STRATEGIC MARKET-BASED INTERVENTIONS AND PRICE VOLATILITY IN THE DAIRY SECTOR: A CASE OF KIAMBU COUNTY, KENYA

Aluku Eugene Barasa

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DECLARATION

This research project is my original work and has not been presented at any university or institution for the purpose of obtaining a degree or consideration for any certification.

Signature: ………. Date: 12th June 2026

Aluku Eugene Barasa

110063369

Supervisors declaration

I confirm that the candidate carried out the work reported in this project under my supervision as the university supervisor (s).

Signature: …… **Date:** 12/06/2026

Dr. Moses Owino

Africa Nazarene University

Nairobi, Kenya

Signature: ..... **Date: 14/06/2026**

Dr. Harley Mutisya

Africa Nazarene University

Nairobi, Kenya

DEDICATION

I would like to dedicate this study to my family, especially my brother, Edwin Tom Aluku and my mother, Florences Imonyatta, who have always been my main form of encouragement, support, and faith in me and my abilities throughout the entire academic path.

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ABSTRACT

This study investigated the effects of strategic market based interventions such as forward contracting, price insurance mechanisms, market intelligence systems, cooperative bargaining capacity and product diversification strategies on price volatility of smallholder dairy farmers in Kiambu County, Kenya. The study was based on the theories of Price Theory, Risk Management Theory, Collective Action Theory and Market Information Theory. A cross-sectional survey design was used, and data was gathered using structured questionnaires. A total of 430 questionnaires were sent out, of which 172 were complete and usable, with a 40.0% response rate. Although this falls below the 70% threshold recommended by Mugenda and Mugenda (2003), the sample provided sufficient statistical power for analysis, and non-response bias is acknowledged as a limitation. Data were analyzed with SPSS version 26 with descriptive statistics, Pearson correlation and multiple regression analysis. The forward contracting, market intelligence systems and capacity for cooperative bargaining interventions all had the highest mean scores and a relatively low standard deviation, with a mean score of 4.5, SD = 0.82 for forward contracting, a mean score of 4.4, SD = 0.80 for market intelligence systems, and a mean of 4.2, SD = 0.88 for capacity for cooperative bargaining. Price insurance mechanisms and product diversification both had a mean of 4.3, but with higher standard deviations of 0.43 and 0.88 respectively. Overall, there was moderate to low price stability (mean = 3.5, SD = 1.05) and the price changes had significant effects on household budgets (mean = 4.1, SD = 0.98). There was no indication of multicollinearity in the data as all the VIF values were within the range of 1.466 – 1.672. The Pearson correlation analysis indicated that market intelligence systems was in a statistically significant negative relationship with price volatility ($r = -.161$, $p = .036$) and all other interventions had weak negative relationships that weren't statistically significant. Multiple regression analysis revealed that the overall model was statistically non-significant ($F(5, 165) = 1.056$, $p = .387$) and that the model explained only 3.1% of the variance in price volatility ($R^2 = .031$, Adjusted $R^2 = .002$), with none of the variables emerging as significant predictors. The results indicate that farm-level strategic interventions do not significantly explain the dairy price volatility in Kiambu County. Based on the study's findings, the study suggests that structural, seasonal and institutional factors are more likely to explain the volatility, and thus calls for systemic measures by policy and other stakeholders, including investments in market infrastructure, formal market price stabilization policies and participatory insurance arrangements.

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DEFINITION OF TERMS

Cooperative bargaining capacity refers to the ability of farmer cooperative organizations to negotiate favorable terms with buyers, processors, and other value chain actors on behalf of their members. This capacity depends on organizational strength, member unity, market linkages, and commercial competence.

Collective action is coordinated behavior among multiple individuals or households to achieve common objectives that cannot be achieved through individual action alone. In dairy systems, collective action through cooperatives enables smallholders to access markets, negotiate better prices, and achieve economies of scale in input procurement and output marketing.

Forward contracting arrangements are agreements between producers or cooperatives and buyers specifying delivery terms, quality standards, volumes, and pricing mechanisms in advance of production or delivery. These contracts reduce uncertainty for both parties by establishing predetermined terms of exchange.

Farm-gate price is the price received by farmers at the point of sale, typically at the farm or cooperative collection center, before any transportation, processing, or marketing costs are incurred. This represents the actual revenue accruing to producers for their milk production.

Income stability refers to the consistency and predictability of household income flows from dairy farming over time. Greater income stability indicates lower variation in monthly or seasonal income, enabling better household financial planning and reducing vulnerability to income shocks.

Market linkages are relationships and connections between producers and buyers, processors, retailers, or other market actors that facilitate product sales, information exchange, and value chain coordination. Strong market linkages provide farmers with reliable market access and reduce transaction costs.

Market intelligence systems are information platforms that collect, analyze, and disseminate data on prices, supply-demand conditions, market trends, and trading opportunities to market participants. These systems reduce information asymmetries that disadvantage smallholder producers in price negotiations.

Price volatility refers to the degree of variation in milk prices over time, measured by statistical indicators such as standard deviation, coefficient of variation, or price range. In this study, price volatility encompasses both predictable seasonal fluctuations and unpredictable price shocks that create income uncertainty for dairy farmers.

Price insurance mechanisms are financial instruments that provide protection against adverse price movements by compensating producers when market prices fall below specified threshold levels. These mechanisms transfer price risk from farmers to insurance providers in exchange for premium payments.

Product diversification strategies involve processing raw milk into multiple value-added products such as yogurt, cheese, butter, or fermented milk products with different market dynamics, storage characteristics, and demand patterns. Diversification aims to reduce dependence on fluid milk markets and stabilize revenue streams.

Strategic market-based interventions are systematic, coordinated approaches designed to address market failures and inefficiencies through mechanisms that work within market structures rather than replacing them. These interventions aim to enhance market functioning by improving information flows, strengthening institutional capacity, facilitating risk management, and promoting coordination among value chain actors.

Smallholder dairy farmers are households that maintain between one and ten dairy animals and produce up to 100 liters of milk daily. These farmers typically operate on small land holdings of 0.5 to 5 acres and rely on dairy farming as a primary or significant secondary source of household income.

Treatment group refers to farmers or cooperatives participating in specific market-based interventions whose outcomes are measured and compared against control groups. Treatment groups receive the intervention being evaluated during the study period.

Value chain encompasses the full range of activities, actors, and relationships involved in moving dairy products from production through processing, distribution, and marketing to final consumers. The dairy value chain includes input suppliers, farmers, cooperatives, processors, transporters, wholesalers, retailers, and support service providers.

LIST OF ABBREVIATIONS

AFDB - African Development Bank

API - Application Programming Interface

ANOVA - Analysis of variance

CAP - Common Agricultural Policy

CBD - Central Business District

DRP - Dairy Revenue Protection

FAO - Food and Agriculture Organization

GDP - Gross Domestic Product

GIS - Geographic Information System

GOK - Government of Kenya

KDB - Kenya Dairy Board

KMDP - Kenya Market-led Dairy Programme

MFI - Microfinance Institution

MALF - Ministry of Agriculture, Livestock and Fisheries

MALFI - Ministry of Agriculture, Livestock, Fisheries, and Irrigation

NEW KCC - New Kenya Cooperative Creameries

R&D - Research and Development

SDG - Sustainable Development Goals

SNV - Netherlands Development Organization

SPSS - Statistical Package for the Social Sciences

VIF - Variance Inflation Factor

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CHAPTER ONE:

INTRODUCTION AND BACKGROUND OF THE STUDY

1.1 Introduction

This chapter presents the study through the background and the context of the dairy price volatility at global, regional, and local levels. It also signifies the strategic market-based interventions studied in the study, it defines the problem statement and reflects the general and specific objectives of the study. In addition, the research questions, justification, scope, assumptions and definitions of key terms are discussed in the chapter.

1.2 Background of the Study

The dairy industry is one of the most important elements of the agricultural sector in Kenya and a significant source of food security and income among smallholder farmers (Kiplagat et al., 2024). Although economically significant, the industry has been typified by chronic instability of milk prices through seasonal production effects, market failures, infrastructural constraints, and institutional malco-ordination. This instability compromises the stability of income, reduces investments and endangers the viability of the smallholder dairy farming especially in those high production areas like Kiambu County.

In Kenya, agriculture represents up to 33 per cent of the gross domestic product and sustains the lives of more than three-quarters of the rural population (De Jong et al., 2024). Kenya has been one of the top milk producers in Africa as it produces more than 5.2 billion liters of milk every year, most of which are produced by smallholder systems (Menjo, 2025). Nevertheless, the very high and regular changes in prices of farm-gate milk inhibit the ability of farmers to plan production, obtain credit, and invest in productivity-improving technologies, as well as derail the consistency of supply to both cooperatives and processors (Cele, 2023).

Climate variability, integration of markets, and structural limitations of agricultural value chains have increased price volatility in the dairy sector globally (Billah, 2023; Kirimi et al., 2025). As the developed economies have been implementing the market-based risk management systems to stabilize the producer incomes, most African dairy markets, such as the Kenya market, are poorly integrated and lacked price stabilization mechanisms (Dumont, 2022; Skevas, 2021). Consequently, the smallholder farmers are disproportionately exposed to price risk.

