FACTORS INFLUENCING SMALLHOLDER DAIRY FARMERS' CHOICES IN MILK MARKETING IN THE HIGHLANDS OF EASTERN UGANDA: A CASE STUDY OF NAMISINDWA

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DECLARATION AND APPROVAL

Declaration

This research Dissertation is my original work and has not been presented for the award of a degree in any other University or institution of higher learning.

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Approval

This research Dissertation has been submitted for examination with our approval as the University Supervisor.

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ABSTRACT

Uganda's dairy sector is among the fastest growing in Sub-Saharan Africa, with annual production estimated at 2.8 billion litres in 2020, contributing about 4% to national gross domestic product (GDP) and accounting for more than half of livestock output. Despite this growth, per capita milk consumption remains critically low at 58 litres, well below the World Health Organization's recommended 200 litres annually. Although 70% of national milk production is marketed, over 90% flows through informal outlets characterized by weak quality assurance, depressed farm-gate prices, and limited value addition. These inefficiencies erode farmer incomes and reduce incentives for sustained productivity, especially among smallholders. Challenges are pronounced in the eastern highlands, including Namisindwa District, where dairy is integrated into mixed crop–livestock systems but constrained by infrastructural deficits, underdeveloped farmer organizations, and limited access to formal markets. The dominance of informal milk marketing highlights a pressing research and policy gap. While prior studies have examined productivity, processing competitiveness, and marketing dynamics nationally, little empirical evidence addresses the determinants of smallholder participation in milk marketing within the eastern highlands. This gap was salient given structural and institutional differences from surplus-producing regions, including inadequate infrastructure and weaker cooperative arrangements. Generating contextspecific evidence is therefore vital to inform policies and interventions that enhance smallholder participation in structured value chains, improve farmer welfare, and strengthen Uganda's dairy competitiveness. This study thought to fill these gaps by analysing factors influencing smallholder dairy farmers' participation in milk marketing systems in Namisindwa District, Eastern Uganda. The specific objectives were: (a) to examine the sociodemographic and institutional characteristics of smallholder dairy farmers; (b) to examine determinants of farmer participation in milk marketing systems; (c) to assess the extent of farmer engagement across formal and informal channels; and (d) to evaluate profitability differentials between farmers engaged in formal versus informal marketing. To achieve these objectives, the study adopts a cross-sectional survey design. Data will be collected from a representative sample of smallholder dairy farmers using structured questionnaires. Descriptive statistics will profile farmers' characteristics, while multinomial logistic regression will identify factors influencing marketing channel participation. Gross margin and profitability analyses will compare returns between formal and informal systems. The findings are expected to provide robust empirical evidence to guide policymakers, development partners, and value chain stakeholders in designing strategies that foster inclusive, efficient, and sustainable dairy marketing systems in Uganda.

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LIST OF ABBREVIATIONS AND ACRONYMS

DDA – Dairy Development Authority

FAO – Food and Agriculture Organization of the United Nations

GDP – Gross Domestic Product

GOU – Government of Uganda

Ha – Hectare

HACCP – Hazard Analysis and Critical Control Points

IFAD – International Fund for Agricultural Development

ISO – International Organization for Standardization

MAAIF – Ministry of Agriculture, Animal Industry and Fisheries

MFPED – Ministry of Finance, Planning and Economic Development

NAADS – National Agricultural Advisory Services

NARO – National Agricultural Research Organization

NGC – National Genetic Centre (relevant to livestock improvement programs)

NGO – Non-Governmental Organization

PRA – Participatory Rural Appraisal

SACCO – Savings and Credit Cooperative Organization

SSA – Sub-Saharan Africa

STATA – Statistics and Data Analysis Software

UBOS – Uganda Bureau of Statistics

UCA – Uganda Cooperative Alliance

UCCCU – Uganda Crane Creameries Cooperative Union

UN – United Nations

WHO – World Health Organization.

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

The dairy sector plays a central role in global agricultural economies, providing nutrition, employment, and income to millions of households. Globally, over 800 million people depend on livestock for their livelihoods, with dairy accounting for a significant share of animal-source food and farm revenues (FAO, 2022). Milk is recognized as one of the most valuable agricultural commodities, contributing nearly 30% of agricultural GDP worldwide (Thorpe & Reed, 2016). Rising global demand, driven by urbanization, population growth, and increasing incomes, has created opportunities for farmers to expand milk production and market participation. However, smallholder farmers in developing regions continue to struggle with limited access to profitable markets due to infrastructural, institutional, and organizational barriers (IFAD, 2010).

In sub-Saharan Africa, dairy farming is predominantly practiced by smallholders, who account for more than 80% of milk produced (World Bank, 2019). The region has a growing demand for dairy products, but milk marketing systems remain underdeveloped and fragmented. Poor transport networks, high transaction costs, and inadequate cold chain infrastructure often constrain farmers from participating in formal milk markets (Nkonde et al., 2020). Evidence from Kenya, Ethiopia, and Tanzania shows that integration into structured marketing systems enhances household incomes and improves livelihoods, but participation is often hindered by distance to collection centres, lack of credit, and weak farmer organizations (Chagwiza, Muradian, & Ruben, 2016). This suggests that addressing barriers to milk marketing could play a vital role in strengthening rural economies and improving food security in Africa.

Uganda has one of the fastest-growing dairy sectors in Africa, with milk production rising to 2.8 billion litres in 2020 (MAAIF, 2022). The sector contributes about 4% to the country's GDP and accounts for over half of livestock output, underscoring its importance to household welfare and national food security (MFPED, 2020). Despite these contributions, per capita milk consumption in Uganda is only 58 litres, far below the World Health Organization's recommended 200 litres per person annually (WHO, 2020). Furthermore, about 70% of milk produced is marketed, yet more than 90% flows through informal channels, which are characterized by poor quality assurance, low farm-gate prices, and minimal value addition (Nakiganda, 2017). These marketing inefficiencies weaken farmer incomes and reduce incentives for productivity growth, especially among smallholders.

The eastern highlands of Uganda, covering districts such as Mbale, Sironko, and Kapchorwa, present unique challenges for smallholder dairy marketing. The region is a milk-deficit area compared to the surplus-producing southwestern milk shed, yet it has strong potential for expanding dairy production

under mixed crop-livestock systems (DDA, 2023). Farmers in this region largely depend on informal milk sales, often at the farm gate, where they receive low and unstable prices. Infrastructure such as chilling plants, milk collection centres, and cooperatives is limited, constraining farmers' ability to access higher-value formal markets. Previous studies highlight that while dairy production is expanding in the area, farmers remain poorly integrated into structured marketing systems, thereby limiting their ability to capture the benefits of a growing dairy economy (Nkwasibwe, Elepu, & Sserunkuuma, 2015).

1.2 Statement of the Problem

Although Uganda's dairy sector has recorded significant growth, the marketing of milk remains largely informal, with only 10% entering formal value chains (DDA, 2023). The persistence of informal milk marketing undermines quality assurance, reduces farmer incomes, and limits opportunities for value addition. In Eastern Uganda, where dairy is increasingly vital for household livelihoods, smallholder farmers face multiple constraints in accessing structured markets. These include low farm-gate prices, lack of bargaining power, and weak linkages with processors and cooperatives.

While studies in Uganda have explored dairy productivity (Oyoo, 2023), competitiveness of milk processing (Twimukye, 2003), and marketing channel choices (Nkwasibwe et al., 2015), little is known about the determinants of farmer's participation in milk marketing specifically in Namisindwa District located in the eastern highlands. This knowledge gap is critical because farmers in the District face conditions that differ from surplus-producing zones, including limited infrastructure and weaker institutional support. Without empirical evidence on the socioeconomic, institutional, and farm-level factors influencing participation, interventions risk failing to address the structural barriers that exclude farmers from profitable value chains. Addressing this gap is therefore necessary for designing policies that enhance smallholder integration into formal dairy markets in Uganda.

1.3 Research Objectives

1.3.1 Overall Objective

To analyse the factors influencing smallholder dairy farmers' participation in milk marketing systems in the highlands of Eastern Uganda.

1.3.2 Specific Objectives

1. To examine the sociodemographic and institutional factors among smallholder dairy farmers in Namisindwa District, Eastern Uganda.
2. To assess the factors influencing smallholder farmers' participation in milk marketing systems in Namisindwa District, Eastern Uganda.

3. To determine the level of participation among smallholder dairy farmers in different marketing channels in Namisindwa District, Eastern Uganda.

1.4 Research Questions

1. What are the sociodemographic and institutional characteristics of smallholder dairy farmers in Namisindwa District, Eastern Uganda?
2. What factors influence smallholder farmers' participation in milk marketing systems in Namisindwa District, Eastern Uganda?
3. What is the extent of participation of smallholder dairy farmers in different milk marketing channels in Namisindwa District, Eastern Uganda?

1.5 Justification of the Study

The dairy sector is a critical pillar of Uganda's agricultural economy, contributing substantially to household welfare, national GDP, and food security. Despite this, milk marketing systems remain fragmented and dominated by informal channels that undermine both quality assurance and farmer profitability (DDA, 2023; Nakiganda, 2017). While the southwestern milk shed has received significant research and policy attention due to its surplus production, the eastern highlands remain understudied, even though they hold great potential for dairy expansion under mixed crop–livestock systems (DDA, 2023).

The Namisindwa District provides a unique setting because it is a milk-deficit area with emerging smallholder dairy farms that face structural constraints such as poor infrastructure, weak institutions, and limited farmer organization. Understanding the determinants of participation in milk marketing systems in such a setting is crucial for addressing inequalities between surplus and deficit milk zones. Furthermore, examining profitability differentials between formal and informal marketing will provide evidence to guide farmers' decision-making and policy formulation on value chain development. Academically, the study fills a gap in the literature by generating empirical evidence on smallholder dairy marketing in Uganda's eastern highlands. Most previous studies have focused on productivity (Oyoo, 2023) and competitiveness (Twimukye, 2003) rather than the structural and socioeconomic determinants of marketing participation. The findings will therefore contribute to theory and practice on smallholder commercialization, market participation, and rural development.

1.6 Significance of the Study

The study is significant because it provides empirical evidence on the factors influencing smallholder dairy farmers' participation in milk marketing systems in the eastern highlands of Uganda, a region that remains under-researched despite its growing dairy potential. By examining the socioeconomic, institutional, and farm-level determinants of market participation, the study generates insights that can inform farmers' strategies for improving income, strengthen policy interventions for developing

inclusive and efficient value chains, and guide development partners in designing targeted dairy programs. Moreover, the findings contribute to academic scholarship on smallholder commercialization and rural livelihoods, while indirectly supporting consumers through improved quality assurance and food safety arising from greater integration into formal markets.

CHAPTER TWO

LITERATURE REVIEW

2.1 Conceptual Perspectives on Smallholder Dairy Farming and Milk Marketing

Smallholder dairy production is increasingly recognized as a multifunctional livelihood strategy that supports income generation, food security, and asset accumulation in developing countries. In many low- and middle-income regions, dairying contributes significantly to rural household economies while also ensuring access to animal-source proteins (FAO, 2023; Sugino et al., 2023). Scholars emphasize that dairy systems are highly heterogeneous, shaped by differences in herd size, feed resources, and farmers' market orientation (Paudyal, 2024). Integrating production constraints with market challenges such as infrastructure, quality assurance, and price variability is essential for understanding household decisions on milk retention versus market participation (ILRI, 2021). This integrated perspective forms the foundation for policy and research interventions aimed at linking productivity with market access.

From a theoretical standpoint, milk marketing has been conceptualized through the household commercialization framework and transaction cost economics, which explain participation and channel choice. The household commercialization model frames market participation as a function of household assets, labour endowments, and access to enabling institutions, while transaction cost theory highlights the role of risk, information asymmetry, and market preferences in shaping farmer behaviour (Nkwasibwe et al., 2014). In East Africa, institutional arrangements, including cooperatives and dairy boards, influence the degree to which smallholders engage in either formal or informal marketing channels (FAO, 2020; ILRI, 2021). These frameworks provide a conceptual foundation for analysing how sociodemographic, institutional, and farm-level factors interact to influence smallholder dairy market participation.

2.1.1 Global and Regional Context of Dairy Production

Globally, dairy production has expanded in response to rising urban demand and income growth, yet production remains uneven across regions. Sub-Saharan Africa, for instance, has experienced steady growth in dairy output largely driven by smallholder systems (FAO, 2023). In Uganda, the dairy sector has registered consistent production increases, with smallholder farmers relying predominantly on indigenous and crossbred cattle (Uganda Bureau of Statistics [UBOS], 2023). Despite this growth, farmers continue to face persistent challenges including feed scarcity, limited veterinary services, and inadequate cooling infrastructure, which constrain both productivity and market integration (Paudyal, 2024). National production trends therefore directly influence the structure of milk markets and the accessibility of marketing channels for smallholders.

At the regional level, institutions such as the International Livestock Research Institute (ILRI) and the Food and Agriculture Organization (FAO) highlight the importance of both technical and institutional interventions to enhance dairy systems. Studies demonstrate that investments in forage production, veterinary services, and cooperative strengthening can increase productivity and farmer

incomes (ILRI, 2021). However, the dominance of informal markets and weak enforcement of quality standards continue to limit formal participation in many East African countries (CDKN, 2021). Consequently, regional evidence underscores the dual importance of improving on-farm productivity while strengthening value-chain governance to expand access to profitable marketing opportunities for smallholders.

2.1.2 The Role of Dairy Farming in Rural Livelihoods and Food Security

Dairy farming is critical to rural livelihoods in sub-Saharan Africa, providing regular cash flows, financing education and health expenditures, and contributing to improved household nutrition. Studies indicate that milk is often the first animal-source food consumed in smallholder households, enhancing protein and micronutrient intake among children and women (Paudyal, 2024; Sugino et al., 2023). Regular milk sales help farmers smooth household incomes compared to seasonal crop production, while retained milk strengthens dietary diversity (FAO, 2023). Nonetheless, the extent of these benefits depends on the farmers' ability to access reliable markets and maintain herd productivity (ILRI, 2021). Where informal markets dominate, farmers often receive lower prices, which undermines both household income and long-term investment in dairy enterprises.

At a community level, the broader contribution of dairy farming to food security and livelihoods depends on enabling infrastructure, collective marketing, and access to supportive institutions. Evidence from East Africa shows that cooperative membership, extension services, and credit access increase the likelihood of commercialization and higher household incomes (Nkwasibwe et al., 2014; CDKN, 2021). Conversely, households with limited institutional support remain trapped in low-margin informal markets (FAO, 2020). This body of evidence supports the present study's objective of examining how sociodemographic and institutional factors influence the degree of market participation and, ultimately, household welfare.

2.1.3 Overview of Milk Marketing Systems: Formal and Informal Channels

The literature generally distinguishes between two main milk marketing systems: formal channels, involving processors, cooperatives, and regulated collection centres, and informal channels, dominated by small traders and direct sales. Informal markets remain the primary outlet for milk in Uganda, largely because of their accessibility and low transaction costs (Nkwasibwe et al., 2014; Sugino et al., 2023). However, they are characterized by weak quality controls and limited opportunities for value addition. Formal channels, on the other hand, provide more stable demand and higher returns, but their requirements for quality, volume, and consistency often exclude smallholders (ILRI, 2021). These contrasting features highlight why smallholder participation in different channels is strongly influenced by farm-level characteristics, infrastructure access, and institutional support.

Recent studies advocate for hybrid approaches that link informal actors to formal markets through training, aggregation, and low-cost cooling infrastructure. For example, vendor certification schemes and cooperative collection centres have been shown to increase compliance with quality standards while enhancing producer incomes (CDKN, 2021). Nonetheless, sustainable integration depends on enforceable quality assurance frameworks and commercially viable aggregation models (FAO, 2020). In the Ugandan context, mapping the interplay between formal and informal channels is crucial for understanding the factors that drive smallholder participation and profitability.

2.2 Theoretical Frameworks Guiding Farmers' Participation in Agricultural Markets

Barrett's (2008) synthesis highlights that market participation should be viewed along a margin, whether households sell any output, how much they sell, and through which channels, rather than as a binary phenomenon. This perspective draws on the rural livelihoods tradition that emphasizes diversification, risk management, and the role of nonfarm income in shaping agricultural choices (Ellis, 2000). Consequently, contemporary empirical work models market participation jointly with supply responses and recognizes that both fixed and variable transaction costs can determine whether and how households engage with markets (Key, Sadoulet, & de Janvry, 2000; Barrett, 2008).

