ZMW)	8451.27	24313.54	11455.38	31644.42	5459.67	6930.50	9968.74	21476.86	0.25
Productive assets (ZMW)	7330.84	24080.00	12523.63	20208.29	25555.00	41116.02	13391.37	27449.04	0.92
Sample Size	N=3574		N=40		N=9		N=202		

Note: ***P<0.01, **P<0.05, *P<0.1 significance level;SD: Standard deviation

Source: Author's computations 2018 from RALS(2015)