On the county level, Kiambu is a region of strategic agro-climate conditions with a high production intensity in terms of dairy production (Wanjala, 2023). However, the prevalence of smallholder production, low processing and storage facilities, and low bargaining power subject producers to high volatility in prices (Mustafa et al., 2024). All these issues point to the necessity of localized and evidence-based strategies to deal with price volatility.

This research is anchored on the Market-Based Price Stabilization Theory; the aim of the research is to investigate how market-based interventions of choice influence the dairy prices volatility using Kiambu County as the research setting. The study used descriptive cross-sectional design to produce empirical data that can be used to inform policy and practice to stabilize milk prices and enhance the wellbeing of the smallholder farmers.

1.2.1 Price Volatility

Price volatility is a trend that shows changes in the prices of agriculture with time and is one of the key factors affecting the stability of incomes, investment choices, and production decisions among farmers (Mustafa et al., 2024). High volatility in the dairy markets does not encourage investment in productivity-enhancing technologies and restrict access to credit. It is typically assessed by such indicators as standard deviation of farm-gate prices, the number of times prices change in a season, and income change that can be attributed to price changes

(Chen et al., 2025). The seasonal and inter-annual fluctuations in production are responsible as the major cause of agricultural price volatility. Seasonal variations are a result of predictable weather patterns, e.g., rainfall cycles, and inter-annual volatility is a result of unpredictable shocks e.g. droughts and epidemics (Mustafa et al., 2024). These dynamics can be represented by the lack of compliance with seasonal average prices and price differences between peak and lean seasons.

The volatility in dairy markets is also enhanced by the structural constraints. The inelasticity of the supply in the short-run, insufficient storage and processing capacity, and the comparatively inelastic demand limits the producers in responding to price changes (Muzaffar and Malik, 2024). Furthermore, market asymmetry and thin markets in developing markets are exposing farmers to manipulations of the price by the intermediaries, making prices more unstable (Chen et al., 2022). Dairy markets are particularly susceptible to price fluctuations in the short-term due to the perishability of milk and due to production cycles, which cannot be postponed. This weak point is reflected in such indicators as short-term price fluctuations, percentage of processed milk, and spoilage rates and helps design interventions based on the market to stabilize prices (Muzaffar and Malik, 2024)

1.2.2 Strategic Market-Based Interventions

Strategic market-based interventions represent systematic, coordinated approaches designed to address market failures and inefficiencies through mechanisms that work within market structures rather than replacing them. In agricultural contexts, particularly within dairy value chains, these interventions aim to enhance market functioning by improving information flows, strengthening institutional capacity, facilitating risk management, and promoting coordination among value-chain actors (Shikuku et al., 2024). The conceptual foundation of market-based interventions rests on the recognition that agricultural markets in developing

countries often suffer from multiple interconnected failures, including information asymmetries, weak bargaining power among smallholder producers, inadequate risk management instruments, and limited value-chain coordination (Shikuku et al., 2024).

Contemporary understanding of market-based interventions has evolved significantly from traditional state-controlled agricultural marketing systems that dominated many developing countries through the 1980s. Historically, parastatal marketing boards bore large financial burdens, were bureaucratic, and often inefficient (Mashingauta, 2024). Following widespread liberalization of agricultural markets in the 1990s, development thinking shifted toward facilitating market development rather than direct market participation by government agencies. This transition reflected recognition that state marketing boards often created inefficiencies, fiscal burdens, and rent-seeking opportunities while failing to achieve the intended objectives of price stabilization and producer support. Modern market-based interventions seek to correct market failures while preserving the efficiency benefits of competitive markets, creating so-called “smart interventions” that strengthen rather than supplant market mechanisms (Siankwilimba et al., 2022).

The theoretical foundations of market-based interventions draw from multiple disciplinary perspectives including institutional economics, which emphasizes the role of formal and informal rules in shaping economic transactions; transaction-cost economics, which analyzes how coordination mechanisms affect the costs of market exchange; and collective action theory, which explains conditions under which groups can organize to pursue common interests (Nason & Bothello, 2023). These theoretical frameworks converge in recognizing that well-designed interventions can reduce transaction costs, improve information availability, enhance producer bargaining power, and facilitate risk management without creating the

distortions associated with direct price controls or heavy subsidies (Ahmed, 2024). Nevertheless, there are three important gaps in the literature that are present.

Theoretically, the majority of studies examine individual interventions independently, but there is a dearth of evidence on the interactions between multiple interventions in stabilizing prices in integrated dairy value chains (Mwangi, 2021). Contextually, most studies concentrate on more developed economies or large-scale production systems where little has been done on the smallholder-dominated dairy industries like the one in Kenya and Kiambu County in particular. Past literature tends to be methodologically based on cross-sectional survey designs, which only take perceptions of volatility and do not conduct a longitudinal study of price changes or an outcome of intervention of empirical price data (Michels & Mußhoff, 2025). Without filling these gaps, smallholder farmers will still be left to work in uncertain market conditions, policymakers will not have evidence-based policies to design effective interventions and the dairy industry will not be able to attain sustainable price stability. This highlights the need to conduct the current study.

Market-based interventions in the dairy value chain are a set of coordinated mechanisms that involve enhancing predictability of prices and income of smallholder farmers (Kariuki, 2025). These interventions involve forward contracting arrangements where there are pre-agreed prices and delivery terms between farmers and buyers; price insurance programs that cushion producers against unfavourable price fluctuations; market intelligence systems that help farmers to add value to raw milk and eliminate the overdependence on one and overly volatile channel of distribution; cooperative bargaining capacity where the farmers can make combined efforts to negotiate better prices and market terms; and product diversification mechanisms that reduce their reliance on one highly volatile channel of distribution (Kariuki, 2025).

The measurement of each of these sub-variables in terms of quantifiable indicators is determined by the level of participation, price outcomes, income stability and market access. Such indicators facilitate a systematic assessment on the impacts of the interventions on the changes in producer earnings and price volatility in smallholder dairy farmers in Kiambu County (Michels & Mußhoff, 2025). The operationalization of the IV offers an orderly system of established interventions that help the most useful contribution to farm-level level stabilization and damping the negative impact of price variations in local milk markets.

1.2.2.1 Forward Contracting Arrangements

Forward contracting arrangements are structured agreements between dairy farmers and consumers in which delivery dates, milk quality and pricing structure are agreed in advance prior to the commencement of production (Neme et al., 2025). This intervention averts price uncertainty to the farmers as the market-based price discovery is maintained. Forwards contracting indicators may comprise: the percentage of farmers holding signed forward contracts (% of the total producers), the rate of contract compliance (percent of deliveries made in accordance with the agreed contract), and the rate of price-adjustment in contracts (number per production cycle). These measures enable the scholars to determine the extent of forward contracting utilization and its success in stabilizing dairy sector incomes (Rogers-Montoyaet al., 2025).

The predictability of income is also doable through forward contracts, which allow farmers to organize the purchase of inputs, loan repayment, and investments in productivity-enhancing technology. The impact of this intervention on income volatility can be determined by monitoring the variance of average income in contracted and non-contracted farmers (standard deviation of monthly income of a year) (Gatawa, 2025). The idea of forward contracting is especially applicable in the case of Kiambu County because milk is a perishable

good, and the production cycle occurs every day, which poses a high risk and significant incentive to enter the contract with the stable buyer.

1.2.2.2 Insurance Mechanisms

Price insurance schemes cover farmers against negative market forces, using products like revenue insurance, minimum price guarantees, and options contracts (Lytton, 2022). Some of the indicators of operation are: the percentage of farmers covered in insurance schemes, the ratio of providing claims (out of claims successfully paid to farmers), and the decrease in the variability of income (percent decrease in monthly income standard deviation of insured farmers) (Rahman & Hye, 2021). These metrics operationalize insurance as an intervention that is capable of cushioning price shocks and financial security of dairy producers.

The insurance mechanisms are in a position to supplement the market intelligence as the farmers are able to operate with the market fluctuations in a confident manner (Mato-Amboage et al., 2022). An example is the farmers being able to quantify the risk reduction using seasonal income stability of insured and uninsured groups. Pilot programs in East African settings with a traditionally low level of formal insurance uptake can serve as a source of quantifiable information regarding the possibility of scaling price insurance mechanisms (Vyas et al., 2025). Insurance helps farmers to keep production at the same level, invest in quality feed, and enhance the productivity of herd by minimizing the risk of extreme price falls.

1.2.2.3 Market Intelligence Systems

The effectiveness of market-based interventions depends critically on contextual factors including market structure characteristics, institutional environments, producer organization capacity, and policy frameworks (Beavor et al., 2024). Interventions that succeed in one context may fail in others due to differences in these enabling conditions (Demir et al., 2025). Research examining intervention effectiveness across diverse contexts provides important insights into

design principles and implementation requirements necessary for successful outcomes (Mielke et al., 2022). Studies from developed country agricultural markets demonstrate how futures markets, comprehensive insurance systems, and sophisticated contract farming arrangements can stabilize producer incomes while maintaining market efficiency (Demir et al., 2025). However, these mechanisms typically require financial market infrastructure, regulatory frameworks, and producer capacity levels rarely present in developing country settings.