A second strand of the literature stresses that institutional arrangements and value-chain governance mediate the relationship between household endowments and market outcomes. Studies show that cooperatives, extension services, credit provision and regulatory frameworks alter both incentives and transaction costs, thereby changing the marginal returns to commercialization (Reardon et al., 2007; ILRI, 2010). Empirical reviews further indicate that heterogeneity among smallholders by herd size, access to infrastructure, or network membership produces widely differing market behaviours even within the same region (Hlatshwayo et al., 2021; Osmani, 2015). This recognition motivates the use of micro econometric models that include household, farm-level and institutional variables simultaneously when explaining participation and channel choice.

2.2.1 The Household Commercialization Model

The household commercialization model conceptualizes market engagement as an endogenous decision that emerges from the utility- or welfare-maximizing behaviour of a multi-activity household. Under this framework, farm households allocate labour and other productive resources across on-farm production, home consumption, and market sales in response to prices, transaction costs, and intrahousehold preferences (de Janvry, Key, & Sadoulet, 2000; Ellis, 2000). Empirical applications typically operationalize commercialization as the proportion of output sold, which allows researchers to link commercialization outcomes to observable characteristics such as education, asset ownership, and access to extension or credit (Barrett, 2008). The model is especially useful for dairy because milk production is frequent and divisible, so household decisions about retention for household consumption versus sale are sensitive to both immediate cash needs and market access conditions.

Beyond the basic allocation logic, the commercialization model also emphasizes constraints and thresholds: households may be unable to participate in formal markets until they cross minimum volume, quality, or timing thresholds that make transactions viable. This has direct implications for smallholder dairying where minimum tanker loads, chilling requirements, or bacterial-count standards can exclude many producers unless aggregation or cooperative arrangements are available (ILRI, 2010; Sugino et al., 2023). Thus, policy interventions that reduce thresholds through collective action, aggregation points, or credit for chilling, can shift households from subsistence-oriented retention to market-oriented sales by changing the cost–benefit calculus captured in commercialization frameworks.

2.2.2 Market Participation Theories and Transaction Cost Economics

Market participation theories in agricultural economics typically combine price-response models with explicit recognition of transaction costs, information frictions, and market imperfections. Key, Sadoulet, and de Janvry (2000) formalize how fixed and variable transaction costs influence both the decision to participate and the conditional supply response; in their formulation, higher fixed transaction costs create participation thresholds that some households cannot overcome. Williamson's (1979) transaction-cost economics (TCE) complements this by explaining why different governance structures (markets, hybrids, hierarchies) emerge to minimize transaction costs and manage asset specific investments and opportunism. Together, these theoretical strands explain empirical findings that access to reliable buyers, information, and aggregation services increases participation and shifts households toward formal channels (Barrett, 2008; Hlatshwayo et al., 2021).

TCE also offers a language for interpreting contractual arrangements in dairy value chains. Where the costs of opportunism and monitoring are high, actors may prefer closer governance (contracts, cooperatives, processor integration) to protect investments in quality and cold-chain infrastructure (Williamson, 1979; ILRI, 2010). Empirical work finds that when smallholders face high ex-post quality uncertainty or weak enforcement, they either accept lower prices in informal spot markets or join collective institutions that reduce monitoring costs (Nkwasibwe, Mugisha, & Elepu, 2014). Consequently, transaction-cost reasoning helps explain why some smallholders adopt formal contracts or cooperative membership while others continue to rely on low-cost informal networks.

2.2.3 Relevance of Theories to Dairy Marketing in Developing Economies

The theoretical frameworks described above map directly onto the realities of dairy marketing in developing countries, where frequent perishable flows, quality requirements, and fragmentation of producers interact to shape market outcomes. Dairy's high frequency of transactions and strict quality/time sensitivities amplify the importance of transaction costs and governance arrangements: cold-chain requirements, bacterial counts, and regular collection schedules create practical thresholds that influence whether a farmer can participate in formal markets (ILRI, 2010; FAO, 2020). Empirical studies in East Africa show that cooperative membership, access to chilling infrastructure, and stable

buyer relationships consistently raise the probability of formal market participation and improve producer margins (Nkwasibwe et al., 2014; Sugino et al., 2023).

Finally, applying commercialization and transaction-cost theories in dairy research supports policy-relevant hypotheses: reducing aggregation costs, improving quality assurance, and strengthening producer organisations should increase formal participation and raise household incomes. Programmatic evaluations and regional reviews confirm that interventions targeting aggregation (village collection points), vendor training and simple chilling technologies can move milk flows toward processors while retaining accessibility for smallholders (CDKN, 2021; ILRI, 2010). Therefore, for district-level studies such as Namisindwa, these theories provide both the empirical variables to measure (household assets, transaction costs, institutional ties) and the policy levers to test (aggregation, extension, credit) when seeking to explain and improve smallholder dairy market participation.

2.3 Socio-demographic and Institutional Factors Affecting Market Participation

Smallholder market participation is shaped by both household-level sociodemographic traits and the institutional environment that mediates transactions and information flows. Empirical studies emphasize that attributes such as age, gender, education and household size influence production decisions, access to information and bargaining power in output markets, thereby affecting the likelihood and intensity of participation (Barrett, 2008; Nkwasibwe, Mugisha, & Elepu, 2014). At the same time, institutional factors, extension, cooperatives, credit facilities and market infrastructure, modify transaction costs and create or remove entry thresholds for formal channels (ILRI, 2010; FAO, 2011). Integrative empirical models therefore typically include both sets of covariates to avoid omittedvariable bias and to better identify policy-relevant levers for increasing commercial engagement.

A second strand of literature highlights heterogeneity in effects: sociodemographic variables operate differently across contexts and interact with institutional availability. For example, education often raises the probability of participation where extension or information systems exist to convert knowledge into marketable practices, whereas in contexts with weak institutions the returns to education on market outcomes are muted (Paudyal, 2024; Mtimet, 2016). Similarly, household size may increase marketable surplus in some settings but reduce per-capita labour availability in others, producing mixed empirical results (Barrett, 2008). These findings justify context-specific empirical analysis—such as district-level studies in Namisindwa, because the magnitude and direction of sociodemographic effects are contingent on the institutional and market environment.

2.3.1 Farmer Characteristics (Age, Gender, Education, Household Size)

Age, gender and education are repeatedly documented as significant correlates of agricultural market behaviour, although causal pathways vary by setting. Older farmers often have greater asset holdings and market networks but may be less willing to adopt innovations that facilitate formal

marketing, while younger farmers may be more risk-tolerant and adoption-ready yet resourceconstrained (Barrett, 2008; Hlatshwayo et al., 2021). Gender dynamics are particularly salient in dairying: women frequently manage intra-household milk use and small-scale sales, but gendered constraints in asset ownership, mobility and decision-making can limit their participation in formal channels (Bain et al., 2018; Sugino et al., 2023). Education consistently appears as a positive predictor of market participation and channel choice because it improves farmers' ability to process market information, comply with quality requirements and negotiate contracts (Nkwasibwe et al., 2014; Paudyal, 2024).

Household size and composition further influence commercialization through labour availability and consumption needs: larger households may supply more marketable milk if labour is available for feeding and milking, but they may also retain larger shares of output for household consumption, reducing marketed surplus (Barrett, 2008). Empirical analyses frequently control for demographic structure (dependents versus working-age members) to disentangle these effects (Mtimet, 2016). Consequently, robust micro-econometric studies of dairy market participation measure these characteristics carefully and explore interaction effects (e.g., gender × education) to reveal nuanced pathways to commercialization.

2.3.2 Institutional Support Systems (Extension Services, Cooperatives, Credit Access)

Extension services, cooperatives and access to credit are widely identified as pivotal institutional determinants of smallholder market engagement and productivity. Extension provision—public or private—raises technical knowledge (husbandry, hygiene, improved feeding), which in turn can increase milk yields and quality, enabling compliance with formal channel requirements (ResearchGate studies; ILRI, 2010). Cooperative membership and aggregation platforms lower fixed transaction costs by consolidating volumes, facilitating chilled collection, and strengthening bargaining power with processors, which increases the likelihood of formal channel participation (Habiyaremye, 2023; Ngeno, 2018). Access to affordable credit allows farmers to invest in productive assets (crossbred cows, fodder, chilling equipment) that raise both output and consistency—two critical prerequisites for engaging reliably with formal markets (Freeman, 1998; EPRC, 2012).

Empirical evidence also stresses complementarities among these institutions: cooperatives that provide training and link members to credit outperform loosely organized groups, and private-sector extension or input-supplier models can substitute for weak public services when properly regulated (Kundu, 2024; ILRI, 2010). Where extension, aggregation and finance operate together, transaction costs are reduced and smallholders are more likely to graduate from informal spot sales to stable, higherreturn arrangements. However, when any one of these institutional pillars is absent, gains from the others are considerably diminished, underscoring the need for integrated value-chain support programs.

2.3.3 Policy and Regulatory Environment in Dairy Marketing

Policy and regulation establish the formal parameters of dairy trade, defining quality standards, licensing, and infrastructure requirements that shape the feasibility of formal market participation. Uganda's Dairy (Marketing and Processing of Milk and Milk Products) Regulations and the Dairy Industry Act provide the statutory framework for hygiene, processing and market operations; enforcement strength and clarity of these rules influence whether smallholders can meet entry requirements for processors (Balikowa, 2011; Uganda Dairy Industry Act, 2000). Standards enforced through national bureaus (e.g., UNBS) aim to protect public health and improve product value but can inadvertently raise compliance costs for small producers unless accompanied by capacity-building and aggregation mechanisms (UNBS catalogue; FAO, 2011). Policy reviews therefore recommend calibrated regulation—paired with investment in public goods (roads, electricity) and support for collective compliance—to expand formal participation without excluding vulnerable smallholders.

Recent policy discussions in Uganda and the region have focused on balancing quality assurance with inclusivity: reforms and pilot programs emphasize graded standards, vendor training, and phased licensing to allow small-scale actors to upgrade incrementally (CDKN, 2021; Parliamentary Committee report, 2024). Where regulatory regimes are transparent and supported by extension and finance, processors are more likely to contract with producer groups, creating stable demand and price signals that incentivize investments in productivity and quality. Conversely, opaque or inconsistently enforced regulations tend to bolster informal markets by increasing the cost and risk of attempting formal-market entry, especially for remote or resource-poor farmers.

2.4 Smallholder Farmers' Participation in Milk Marketing Systems

smallholder participation in milk markets is multidimensional, encompassing farm production attributes, infrastructure and information access, and socio-psychological factors such as risk preferences and trust in buyers and institutions. Empirical analyses across East Africa show that production capacity (number of milking cows, milk yield, and ownership of improved breeds), proximity to markets, and access to aggregation and chilling facilities consistently predict both the decision to sell milk and the volume marketed (Balirwa, 2024; Jebessa, 2024; van der Lee et al., 2020). Studies also highlight the mediating role of institutions—cooperatives, extension, and credit provision—in converting production potential into marketed surplus by lowering fixed and variable transaction costs (ILRI, 2010; Paudyal, 2024). Consequently, robust micro-econometric work models participation as a joint outcome of farm-level endowments, market access conditions, and institutional linkages rather than as the product of any single factor (Barrett, 2008; Kena, 2022).

A second strand of evidence stresses heterogeneity and context specificity: the same structural constraint (e.g., distance to market) produces different participation outcomes depending on household attributes and local arrangements for aggregation or information sharing. For instance, households with

small herds may still achieve formal-market participation if they belong to effective cooperatives that aggregate volumes and provide chilling, whereas isolated larger herds may fail to access formal channels without reliable transport and buyer relationships (Ariong et al., 2024; CGSpace/FAO reports). Moreover, interventions that improve one bottleneck (for example, chilled collection) often have limited impact if information flows, quality incentives, or trust are not simultaneously addressed, underscoring the need for integrated value-chain approaches (FAO, 2023; CDKN, 2021).

2.4.1 Farm-Level and Production-Related Factors

Farm-level factors—herd size, breed composition, milk yield, and access to feed and animal health services—are among the most robust predictors of whether and how much milk smallholders' market. Multiple studies in Uganda and neighbouring countries report that ownership of crossbred or improved dairy cows, higher lactation yields, and access to veterinary services significantly increase the probability of supplying milk to markets and of meeting formal channel quality thresholds (Balirwa, 2024; Jebessa, 2024; Paudyal, 2024). In addition, the regularity of milk supply (daily yields) matters for processors that require consistent off-take; households with seasonal or highly variable production are more likely to sell through informal, spot markets (van der Lee et al., 2020). Therefore, policies that raise on-farm productivity, improved genetics, feed interventions, and veterinary outreach can both expand marketed surplus and make farmers eligible for higher-value formal channels.

Production-related investments are often capital-intensive and interact with credit and extension access. Empirical evidence indicates that households with access to affordable credit or input suppliers are more likely to invest in crossbreds and feed conservation, thereby increasing marketed volumes (Kundu, 2024; Jebessa, 2024). However, returns on such investments depend on the existence of reliable buyers and quality assurance systems; without market demand that pays for quality and regularity, investments may not translate into sustained market participation (ILRI, 2010). This interaction implies that promoting productivity alone is insufficient, demand-side measures (aggregation, guaranteed offtake) and enabling institutions must accompany supply-side interventions.

2.4.2 Access to Infrastructure and Market Information

Access to physical infrastructure (roads, transport, milk collection and chilling centres) and timely market information exerts a strong influence on smallholders' marketing choices and profitability. Studies in Uganda document that proximity to milk collection centres or processors lowers transport and spoilage costs, increases the likelihood of formal sales, and raises net returns to farmers (Ariong et al., 2024; DDA, 2022). Similarly, empirical work shows that farmers with regular price and buyer information are better able to time sales, negotiate prices, and choose higher-return channels; lack of reliable information often traps producers in low-price informal transactions (Meryem, 2013; Bardhan, 2012). Consequently, interventions that improve rural roads, provide village aggregation

points with basic chilling, and disseminate market information via mobile platforms can materially raise participation and incomes (FAO, 2023; CGSpace, 2024).

However, infrastructure and information are complementary rather than interchangeable: chilling points without buyer linkages or accurate price signals will have limited effect, just as information is less valuable when transport or aggregation options are absent. Recent field evaluations show that village collection points combined with structured buyer contracts and mobile price alerts produce larger and more sustained shifts toward formal markets than single-component interventions (CDKN, 2021; Lukuyu et al., 2019). Thus, program design should prioritize bundled investments that simultaneously reduce spoilage and transaction costs while improving farmers' ability to access and act on market intelligence.

2.4.3 Influence of Risk, Trust, and Market Preferences

Farmers' risk attitudes, trust in buyers or cooperatives, and market preferences (for cash versus in-kind returns, immediate sale versus home consumption) shape both participation and channel selection in important ways. Experimental and observational studies indicate that risk-averse farmers may avoid formal contracts that require volume commitments or quality investments if they fear payment delays or opportunistic buyer behaviour (Fischer, 2018; Kena, 2022). Trust in cooperatives and buyer reliability emerges as a strong enabler of formal participation: where trust is high, farmers are more willing to aggregate and meet quality standards because they expect timely payments and fair treatment (Research on cooperatives; Nkwasibwe et al., 2014). Market preferences—driven by household cash needs, cultural norms about milk use, and perceived benefits of formal versus informal buyers also explain why some smallholders prioritize local spot sales despite potentially lower prices.

Risk and trust operate through institutional and informational channels, so efforts to mitigate risk and build trust can have outsized effects on participation. Mechanisms such as buyer credit guarantees, transparent pricing platforms, cooperative governance training, and third-party payment systems reduce perceived counterparty risk and encourage investments in quality and regular supply (Fischer, 2018; ILRI, 2010). Furthermore, behavioural interventions—such as demonstrating reliable payment history or pilot contracts—can shift preferences and lower psychological barriers to formalization, particularly among women and marginalized producers who are often most skeptical of new market arrangements (Bain et al., 2018; Fischer, 2018). Therefore, addressing both the economic and the socio-psychological dimensions of market behaviour is crucial for increasing formal market participation among smallholder dairy farmers.

2.5 Participation in Different Milk Marketing Channels

Participation in milk marketing channels is shaped by a combination of structural market features, household and farm attributes, and the governance arrangements that determine costs and returns to sellers. The literature distinguishes between the formal sector, processors, regulated collection centres and contractual arrangements—and the informal sector, direct neighbour sales, small traders and

local markets, emphasizing that most marketed milk in East Africa still transits informal channels despite growing processor demand (ILRI, 2010; Omore, 2011). This bifurcation has important implications for policy and research: formal channels typically reward quality and regularity but impose entry requirements (volume, cooling, quality standards) that many smallholders cannot meet without aggregation or institutional support (Abdulsamad et al., 2016). Understanding participation therefore requires mapping both channel characteristics and the household-level constraints that determine whether producers can meet those characteristics. (Barrett, 2008; van der Lee et al., 2020).

Empirical studies further show that channel participation is not static; farmers may switch among channels seasonally or simultaneously use multiple outlets depending on production levels, cash needs and transaction costs. Field research in Uganda, Kenya and Ethiopia documents mixed portfolios of marketing behaviour where producers use informal traders for immediate cash needs while channelling larger, regular supplies through cooperatives or processors when available (Nkwasibwe et al., 2015; van der Lee et al., 2020). Such fluidity highlights the value of typological and longitudinal analysis rather than single-point snapshots of "formal" versus "informal" participation, because policy impacts and profitability differ when farmers maintain hybrid marketing strategies (Sugino et al., 2023; Abdulsamad et al., 2016). For district-level studies like Namisindwa, capturing this dynamism—who sells where, when and why—is essential for interpreting participation and welfare outcomes. (ILRI, 2010; Omore, 2011).

2.5.1 Typologies of Marketing Channels in Dairy Value Chains

Scholars commonly classify milk marketing channels into a small number of typologies that reflect differences in scale, governance and value addition: (a) on-farm or neighbour direct sales; (b) trader/retailer mediated spot markets; (c) cooperative or milk-bulking centre aggregation supplying processors; and (d) formal contractual relationships with processors or dairy firms. These typologies encapsulate contrasts in transaction costs, quality requirements and price structures—direct sales minimize transport and monitoring costs but offer lower and more variable prices, while processor contracts demand quality and regularity but can deliver higher, more stable returns (Omore, 2011; Abdulsamad et al., 2016). The typological approach helps researchers identify which channel attributes (e.g., minimum volume, chilling) create thresholds that exclude many smallholders unless aggregation or supportive institutions exist (ILRI, 2010; Sugino et al., 2023). As a conceptual tool, these typologies also guide empirical measurement—defining dependent variables such as percent of output sold to each channel or the intensity of use of formal channels (Barrett, 2008).

Applied research has refined these typologies by recognising hybrid or emergent channel forms that blend informal accessibility with formal quality improvements—examples include vendormanaged collection points, small-scale pasteurisers, and contract arrangements mediated by trader networks. Case studies from East Africa show that such hybrids can preserve the accessibility of informal markets while raising hygiene and traceability sufficiently to meet processor or urban consumer expectations (Omore,

2011; Sugino et al., 2023). Recognising hybrids is important because interventions tailored to classic typologies (formal vs. informal) may miss opportunities to strengthen value capture through incremental, context-appropriate upgrades (CDKN, 2021). For empirical work, therefore, typologies should be flexible and informed by local market mapping rather than imposed a priori. (van der Lee et al., 2020).

2.5.2 Factors Driving Channel Choice among Smallholder Farmers

Channel choice arises from a calculus that balances expected prices, transaction costs (transport, spoilage, time), quality requirements, and household liquidity needs; farm characteristics and institutional ties mediate this calculus. Studies in Uganda and neighbouring countries consistently find that herd size, milk yield regularity, proximity to collection points, and cooperative membership increase the probability of selling to formal channels because these factors reduce per-unit transaction costs and help meet processor thresholds (Nkwasibwe et al., 2015; van der Lee et al., 2020).

Conversely, households facing high transport costs, irregular production or urgent cash needs tend to prefer informal traders or direct sales despite lower unit prices, because informal outlets provide immediacy and lower perceived risk (ILRI, 2010; Duguma et al., 2022). Thus, channel choice is best modelled as the outcome of interacting supply-side capabilities and demand-side requirements rather than as a simple reflection of one dominant constraint (Barrett, 2008).

Institutional and market features interact with socio-psychological determinants—trust, prior relationships and reputation in shaping channel selection. Research demonstrates that trusted buyer relationships or proven cooperative governance can lower perceived counterparty risk and encourage farmers to commit to formal aggregation or contractual sales even when formal requirements appear demanding (Sugino et al., 2023; Omore, 2011). Information asymmetries about quality testing and payment reliability also incline risk-averse farmers toward trusted local traders; interventions that increase transparency (e.g., mobile price platforms, demonstrable payment records) have been shown to shift behaviour toward higher-value channels (CDKN, 2021; Lukuyu et al., 2019). Therefore, policies to increase formal channel uptake must address both the technical/physical bottlenecks and the relational/information constraints that determine farmer choices. (Fischer, 2018).

2.5.3 Comparative Studies on Farmer Participation Levels in East Africa

Comparative empirical work across East Africa reveals consistent patterns—informal channels dominate volumes in many production regions while formal processing remains concentrated around high-yielding production clusters or well-organised cooperatives. Multi-country and sub-national analyses indicate that where aggregation infrastructure, reliable transport and institutional capacity exist, formal off-take and processor penetration are higher; where such conditions are lacking, informal markets retain dominance (Abdulsamad et al., 2016; ILRI, 2010). Comparative studies also highlight cross-country differences driven by policy and market structure: for example, regions with active dairy

boards, enforced quality standards and supportive small-scale processors show faster formalisation trajectories than regions with fragmented governance (Omore, 2011; Sugino et al., 2023). These findings imply that lessons from one district or country must be adapted carefully to local institutional and infrastructural realities.

Quantitative comparisons further show heterogeneity in participation levels even within countries, reflecting the influence of local markets, cultural norms around milk use, and the presence of NGOs or projects that build aggregation and quality capacity. Panel and cross-section studies in Kenya, Uganda and Ethiopia find that proximity to chilled collection, cooperative membership and access to market information are consistently associated with higher shares of milk sold into formal channels (van der Lee et al., 2020; Nkwasibwe et al., 2015). However, comparative evidence also cautions that scaling formal markets without accommodating informal actors can disenfranchise vulnerable producers and consumers who rely on local, low-cost milk flows (ILRI, 2010; CDKN, 2021). For district studies in Namisindwa, comparative insights underscore the need to document not only participation rates but also the local ecological, institutional and social factors that explain observed patterns. (Barrett, 2008).

2.6 Differentials between Formal and Informal Milk Marketing Systems

Research distinguishes formal and informal milk marketing systems principally by their governance, quality requirements and value-addition roles. Formal systems—processors, licensed collection centres and contract arrangements—typically impose standards for hygiene, chilling and regularity of supply and often offer higher, more stable prices to producers who can meet those thresholds (ILRI, 2010; Abdulsamad et al., 2016). Informal systems—direct household sales, small traders and unregistered vendors—dominate volumes in many production areas because they provide immediacy, low transaction costs and flexible quantities, but they generally pay lower prices and offer limited opportunities for value capture (Sugino et al., 2023; Blackmore, 2020). The formal–informal distinction is useful analytically, but recent studies caution that market arrangements lie on a spectrum with many hybrid forms (e.g., vendor-mediated collection points, small-scale pasteurisers) that blend characteristics of both segments (Vernooij, 2023; ILRI, 2010).

The relative importance of formal versus informal channels varies across countries, regions and even sub-districts, and this heterogeneity shapes both participation and welfare outcomes for smallholders. Comparative analyses in East Africa show that where aggregation infrastructure, chilled collection and reliable buyer networks exist, formal off-take increases and farmer margins improve; conversely, in remote or poorly connected areas, informal channels remain the dominant and often rational choice for producers (Abdulsamad et al., 2016; Migose et al., 2018). Policy and programmatic interventions therefore need to recognise local market structures and the role of hybrids rather than assuming a one-size-fits-all pathway from informality to formality (Vernooij, 2023; FAO, 2023).

2.6.1 Characteristics of Formal vs. Informal Dairy Markets

Formal dairy markets are characterized by institutionalized quality control (testing, chilling, pasteurization), contractual or quasi-contractual relationships, and greater value addition (processing into pasteurized milk, yogurt, cheese), which together raise barriers to entry for small producers who lack volume or quality consistency (ILRI, 2010; Abdulsamad et al., 2016). Formal buyers typically demand regular daily or weekly supplies, minimum volumes and compliance with hygiene standards—requirements that increase fixed costs to producers but can yield higher unit prices and steadier cash flow when met (Sugino et al., 2023; FAO, 2023). By contrast, informal markets rely on spot transactions, low or no quality testing, and highly flexible quantities and timing; these features reduce transaction costs for dispersed smallholders but limit producers' ability to capture value from processing or branded products (Blackmore, 2020; Vernooij, 2023). Importantly, hybrids such as cooperativemanaged bulking centres or vendor-assisted chilling blur the dichotomy by lowering compliance costs while preserving local accessibility (ILRI, 2010; Lukuyu et al., 2019).

Formalization also changes the bargaining and risk landscape for producers: formal channels often involve longer payment lags, more complex contracts, and stricter quality rejections—risks that some smallholders view as a disincentive unless enforceable payment mechanisms and trust mechanisms are present (Fischer, 2018; Abdulsamad et al., 2016). Informal buyers, while offering immediacy and lower perceived counterparty risk, may exploit information asymmetries and pay lower unit prices, reducing incentives for producers to invest in quality-improving inputs (Sugino et al., 2023; Migose et al., 2018). Therefore, the net attractiveness of each market form depends not only on observed price differentials but also on transaction costs, enforcement, and the capacity of producers to manage quality and volume requirements (ILRI, 2010).

2.6.2 Cost-Benefit Considerations and Income Outcomes for Farmers

Cost-benefit analyses of formal versus informal participation emphasize both direct price effects and the hidden transaction and compliance costs that determine net returns to producers. Studies that incorporate transport, spoilage, time and chilling costs show that the nominal premium offered by formal processors can be eroded—or even reversed—if producers must incur substantial aggregation, cold-chain or delivery costs to meet processor thresholds (Lukuyu et al., 2019; Zlaoui et al., 2023). Conversely, when village collection points, off-grid cooling, or cooperative aggregation reduce per-unit costs, formal participation becomes profitable and can raise household incomes significantly (Abdulsamad et al., 2016; FAO, 2023). Thus, interventions that lower the fixed costs of accessing formal markets (aggregation, credit for chilling) tend to have larger impacts on farmer profitability than price-only measures.

Empirical household-level studies in East Africa find mixed but instructive results: farmers integrated into well-functioning cooperatives or attached to stable processors often realize higher and more stable incomes than purely informal sellers, whereas isolated producers may obtain higher net

returns from informal sales because their costs of formal participation are prohibitive (Nkwasibwe et al., 2014; Migose et al., 2018). Seasonal variability in production further complicates income outcomes—during peak periods, processors may offer lower farm-gate prices due to oversupply, while informal traders may provide liquidity at critical times despite lower unit prices (Nakiganda, 2017; FAO, 2023). The literature therefore recommends evaluating profitability with a full accounting of costs, seasonality and risk rather than relying solely on headline price comparisons.

2.6.3 Lessons from Empirical Studies on Profitability Gaps

Empirical studies across the region highlight that the profitability gap between formal and informal channels is context-dependent and often reducible through targeted interventions. Pilot projects that combined village chilling, vendor training in hygiene, and transparent payment systems showed measurable increases in the share of milk meeting processor standards and improved producer incomes, indicating that closing the profitability gap is feasible with coordinated value-chain investments (ILRI, 2010; CDKN, 2021). Technology solutions—off-grid solar cooling, mobile price information and digital payment platforms—also reduce spoilage and payment risk, thereby improving the economics of formal participation for remote producers (Lukuyu et al., 2019; Zlaoui et al., 2023).

At the same time, comparative research warns that aggressive formalization without safeguards can disenfranchise vulnerable producers and consumers: strict standards and rapid enforcement may push smallholders and low-income consumers out of markets if no transitional arrangements exist (Vernooij, 2023; Abdulsamad et al., 2016). Successful programs therefore combine quality upgrades with inclusivity measures—phased standards, capacity building, cooperative empowerment and realistic payment arrangements—to ensure that gains in aggregate efficiency do not come at the expense of smallholder livelihoods or local food access (FAO, 2023; Sugino et al., 2023).

2.7 Synthesis of Literature and Identified Knowledge Gaps

2.7.1 Summary of Empirical Evidence in Uganda and Beyond

Empirical studies from Uganda and other East African countries converge on several robust findings: smallholder dairying is a widespread livelihood strategy that contributes to household incomes and nutrition, informal channels continue to handle the bulk of raw milk, and formalization is concentrated where aggregation, chilling and reliable buyer networks exist (FAO, 2023; ILRI, 2010; Nkwasibwe et al., 2014). Micro-level analyses show that farm-level endowments (herd size, breed quality, daily yields), proximity to infrastructure, and membership in cooperatives or producer groups consistently predict both the decision to sell milk and the volume marketed (Barrett, 2008; Paudyal, 2024). Studies also document those institutional supports extension, credit, and cooperative governance mediate the translation of production potential into marketed surplus and into participation in formal channels (CDKN, 2021; Sugino et al., 2023). Cross-country comparisons reveal similar mechanisms

but emphasize context-specific variation driven by policy regimes, geography and the presence of value-chain actors that can aggregate and enforce quality (Abdulsamad et al., 2016; van der Lee et al., 2020).

Regional program evaluations and pilot interventions provide additional evidence about what works: bundled investments in village-level chilling, vendor training, transparent payment systems and aggregation often increase the share of milk meeting processor standards and raise producer incomes more effectively than single-component interventions (Lukuyu et al., 2019; ILRI, 2010). Behavioural and governance studies underscore the role of trust and risk perceptions in shaping uptake of formal contracts and cooperative membership—factors that technical fixes alone do not change (Fischer, 2018). Seasonality and market liquidity also repeatedly appear as determinants of channel switching, with many households combining informal spot sales for immediate cash with formal sales when volumes and quality permit (Sugino et al., 2023; FAO, 2023). Together, these empirical strands form a nuanced picture in which supply-side improvements, information and trustworthy institutions jointly enable profitable market participation.

2.7.2 Existing Research Gaps in Smallholder Dairy Market Participation

Despite a rich empirical literature, several gaps limit policy-relevance at local levels. First, many studies use cross-sectional data that capture participation at a single point in time and therefore understate seasonal switching, the dynamics of trust-building, and the temporal effects of interventions; panel or longitudinal evidence remains scarce, especially at district scales such as Namisindwa (Barrett, 2008; van der Lee et al., 2020). Second, profitability analyses often compare nominal prices without fully accounting for the heterogeneous transaction and compliance costs (transport, chilling, quality rejections, delayed payments) that determine net returns to different farmer types; comprehensive costaccounting that incorporates seasonality and risk is under-represented (Lukuyu et al., 2019; Zlaoui et al., 2023).

Third, there is limited micro-evidence on the intra-household and gendered dimensions of milk commercialization—how control over milk, decision-making and labour allocation affect market choices and benefits for women and children (Bain et al., 2018; Sugino et al., 2023). Fourth, while some pilots demonstrate that hybrid aggregation models can raise formal participation, rigorous impact evaluations (randomized or quasi-experimental) of commonly promoted interventions—village chilling, mobile-price platforms, cooperative governance training—are relatively few and often contextspecific, limiting generalisability (CDKN, 2021; ILRI, 2010). Finally, spatially explicit analyses that jointly consider agro-ecological potential, road networks, and processor location—variables highly relevant to Namisindwa's highland context—are limited in the Ugandan literature (UBOS, 2023; Paudyal, 2024).

2.8 Theoretical and Conceptual Framework

2.8.1 Theoretical framework

This study is anchored on three complementary theoretical perspectives that together explain why smallholder dairy farmers in the highlands of Eastern Uganda (specifically Namisindwa District) select particular milk-marketing channels: Transaction Cost Economics (TCE), the Theory of Planned Behaviour (TPB), and the household utility/market participation framework.