Market intelligence systems are information platforms that collect, analyse, and disseminate data on prices, supply-demand conditions, quality requirements, and trading opportunities to market participants (Kariuki, 2025). They are operationalised in this study through three key indicators aligned with Objective 3: the level of farmer access to timely market price information, the degree of reduction in information asymmetry between farmers and buyers, and the improvement in price transparency in local dairy markets. These indicators capture whether farmers possess the information necessary to make informed marketing decisions, negotiate from a position of knowledge, and avoid being exploited by better-informed intermediaries. By reducing information asymmetries rooted in Akerlof's (1970) framework, market intelligence systems are hypothesised to enable farmers to identify best-paying outlets, negotiate more effectively, and time their sales strategically, all of which should reduce experienced price volatility. Mobile-based platforms and SMS price alerts have shown particular promise in Kenyan contexts as cost-effective channels for reaching smallholder farmers with real-time price data (Kariuki, 2025; Sun et al., 2025).

1.2.2.4 Cooperative Bargaining Capacity

The capacity of cooperative bargaining is aimed at strengthening the collective structure of farmers to obtain economies of scale in the process of acquiring inputs, marketing of outputs, and price bargaining (Khushwaha, 2024). They are indicated as: number of cooperative members at work, amount of milk sold cooperatively (liters/month), and price premiums gained

in cooperative negotiation (percentage above average local market price). These indicators are a way of operationalizing the intervention, indicating how collaborative power can be transferred into actual economic gains to the smallholders.

Cooperatives are also very important in coping with perishability and daily production issues in dairy systems. As an example, the greater the total sales in terms of volume, the less susceptible individual farmers are to the market fluctuations (Khushwaha, 2024). The study was be able to follow the variation in the income of the members before and after cooperative strengthening interventions giving quantifiable information on the effect of collective bargaining on the price stabilization. Increased cooperatives enhance the access of farmers to inputs, finance, and technical assistance, which increase the general output and resistance to shocks in the market.

1.2.2.5 Product Diversification Strategies

Diversification policies on products motivate farmers to convert raw milk into premium goods like yogurt, cheese, and butter in order to minimize the risks associated with fluctuations in the prices of raw milk (Snorek et al., 2023). They include: percentage of farmers making at least one value-added product, percent of total farm earnings contributed by diversified products (%), and decline in income dispersion as a result of value-added production, percentage change in standard deviation of income. These measures enable the researcher to assess the effectiveness of diversification in cushioning volatility in the primary dairy markets (Rahman & Hye, 2021).

Diversification also helps farmers to enter new market segments and lengthen the shelf-life of their products, by reducing risks linked to the perishable milk (Rahmasari & Abidin, 2025). The study can determine the effectiveness of this intervention in the stabilization of earnings by comparing the income stability of farmers who do diversified production to farmers who do not do diversified production but only sell raw milk. Diversification of products to

smallholders in Kiambu County presents a quantifiable solution to increasing resilience and economic sustainability since they have to struggle with daily market pressures and high risks of perishable products (Mutio etal., 2025).

1.3 Statement of the Problem

Although there is increasing interest in dairy sector development in Kenya, the current literature is largely focused on production-oriented interventions, such as the use of improved breeds, feed technologies, and extension services, with limited attention to coordinated market-based interventions like cooperative bargaining, market intelligence systems, price insurance, and forward contracting (Cooper, 2021). This is a crucial gap, one which production-side interventions cannot close in the absence of market-based solutions to structural market failures, driven by failures on the demand-side, market power imbalances, and information asymmetries, and which need to be implemented within the price-formation mechanisms. Furthermore, the majority of price stabilization instruments used in the dairy industry in Kenya come from a developed country context where contract enforcement is strong, functioning financial markets and effective farmer organizations are common, conditions which are not always applicable in the smallholder systems in Kiambu County (Cooper, 2021; Coromina, 2022).

The existing evidence base is also limited by the lack of use of longitudinal and randomized designs that focus more on farmer perceptions than on measurable price and income results, as well as by the absence of designs that clearly separate out the effects of integrated interventions (Dumont, 2022; Kirui, 2022). Empirical models are still lacking in analytical coverage on a number of key intermediate mechanisms, such as transaction costs, farmer bargaining power, and access to market information. There is therefore a lack of evidence to support the effectiveness of integrated market-based interventions in lowering milk

price volatility and improving income stability of smallholder dairy farmers especially in contexts such as Kiambu County.

1.4 Purpose of the Study

The purpose of this study was to assess the effect of strategic market-based interventions on price volatility in the dairy sector of Kiambu County, Kenya. In particular, this study aimed to provide empirical evidence of the relationship of each type of forward contracting arrangement, price insurance mechanism, market intelligence system, cooperative bargaining capacity and product diversification strategy to smallholder dairy farmer's price volatility, in order to inform more effective market stabilization policies and practices.

1.5 Research Objective

The research objective is discussed under the following definitive sub headlines

1.5.1 General Objective

To assess the effect of strategic market-based interventions on price volatility in the dairy sector of Kiambu county.

1.5.2 Specific Objectives

i. To determine the effect of forward contracting arrangements on price volatility in the dairy sector in Kiambu county, Kenya.
ii. To assess the effect of price insurance mechanisms on price volatility in the dairy sector of Kiambu county, Kenya.
iii. To evaluate the effect of market intelligence systems on price volatility in the dairy sector of Kiambu county, Kenya.
iv. To analyze the effect of cooperative bargaining capacity on price volatility in the dairy sector of Kiambu county, Kenya.

v. To investigate the effect of product diversification strategies on price volatility in the dairy sector of Kiambu county, Kenya.

1.6 Research Hypotheses

Based on the specific objectives of the study, the following hypotheses were formulated:

$H_0$1: Forward contracting arrangements have no statistically significant effect on price volatility in the dairy sector of Kiambu County.

$H_0$2: Price insurance mechanisms have no statistically significant effect on price volatility in the dairy sector of Kiambu County.

$H_0$3: Market intelligence systems have no statistically significant effect on price volatility in the dairy sector of Kiambu County.

$H_0$4: Cooperative bargaining capacity has no statistically significant effect on price volatility in the dairy sector of Kiambu County.

$H_0$5: Product diversification strategies have no statistically significant effect on price volatility in the dairy sector of Kiambu County.

1.7 Significance of The Study

This research project holds substantial significance for multiple stakeholders within Kenya's dairy sector and contributes to broader academic and policy discourse on agricultural market development in developing country contexts. The findings directly benefit approximately 50,000 smallholder dairy farming households in Kiambu county by providing empirical evidence on the extent to which market-based interventions are associated with lower price volatility and more stable farm incomes. By identifying which interventions show the

strongest associations with reduced price fluctuations, the study enables farmers to make more informed decisions about participating in various market arrangements, cooperative structures, and risk management mechanisms. Beyond immediate beneficiaries in Kiambu county, the findings have applicability to dairy farming communities across Kenya's high-potential dairy zones and throughout East Africa, potentially impacting millions of smallholder producers facing similar market challenges.

For policymakers and government agencies, the study provides critical evidence to inform agricultural policy formulation at both county and national levels. The Kiambu county government will gain insights into effective interventions that agricultural departments can promote through extension services, cooperative development programs, and infrastructure investments. At the national level, findings will inform the ministry of agriculture, livestock, fisheries and irrigation in refining implementation of the Kenya dairy master plan and aligning interventions with Kenya vision 2030 agricultural transformation objectives. The Kenya dairy board will gain insights into regulatory frameworks, market oversight mechanisms, and institutional arrangements necessary to support price stabilization while maintaining competitive market structures.

Development practitioners and non-governmental organizations implementing dairy sector programs will benefit from rigorous evidence on the relative associations between different interventions and price outcomes. Organizations such as Netherlands development organization, unsaid, the world bank, and the African development bank frequently design and fund dairy value chain development initiatives but often lack robust evidence on which approaches show the strongest associations with intended outcomes. This study's comparative assessment of multiple intervention strategies can inform more evidence-based program design. Dairy cooperative societies will gain insights into organizational strategies and market engagement approaches that may support member income stability, while dairy processors and

private sector actors will benefit from understanding how different market arrangements correlate with supply stability, quality consistency, and value chain efficiency.

The research makes several important contributions to academic literature on agricultural markets, price volatility, and development economics. It addresses significant knowledge gaps regarding effective price stabilization mechanisms in smallholder dairy systems within developing country contexts, employs rigorous cross-sectional methodology to examine associations between interventions and price outcomes, and provides comparative evidence on the relative strength of relationships across multiple intervention approaches. The study contributes to theoretical understanding of how market-based interventions function in contexts characterized by weak institutions, limited financial market development, and fragmented producer organizations. While focused on Kiambu county, the findings have broader geographic relevance across east Africa and contribute to international discourse on agricultural transformation in developing countries. The research directly supports achievement of multiple united nations sustainable development goals, particularly SDG 1 (no poverty), SDG 2 (zero hunger), and SDG 8 (decent work and economic growth), by generating evidence on market-based interventions and their potential role in supporting smallholder farmer income stability and food security.