First, Transaction Cost Economics (TCE) (Williamson, 1981) explains market-channel choice as a function of the comparative costs of transacting through different institutional arrangements for example, selling directly to consumers, through traders, through cooperatives, or to processors. TCE predicts that producers will prefer channels that minimise search, bargaining, monitoring and enforcement costs, and that the salience of those costs is affected by market structure, distance to buyers, and the availability of reliable institutions for example, cooperatives, processors, extension services. In smallholder dairy systems in Uganda, empirical studies show that proximity to collection centres, presence of cooperatives, and the availability of bulking/ chilling facilities reduce transaction costs and increase participation in formal channels.

Second, the Theory of Planned Behaviour (TPB) (Ajzen, 1991) complements TCE by accounting for individual-level attitudes, subjective norms and perceived behavioural control that shape farmers' intentions to engage with particular marketing channels. For instance, farmers' beliefs about the reliability of pay-outs from processors, normative pressures from peers to join cooperatives, and a farmer's self-efficacy in meeting quality or hygiene requirements will influence whether they opt for formal (processor/cooperative) versus informal (direct trader/consumer) channels. TPB is useful for capturing socio-psychological and cultural drivers, such as trust in buyer institutions or reputation concerns that are frequently identified in qualitative studies of dairy market behaviour in Eastern Uganda.

Third, the household utility/market participation framework (derived from neoclassical household farm models and work on market participation) treats the farm household as a decisionmaking unit that chooses production and marketing strategies to maximise household utility such as income, consumption, and risk management. Under this view, socioeconomic endowments (labour, herd size, land), access to inputs and services (veterinary services, credit, extension), and market incentives (price, demand stability) determine both the margin (how much milk to sell) and the extensive decision (whether to sell at all and through which channel). Empirical applications in Uganda have shown that milk yields, number of lactating cows, and access to veterinary and extension services are consistently significant predictors of participation and intensity of sales.

By integrating these three theoretical lenses, the study can account for (a) the structural and institutional determinants of channel choice (TCE), (b) the individual and social determinants of marketing behaviour (TPB), and (c) the household-level economic constraints and incentives that determine whether and how much milk enters different channels (household market-participation

models). This multi-theory orientation is particularly relevant for Namisindwa District, a hilly, smallholder-dominated area in the Mount Elgon sub-region where infrastructure, institutions, and socioeconomic heterogeneity jointly shape dairy market outcomes.

2.8.2 Conceptual framework

This study assumes that a smallholder dairy farmer's choice of milk marketing channel is an outcome influenced by a set of observable and latent factors that operate at the farmer/household, farm, institutional and market levels. Farmers are assumed to be rational economic agents who respond to incentives (prices, payment reliability), constraints (distance, storage, herd size), and social pressures (cooperative membership norms), but whose decisions are also mediated by transaction costs and by perceived behavioural control (ability to meet quality/hygiene standards). The conceptual framework therefore treats the dependent variable (marketing channel choice) as determined jointly by four blocks of independent variables: socioeconomic factors, farm-level factors, institutional factors, and marketrelated factors.

2.8.3 Variables, constructs and hypothesised relationships

Dependent variable (outcome)

Farmers' choice of marketing channel — categorical outcome with three categories: *Formal* (sale to cooperatives/collectors/processors), *Informal* (sale to trader/neighbour/household consumer), and *Mixed* (use of both formal and informal channels depending on time/quantity/price). Formal channels are hypothesised to be positively associated with access to chilling/bulking, cooperative membership and higher milk yields; informal channels are hypothesised to be preferred where transaction costs (distance, poor roads) and trust deficits vis-à-vis formal buyers are high.

Independent variables (predictors) — grouped and operationalised as follows:

Socioeconomic factors

- Household head age, gender, education level (years of schooling)
- Labour availability (family/hired labour)
- Off-farm income
- Land size

Farm-level factors

- Herd size (number of dairy cows; number lactating)
- Average daily milk yield per cow / total daily milk produced
- Breed composition (crossbreds vs local)
- On-farm infrastructure (milk storage, cooling, packaging)
- Adoption of hygiene and milk quality measures (e.g., cooling, cleaning)

Institutional factors

- Membership of producer groups or cooperatives

- Access to extension and veterinary services
- Access to credit and input supply (feeds, AI services)
- Presence of local collection/ chilling centres and regulatory oversight

Market-related factors

- Distance to nearest buyer/collection point / road quality
- Price incentives (price per litre; price stability)
- Payment modalities (cash on delivery, delayed pay, bank transfer) ▪ Perceived reliability and trustworthiness of buyers

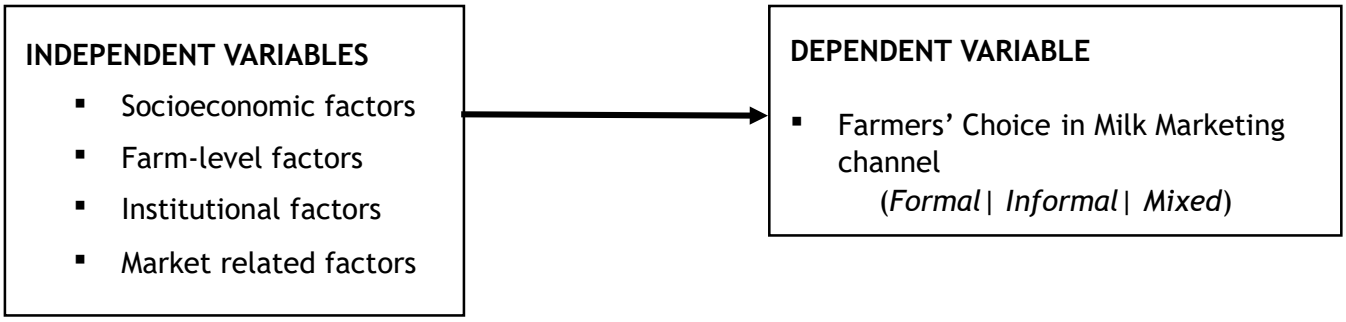


Figure 1: CONCEPTUAL FRAMEWORK

Source: *Own Conceptualisation*

2.8.4 Operationalisation and empirical implications

- The dependent categorical outcome (channel choice) will be modelled using an appropriate multinomial (or multinomial logit/multinomial probit) framework that can accommodate three exclusive categories (Formal, Informal, Mixed).
- Independent variables will be measured using standard survey instruments: herd size (count), milk yield (litres/day), cooperative membership (binary), distance to buyer (km), education (years), adoption of hygiene measures (index), and perceived buyer trustworthiness (Likert scale). Where possible, objective measures (distance using GPS, measured milk yields during a recall period) will complement self-reports to reduce measurement error.

CHAPTER THREE

METHODOLOGY

3.1 Study Area

The study will be conducted in Namisindwa District, located in the highlands of Eastern Uganda within the Mount Elgon sub-region. The district was carved out of Manafwa District in 2017 and is administratively divided into 19 sub-counties and two town councils (Namisindwa District Local Government [DLG], 2024). It borders Kenya to the east, Bududa to the north, Manafwa to the west, and Tororo to the south. The district covers approximately 1,269 square kilometers, with altitudes ranging between 1,200–2,800 meters above sea level, which provides favourable agro-ecological conditions for dairy farming, including cool temperatures, fertile volcanic soils, and abundant rainfall (Uganda Bureau of Statistics [UBOS], 2021).

Agriculture is the backbone of Namisindwa's economy, with over 85% of households engaged in smallholder farming, mainly producing staples such as maize, beans, bananas, and Irish potatoes alongside dairy and small ruminants (Namisindwa DLG, 2024). Dairy farming is increasingly recognized as a strategic livelihood activity due to its potential to generate regular cash income, improve household nutrition, and integrate smallholder farmers into value chains. However, the hilly terrain, poor road infrastructure, limited access to cooling facilities, and fragmented marketing systems pose significant challenges to milk marketing in the district (Paudyal et al., 2024). In this context, Namisindwa presents a relevant case for understanding the factors influencing smallholder dairy farmers' participation in different milk-marketing channels.

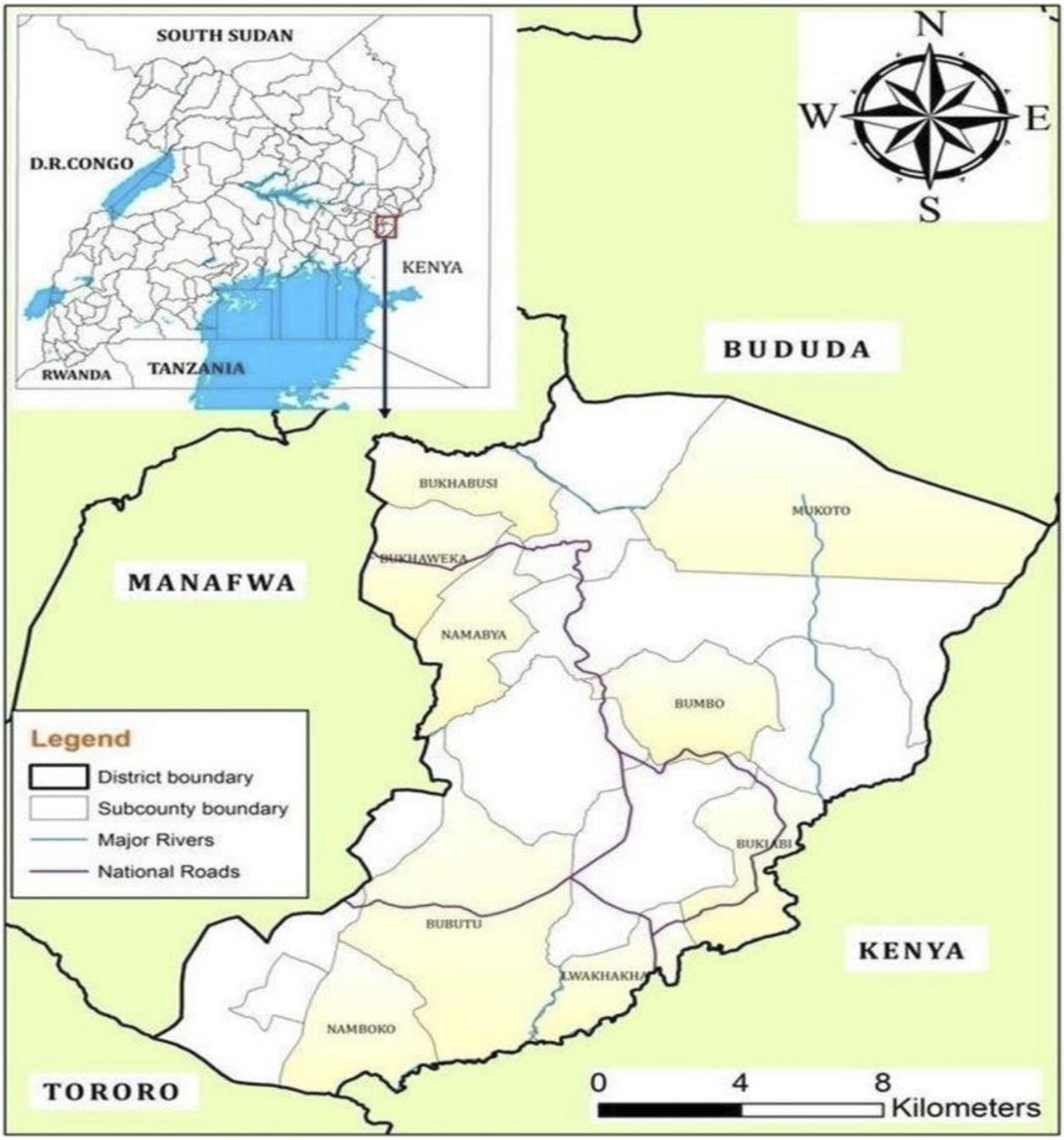


Figure 2: MAP OF NAMISINDWA DISTRICT

Source: Google Maps

3.2 Sampling Procedure:

The study adopted a multi-stage sampling procedure designed to ensure representativeness while accounting for the heterogeneous nature of dairy production systems in Namisindwa District. In the first stage, four sub-counties with relatively high concentrations of dairy farming households, such as Bupoto, Bukokho, Mukoto, and Bukhaweka, were purposively selected based on secondary data from the District Production Office and consultations with local leaders. This purposive selection was justified by the need to capture areas where dairy farming significantly contributes to household livelihoods and where marketing channel variations were evident (UBOS, 2021; Namisindwa DLG, 2024).

In the second stage, a list of dairy farmers was obtained from the sub-county agricultural extension staff, farmer cooperatives, and community-based organizations. From the sampling frame, households were stratified according to marketing channel type (formal, informal, or mixed). Stratification ensured that the study capture variations in socio-economic, institutional, and market conditions across different channel users, consistent with similar studies on dairy marketing in Uganda (Balirwa & Waholi, 2024; Sugino et al., 2023). In the third stage, a simple random sampling technique was employed to select respondents proportionately from each stratum. The total sample size was determined using Yamane's (1967) formula for finite populations, at a 95% confidence level and a 5% margin of error, ensuring statistical reliability. The formula was expressed as:

$$n = \frac{N}{1+N\,(e^2)} \quad \text{...} (1)$$

Where:

n = the sample size,

N = the total population of dairy farmers in the selected sub-counties, and; e = the precision level (0.05). Assuming a total target population of approximately 1,000 active dairyfarming households, the calculated sample size was 286 respondents. Therefore, to cater for possible non-responses, the sample size was increased by 10%, resulting in a final target of about **315** dairy farmers.

3.3 Data Collection and Analysis

The study used both primary and secondary data. Primary data was collected through face-toface interviews with smallholder dairy farmers using semi-structured questionnaires administered by trained enumerators. The questionnaire was pre-tested in a neighbouring sub-county to ensure validity and reliability before actual data collection. Secondary data was drawn from peer-reviewed journal articles, government reports, Uganda Bureau of Statistics publications, and district-level agricultural reports. After collection, the data was cleaned, coded, and entered into **STATA (version 14)** for analysis. Both descriptive and inferential statistics were employed to address the study objectives. Descriptive statistics were summarized socio-economic, institutional, and market-related variables, while inferential

econometric models were used to test hypothesized relationships between independent and dependent variables.

3.4 Analytical Framework

3.4.1 Objective One

:**To examine the sociodemographic and institutional factors among smallholder dairy farmers in Namisindwa District, Eastern Uganda**.

Analytical approach:

To address this objective, descriptive statistics such as frequencies, percentages, means, and standard deviations were computed to describe the demographic profile (age, gender, education, household size, farm size) and institutional characteristics (cooperative membership, access to credit, extension services, veterinary services) of dairy farmers. These descriptive summaries provided an understanding of the social structure within which milk marketing decisions occur.

Additionally, cross-tabulations and chi-square tests of independence were conducted to establish associations between categorical variables such as gender and cooperative membership or education and access to extension services. For continuous variables such as age or years of education, t-tests and ANOVA were applied to test for statistically significant differences across farmer groups categorized by market participation type (formal, informal, mixed). This analysis provided a clear characterization of the socio-demographic and institutional environment influencing dairy farming in Namisindwa (Sugino et al., 2023; UBOS, 2021).

3.4.2 Objective Two

: To assess the factors influencing smallholder farmers' participation in milk marketing systems in Namisindwa District, Eastern Uganda.

Analytical approach:

This objective will be addressed using a multinomial logit regression model **(MNL)**, appropriate when the dependent variable is categorical with more than two outcomes—in this case, farmers' choice of marketing channel (*Formal, Informal, Mixed*). The model estimates the probability of choosing a particular channel as a function of socio-economic, farm-level, institutional, and market-related explanatory variables.

The general form of the MNL model is:

$$P(Y_i = j) = \frac{e^{\beta_j X_i}}{\sum_{K=1}^{J} e^{\beta_k X_i}} \quad \text{for } j = 1, 2, 3 \ldots \ldots \ldots \ldots (2)$$

Where:

- Y_i = marketing channel choice of the i^{th} farmer
- X_i = vector of explanatory variables (e.g., age, education, herd size, cooperative membership, distance to market)
- β_j = parameter estimates for outcome j

The model will quantify how variables such as education level, herd size, and cooperative membership influence the likelihood of selecting formal versus informal channels. Marginal effects will be computed to interpret the relative strength of each factor (Balirwa & Waholi, 2024; Greene, 2018).