1.8 Scope of The Study

This study is geographically confined to Kiambu county, located in Kenya’s central highlands, approximately 20 kilometers from Nairobi. The county was selected due to its status as one of Kenya’s premier dairy-producing regions, with over 350 million liters of annual milk production and approximately 50,000 smallholder dairy farming households providing sufficient sample size for rigorous statistical analysis. The county's proximity to Nairobi creates unique market dynamics distinct from more remote dairy-producing regions, while its diverse dairy production systems, ranging from zero-grazing units to semi-intensive mixed farming

operations, enable analysis of intervention effectiveness across production system types. Within Kiambu county, the study focuses on major dairy-producing sub-counties, including Kikuyu, Limuru, Lari, and Githunguri, where dairy farming constitutes a primary livelihood activity.

The research covers an 18-month period encompassing multiple production cycles and seasonal variations critical for assessing intervention effectiveness under varying market conditions. This timeframe allows observation of outcomes across at least three distinct seasonal periods during which production levels and price patterns typically vary substantially. Baseline data collection occurs during the initial three months, followed by intervention implementation and a 15-month monitoring period during which outcome variables are measured at monthly intervals. Historical price data covering the 24 months preceding the intervention period are collected to establish baseline volatility patterns and provide context for interpreting observed changes.

Conceptually, the study examines five specific strategic market-based interventions for reducing dairy price volatility: forward contracting arrangements between farmers and processors, price insurance mechanisms providing financial protection against adverse price movements, market intelligence systems enhancing farmer access to price information and market trends, cooperative bargaining capacity enhancement through governance strengthening and market linkage development, and product diversification strategies involving processing of milk into value-added products. The study focuses specifically on interventions that work within market structures rather than replacing market mechanisms, excluding examination of direct price controls, subsidies, or state-led marketing schemes. While recognizing that production-side factors, including animal genetics, feeding practices, and animal health services, influence dairy sector development, these factors lie outside the study's primary focus on market-based volatility mitigation strategies.

1.9 Limitations of the study

The study is also limited in a number of ways that must be taken into consideration when interpreting the results. First, the research uses part of self-reported information on dairy farmers which can be influenced by recall bias or deliberate misreporting especially on matters concerning prices received, market participation and exposure to market-based interventions. Even though where available, triangulation with cooperative and county records is used, full removal of such bias cannot be ensured. Second, the study has a geographical constraint because it is restricted to Kiambu County. Although the county represents a large dairy-producing area and an appropriate setting in which to conduct an analysis of market-based interventions, the results might not be entirely applicable to other counties with varying agro-ecological factors, market structure, and institutional set-ups.

Third, the academic time frame of six months does not allow observing the long-term fluctuations in prices and the delayed implementation of some of the interventions like product diversification interventions and cooperative governance reforms. Consequently, the study reflects short- to medium-term changes and not long-run structural changes. Fourth, the level of data and quality of the data available among the farmers, cooperatives, and institutions, can influence the accuracy of certain estimates. Specifically, the transaction in the informal market and non-cooperative farmers can be incompleteness in records that can create measurement error. Lastly, the analysis targets the identified market-based interventions and fails to take into consideration all the potential external variables that might cause dairy price volatility, including macroeconomic shocks, extreme weather conditions, or unexpected policy changes. Even after observable characteristics of the market and farms have been checked, there are still possibilities of unobservable factors that could not be reflected in the study.

1.10 Delimitations of the Study

Delimitations are the boundaries intentionally established by the researcher to enclose the scope and focus of the research. Delimitations are deliberate decisions made to ensure the study is manageable, focused and related to the topic, whereas limitations are constraints that are not under the control of the researcher.

The study was deliberately limited to Kiambu County and was not conducted in any of the other dairy counties in Kenya including Nyandarua, Nakuru or Meru. Kiambu County was selected because it is one of the most active smallholder dairy production areas in Kenya, has well documented cooperative structures, and has good market linkages, providing an appropriate and information-rich environment to explore market-based interventions. The conclusions drawn and generalizations made were not meant for other counties having different Agro-ecological zones, market systems, or institutional structures.

Second, the study only took a snapshot of five strategic market-based interventions: forward contracting arrangements; price insurance systems; market intelligence systems; cooperative bargaining capacity; and product diversification strategies. Other possible mechanisms of stabilization that are not market based, such as government subsidies, direct price controls, parastatal marketing boards, and monetary policy tools, were intentionally omitted because they are not market based and are beyond the scope of market-based intervention.

Thirdly, the study focused on only the commercial smallholder dairy farmers and excluded large-scale commercial dairy farmers and subsistence farmers who do not sell milk and excluded dairy processed as primary respondents. This boundary has been placed, as the study focuses on the smallholder sector, which is the most vulnerable group and also the largest in terms of numbers in Kenya's dairy industry.

Fourth, all data used in the study was primary data, collected by using structured questionnaires, and was not secondary price panel data, cooperative payment data, or processor transaction data. This was because there was no reliable and readily available smallholder administrative price record in Kiambu County.

Finally, no macroeconomic variables were incorporated in the analytical model such as inflation, exchange rate movements, fuel prices, and national monetary policy. These factors are recognized as the potential contributors to dairy price volatility but are not included in the analysis of farm-level and market-based factors and a different methodological approach would be necessary to explore them thoroughly.

1.11 Assumptions of the Study

This study operates under several fundamental assumptions directly tied to the study context and design. First, the study assumes that the perceived price volatility reported by farmers correlates meaningfully with actual farm-gate price fluctuations experienced during the study period in Kiambu County's dairy markets. Second, farmers who reported participating in forward contracting, price insurance, cooperative bargaining, market intelligence systems, or product diversification are assumed to have engaged with these interventions in ways that materially affected their price outcomes, rather than having only nominal or inactive membership. Third, the study assumes that the five strategic market-based interventions examined represent the primary formal risk-management mechanisms available to smallholder dairy farmers in Kiambu County; other informal coping strategies are assumed to be randomly distributed across the sample and therefore not systematically biased across intervention groups. Fourth, the 172 usable responses, though below the targeted sample, are assumed to be drawn from a cross-section of farmers sufficiently representative of the broader population to support the cross-sectional comparisons conducted. Finally, the study assumes that cooperative registration records and county agricultural data used to construct the sampling

frame accurately reflect the population of active commercial dairy farmers in the county during the data collection period.

1.12 Theoretical Framework

The paper is based on the Market-Based Price Stabilization Theory and reinforced by the Price Theory, Risk Management Theory, Collective Action Theory, and Market Information Theory. The theories all explain the reasons why the dairy prices are volatile and offer a base on how to assess the market-based interventions among the smallholder dairy farmers, with Kiambu County being the study area.

These four theories complement each other and offer a holistic framework for understanding the dynamics of dairy price volatility and market-based interventions. Price Theory provides the foundation for understanding the mechanisms by which the forces of supply and demand determine price fluctuations at the farm gate, and Risk Management Theory provides the foundation for understanding how instruments like forward contracting, price insurance and product diversification can help producers manage their exposure to price fluctuations at the farm gate. Collective Action Theory subsequently examines how individual farmers who are small enough to have no real impact on the market, can combine their bargaining power to get more stable and equitable market outcomes by forming cooperatives. Last, Market Information Theory discusses the information asymmetries that impact on fair price setting and the importance of market intelligence systems to allow farmers to engage in knowing rather than in ignorance. The four theories together provide an explanation of the causes of price volatility and the way each of the five strategic market-based interventions studied in this paper is expected to mitigate price volatility for smallholder dairy farmers in Kiambu County.

1.12.1 Price Theory

The Price Theory has its origins in classical and neoclassical economics, and was pioneered by Adam Smith (1776) and David Ricardo (1817), and formalized by Alfred Marshall (1890). In the theory, the rational economic agents are held to be in competitive markets where price is set as a result of supply and demand and serves as a guide that guides production and consumption choices. Within the following assumptions, market conditions are directly transmitted in changes in price movements and resource allocations.

Price Theory in the present paper describes how seasonal volatility of milk prices in Kiambu County was caused by the interplay of price fluctuations in the supply of milk and the relativity inelastic demand. The dependent variable- dairy price volatility is directly supported by the theory and guides the interventions analysis; storage facilities, coordinated marketing, and buffering mechanisms. The theory is however criticized to be based on perfect information and efficient markets conditions that are not common in smallholder dairy systems which are often associated with information asymmetry and unequal bargaining power.

1.12.2 Risk Management Theory

Frank Knight (1921) propounded Risk Management Theory which differentiates between measurable risk and uncertainty and was later developed by John Maynard Keynes and Harry Markowitz (1952) with the concepts of hedging, forward markets, and diversification. The theory presupposes that economic participants are risk aversive and aim at reducing income volatility through controlling exposure to the unpredictable consequences with the help of structured financial and contractual instruments.

In the context of the current study, Risk Management Theory is used to describe how Kiambu County dairy farmers face income risk because of the unpredictability in milk prices and the lack of price promptness. Product diversification, price insurance, and forward

contracting are the independent variables associated with this theory and are aimed at stabilizing the expected income. One major critique is that the theory assumes the existence of well-develop financial and insurance markets, which are not prevalent under the conditions of smallholder contexts; it is, however, still applicable in the analysis of the possibility of market-based instruments in the reduction of vulnerability to price volatility in farmers.

1.12.3 Collective Action Theory

Mancur Olson (1965) came up with the Collective Action Theory and it was extended by Elinor Ostrom in the late twentieth century. The theory presupposes that the person acting by themselves possesses low incentives and bargaining power, and the collective organization can enhance performance as a result of cooperating, sharing governance, and institutional factors, which facilitate collective action. Regarding this research, the Collective Action Theory confronts the rationale of dairy cooperatives and producers' organizations in increasing bargaining power, lowering the transaction costs, and increasing access to the market in the Kiambu County. Collective marketing, cooperative membership, and the strength of the bargaining are associated with the theory. Despite its topicality, the theory is criticized with the following challenges such as free-riding, elite capture, weak governance, and low participation of the members, which can reduce the effectiveness of collective interventions.

1.11.4 Market Information Theory

Market Information Theory is based upon the research of George Akerlof (1970) on information asymmetry, and it was further developed by Michael Spence and Joseph Stiglitz in the 1970s. The theory presumes that the distribution of information is unequal thereby resulting in inefficient market performance, price formation as well as unequal bargaining power by the participants in the market. This paper in its analysis employs the Market information Theory to provide an understanding of the exposure of the dairy farmers in Kiambu County to price

manipulation by middlemen due to insufficient access to pertinent and timely price information. Access to market information, price transparency mechanism, and market intelligence systems are some of the variables which are associated with the theory in an attempt to enhance the bargaining power and stabilize prices. The theory is however criticized by the fact that the information alone may not be able to lower the price volatility when farmers do not have the infrastructure or lack access to the market to act on the information.

1.13 Conceptual Framework

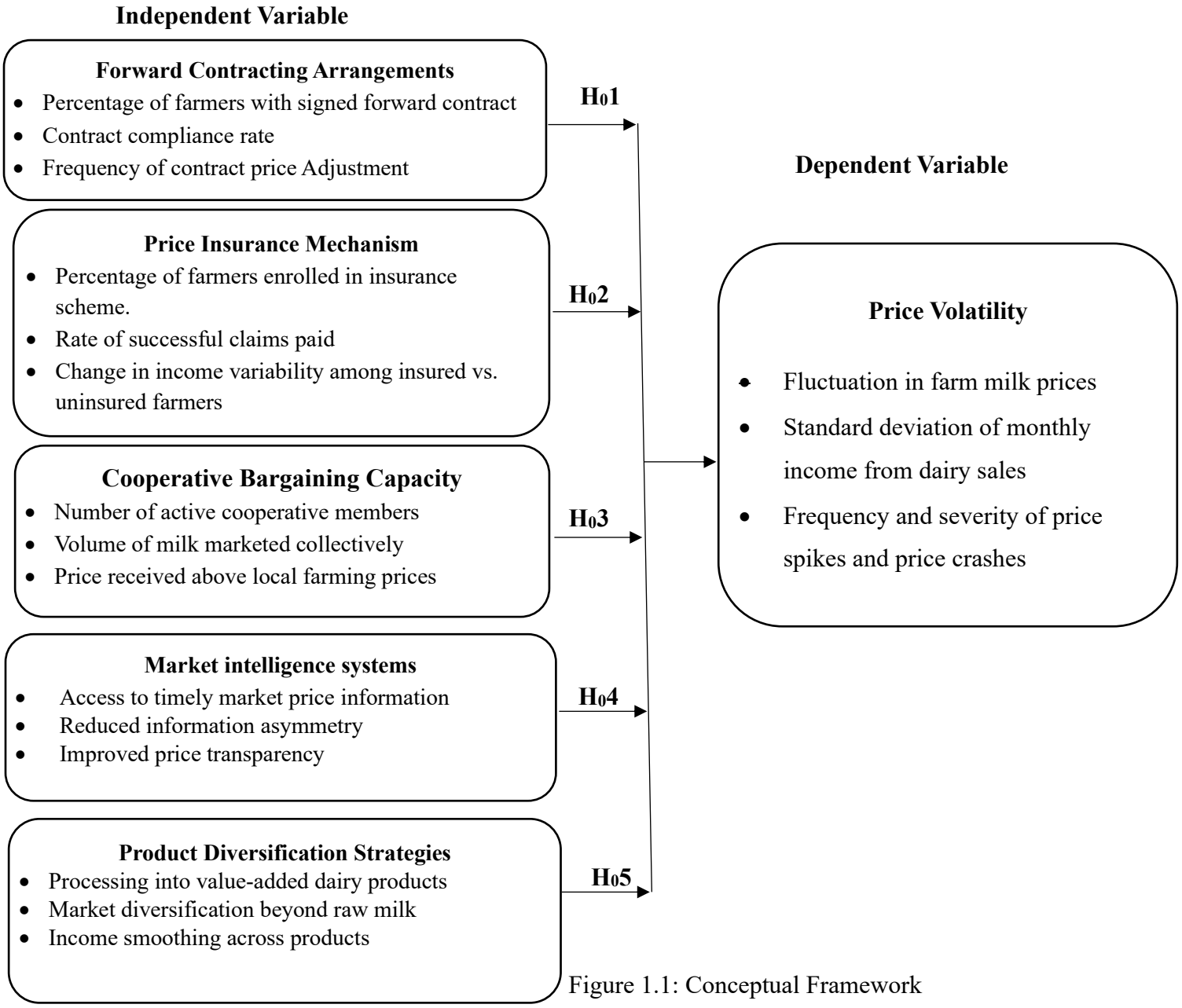


Figure 1.1: Conceptual Framework

The conceptual framework describes the hypothetical associations between the strategic market-based interventions and dairy price volatility in Kiambu County. It frames price volatility as the dependent variable, which is influenced by interventions, including forward contracting, price insurance, cooperative bargaining, market intelligence, and product diversification, and the relevant variables in the market are held constant by other factors including farmer, farm, and market characteristics.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter examines both theoretical and empirical literature on price volatility in the dairy industry in Kiambu County. It is broken down into the theoretical framework, based on the price theory, risk management theory, collective action theory, and market information theory, and the empirical literature, analyzing the dynamics of dairy markets, price variations, and interventions. The combination of these views offers a clear insight to examine the reasons behind price volatility and the success of market-based approaches. In particular, each of the theoretical lenses directly relates to the five specific objectives of the study: Price Theory provides the conceptual framework for analyzing forward contracting arrangements and price insurance mechanisms, as it explains how price signals affect producer decisions, and how structured contracts, or financial instruments, can be used to dampen or alter price signals. The risk management theory also aids these goals by describing the benefits of forward contracts and insurance from the farmer's viewpoint in limiting the impact of price shock on farmer income. Collective Action Theory offers a theoretical basis for analyzing the bargaining power of collective organization, as a way to counteract power imbalances that leave individual smallholders vulnerable to price manipulation. Market Information Theory is directly relevant to understanding the analysis of market intelligence systems as it relates to both information access and the reduction of information asymmetry and price transparency. Lastly, Product diversification strategies are supported by the combination of Risk Management Theory and Market Information Theory; diversification diminishes the risk of the portfolio and improved market knowledge facilitates farmers to discover and access value added markets. The

theoretical model thus includes all five independent variables and the proposed links to price volatility reduction.

2.2 Empirical Review

The empirical review summarizes the current literature on strategic market-based interventions and their impact on agricultural price volatility, specifically, the dairy value chain. Using empirical evidence gained through global, regional, and local investigations, this part brings to focus what is empirically known about the mechanisms used like forward contracting, insurance schemes, market intelligence systems, cooperative strengthening, and product diversification and the impact of these on the stability of markets, decision-making by producers, and the dynamics of the prices in general. The thematic structure of the review based on the conceptual framework of the study ensures that every intervention is presented using measurable evidence-based results as opposed to theoretical conjectures to support the study with the existing body of empirical work.

Current literature shows regular trends in the sources of price volatility alongside significant contextual variations in the operation of market-based intervention in the dairy systems. Evidence demonstrates again that market structure, institutional quality, farmer organization as well as contract enforcement capacity determine the effectiveness of interventions. Nonetheless, there are still substantial gaps especially on how these interventions can work together in the localized dairy settings like the Kiambu County where the smallholder hegemony, lack of proper infrastructures, and poor market coordination intersect in a unique way. This part thus offers a basis on which one can determine unanswered empirical questions that support the current research.

2.3 Forward Contracting Arrangements and Price Volatility (Objective One)

Forward contracting arrangements, whereby farmers and buyers agree on prices and quantities in advance of delivery, represent a widely studied mechanism for managing agricultural price volatility. The empirical literature examining forward contracts in dairy markets reveals mixed but generally positive effects on price stability, though effectiveness varies substantially with contract design, enforcement mechanisms, and market structure characteristics.

International evidence from developed dairy markets demonstrates that forward contracts can significantly reduce price volatility exposure for participating farmers. Winston, (2021). analyzing united states dairy markets found that farmers utilizing forward contracts with processors experienced 35 to 48 percent lower income volatility compared to spot market participants over a five-year period. Their analysis revealed that contracts reduced downside risk more effectively than they constrained upside potential, creating favorable risk-return profiles for risk-averse farmers. However, the study documented that only 23 percent of eligible farmers participated in forward contracting programs, with non-participation attributed to trust deficits with processors, complexity of contract terms, and concerns about production uncertainty making quantity commitments risky.