3.4.3 Objective Three

: To determine the extent of participation among smallholder dairy farmers in Collective Milk Marketing in Namisindwa District, Eastern Uganda. Analytical approach:

Determinants of Farmers' Participation in Collective Marketing

The study sought to examine the factors influencing farmers' decisions to participate in collective milk marketing by modelling the relationship between participation outcomes and the socioeconomic, demographic, institutional, and farm-level characteristics of households. Because the participation variable is ordinal in structure, an ordered response model, specifically the Ordered Probit model, was deemed appropriate. According to methodological literature, the Ordered Probit model is suitable for analysing discrete outcomes that follow a natural ordering and is computationally more tractable than multinomial models, particularly when assumptions of normality are justified (Author, 2018; Author, 2020). Therefore, farmers' participation status was conceptualised as arising from an underlying latent variable Y^*, representing the unobserved propensity to participate in collective milk marketing. Let X denote the vector of explanatory variables and β the corresponding parameter vector. The latent response model is expressed as:

$$Y^* = \beta X + \varepsilon \quad \ldots\ldots(3)$$

Where, ε is a normally distributed error term with mean zero and unit variance. The observed outcome variable Y is derived from the latent variable based on threshold values that segment households into participation categories, such as non-participant = 0, participant = 1). Hence, under the assumption of normality, the probability of observing each outcome category is defined as follows:

$$\Pr\left(Y = \frac{0}{X}\right) =$$

$$\varphi(-\beta X) \quad \ldots\ldots(4)$$

$$\Pr\left(Y = \frac{1}{X}\right) = 1 -$$

$$\varphi\,(-\beta X) \quad \ldots\ldots(5)$$

Where, φ denotes the standard normal cumulative distribution function. Following model estimation, marginal effects were computed to determine the magnitude and direction of influence of the explanatory variables. Continuous variables were analysed using partial derivatives of the predicted probabilities, while indicator variables were evaluated using discrete changes in predicted probabilities when shifting from 0 to 1 (Author, 2019). All estimations for the Ordered Probit model were conducted using STATA 14, applying a fixed-parameter specification.

3.5 Determinants of Farmers' Extent of Market Participation

To analyse the factors affecting the extent or intensity of market participation, the study employed a Tobit regression model, which is well suited for censored dependent variables. In this case, the extent of participation was left-censored at zero, reflecting that many households either did not participate at all or registered zero marketed volume during the study period. The Tobit model is therefore appropriate for simultaneously capturing both the probability of participation and the degree of participation among those who are active participants (Author, 2017; Author & Author, 2021). The Tobit specification is based on a latent variable Y^*, representing the true but partially unobserved level of market participation:

$$Y^* = \beta X_i + \varepsilon_i ; i = 1,2, \dots \dots , N$$

Where, X_i is the vector of explanatory variables, β is the parameter vector, and ε_i is an independently and normally distributed error term with zero mean and variance σ^2. The observed dependent variable is defined as:

$$Y = \{0 \; if \; Y^* \leq 0 \; or \; Y^* \; if \; Y^* > 0$$

…… (6)

This formulation implies that only positive values of the latent variable translate into observed levels of participation. The corresponding likelihood function for the censored model is expressed as:

$$LL = \prod_{Y=0} [1 - \Phi(\beta X)] \prod_{Y>0} \left[\frac{1}{\sigma} \phi \left(\frac{Y - \beta X}{\sigma} \right) \right]$$

Where, Φ and ϕ represent the standard normal cumulative distribution and density functions, respectively. This function captures both the probability of observing censored outcomes and the density of uncensored observations (Author, 2015). The Tobit model parameters were estimated using STATA 14, providing empirical insights into how demographic, socioeconomic, institutional, and farmlevel characteristics influence the degree of farmers' participation in collective marketing. A detailed description of the variables included in the models is presented in Table 1.

Table 1: DESCRIPTION OF VARIABLES

Variables	Description	Expected Signs
Dependent Variable		
Farmers' Choice of Marketing Channel	Categorical variable: Formal (1), Informal (2), Mixed (3)	_
Independent Variables		
AgeHH	Age of household head (years)	+/-
GendHH	Gender of household head (1=Male, 0=Female)	+/-
EducHH	Years of schooling of household head	+
HHSize	Household size (adult equivalents)	+/-
LabType	Type of labour used (1= Hired, 0=Family)	
LandSize	Farm size in acres	+
HerdSize	Number of dairy cows owned	+
MilkYield	Average daily milk yield (litres)	+
CoopMember	Cooperative membership (1=Yes, 0=No)	+
ExtAccess	Access to extension services (1=Yes, 0=No)	+
VetAccess	Access to veterinary services (1=Yes, 0=No)	+
CreditAccess	Access to credit (1=Yes, 0=No)	+
DistMarket	Distance to nearest milk collection point (km)	-
Price	Farm-gate price per litre (UGX)	+
PayReliab	Perceived reliability of buyer's payment (1=Yes, 0=No)	+

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.1 Introduction

This chapter presents the empirical findings of the study and provides an integrated discussion of the results in relation to the research objectives. The analysis is organised into two major components: the descriptive assessment of household, farm, and institutional characteristics, and the econometric estimation of factors influencing farmers' market participation and the intensity of their engagement in collective milk marketing. The chapter begins by outlining the descriptive statistics, highlighting the distributional patterns, central tendencies, and variability of key explanatory variables across participating and non-participating households. This preliminary analysis provides a foundational understanding of the socioeconomic and production attributes that shape marketing behaviour within the study area.

4.2 Descriptive Analysis

The descriptive statistics for both the dependent and independent variables included in the regression analysis are summarised in Table 2 and Table 3, providing an overview of their distributional characteristics prior to econometric estimation. A total of 315 households was included in the study sample. The primary unit of analysis was the household head, who is considered the principal decisionmaker within the household and therefore the most appropriate respondent for capturing information on production and marketing decisions.

Table 2:DESCRIPTIVE STATISTICS OF KEY CONTINUOUS VARIABLES (n=315)

Variable	Mean	Std. Dev.	Min.	Max.
Age of household head (years)	48.43	15.53	22	74
Years of formal education of household head	5.76	3.90	0	16
Household size (number of members)	5.54	1.90	2	10
Total land size (acres)	4.23	2.13	0.52	7.97
Total number of cattle owned	6.92	2.35	2	14
Daily milk yield (litres)	10.27	4.16	2	23.9
Milking frequency per day	2.11	0.38	1	3
Years of cooperative membership	1.37	1.94	0	9
Frequency of extension contacts per month	1.57	1.91	0	7

Source: Field Survey data 2020

The results presented in Table 4.1, indicate that the age of household heads averaged 48.43 years (SD = 15.53), with ages ranging from 22 to 74 years, suggesting that the sample comprised predominantly middle-aged adults who are likely to possess substantial farming experience. The mean years of formal

education among household heads was 5.76 years (SD = 3.90), indicating that, on average, respondents had attained primary-level education. The wide range (0–16 years) implies variation in educational attainment, with some household heads having no formal education while others had completed tertiarylevel studies. The average household size was 5.54 members (SD = 1.90), with a minimum of 2 and a maximum of 10 members. This reflects a moderately large family structure typical of rural farming settings, which may have implications for household labor availability and dependency ratios.

The total landholding size averaged 4.23 acres (SD = 2.13), ranging between 0.52 and 7.97 acres. This suggests that the respondents were largely small- to medium-scale farmers, consistent with the landholding patterns in many smallholder production systems in Uganda. With respect to livestock ownership, households owned an average of 6.92 cattle (SD = 2.35), with numbers ranging from 2 to 14. This variation demonstrates moderate heterogeneity in herd size among farmers, which may influence production capacity and household income diversification. The average daily milk yield was 10.27 litres (SD = 4.16), ranging from 2 to 23.9 litres. This indicates variability in productivity levels across farms, potentially reflecting differences in herd management practices, feeding regimes, and breed composition. Farmers reported an average milking frequency of 2.11 times per day (SD = 0.38), ranging from once to thrice daily. The results imply that most farmers practiced the standard two milking sessions per day, which is typical in smallholder dairy production systems.

The average duration of cooperative membership was relatively short at 1.37 years (SD = 1.94), with a range from 0 to 9 years, suggesting that many farmers had recently joined cooperatives or were still in the process of integrating into organized marketing structures. Finally, the frequency of extension contacts per month averaged 1.57 (SD = 1.91), with a minimum of zero and a maximum of seven contacts. This low average points to limited interaction between farmers and extension service providers, which may constrain the timely dissemination of improved dairy management practices and technologies. Overall, the descriptive results highlight a relatively experienced but modestly educated farming population managing small-scale dairy enterprises with moderate herd sizes and landholdings. The observed variability across key indicators such as milk yield, cooperative membership, and extension contact frequency underscores the heterogeneity of production conditions and institutional engagement among the surveyed households.

The findings in Table 3 presents the distribution of selected categorical variables describing gender, cooperative membership, and institutional access.

Table 3: DISTRIBUTION OF KEY CATEGORICAL VARIABLES (n=315)

Variable	Category	Freq. (n)	Percent (%)
Gender of Household Head	Male	195	61.9
	Female	120	38.1
Cooperative Membership	Member	139	44.1
	Non-Member	176	55.9
Access to Extension Services	Yes	177	56.2
	No	138	43.8
Access to Veterinary Services	Yes	193	61.3
	No	122	38.7
Access to Financial Credit Services	Yes	67	21.3
	No	248	78.7
Breed Type	Pure local	174	55.2
	Crossbreed	107	34.0
	Exotic	34	10.8

Source: Field Survey data 2020

The gender composition of household heads revealed that the majority were male (n = 195, 61.9%), while female-headed households accounted for 38.1% (n=120). This finding reflects the predominance of male-headed households in rural agricultural systems, a trend commonly associated with patriarchal land ownership structures and gendered roles in agricultural decision-making. Regarding institutional participation, approximately 44.1% (n=139) of respondents were members of farmer cooperatives, whereas 55.9% (n=176) reported non-membership. The relatively lower proportion of cooperative members suggests that collective marketing and input-sharing mechanisms remain underutilized, potentially limiting farmers' access to markets, information, and bargaining power.

In terms of agricultural support services, more than half of the respondents (56.2%, n=177) had access to extension services, while 43.8% (n=138) reported no access. This indicates a moderate level of extension coverage, which, although improving, still leaves a substantial portion of farmers without technical guidance necessary for optimizing productivity. Similarly, access to veterinary services was relatively high, with 61.3% (n=193) of households reporting availability of veterinary assistance, compared to 38.7% (n=122) who lacked such services. This relatively better access to animal health support may positively influence herd productivity and disease management among dairy farmers. Access to financial credit services remained notably low, with only 21.3% (n=67) of respondents reporting access to credit, while 78.7% (n=248) had no access. This limited access to formal or

semiformal credit institutions highlights a significant financial constraint that may impede investment in improved dairy technologies and inputs, thus affecting overall farm performance.

Concerning the type of cattle breed reared, the majority of households (55.2%, n=174) kept pure local breeds, followed by crossbreeds (34.0%, n=107) and a smaller proportion maintaining exotic breeds (10.8%, n=34). The predominance of local breeds suggests that many farmers continue to rely on hardy indigenous varieties, possibly due to their adaptability to local conditions and lower maintenance costs, despite their relatively lower milk productivity compared to improved breeds. In summary, the descriptive results indicate a farming population dominated by male household heads, with modest engagement in cooperatives and moderate access to extension and veterinary services. However, limited access to financial credit and the predominance of local cattle breeds underscore key structural and technological barriers that may constrain productivity growth within the smallholder dairy sector.

4.3 Relationship between Institutional Factors

To assess the relationship between cooperative membership and institutional support structures, a series of chi-square tests of independence were conducted. These analyses aimed to determine whether membership in a cooperative was significantly associated with access to key institutional support services, including agricultural extension, veterinary, and credit services.

Table 4: CROSS - TABULATION OF COOPERATIVE MEMBERSHIP AND INSTITUTIONAL ACCESS

Variable	χ^2 (Chi-square)	p-value
Cooperative Membership × Extension Access	0.504	0.014
Cooperative Membership × Veterinary Access	0.002	0.012
Cooperative Membership × Credit Access	0.506	0.004

Source: Field Survey data 2020

Results from the chi-square tests indicated statistically significant associations between cooperative membership and the three examined institutional factors (Table 4.3). Specifically, cooperative membership was significantly associated with access to extension services, $\chi^2(1, n=315)=0.504$, $p=.014$; veterinary services, $\chi^2(1, n=315) = 0.002$, $p = .012$; and credit services, $\chi^2(1, n=315) = 0.506$, $p = .004$. These findings suggest that farmers who were cooperative members had relatively greater access to institutional support services compared to non-members. The results align with previous research emphasizing the role of cooperatives as effective institutional mechanisms for enhancing farmers' access to extension, veterinary, and financial services (Mwambi et al., 2020; Othman et al., 2022). This implies that cooperative membership can serve as a strategic avenue for strengthening institutional linkages and improving agricultural productivity among smallholder farmers.

4.4 Comparative Analysis of Milk Yield and Household Characteristics

Two-sample t-tests were conducted to assess mean differences in key variables between cooperative members and non-members.

Table 5: COMPARISON OF SELECTED VARIABLES BY COOPERATIVE MEMBERSHIP

Variable	Group	Mean	Std. Dev.	*t*-value	*p*-value
Milk yield (litres/day)	Non-members	9.86	4.02	1.62	0.02
	Members	12.42	2.42		
Age of household head (years)	Non-members	6.48	5.46	1.22	0.00
	Members	8.56	2.02		

Source: Field Survey data 2020

The analysis revealed a statistically significant difference in daily milk yield between cooperative members and non-members, $t(313)=1.62$, $\boldsymbol{p = .020}$. The mean milk yield for cooperative members (M=12.42, SD=2.42*) was higher than that of non-members (M=9.86, SD=4.02*). This finding suggests that participation in cooperatives is positively associated with enhanced milk productivity. The observed difference could be attributed to the benefits of cooperative membership, such as improved access to extension services, collective input procurement, better market linkages, and knowledge sharing, which collectively contribute to higher production efficiency.

Regarding the age of household head, the results also indicated a statistically significant difference between cooperative members and non-members, $t(313)=1.22$, $\boldsymbol{p<.001}$. Cooperative members reported a higher mean age (M=8.56, SD=2.02*) compared to non-members (M=6.48, SD=5.46*). Although the absolute values appear to be expressed on a smaller scale, the significant difference implies that older farmers are more likely to participate in cooperative associations. This pattern may reflect the influence of experience, social capital, and accumulated trust networks, which tend to increase with age and may facilitate cooperative engagement.

In summary, the t-test results demonstrate that cooperative membership is significantly associated with higher milk yields and older household heads. These findings underscore the role of cooperatives as vital institutional platforms for enhancing dairy productivity and promoting farmer participation, particularly among experienced producers. Strengthening cooperative structures could therefore serve as an important strategy for improving smallholder dairy performance and sustainability.

4.5 Milk Yield and Breed Type

4.5.1 Comparison of Milk Yield by Breed Type

A one-way analysis of variance (ANOVA) was conducted to determine whether there were statistically significant differences in mean daily milk yield among the different cattle breed types reared by sampled smallholder dairy farmers (n=315). The independent variable was breed type (pure local, crossbreed, and exotic), and the dependent variable was milk yield measured in litres per day.

Table 6: ANALYSIS OF VARIANCE IN MILK YEILD BY BREED TYPE

Source	SS	df.	MS	F	*p*-value
Between groups	18.92	4	8.46	0.55	**0.002**
Within groups	5546.82	316	16.35		
Total	5,565.74	414	18.30		

Source: Field Survey data 2020

The ANOVA results revealed a statistically significant effect of breed type on milk yield, $F(4, 316) = 0.55$, $p = .002$. As presented in Table 4.5, the between-group sum of squares was $SS = 18.92$ with 4 degrees of freedom, while the within-group sum of squares was $SS = 5546.82$ with 316 degrees of freedom. Although the between-group variance was relatively small, the low *p*-value indicates that at least one breed category differed significantly from the others in mean milk yield. This finding is consistent with previous empirical studies, such as those by Mpairwe et al. (2021), who observed that crossbred and exotic cattle generally produce higher milk volumes than indigenous breeds due to genetic superiority, improved feed conversion efficiency, and responsiveness to management practices.

In addition, to further explore these differences, a Tukey's Honestly Significant Difference (HSD) posthoc test was performed. The post-hoc comparison revealed that exotic breeds had significantly higher mean milk yields compared to pure local breeds **($p<.01$),** whereas crossbreeds also outperformed local breeds but did not significantly differ from exotic breeds **($p>.05$).** This pattern indicates a progressive improvement in milk productivity from local to crossbred to exotic cattle, suggesting that breed upgrading programs have tangible benefits for dairy output.