European research provides additional insights into contract farming effectiveness. Tambadou, (2024). examining swiss dairy contracts found that price risk reduction through contracts averaged 41 percent for participants, with particularly strong benefits for smaller farms facing limited risk management alternatives. Importantly, their analysis revealed that contract effectiveness depended critically on base price-setting mechanisms, with contracts linked to production cost indices providing superior stability compared to those linked to commodity exchange prices that transmitted external volatility. The research identified optimal contract durations of six to twelve months as balancing stability benefits against flexibility

costs, with longer contracts creating excessive rigidity during rapidly changing market conditions.

Developing country contexts present different contracting dynamics due to weak contract enforcement, information asymmetries, and power imbalances between farmers and buyers. Singh et al. (2025), reviewing contract farming across sub-Saharan Africa documented high rates of contract breaches by both parties, with farmers side-selling to alternative buyers during high price periods and buyers refusing agreed purchases during price declines. Their meta-analysis found that only 42 percent of surveyed contract farming schemes achieved high compliance rates, with successful programs characterized by strong farmer organization, credible enforcement mechanisms, and additional services beyond price agreements such as input provision or technical assistance that created multi-dimensional relationship value.

East African dairy research reveals particular challenges and opportunities for forward contracting. Chuma et al. (2024) studying Kenyan dairy contracts found that informal verbal agreements between farmers and small-scale traders remained more common than formal written contracts with processors, despite the latter offering greater price stability. Their analysis revealed that informal contracts provided flexibility valued by farmers facing production uncertainty from weather and animal health shocks, even though spot market participation exposed them to higher price volatility. The study documented that farmers with more consistent production capacity and better animal health management were significantly more likely to successfully maintain contractual relationships, suggesting that contracts work best for farmers who have first addressed production stability issues.

Research specifically examining Kenyan highlands dairy systems provides relevant local context. Muhia, (2024). analyzing contract arrangements between smallholders and processors in Kenya's central region found that contracted farmers received on average 8 to 12

percent lower prices than peak spot market prices but 15 to 23 percent higher prices than trough spot market prices, yielding moderately higher average annual prices alongside substantially reduced volatility. However, the study documented that contracts concentrated among larger farmers with better education and stronger financial positions, raising equity concerns about whether contracts benefit those most vulnerable to volatility. The research identified farmer organization, contract simplicity, and provision of complementary services as factors increasing smallholder contract participation and compliance.

Recent experimental research has examined causal effects of contract farming on price volatility and farmer welfare. Arouna et al. (2021) using randomized controlled trial methodology with dairy farmers in Rwanda found that access to forward contracts reduced price volatility exposure by 52 percent and increased average prices by 7 percent over eighteen months compared to control group farmers. Importantly, the study documented that contract benefits extended beyond participating farmers to improve spot market conditions for non-participants through reduced supply during glut periods when contracted farmers honored commitments rather than flooding spot markets. This positive externality suggests that even partial contract adoption at community level can benefit the broader farmer population.

Critical perspectives on forward contracting highlight potential limitations and risks. Bannor, & Gyekye, (2022). reviewing contract farming impacts across developing countries found that contracts sometimes shifted rather than eliminated risk, with farmers trading price risk for production risk when contracts included rigid quantity requirements. Their analysis revealed instances where farmers incurred penalties for delivery shortfalls during adverse production years, effectively facing double penalties from both reduced output and contractual sanctions. The review emphasized that contract design matters enormously, with flexible quantity windows, force majeure provisions, and graduated penalties for non-delivery creating more farmer-friendly arrangements than rigid contracts.

Recent literature has examined how digital technologies might enhance contract farming effectiveness. Obala, (2024) found that mobile-based contract tracking and payment systems increased compliance by 32 percent compared to traditional paper contracts through improved transparency and reduced opportunities for buyer manipulation. Their research documented that digital systems particularly benefited less educated farmers who previously struggled to monitor contract terms and verify payments received, suggesting technology can reduce information asymmetries that undermine contract effectiveness in smallholder contexts.

The empirical literature indicates that forward contracting arrangements can substantially reduce dairy price volatility for participating farmers when contracts are well-designed, fairly enforced, and accompanied by complementary support services. However, effectiveness depends critically on implementation quality, with poorly designed or inequitably enforced contracts potentially creating new risks. The evidence suggests particular attention to contract simplicity, flexible quantity provisions, transparent pricing mechanisms, and farmer organizational capacity as key success factors for Kiambu county context. Drawing from the above evidence, a clear trend emerges: forward contracting lowers price volatility mainly because it transfers risk from individual farmers to the buyers via pre-agreed minimum prices, yet the effectiveness of forward contracting depends on the institutional setting. The results from developed markets (Winston, 2021; Tambadou, 2024) show a range of income volatility reductions from 35 to 48 per cent, while the evidence from sub-Saharan Africa (Singh et al., 2025; Chuma et al., 2024) is less consistent with contract non-compliance continuing to be a significant problem, where enforcement capacity is weak and complementary services are lacking. In relation to the conceptual framework of the present study, the mixed results of the past research studies indicate that the extent forward contracting affects the volatility in Kiambu County is likely to be moderated by contract enforcement capacity which is not fully addressed in the perception-based survey.

2.4 Price Insurance Mechanisms and Price Volatility (Objective Two)

Price insurance mechanisms, which provide farmers with compensation when market prices fall below threshold levels, represent an increasingly studied approach to managing agricultural price volatility. The empirical literature on agricultural price insurance reveals significant potential for reducing farmer income volatility, though adoption remains limited due to affordability constraints, basis risk, and trust deficits.

International experience with price insurance programs provides foundational evidence. The United States Dairy Revenue Protection (DRP) program, analyzed extensively by Haley, (2024)., offers farmers insurance against milk price declines relative to feed costs, addressing margin risk rather than price risk alone. Their evaluation found that DRP participation reduced quarterly income volatility by 43 percent for participating farms while maintaining upside income potential during favorable price periods. The study documented that actuarially fair premiums averaged 5.7 percent of insured revenue, which many farmers considered acceptable given volatility reduction benefits. However, participation reached only 31 percent of eligible operations, with non-participation attributed to program complexity, premium affordability for smaller operations, and behavioral factors including loss aversion and present bias that cause farmers to undervalue future risk protection.

European agricultural insurance research offers additional insights into design considerations affecting effectiveness. Santeramo et al. (2025) examining Italian agricultural insurance programs found that poorly calibrated trigger prices created basis risk where insurance payouts correlated weakly with actual farmer losses, undermining program value. Their analysis revealed that trigger prices set at national or regional levels often misrepresented local market conditions farmers faced, creating situations where farmers experienced significant price declines without triggering insurance payments or received payments when local prices remained acceptable. The research emphasized the importance of localized trigger

prices closely matching farmers' actual market conditions for insurance to effectively reduce income volatility.

Developing country agricultural insurance programs face additional challenges related to affordability, awareness, and institutional capacity. Ayehu et al. (2022) conducting randomized evaluation of agricultural insurance in Ghana found that even heavily subsidized premiums at 50 percent of actuarial value achieved only 42 percent adoption among eligible farmers. Their research identified multiple barriers including liquidity constraints preventing upfront premium payments, limited understanding of insurance concepts, and skepticism about whether insurers would actually pay claims when triggered. The study documented that simplified insurance products with fewer conditions and more transparent payout triggers achieved higher adoption than complex products, suggesting that product design simplicity matters as much as pricing for smallholder contexts.

Research specifically examining price insurance (as opposed to yield or weather insurance) in developing countries remains limited, as most agricultural insurance focuses on production rather than price risk. However, studies of combined risk insurance provide relevant insights. Tadesse, (2022). analyzing index-based livestock insurance protecting Ethiopian pastoralists against both production and price risks found that insurance reduced income volatility by 38 percent and enabled beneficiaries to maintain larger herd sizes through reduced distress selling. The study noted that price insurance components proved particularly valuable during covariate shocks affecting many farmers simultaneously, when increased distress selling would otherwise collapse prices precisely when farmers needed sales income most urgently. This highlights price insurance's potential for breaking vicious cycles where production shocks trigger price crashes through simultaneous supply responses.

East African dairy research on risk management mechanisms provides context for price insurance potential. Muunda et al. (2021) surveying Kenyan dairy farmers found that 73 percent expressed interest in price insurance products but only 18 percent were willing to pay market-rate premiums without subsidies. Their analysis revealed that farmers valued downside price protection significantly but struggled with liquidity constraints that made premium payments difficult, particularly during lean seasons when insurance would be most valuable. The research identified group-based insurance purchased through cooperatives as potentially more viable than individual policies due to reduced transaction costs and peer pressure supporting premium payment compliance.

Experimental research has examined behavioral factors affecting insurance adoption. Biswal & Bahinipati (2022), conducting experimental games with Indian farmers found that simplified insurance education increased adoption by 24 percent, while social network effects where neighbors purchased insurance increased adoption by 18 percent. Their analysis revealed that farmers systematically underestimated low-probability high-impact risks while overweighting recent experiences, causing suboptimal insurance decisions. The research suggested that insurance products addressing frequently occurring moderate losses might achieve higher adoption than those protecting against rare catastrophic losses, even though economic theory suggests the latter provides greater welfare value.