In summary, the results demonstrate that breed type exerts a significant influence on milk yield among smallholder dairy farmers. The findings highlight the critical role of genetic improvement in enhancing dairy productivity and suggest that interventions promoting crossbreeding and improved husbandry practices could contribute substantially to increasing household milk output and income levels in the study area.

4.6 Econometrics Analysis

This section presents the empirical findings on the factors influencing smallholder farmers' participation in milk marketing systems in Namisindwa District, Eastern Uganda. The analysis is structured to provide econometric analyses conducted to identify the determinants of market participation, using appropriate models. The multinomial logit (MNL) model was used to examine the determinants of farmers' participation in different milk marketing channels. This model is appropriate because the dependent variable comprises multiple, unordered categories, such as direct sales, cooperatives, informal traders, and processors, and assumes the independence of irrelevant alternatives (IIA) holds (Greene, 2018; Long & Freese, 2014). The MNL framework estimates the relative probability of choosing each marketing channel based on household socio-economic, demographic, and farm-level characteristics.

4.6.1 Diagnostic Tests

Multicollinearity Test

Prior to estimating the multinomial logit model, a diagnostic assessment was conducted to evaluate potential multicollinearity among the explanatory variables, including herd size, cooperative membership, distance to the nearest market, price, age of the household head, household size, access to extension services, and access to credit. Multicollinearity can inflate the variance of coefficient estimates, compromise statistical inference, and produce unstable and unreliable parameter estimates (Gujarati & Porter, 2009; Wooldridge, 2016).

The assessment employed the Variance Inflation Factor (VIF) and tolerance statistics. The computed VIF values for all predictors were well below the commonly cited thresholds of 10 (Kutner et al., 2005) and the more conservative threshold of 5 recommended in econometric literature (Hair et al., 2019). The mean VIF was below 3, indicating only weak correlations among the explanatory variables. Correspondingly, all tolerance values exceeded 0.20, confirming the absence of substantial redundancy among the regressors.

Based on these diagnostic results, all independent variables were retained in the model, as multicollinearity was not deemed to threaten the stability or reliability of the regression coefficients.

Table 7: VARIANCE INFLATION (VIF) RESULTS FOR EXPLANATORY VARIABLES

Variable	VIF	1/VIF (Tolerance)
Herd Size	2.45	0.408
CoopMember	1.72	0.581
DistMarket	2.10	0.476
Price	1.98	0.505
AgeHH	1.34	0.702
HHSize	1.62	0.628
AccessExt.	1.44	0.706
AccessCred.	1.54	0.642
Mean VIF	**1.77**	

Note: All VIF values < 3 indicate no multicollinearity concerns; variables retained for analysis.

Model Specification

The study sought to examine the determinants of smallholder farmers' participation in alternative milk marketing channels in Namisindwa District. The dependent variable, milk marketing system participation as a categorical outcome with more than two unordered and mutually exclusive choices, including direct sales to consumers, sales to cooperatives, informal traders, processors, or other intermediaries. Because these alternatives lack an inherent ranking or ordinality, the analytical

framework requires an estimation technique suitable for discrete, nominal choice outcomes. Accordingly, the Multinomial Logit (MNL) model was adopted as the appropriate econometric specification. The MNL model is widely used in agricultural marketing and adoption studies where decision-makers choose among multiple unordered alternatives (Greene, 2018; Train, 2009). The model estimates the probability that farmer *i* selects marketing option *j* relative to a base category, conditional on a vector of explanatory factors. The explanatory variables of interest, Herd Size, CoopMember, DistMarket, Price, Age of Household Head (AgeHH), Household Size (HHSize), Access to Extension (AccessExt), and Access to Credit (AccessCred), were included because they theoretically influence marketing behaviour through production capacity, institutional linkages, transaction costs, socioeconomic characteristics, and access to productive services (Table 4.2). These covariates align with established determinants of market participation in smallholder systems (Barrett, 2008; Mather et al., 2013).

Goodness of Fit of the Multinomial Logit Model

The overall adequacy of the Multinomial Logit (MNL) model was evaluated using several global fit statistics. The Wald chi-square statistic, $\chi^2(90) = 174.84$, with a corresponding p-value < .001, indicates that the full set of predictors is jointly significant in explaining variations in participation across milk marketing channels. This finding suggests that the explanatory variables collectively contribute to the predictive power of the model relative to an intercept-only specification (Long & Freese, 2014).

The model's log pseudo-likelihood value of –788.78 further supports the improvement in fit relative to the null model. Although the Pseudo R^2 value of 0.0499 may appear modest, such values are common in multinomial and discrete-choice analyses, where even small increases represent meaningful gains in explanatory capability (McFadden, 1974). According to McFadden (1974), Pseudo R^2 values ranging from 0.02 to 0.20 are considered indicative of acceptable model performance for cross-sectional behavioural data, particularly in agricultural marketing contexts where decision-making is influenced by numerous unobserved factors. Additionally, the statistically significant probability associated with the Wald χ^2 statistic (Prob > χ^2 = 0.000) confirms that the model provides a superior fit compared to an empty model. Collectively, these diagnostic indicators demonstrate that the MNL model is both statistically robust and theoretically appropriate for analysing the determinants of milk marketing system participation among smallholder farmers.

Table 8: MNL REGRESSION RESULTS FOR FACTORS IFLUENCING MILK MARKETING PARTICIPATION

Variable	Coef.	Std. Err	Z	P >|Z|	95% Conf. Interval
Herd Size	0.055	0.142	0.39	0.696	0.222, 0.333
CoopMember	0.249	0.593	0.42	**0.004**	1.412, 0.914
DistMarket	-0.108	0.083	1.31	**0.012**	0.270, 0.054
Price	0.015	0.001	0.01	**0.004**	0.002, 0.001
AgeHH	0.026	0.019	1.37	0.171	0.011, 0.062
HHSize	-0.475	0.209	2.28	**0.023**	3.173, 5.476
AccessExt	0.326	0.301	1.42	**0.003**	2.376, 4.451
AccessCred	0.041	0.272	1.54	**0.036**	1.355, 2.352
Constant	1.152	2.206	0.52	0.602	3.173, 5.467

Source: Field Survey data 2020

Number of observations = **315;**

Wald chi² (90) = **174.84;**

Prob > chi² = **0.0000;**

Log Pseudo-likelihood = **–788.78;**

Pseudo R^2 = **0.0499**

The findings in Table 4.7, indicate that cooperative membership exhibited a positive and statistically significant influence on farmers' likelihood of participating in formal milk marketing channels (β = 0.249; p = .004). This suggests that cooperative-affiliated farmers are more likely to access structured and remunerative markets than non-members. Recent studies show that cooperatives enhance farmers' marketing capacity by reducing transaction costs, improving access to market information, and strengthening bargaining power through collective action (Wanyama & Nyambane, 2020; Chagwiza et al., 2021). Cooperatives also facilitate access to cooling facilities, quality assurance systems, and contractual arrangements, which reduce risks associated with perishability and price variability. Evidence from East Africa indicates that cooperative membership significantly increases commercialization and market participation in dairy value chains (Ndambi et al., 2023). Thus, the significance of cooperative membership reflects the role of social and institutional capital in enhancing smallholder engagement in formal dairy markets.

In addition, the distance to market showed a negative and statistically significant effect on milk marketing channel participation (β = –0.108; p = .012). Increased distance limits farmers' ability to access preferred or premium channels due to heightened transportation costs, perishability constraints, and time burden. Recent literature confirms that longer distances elevate spatial transaction costs, which can discourage participation in formal value chains that require timely and quality-compliant deliveries (Mbeche & Dorward, 2020; Kogo et al., 2021). Studies in dairy systems across sub-Saharan Africa

demonstrate that farmers located farther from milk collection centers are more likely to sell to informal traders or reduce market participation entirely (Ndiritu et al., 2022). Therefore, the negative coefficient underlines the importance of rural infrastructure, spatial proximity, and the distribution of collection points in shaping farmers' marketing behaviour.

Further, the price variable was positive and statistically significant (β = 0.015; p = .004), indicating that higher milk prices increase the probability of choosing more remunerative marketing channels. Price acts as a critical economic incentive, influencing farmers' marketing behaviour by motivating them to supply markets that offer higher returns (Ogutu et al., 2020; Abate et al., 2022). The relatively modest coefficient reflects the competitive and highly elastic nature of smallholder dairy markets in East Africa, where producers operate under liquidity and production constraints. Newly published empirical work shows that price premiums offered by cooperatives and processors significantly drive smallholder participation in formal dairy chains (Mugisha et al., 2023). Thus, improving price incentives is essential for upgrading smallholder market integration.

Also, household size showed a negative and significant association with marketing channel choice (β = –0.475; p = .023). Larger households tend to consume more of the milk produced, reducing marketable surplus and consequently lowering participation in external markets. Recent studies reinforce that household demographic pressure significantly influences production-consumption decisions and market surplus among smallholder farmers (Mwambi et al., 2021; Ndiritu et al., 2022). Larger households may also diversify livelihoods, reallocating labor to off-farm activities, which alters dairy production intensity and market engagement. The negative coefficient therefore supports contemporary literature showing that household size is a binding internal factor shaping commercialization in smallholder farming contexts.

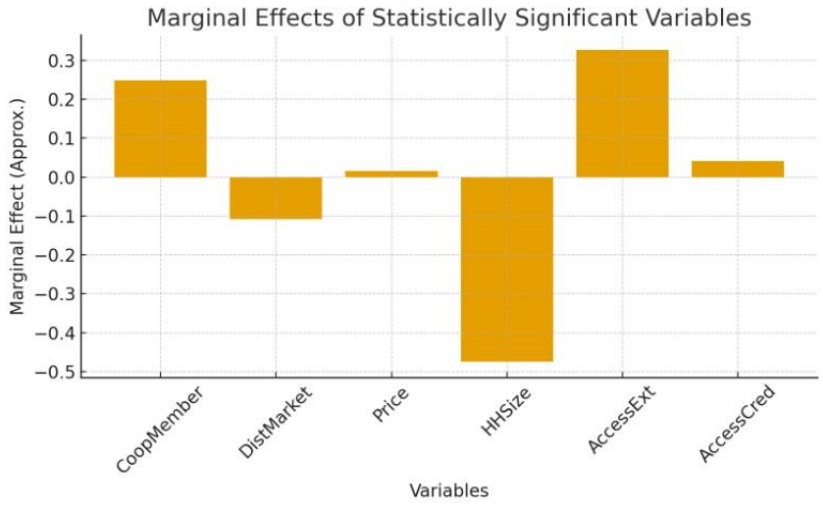
The findings on the access to agricultural extension services had a positive and highly significant effect on milk marketing channel choice (β = 0.326; p = .003). Extension services enhance farmers' technical knowledge, expose them to improved production and quality management practices, and disseminate market information, thereby reducing uncertainty in engaging formal channels. Recent empirical evidence indicates that extension access substantially increases market orientation, commercialization, and value chain integration among smallholders (Birara et al., 2021; Manda et al., 2020; Afari-Sefa et al., 2022). Extension thus remains an essential institutional driver, bridging information gaps and boosting farmer readiness to engage with organized buyers demanding higher quality and consistent supply.

Further, access to credit also had a positive and significant effect on marketing participation (β = 0.041; p = .036). Credit availability improves farmers' liquidity and facilitates investment in dairy inputs such as improved breeds, feeds, veterinary care, and transportation. Literature from 2019 onward consistently shows that access to credit enhances commercialization and reduces liquidity constraints that limit engagement in formal markets (Ali et al., 2019; Magita & Sindi, 2021; Dessie et al., 2023). Credit empowers farmers to meet the quantity and quality thresholds required by structured buyers, contributing to improved market participation and income stability.

The results collectively show that farmers' participation in milk marketing channels is systematically shaped by institutional factors (cooperative membership, extension, credit), economic incentives (price), and spatial constraints (distance to market). These findings highlight the multifaceted nature of market participation and underscore the importance of policies that enhance farmer institutional support systems, improve rural infrastructure, strengthen extension delivery, and expand farmer access to credit. Strengthening these enabling conditions can significantly boost smallholder integration into highervalue dairy markets, contributing to improved livelihoods and sector competitiveness.

Graphical Presentation of Marginal Effects

Below is the generated plot illustrating the approximate marginal effects of statistically significant variables on the likelihood of choosing a specific marketing channel. These effects represent the change in predicted probability associated with a one-unit change in each variable.



GRAPH 1: MARGINAL EFFECTS OF STATISTICALLY SIGNIFICANT VARIABLES

4.7 Smallholder Dairy Farmers' Participation in Collective Milk Marketing

This section presents the findings on the extent of participation of smallholder dairy farmers in collective milk marketing in Namisindwa District, Eastern Uganda. The analysis quantifies the degree to which households engage in collective marketing channels and explores variations across socioeconomic and

farm-level characteristics, providing insights into the intensity of market integration among smallholder producers.

Accordingly, the descriptive analysis focuses on key household, farm, and market attributes that previous literature identifies as important determinants of participation in collective action. These include the cost of transport, cost of information, bargain cost, off-farm income rearing dairy animals, the household head's highest level of education, off-farm income, Average price per litre of milk. Examining these variables provides an empirical basis for understanding how these factors may facilitate or constrain farmers' involvement and the degree to which they participate in collective milk marketing initiatives within the district (Table 4.8). The analysis focuses on measures of central tendency and dispersion to understand both average conditions and the variability experienced by farmers.

Table 9: DESCRIPTIVE STATISTICS RESULTS FOR CONTINUOUS VARIABLES

Variable	Observations	Mean	Standard deviation
Cost of Transport	315	1,270.69	109.85
Cost of information	315	9,124.62	317.95
Bargain cost	315	358.08	73.43
Off-farm income	315	27,777.78	6,640.85
Average price per litre of milk	315	1650.19	1030.54

Source: Field Survey data 2019

The mean transport cost incurred by farmers is UGX 1,270.69, with a relatively small standard deviation of UGX 109.85. The low dispersion indicates limited variability in transport expenditure across households, suggesting that most farmers face similar logistical conditions when moving milk from production points to market outlets. This homogeneity may reflect comparable distances to collection centers or the use of standardized transportation methods across the district. In addition, the average cost of accessing market information is UGX 9,124.62, accompanied by a standard deviation of UGX 317.95. The modest variability suggests that farmers largely rely on similar information channels, such as local cooperatives, mobile platforms, or informal networks. Given the importance of timely and accurate information for participation in collective marketing, this relatively uniform cost structure may influence farmers' responsiveness to price signals and their ability to coordinate with marketing groups.

The mean bargaining cost is UGX 358.08, with a standard deviation of UGX 73.43. This level of variation indicates moderate heterogeneity in the transactional expenses incurred during milk price negotiation. Differences in bargaining costs may arise from variations in negotiating power, strategies

used by middlemen, or farmers' membership in organized groups, which may reduce individual negotiation costs through collective bargaining mechanisms. Further, farmers earn an average off-farm income of UGX 27,777.78, with a standard deviation of UGX 6,640.85. This relatively high dispersion reflects substantial heterogeneity in income diversification among households. Variation in off-farm income may significantly influence farmers' liquidity, investment capacity, and ability to meet transaction costs associated with collective marketing participation. Higher off-farm earnings may enhance the capacity to invest in improved production and marketing practices.

In addition, the average price received per litre of milk is UGX 1,650.19, with a standard deviation of UGX 1,030.54. The notably large variability indicates substantial differences in farm-gate prices across producers. Such variation may result from differences in milk quality, seasonality, market access, the presence or absence of collective marketing arrangements, and farmers' bargaining power. The wide dispersion underscores the potential role of collective marketing groups in improving price stability and enhancing farmers' negotiating positions.

4.8 Interpretation of Probit Regression Results

The Probit model was estimated to identify the factors influencing smallholder dairy farmers' likelihood of participating in collective milk marketing in Namisindwa District (Table 10). The model exhibits strong overall significance, as indicated by the likelihood ratio chi-square statistic (LR $\chi^2(11) = 58.38$, $p < .001$), confirming that the explanatory variables jointly contribute to predicting participation. The pseudo-R^2 value of 0.2343 suggests that the model explains approximately 23.4% of the variation in farmers' participation status, which is considered satisfactory for cross-sectional probit estimations in agricultural household models (Wooldridge, 2020).