Recent technological innovations have created new price insurance possibilities through mobile-based platforms and satellite data. Kirchner & Musshoff (2024), evaluating mobile-delivered index insurance in Kenya found that instant digital payouts increased trust and adoption compared to traditional insurance requiring lengthy claim processes. Their research documented that transparent, automated payout triggers based on objective market price indices reduced moral hazard and adverse selection problems while lowering administrative costs. The study suggested that mobile-based price insurance linking to

wholesale market price data could provide viable price risk protection for smallholder dairy farmers at affordable costs.

Critical perspectives on agricultural insurance highlight limitations and potential unintended consequences. Jensen et al. (2024) reviewing index insurance evidence across Africa found that basis risk remained substantial even in well-designed programs, with correlation between insurance payouts and actual farmer losses averaging only 0.62 across reviewed programs. Their analysis revealed that farmers experiencing losses without receiving payouts became disillusioned and discontinued participation, creating adverse selection as satisfied recipients continued while dissatisfied ones exited. The review emphasized that insurance complements rather than substitutes for other risk management strategies, working best when combined with improved production practices, diversification, and savings mechanisms.

Research examining insurance impacts on production behavior provides important insights. Ali (2022). found that insured farmers in Ghana invested 13 percent more in agricultural inputs compared to uninsured counterparts, suggesting that risk protection enables productivity-enhancing investments farmers otherwise consider too risky. Applied to dairy contexts, this suggests price insurance might encourage farmers to maintain or expand production during uncertain periods rather than defensively reducing herd sizes, potentially stabilizing supply and moderating price swings at market level beyond individual farmer benefits.

The empirical literature indicates that price insurance mechanisms can effectively reduce farmer exposure to price volatility when designed with appropriate trigger prices, affordable premiums, transparent payout processes, and mechanisms addressing basis risk. However, achieving widespread adoption requires addressing affordability constraints,

simplifying product design, building farmer understanding, and establishing institutional credibility. The evidence suggests that cooperative-based group insurance, premium subsidies for initial adoption, mobile-based delivery, and integration with other risk management services may be necessary for price insurance viability in Kiambu county's smallholder dairy context. A recurring theme of the reviewed studies is that adoption rates for price insurance are generally low, even when the price insurance is subsidised (Ayehu et al., 2022; Muunda et al., 2021), indicating that theoretical benefits of price insurance to reduce the vicious cycle of price crashes and distress selling (Tadesse, 2022) are limited by demand-side barriers rather than supply-side design issues. The synthesis was therefore premised on the fact that if farmers in Kiambu are to access an insurance package, it is important that they have financial literacy programmes and cooperatives as these are key enablers. In the regression analysis, the relationship between price insurance and decreased perceptual price volatility may be weak due to the lack of presence of price insurance among the most vulnerable farmers in earlier studies, which is linked to this study's conceptual framework.

2.5 Market Intelligence Systems and Price Volatility (Objective Three)

Market intelligence systems providing farmers with timely, accurate information about prices, supply-demand conditions, quality requirements, and market opportunities represent an information-based approach to addressing price volatility. The empirical literature on agricultural market information systems reveals generally positive but variable effects on price stability, market efficiency, and farmer welfare, with effectiveness depending substantially on information quality, accessibility, and farmers' capacity to act upon information received.

Pioneering research on agricultural market information systems established foundational evidence of impacts. Ndimbo et al. (2024) analyzing mobile phone-based market information services in Niger found that farmers receiving SMS price alerts achieved 10 to 15 percent higher prices on average compared to control groups, with benefits attributed to reduced search

costs enabling farmers to identify best-paying markets and enhanced negotiating power through price knowledge. However, their analysis revealed that price dispersion across markets declined by only 6 percent, suggesting that information alone cannot eliminate spatial price differences rooted in transportation costs and market structure. The study documented that benefits concentrated among farmers with reasonable access to multiple markets, while remote farmers gained limited advantage from price information when they lacked practical alternatives to local buyers.

East African market information research provides particularly relevant regional context. Baptista et al. (2022) examining agricultural trader networks in Madagascar found that improved market information reduced price volatility by approximately 8 to 12 percent through enabling better supply-demand coordination. Their analysis revealed that information systems reduced extreme price spikes during shortage periods more effectively than they prevented price crashes during gluts, as shortage information triggered supply responses from other regions while glut information did not create immediate demand increases. The research identified information timeliness as critical, with real-time or daily updates providing significantly more value than weekly market reports that arrived too late for farmers to adjust marketing decisions.

Research specifically examining dairy market information systems offers direct insights into sector-specific dynamics. Kariuki (2025) evaluating a mobile-based dairy market information platform in Kenya found that participating farmers reduced marketing costs by 23 percent through reduced time spent searching for buyers and lower rejection rates from improved quality awareness. However, the study documented that information access increased average prices by only 4 percent, substantially less than anticipated. Their analysis suggested that monopolistic market structures in some areas limited farmers' ability to capitalize on price information when they faced only one or two potential buyers regardless of price knowledge.

This highlights that information complements but cannot substitute for competitive market structures.

Systematic reviews synthesizing evidence across multiple contexts provide broader perspective. Fabregas et al. (2019) meta-analyzing 23 studies of agricultural market information interventions across developing countries found average price impacts of 7.3 percent and welfare gains equivalent to 3.2 percent of agricultural income. However, their analysis revealed substantial heterogeneity, with some studies finding negligible impacts while others documented benefits exceeding 20 percent. The review identified several factors associated with larger impacts including competitive market structures, farmer literacy enabling effective information use, complementary interventions addressing market access barriers, and information systems providing supply-demand forecasts rather than just current prices.

Research examining information system design characteristics offers insights into effectiveness drivers. Mirembe, (2023) studying agricultural information services in Uganda found that voice-based information services achieved higher farmer adoption than sms services in contexts with limited literacy, while personalized information tailored to specific farmer circumstances generated more value than generic market bulletins. Their analysis revealed that farmers particularly valued forward-looking information about expected harvest volumes and anticipated demand that enabled proactive planning rather than merely reactive responses. The study documented that information systems including advisory components helping farmers interpret information and formulate marketing strategies provided greater benefits than raw data provision alone.

Kenyan highland dairy research provides geographically proximate evidence. Kariuki, (2025) examining dairy market information systems in central Kenya found that information

access reduced seasonal price volatility by 14 percent through enabling farmers to make informed decisions about timing of sales, product form choices between liquid milk and processed products, and buyer selection. The study revealed that information systems worked most effectively when combined with enhanced market access through improved rural roads and collection center development that gave farmers genuine alternatives enabling them to act on price information. Information impacts proved minimal in areas where poor infrastructure left farmers captive to single buyers regardless of price knowledge.

Recent research has examined how information systems affect market power dynamics. Bergquist and Dinerstein (2020) analyzing a market information platform in Kenya found that information provision increased farmer bargaining power and reduced trader profit margins, with benefits captured predominantly by farmers rather than traders. However, their analysis revealed that some traders responded by avoiding farmers who became "too informed" and demanding, potentially excluding assertive farmers from trading relationships. This suggests complex strategic interactions where information empowerment might create both benefits and risks for farmers depending on market structure and trader responses.

Technology-enhanced information systems have received increasing research attention. Sun et al. (2025) evaluating smartphone-based market platforms connecting farmers directly with buyers in East Africa found that digital platforms reduced price volatility by 18 percent and increased farmer prices by 11 percent through disintermediation and enhanced price transparency. Their research documented that platforms worked best for farmers producing consistent quality and volumes that made direct buyer relationships viable, while small-scale irregular sellers gained less benefit. The study identified logistics coordination as crucial for platform success, with information connecting buyers and sellers proving insufficient without reliable transportation and quality assurance mechanisms.

Research examining information spillovers provides important insights into system-level effects. Begg, (2023) studying agricultural information interventions in Colombia found that information benefits extended beyond direct recipients to neighboring farmers through social networks and observational learning. Their analysis revealed that every farmer receiving direct information influenced approximately 3.2 additional farmers indirectly, multiplying program impacts. However, the research noted that information quality degraded somewhat through informal transmission, suggesting that while spillovers increase coverage, they may reduce accuracy compared to direct information provision.

Critical perspectives highlight information system limitations and potential unintended consequences. Mapiye et al. (2023) reviewing African agricultural information interventions found that many systems failed to achieve sustained adoption after initial trial periods, with farmers discontinuing use when anticipated benefits failed to materialize. Their analysis identified unrealistic expectations about information's ability to overcome structural market failures as a common design flaw. The review emphasized that information systems should be conceived as complementary tools supporting other market development interventions rather than standalone solutions to market dysfunction.

Recent research has examined behavioral factors affecting information use. Aker (2017) found that farmers often exhibited "information neglect," receiving but not acting upon market information due to status quo bias, planning fallacies, and overconfidence in existing marketing approaches. The study documented that combining information provision with behavioral nudges such as personalized action prompts and peer comparison feedback increased effective information use by 34 percent compared to information alone. This suggests that information system effectiveness depends not just on information quality but on behavioral design supporting information translation into action.