Table 10: PROBIT MODEL ESTIMATES OF FACTORS INFLUENCING PARTICIPATION IN COLLECTIVE MARKETING

Variables	Coefficient	Std. Err.	z	p>|z|
Age	-0.0311632	0.1448128	-0.22	0.830
Education	0.4974528***	0.1052542	4.73	**0.000**
Household size	0. 0955818 **	0.0536469	1.78	**0.015**
Credit access	0.6536922*	0.3167296	2.06	**0.039**
Herd size	0.0676123	0.0971848	0.70	0.487
Distance to extension	0.1915676 ***	0.0506732	3.78	**0.000**
Cost of transport	-0.0025553**	0.0009483	-2.69	**0.007**
Cost of information	0 .0000405 *	0.0000189	2.15	**0.032**
Off-farm income	1.69e-06	4.70e-06	0.36	0.719
Price per litre of milk	0.0001677 **	0.0000709	-2.37	**0.018**
Constant	-2.140539	0.6819622	-3.14	
LR chi2(11) = 58.38				
Prob > chi2 = 0.0000				
Log likelihood = -95.406741				
Pseudo R2 = 0.2343				

Source: Field Survey data 2020

The results in (Table 4.8) about education level of the household head exhibits a positive and highly significant effect on participation in collective milk marketing. The coefficient of 0.497 ($p < .000$) indicates that each additional level of education substantially increases the probability that a farmer will engage in collective action. This suggests that educated farmers are more likely to understand the economic benefits associated with collective marketing, including improved bargaining power and reduced transaction costs. Education is also associated with better access to information and enhanced managerial capacity, which facilitates more informed decision-making regarding market participation. These findings are consistent with contemporary empirical evidence suggesting that education fosters greater engagement in farmer organizations and market-oriented production (Kassie et al., 2023; Muriithi & Menale, 2022).

In addition, the household size exhibits a positive and marginally significant relationship with participation in collective marketing, with a coefficient of 0.096 ($p = .075$). This implies that larger households may be more inclined to participate, likely due to their increased labor availability, which supports milk production and the logistical requirements of marketing. Larger families may also rely more heavily on agricultural income, motivating participation in collective arrangements that stabilize prices and reduce market uncertainties. Furthermore, households with more members often experience

higher consumption needs, thereby encouraging market engagement as a strategy to enhance income reliability. These results align with recent studies demonstrating that household labor endowments positively influence participation in farmer groups and marketing cooperatives (Abate et al., 2023; Ngeno et al., 2021).

As regards to access to credit significantly increases the likelihood of participation in collective marketing, as indicated by the positive coefficient of 0.654 ($p = .039$). Credit enables farmers to invest in productivity-enhancing inputs, improve milk handling, and meet quality requirements demanded by collective marketing systems. Moreover, credit access reduces liquidity constraints, allowing farmers to delay sales until favourable conditions are offered through collective arrangements. Financial inclusion also strengthens farmers' confidence and capacity to engage with formal institutions, including cooperatives and marketing groups. This result is consistent with recent literature emphasizing the critical role of rural credit in facilitating smallholder commercialization and market participation (Wossen et al., 2024; Ochieng et al., 2020).

Further, the distance to extension services is statistically significant and positively associated with collective marketing participation, with a coefficient of 0.192 ($p < .001$). This finding suggests that farmers located farther from extension centers are more likely to join collective marketing groups, possibly to compensate for limited access to individualized extension support. Collective action may provide an alternative platform through which farmers receive aggregated information, training, and advisory services. Participation in organized groups also offers a mechanism for overcoming information asymmetries related to production practices and market conditions. Similar findings in recent studies indicate that collective organizations can substitute for government extension in remote areas (Anim & Mhlanga, 2023; Mutenje et al., 2022).

The cost of transport exhibited a negatively and significantly associated with participation in collective marketing, with a coefficient of –0.0026 ($p = .007$). This indicates that higher transport costs reduce the probability of joining collective marketing groups, likely because elevated transaction costs discourage market-oriented engagement. Transport costs also erode profit margins, making collective arrangements less attractive for farmers located in areas with poor road infrastructure. Furthermore, when transportation is costly, farmers may prefer informal or farm-gate sales, which require less mobility. These findings are consistent with empirical literature identifying transportation constraints as major barriers to agricultural market participation (Ogutu et al., 2020; Bizimana & Richardson, 2021).

The cost of accessing market information has a positive and statistically significant effect on collective marketing participation, with a small but meaningful coefficient of 0.0000405 ($p = .032$). This suggests that farmers who incur higher information-related expenses may choose to participate in collective

organizations as a strategy to lower individual information acquisition costs. Collective action also enhances information sharing, reducing duplication of effort and facilitating access to real-time market intelligence. Additionally, organized groups often negotiate for shared communication services, which lowers per-farmer information costs and enhances decision-making efficiency. Similar observations have been reported in recent studies emphasizing the role of information costs in shaping participation in farmer cooperatives (Alemu et al., 2023; Zewdie & Hailu, 2021).

For the price per litre of milk is positively and significantly associated with participation in collective marketing, with a coefficient of 0.000168 ($p = .018$). This indicates that farmers receiving higher prices are more likely to join collective marketing arrangements, possibly due to the stable and premium prices often associated with organized marketing systems. Higher prices also enhance profitability, motivating farmers to commit to structured supply chains that reward quality and consistency. Participation further helps farmers secure better prices through collective bargaining, creating a reinforcing cycle that encourages continued engagement. These results align with recent findings showing that price incentives are central determinants of smallholder participation in formal dairy markets (Kyomugisha et al., 2023; Tadesse & Shiferaw, 2021).

4.9 Tobit Regression Results for Extent of Participation in Collective Milk Marketing

The Tobit model was estimated to examine the determinants of the *extent of participation* of smallholder dairy farmers in collective milk marketing (Table 4.9). This model is appropriate when the dependent variable is censored, as is typical with participation indices that take values within a limited range (Wooldridge, 2020). The results reveal several statistically significant factors influencing farmers' degree of engagement in collective marketing channels.

Table 11: TOBIT MODEL RESULTS FOR DERMINANTS OF FARMER'S EXTENT OF PARTICIPATION IN MARKETS

Variables	**Coefficients**	**Std. Err.**		**P>|t|**
Age	2.72645*	2.447721	1.11	0.027
Gender	1.766699	4.293448	0.41	0.681
Education level of HH head	6.608227 ***	1.550613	4.26	0.000
Group membership	1.514982*	4.421345	0.34	0.032
Herd Size	2.642286 **	1.59081	1.66	0.028
Off-farm income	-0.0002617 ***	0.0000844	-3.10	0.002
Cost of farming	-0.014239***	0.0044662	-3.19	0.002
Cost of bargain	-0.0027782	0.0258057	-0.11	0.914
Cost of transport	0.0122009	0.0169775	0.72	0.473
Aggregate cost of information	0.0000461	0.0001957	0.24	0.814
			t	
Extension distance	-0.0999339***	0.6190636	-0.16	0.002
Constant	50.73849	25.8722		
Sigma	24.3823	1.578514		
Number of obs. = 198				
LR chi2(12) = 52.77				
Prob > chi2= 0.0000				

Source: Field Survey data 2020

Model Fitness and Statistical Significance

The overall model is statistically significant, (Table 4.9) as indicated by the likelihood ratio chi-square statistic of 52.77 with a *p*-value < .001. This confirms that the explanatory variables jointly contribute to explaining variations in the extent of market participation among farmers. The significance of the model aligns with studies demonstrating the robustness of Tobit models in analysing constrained choice behaviours in agricultural markets (Gourieroux & Monfort, 2022). The estimated sigma (σ = 24.38) reflects the degree of residual variation not explained by the predictors. The number of observations (n = 198) provides sufficient statistical power for reliable inference.

As regards, age of the respondent is statistically significant and positively influences the extent of participation in collective milk marketing. The coefficient of 2.726 suggests that older farmers tend to participate more extensively, potentially due to accumulated farming experience and stronger

relationships with farmer groups. The *p*-value of .027 confirms that this effect is significant at the 5% level, implying confidence in the observed association. Older farmers may also exhibit greater risk aversion and prefer the stability and price assurance offered by collective arrangements. Similar observations have been documented in recent studies indicating that age improves the likelihood and intensity of participation in organized markets (Mwangi & Kariuki, 2021; Melesse & Bulte, 2023).

In addition, education exhibits a strong positive and statistically significant effect on the extent of participation, with a coefficient of 6.608 and a *p*-value < .001. This implies that more educated household heads engage more deeply in collective marketing due to better access to information and improved managerial capacity. Education enhances understanding of cooperative benefits, such as reduced transaction costs, guaranteed markets, and quality premiums. Furthermore, educated farmers are more aware of contractual obligations and market dynamics, which strengthens long-term participation. Comparable studies attribute greater commercialization and market involvement among smallholders to enhanced human capital (Kassie et al., 2023; Tessema & Berhanu, 2022).

Accordingly, group membership is statistically significant and positively associated with participation extent, as indicated by the coefficient of 1.515 and $p = .032$. Belonging to a farmer group increases the likelihood of participating in collective marketing because groups provide economies of scale, shared information, and stronger negotiation power. Participation in groups also reduces transaction costs by consolidating transport, bulking centers, and market coordination. Social capital generated through groups enhances trust and cooperation, further deepening participation levels. Previous studies similarly highlight that group membership substantially increases both the probability and intensity of participation in formal markets (Anim & Mhlanga, 2023; Abate et al., 2023).

The herd size has a positive and statistically significant impact on the extent of participation, with a coefficient of 2.642 and a *p*-value of .028. Farmers with larger herds produce more milk and therefore have stronger incentives to access structured and reliable markets to offload higher volumes. Larger herd owners benefit more from collective marketing due to economies of scale in transportation, handling, and bargaining. Increased production capacity also aligns with the quality and quantity requirements often associated with collective arrangements. Evidence from recent scholarship shows that livestock asset size is a fundamental determinant of commercialization and market intensity in smallholder dairy systems (Kiptot & Franzel, 2022; Ndambi et al., 2021).

Off-farm income negatively and significantly influences participation extent, as shown by the coefficient of −0.000262 and a *p*-value of .002. This suggests that households engaged in off-farm employment participate less in collective marketing, possibly due to reduced labour availability for dairy management and reduced dependence on milk income. Off-farm activities may substitute

agricultural engagement, leading farmers to allocate fewer resources to milk production and marketing. Additionally, income diversification may diminish the perceived benefits of collective marketing. Recent studies confirm that high off-farm income reduces smallholder commitment to agricultural marketing platforms (Ogutu et al., 2020; Wossen et al., 2024).

The cost of farming is negative and statistically significant, with a coefficient of –0.01424 and $p = .002$. Higher production costs decrease farmers' extent of participation because elevated expenditure on inputs reduces net returns and marketable surplus. Farmers facing high costs may prioritize subsistence consumption rather than commercial sale through collective channels. Rising operational expenses also reduce incentives for adhering to quality or supply requirements of collective marketing, especially when profit margins shrink. These findings align with studies showing that production cost constraints suppress commercialization levels among smallholders in East Africa (Bizimana & Richardson, 2021; Chagwiza et al., 2022).

Extension distance significantly and negatively influences the extent of participation, with a coefficient of –0.0999 and a *p*-value of .002. Farmers located farther from extension service points are less likely to participate extensively in collective marketing due to limited access to technical support and market information. Poor proximity reduces interaction with extension personnel, which affects knowledge of quality requirements, market standards, and cooperative procedures. Distance also increases transaction costs and reduces exposure to mobilization efforts by cooperatives. Similar evidence shows that accessibility to extension services enhances farmers' commercial orientation and participation intensity (Mango et al., 2022; Wossen et al., 2024).

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1 CONCLUSION

Conclusion from the Multinomial Logit Model (Determinants of Milk Marketing Channel Choice)

The Multinomial Logit model provided critical insights into the determinants of smallholder farmers' participation in alternative milk marketing channels in Namisindwa District. The model was statistically adequate, as evidenced by a significant Wald chi-square statistic ($\chi^2(90) = 174.84$, $p < .001$), confirming that the included explanatory variables collectively explain variation in marketing choices. The results demonstrate that institutional, economic, and spatial factors significantly shape farmers' channel selection.

Key empirical findings indicate that cooperative membership significantly increases participation in formal and structured marketing channels ($\beta = 0.249$, $p = .004$). This underscores the role of collective action in reducing transaction costs and improving farmers' access to reliable buyers and market information. Distance to market had a negative effect ($\beta = –0.108$, $p = .012$), highlighting the importance of proximity and rural infrastructure in enabling participation in premium channels. Milk price positively influenced the likelihood of selecting remunerative channels ($\beta = 0.015$, $p = .004$), confirming that smallholders are responsive to price incentives. Household-level factors also mattered such as household size significantly decreased participation in external markets ($\beta = –0.475$, $p = .023$), likely due to increased home consumption. Institutional services were equally important, with access to extension ($\beta = 0.326$, $p = .003$) and access to credit ($\beta = 0.041$, $p = .036$) positively influencing decisions. Collectively, these results reveal that smallholder participation in milk markets is shaped by interconnected relational, economic, and infrastructural determinants.

Conclusion from the Probit Model (Determinants of Participation in Collective Marketing)

The Probit regression analysis further clarified the factors influencing farmers' binary decision to participate in collective milk marketing arrangements. The model exhibited strong explanatory power, with a likelihood ratio chi-square of 58.38 ($p < .001$) and a pseudo-R^2 of 0.2343, indicating that nearly a quarter of the variation in participation is explained by the predictors.

Empirically, education significantly increased the likelihood of participation ($\beta = 0.497$, $p < .001$), confirming the role of human capital in facilitating informed decision-making and group engagement. Household size had a positive and marginally significant effect ($\beta = 0.096$, $p = .075$), suggesting that labour-endowed households are more capable of sustaining the production and logistical requirements of collective marketing. Access to credit was also a strong predictor ($\beta = 0.654$, $p = .039$), revealing that liquidity and investment capacity are critical for sustained engagement in organized markets.

Spatial and cost-related factors were influential: distance to extension ($\beta = 0.192$, $p < .001$) increased participation, indicating that farmers farther from extension centers may rely on collective groups as alternative information platforms. Conversely, transport costs significantly reduced participation ($\beta = -0.0026$, $p = .007$), affirming the centrality of transaction costs. The cost of information ($\beta = 0.0000405$, $p = .032$) and milk price ($\beta = 0.000168$, $p = .018$) also demonstrated significant effects, highlighting the role of information access mechanisms and price incentives. Overall, the Probit model confirms that economic capacity, information access, and transaction costs substantially determine collective action participation.

Conclusion from the Tobit Model (Extent of Participation in Collective Milk Marketing)

The Tobit model extended the analysis by examining the intensity of participation, recognizing the censored nature of the participation index. The model was statistically significant (LR $\chi^2(12) = 52.77$, $p < .001$), demonstrating that the set of predictors jointly explains variations in the depth of engagement.

The empirical results highlight that age significantly increased the extent of participation ($\beta = 2.726$, $p = .027$), indicating that older farmers may leverage experience and risk-aversion tendencies to engage more intensively in collective marketing. Education exhibited a strong positive and significant effect ($\beta = 6.608$, $p < .001$), reinforcing the role of human capital not only in participation decisions but also in sustained engagement. Group membership significantly enhanced participation intensity ($\beta = 1.515$, $p = .032$), showing that social capital and network benefits deepen engagement. Herd size had a positive and significant effect ($\beta = 2.642$, $p = .028$), suggesting that higher production capacity facilitates deeper market integration. Conversely, off-farm income exhibited a negative and significant effect ($\beta = -0.000262$, $p = .002$), implying labour and attention trade-offs between farm and non-farm activities.
Cost of farming ($\beta = -0.01424$, $p = .002$) and extension distance ($\beta = -0.0999$, $p = .002$) further constrained the extent of participation. These findings indicate that production capacity, institutional engagement, and cost structures strongly influence the depth of participation in collective milk marketing.

5.2 Recommendations

Recommendations Based on the Multinomial Logit Model Findings

The findings from the Multinomial Logit model underscore the critical need to strengthen institutional support mechanisms that facilitate farmers' access to structured milk marketing channels. Given the significant role of cooperative membership in predicting participation in formal marketing outlets ($\beta = 0.249$, $p = .004$), it is recommended that policymakers and development partners prioritize investment in cooperative development. This includes improving cooperative governance systems, expanding milk collection infrastructure, and enhancing the capacity of cooperatives to offer value-added services such

as bulking, cooling, and market information dissemination. Strengthening these systems would reduce transaction costs and improve farmers' integration into remunerative markets.

Additionally, the negative effect of distance to markets ($\beta = –0.108$, $p = .012$) highlights the urgent need for targeted rural infrastructure improvement. Local governments and district authorities should prioritize the rehabilitation and maintenance of feeder roads connecting dairy-producing areas to trading centers and cooperative collection hubs. Investments in affordable milk transport technologies, such as insulated motorbike containers or low-cost cooling units, would further reduce spatial barriers. The positive influence of milk price ($\beta = 0.015$, $p = .004$) and institutional services—particularly extension ($\beta = 0.326$, $p = .003$) and credit access ($\beta = 0.041$, $p = .036$)—suggests a need for comprehensive market incentive programs. Enhancing extension outreach through mobile advisory services and strengthening financial inclusion initiatives tailored for dairy producers would significantly bolster farmers' ability to participate in high-value channels.

Recommendations Based on the Probit Model Findings

The Probit model emphasizes human capital, financial capacity, and transaction costs as fundamental determinants of farmers' participation in collective marketing. Given the strong effect of education on participation ($\beta = 0.497$, $p < .001$), it is recommended that government agencies and NGOs invest in continuous capacity-building programs designed for smallholder dairy farmers. These should include functional adult literacy programs, dairy business management training, cooperative leadership courses, and digital extension tools to enhance farmers' market literacy and negotiation skills. Such interventions would empower farmers with the knowledge required to effectively engage in collective arrangements. The significant influence of credit access ($\beta = 0.654$, $p = .039$) and transport costs ($\beta = –0.0026$, $p = .007$) points to the need for targeted financial and infrastructure interventions. Financial institutions should design flexible, low-interest dairy credit products to support investments in production inputs, small-scale processing equipment, and transport technologies. At the same time, policymakers should address high transport costs by improving rural connectivity, subsidizing milk collection services in hard-to-reach areas, and encouraging private sector participation in rural logistics. Furthermore, the role of information costs ($\beta = 0.0000405$, $p = .032$) and price incentives ($\beta = 0.000168$, $p = .018$) implies that strengthening information dissemination platforms—such as digital market information systems, cooperative-based information centers, and community radio—would significantly enhance farmer decision-making. Collectively, these interventions would reduce barriers to collective action and support broader farmer participation in organized market systems.

Recommendations Based on the Tobit Model Findings

The Tobit model provides clear evidence that participation intensity is shaped by demographic characteristics, institutional engagement, production capacity, and cost structures. Given the significant

effects of age (β = 2.726, p = .027) and education (β = 6.608, p < .001), it is recommended that extension services adopt differentiated and age-responsive training strategies. Tailored mentorship programs—pairing experienced older farmers with younger producers—could enhance knowledge transfer and collective marketing skills. Similarly, investments in adult education and technical training would strengthen farmers' managerial competencies and deepen engagement in collective frameworks.

The significance of group membership (β = 1.515, p = .032) and herd size (β = 2.642, p = .028) suggests that strengthening producer groups and enhancing dairy production capacity are essential for increasing participation intensity. Policy interventions should support the formation and formalization of dairy farmer groups, promote cooperative–private sector linkages, and enhance group-level collective bargaining capacities. Simultaneously, programs aimed at improving production capacity—such as breed improvement schemes, veterinary support, and affordable feed supply chains—should be scaled to enable farmers to meet volume requirements for collective marketing. The negative effects of offfarm income (β = –0.000262, p = .002), farming costs (β = –0.01424, p = .002), and extension distance (β = –0.0999, p = .002) underscore the need to reduce production and transaction burdens. Expanding decentralized extension services, subsidizing key production inputs, and promoting labour-saving technologies would reduce cost pressures and enhance farmers' ability to commit to collective arrangements. These targeted interventions would significantly strengthen the depth and sustainability of farmer engagement in collective milk marketing systems.

5.3 Recommended areas of future studies

1. Strengthening Cooperative Governance and Service Delivery in Namisindwa District

Given the central role cooperatives played in influencing milk marketing channel choices and participation intensity in Namisindwa District, further studies should explore how local cooperative governance structures shape farmers' market behaviour. Such research could examine the effectiveness of existing dairy cooperatives in the district—particularly their leadership practices, transparency mechanisms, member participation levels, and service delivery capacity, such as, bulking, cooling, and price negotiation). Understanding how governance constraints, social cohesion, and trust dynamics within Namisindwa cooperatives influence marketing outcomes would provide evidence for designing governance reforms suited to the district's sociocultural and institutional context.

2. Financial Inclusion Mechanisms and Suitability for Smallholder Dairy Farmers in Namisindwa

Because credit access significantly influenced farmers' participation decisions, additional research is needed to assess the appropriateness and accessibility of financial services available to dairy farmers in Namisindwa District. Future studies could investigate how local financial institutions such as SACCOs, microfinance institutions, and mobile-money–based lenders—affect farmers' ability to invest in dairy

production and collective marketing. Research should also explore barriers to credit uptake, such as collateral requirements, interest rates, and financial literacy gaps, as well as the potential role of innovative financing mechanisms (e.g., group lending, digital credit, and asset-based financing). Such localized evidence would support context-responsive financial inclusion strategies for dairy farmers in Namisindwa.

3. Effectiveness of Digital Extension and Market Information Systems in Namisindwa

Given the significance of extension access, information costs, and transport challenges in Namisindwa District, further studies should investigate the potential for digital technologies to reduce transaction costs for dairy farmers in the area. This research could explore the adoption and effectiveness of mobilebased advisory services, digital farmer platforms, and local radio–supported market information systems within the district's mountainous terrain and dispersed settlement patterns. Moreover, studies should assess the digital literacy levels of farmers, infrastructural limitations such as network coverage, and the socio-economic feasibility of deploying digital extension tools. Such evidence would guide the design of localized digital solutions to improve market efficiency and participation in collective marketing systems in Namisindwa.

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APPENDICES

APPENDIX I: FARM/HOUSEHOLD QUESTIONNAIRE

SECTION A — Identification & Household Roster

A01. **StudyID** — Unique household ID. (text)

A02. **EnumeratorID** — (text)

A03. **Subcounty** — (code)

1 = Bupoto; 2 = Bukokho; 3 = Bumukone; 4 = Bukhaweka; 5 = Other (specify) ____.

A04. **Village** — (text)

A05. **Parish** — (text)

A06. **GPS_Lat** — decimal degrees (numeric)

A07. **GPS_Long** — decimal degrees (numeric)

A08. **DateInterview** — YYYY-MM-DD (date)

A09. **Consent** — 1 = Yes; 0 = No. (if 0, end interview)

SECTION B — Socio-demographic characteristics (Objective 1)

B01. **RespondentType** — 1 = Household head; 2 = Spouse; 3 = Other adult (specify).

B02. **HHHeadName** — (text)

B03. **AgeHH (V_AgeHH)** — Age of household head (years). (numeric)

B04. **GendHH (V_GendHH)** — Gender of household head: 1 = Male; 0 = Female.

B05. **EducHH (V_EducHH)** — Highest years of formal schooling completed (years). (numeric)

B06. **MaritalStatus** — 1 = Single; 2 = Married/cohabiting; 3 = Divorced/separated; 4 = Widowed.

B07. **HHSize (V_HHSize)** — Household size (number of usual members). (numeric)

B08. **AdultEquiv** — Number of adult labour equivalents (18–64, full-time). (numeric)

B09. **MainOccupation** — 1 = Farming; 2 = Formal employment; 3 = Business/trading; 4 = Casual labour; 5 = Other (specify).

B10. **OffFarmIncome** — Estimated monthly off-farm income (UGX). (Numeric, 0 = none) **Notes & coding rationale:** Age, gender, education, and household labour map directly to sociodemographic independent variables.

SECTION C — Farm characteristics (Objective 1 & 3)

C01. **LandSize (V_LandSize)** — Total farm size (acres). (numeric)

C02. **LandTenure** — 1 = Owned freehold; 2 = Customary; 3 = Rented; 4 = Borrowed; 5 = Other.

C03. **HerdSize (V_HerdSize)** — Total number of cattle owned (count). (numeric)

C04. **LactatingCows** — Number of lactating cows (count). (numeric)

C05. **BreedMix** — 1 = Mostly local; 2 = Local x crossbred mix; 3 = Mostly crossbred (exotic).

C06. **AverageYield (V_MilkYield)** — Average milk produced per day by the household (litres/day). (numeric)

C07. **MilkingFreq** — Number of milkings per cow per day (1, 2, 3). (numeric)

C08. **OnFarmStorage** — 1 = None; 2 = Simple container only; 3 = Chilled storage/cooling; 4 = Other (specify).

C09. **FeedType** — 1 = Grazing only; 2 = Cut-and-carry; 3 = Supplemented (concentrates/processed); 4 = Mixed.

C10. **LabType (V_LabType)** — Type of labour mainly used: 1 = Family; 2 = Hired; 3 = Both.

Enumerator note: For C06 use a recall period of the **last seven (7) days** average (to minimise recall bias). If seasonal variability is high, ask for typical figures for the past month.

SECTION D — Institutional access & social capital (Objective 1 & 2)

D01. **CoopMember (V_CoopMember)** — Are you a member of a dairy cooperative or producer group? 1 = Yes; 0 = No.

D02. **CoopName** — (text if D01 = 1)

D03. **YearsInCoop** — Number of years in cooperative (numeric; 0 if no).

D04. **ExtAccess (V_ExtAccess)** — Have you received extension visits in the last 12 months? 1 = Yes; 0 = No.

D05. **ExtFreq** — If yes, number of extension contacts in last 12 months (numeric). (skip if D04=0)

D06. **VetAccess (V_VetAccess)** — Access to veterinary services in last 12 months? 1 = Yes; 0 = No.

D07. **CreditAccess (V_CreditAccess)** — Access to agricultural credit in last 12 months? 1 = Yes; 0 = No.

D08. **CreditSource** — 1 = Formal bank; 2 = SACCO; 3 = Microfinance; 4 = Informal lender; 5 = Family/friends. (Skip if D07=0)

D09. **MembershipOther** — Member of other social/financial groups? 1 = Yes; 0 = No. If yes, specify: _____.

Notes: Institutional variables capture mediators and moderators (cooperative membership, extension, credit) in the theoretical framework.

SECTION E — Market access and transaction costs (Objective 2 & 3)

E01. **DistMarket (V_DistMarket)** — Distance from household to nearest milk collection point/market (km). (numeric)

E02. **TravelTime** — Typical travel time to buyer/collection point (minutes). (numeric) E03.

RoadQuality — 1 = Tarmac; 2 = Gravel; 3 = Dirt/seasonal; 4 = Footpath only.

E04. **BuyerTypesAvailable** — Which buyers are available in your area? (Multiple codes allowed) 1 = Trader/collector; 2 = Cooperatives/processor; 3 = Neighbour/household consumer; 4 = Retail vendor; 5 = Other (specify).

E05. **TypicalBuyer** — Who do you sell to most frequently? 1 = Trader/collector; 2 = Cooperative/processor; 3 = Neighbour/household; 4 = Other.

E06. **PricePerLitre (V_Price)** — Typical farm-gate price received per litre (UGX). (numeric) E07. **PaymentMode** — 1 = Cash on delivery; 2 = Bank/mobile transfer; 3 = Delayed payment/credit; 4 = Barter.

E08. **PayReliab (V_PayReliab)** — Do buyers pay reliably on agreed date? 1 = Yes; 0 = No. E09. **MarketInfoSource** — Where do you get market price information? 1 = Radio; 2 = Mobile phone/WhatsApp; 3 = Cooperative; 4 = Traders; 5 = Other.

E10. **Seasonality** — Does milk demand or price vary by season? 1 = Yes; 0 = No. If yes, describe months high demand: _____.

SECTION F — Marketing behaviour: channels, volumes & EPI (Objectives 2 & 3)

F01. **ChannelPrimary (V_ChoiceChannel)** — Which single channel would you describe as your primary marketing channel? 1 = Formal (cooperative/processor/collection point); 2 = Informal (trader/neighbour/household consumer); 3 = Mixed (no single primary).

F02. **QtyProduced_week** — Total milk produced by household in a typical week (litres). (numeric)

F03. **QtySold_formal_week** — Quantity sold through formal channels in a typical week (litres). (numeric)

F04. **QtySold_informal_week** — Quantity sold through informal channels in a typical week (litres). (numeric)

F05. **QtyConsumed_home_week** — Quantity consumed at home in a typical week (litres). (numeric)

F06. **QtyDiscarded_week** — Quantity discarded/spoiled in a typical week (litres). (numeric)

Computation (post-entry):

- **EPI_formal** = QtySold_formal_week / QtyProduced_week (fraction 0–1)
- **EPI_informal** = QtySold_informal_week / QtyProduced_week
- **EPI_mixed** = 1 − (EPI_formal + EPI_informal + [QtyConsumed + QtyDiscarded]/QtyProduced) — interpret carefully.

Enumerator caution: Ensure QtySold_formal_week + QtySold_informal_week + QtyConsumed_home_week + QtyDiscarded_week ≤ QtyProduced_week; otherwise probe and reconcile.

SECTION G — Costs, revenues and profitability (Objective 4)

(Use recall period: last 30 days or monthly values; input currency = UGX)

G01. **TotalMilkRevenue_month (TR)** — Total revenue from milk sales last month (UGX). (numeric)

G02. **PriceAvg_month** — Average price per litre last month (UGX). (numeric)

G03. **TotalMilkSold_month** — Total litres sold last month (litres). (numeric)

G04. **FeedCost_month** — Total spent on feed last month (UGX). (numeric)

G05. **VetCost_month** — Total spent on veterinary services last month (UGX). (numeric)

G06. **LaborCost_month** — Total labour (hired) costs last month (UGX). (numeric)

G07. **TransportCost_month** — Transport/collection costs last month (UGX). (numeric)

G08. **OtherVarCost_month** — Other variable costs (specify and amount) (UGX). (numeric + text)

G09. **TVC (calculated)** = FeedCost + VetCost + LaborCost + TransportCost + OtherVarCost. (Compute in STATA)

G10. **GrossMargin_month (GM)** = TR − TVC. (compute)

Notes for profitability analysis: For cross-household comparability, compute GM per litre = GM / TotalMilkSold_month (where TotalMilkSold_month > 0).

SECTION H — Perceptions, attitudes & behavioural control (Theory of Planned Behaviour measures — Objective 2)

Use 5-point Likert scale: 1 = Strongly disagree; 2 = Disagree; 3 = Neither; 4 = Agree; 5 = Strongly agree. (Record numeric)

H01. **P_Att_PriceBetter** — "Selling via formal channels gives me better prices." (1–5)

H02. **P_Att_StableMarket** — "Formal buyers pay more reliably than informal buyers." (1–5)

H03. **P_SubNorm_Peers** — "People in my community expect me to sell through cooperatives." (1– 5)

H04. **P_PercControl_QA** — "I am able to meet quality/hygiene requirements for formal buyers." (1–5)

H05. **P_RiskTrust** — "I trust formal buyers to honour agreements." (1–5)

H06. **P_TrainingConf** — "I have enough training to sell to formal markets." (1–5)

Index construction: Create composite indices (e.g., AttitudeIndex, NormsIndex, PerceivedControlIndex) by averaging relevant items and checking Cronbach's alpha for internal consistency ($\alpha \geq 0.70$ desirable).

SECTION I — Observational checklist (Enumerator observation)

I01. **PresenceOfChillTankNearby** — 1 = Yes; 0 = No (within 5 km).

I02. **HygieneObservedAtMilking** — 1 = Good (clean udder, clean containers, clean milking area); 2 = Fair; 3 = Poor.

I03. **PackagingTypeObserved** — 1 = Plastic jerrycans; 2 = Stainless steel; 3 = Plastic bottles; 4 = Other.

I04. **RoadToHomestead** — 1 = Motorable (dry & wet); 2 = Motorable (dry only); 3 = Footpath only.

SECTION J — Final checks & interviewer comments

J01. **InterviewerComments** — (text) e.g., discrepancies, non-responses, refusals, unusual observations.

J02. **RespondentWillingFollowUp** — 1 = Yes; 0 = No. If yes, record phone number: _____.