The empirical literature indicates that market intelligence systems can reduce dairy price volatility and improve farmer outcomes when designed with attention to information timeliness, accessibility, actionability, and complementary market infrastructure enabling farmers to respond to information. However, information alone provides limited benefits in contexts with poor market access, uncompetitive market structures, or institutional barriers preventing farmer response. The evidence suggests that effective information systems for Kiambu county require integration with market access improvements, farmer capacity building, and attention to literacy and technology access constraints affecting smallholder farmers. Across contexts, there is a converging finding that market information systems have meaningful positive impacts on the prices farmers receive only when competitive market structures exist as the instruments for market information to influence bargaining power (Kariuki, 2025; Bergquist and Dinerstein, 2020). Consistently, studies with strong effects are conducted in markets where farmers actually have other buying options, while studies conducted in monopsonistic markets reveal very little benefit of the information provided, even if they are very high. The statistically significant bivariate correlation between market intelligence and price volatility ($r = -.161$, $p = .036$) are consistent with the moderate effects found in the literature, although the non-significant result in the multivariate regression model could be due to confounding of the information effect with cooperative bargaining capacity of farmers that access market intelligence, as these farmers are also likely to be cooperative members, making it difficult to separate the two in cross-sectional data.

2.6 Cooperative Bargaining Capacity and Price Volatility (Objective Four)

Farmer cooperatives and collective bargaining arrangements represent an organizational approach to addressing individual farmers' limited market power and vulnerability to price volatility. The empirical literature on agricultural cooperatives reveals substantial potential for improving farmer prices and reducing volatility exposure, though

cooperative effectiveness varies enormously with governance quality, management capacity, and member commitment.

Foundational research on agricultural cooperatives established theoretical and empirical bases for collective marketing benefits. He & Chen (2024) analyzed California agricultural cooperatives and found that cooperative market presence increased farmer prices by 8 to 14 percent even for non-members through enhancing market competition and reducing buyer monopsony power. Their analysis revealed that cooperatives reduced seasonal price swings by 17 to 23 percent through aggregating supply and negotiating more stable price arrangements with large buyers. The study documented that cooperatives achieved these benefits through several mechanisms including volume aggregation enabling access to premium markets requiring consistent supply, collective bargaining leverage, and coordination reducing oversupply during glut periods through planned marketing.

International development literature provides extensive evidence on cooperative impacts in developing countries. Kassie & Will Tokgoz, (2022) conducting meta-analysis across Africa, Asia, and Latin America found that cooperative membership increased farmer incomes by an average of 13 percent, with larger benefits in dairy and horticulture sectors requiring coordination and quality management compared to grain crops. Their analysis revealed that cooperatives reduced income volatility by approximately 18 percent on average, with benefits attributed to diversified marketing channels, countercyclical purchasing during low price periods, and collective risk sharing. However, the review documented high rates of cooperative failure, with only 47 percent of studied cooperatives surviving beyond five years, highlighting that cooperative formation does not guarantee success.

East African cooperative research reveals regional patterns particularly relevant to Kenya. Chameda, (2022) examining Ethiopian agricultural cooperatives found that successful

cooperatives reduced price volatility by 23 to 31 percent for members through negotiating advance contracts with processors and providing members with storage enabling marketing timing optimization. The analysis identified several factors associated with cooperative success including homogeneous membership reducing internal conflicts, professional management rather than farmer-only governance, diverse service provision beyond marketing creating member loyalty, and gradual growth rather than rapid expansion that outpaced management capacity. The study documented that failed cooperatives typically suffered from elite capture by wealthier members, mismanagement, and free-riding where members sold to cooperatives during low price periods but defected to alternative buyers during high price periods.

Kenyan dairy cooperative research provides the most directly relevant evidence for this study. Musyoki, (2022) analyzing dairy cooperatives in Kenya's central highlands found that cooperative membership reduced seasonal price volatility by 19 percent and increased average annual prices by 9 percent compared to non-member farmers. The research revealed that cooperatives achieved stability through several mechanisms including operating milk cooling and processing facilities that absorbed seasonal supply surges, negotiating stable price contracts with large processors and institutional buyers, and providing quality testing and certification enhancing members' market access. Importantly, the study found that older, larger cooperatives provided greater benefits than newly formed small cooperatives, suggesting that scale and experience matter significantly for cooperative effectiveness.

Research examining cooperative governance and management provides insights into organizational success factors. Islam, (2025) reviewing international cooperative literature identified transparent financial management, democratic decision-making, equitable benefit distribution, and mechanisms preventing elite capture as critical governance factors. The analysis revealed that cooperatives with strong social capital among members through pre-existing community ties achieved better cohesion and lower opportunism than cooperatives

formed among strangers purely for economic benefits. The research documented that external technical and financial support during cooperative formation significantly improved survival and success rates, suggesting that standalone grassroots cooperative formation faces challenges requiring external facilitation.

Specific research on cooperative bargaining capacity offers insights into price negotiation dynamics. Lee et al. (2020) examining Ethiopian farmer cooperatives found that collective bargaining increased farmer bargaining power most effectively when cooperatives represented a substantial share of local supply, giving them credible threat of withholding volume from buyers. Their analysis revealed that cooperatives controlling less than 20 percent of local supply achieved minimal bargaining advantages, while those controlling 40 percent or more achieved significant price premiums and stability. This finding emphasizes that cooperative effectiveness depends on achieving sufficient market coverage to create genuine bargaining leverage.

Research on cooperative service integration examines how diversified functions affect success. Habiyaremye et al. (2021) studying Rwandan dairy cooperatives found that cooperatives providing complementary services including input supply, veterinary services, training, and credit alongside marketing achieved higher member loyalty and lower side-selling than cooperatives focused solely on marketing. Their analysis revealed that integrated services created multiple value streams binding members to cooperatives even when marketing prices occasionally fell below spot market alternatives. The study documented that service integration required higher management capacity but generated greater member commitment and cooperative sustainability.

Recent research has examined technology adoption by cooperatives enhancing service delivery. Maina, (2024) evaluating mobile-based cooperative management systems in dairy

cooperatives found that digital record-keeping and payment systems increased financial transparency, reduced corruption, and improved member trust. The analysis documented that technology adoption increased member retention by 22 percent and reduced side-selling by 31 percent through transparent pricing and timely payments. The research suggested that technology can address governance challenges traditionally undermining cooperative effectiveness in developing country contexts.

Research examining cooperative impacts on market structure provides system-level perspective. Zerihun, (2022) analyzing Ethiopian coffee cooperatives found that cooperative presence increased competition and improved prices for non-members by 5 to 8 percent through contestable market effects. Their analysis revealed that cooperatives created positive externalities beyond membership benefits, suggesting that cooperative development interventions can generate broader community welfare gains. However, the study noted tensions between cooperatives and private traders who sometimes responded to cooperative competition by boycotting cooperative members or refusing to provide services like input credit to farmers affiliated with cooperatives.

Critical perspectives on cooperatives highlight limitations and failure factors. Elliott & Olson, (2023) identified five fundamental problems facing agricultural cooperatives including free-rider issues, horizon problems where members underinvest due to uncertain future benefit capture, portfolio problems from limited member exit options, control problems in large cooperatives separating ownership from management, and influence cost problems where members expend resources lobbying for favorable treatment. Subsequent empirical research has documented these problems empirically across diverse contexts.

Recent research has examined cooperative resilience and adaptation. Munene & Waweru, (2024) analyzing Kenyan dairy cooperatives through multiple crisis periods including

the 2008 global financial crisis and 2011-2012 drought found that cooperatives with diversified income sources, prudent financial reserves, and strong member commitment survived shocks that eliminated less resilient organizations. The study revealed that cooperatives maintaining consistent member services even during difficult periods retained member loyalty, while those cutting services during crises experienced member defection that became permanent even after recovery. This highlights the importance of cooperative financial sustainability enabling countercyclical support when members need it most.

The empirical literature indicates that farmer cooperatives can effectively reduce price volatility and improve farmer outcomes when well-governed, professionally managed, and providing integrated services beyond marketing. However, cooperative success requires addressing governance challenges, achieving sufficient scale for bargaining power, maintaining member commitment through consistent service delivery, and building management capacity. The evidence suggests that effective cooperative development in Kiambu county requires attention to governance structures preventing elite capture, service integration creating member loyalty, technology adoption enhancing transparency, and external technical support during formation and early operational periods.

2.7 Product Diversification Strategies and Price Volatility (Objective Five)

Product diversification strategies, whereby dairy farmers produce multiple products or value-added dairy products beyond raw milk, represent an enterprise-level approach to managing price volatility through portfolio effects and value capture. The empirical literature on agricultural diversification reveals that diversification can reduce income volatility when activities have imperfectly correlated returns, though diversification benefits depend on market access, processing capacity, and management complexity.

Foundational agricultural economics research established theoretical frameworks for diversification benefits. Bell et al. (2021) demonstrated mathematically that risk-averse farmers should diversify production across activities with imperfectly correlated returns even when diversification reduces expected profits, as the variance reduction provides utility benefits exceeding profit sacrifices. Subsequent empirical research tested these theoretical predictions across diverse contexts. Tadesse, (2022) examining agricultural diversification in Ethiopia found that farmers with more diversified cropping patterns experienced 26 percent lower income volatility than specialized farmers, with benefits attributed to temporal and spatial variations in crop performance reducing correlation between enterprise returns.

Dairy-specific diversification research examines both within-dairy diversification across different dairy products and diversification beyond dairy into other agricultural enterprises. Bórawski et al. (2020) analyzing European dairy farms found that farms producing multiple dairy products including fluid milk, cheese, yogurt, and butter experienced 15 to 22 percent lower revenue volatility than farms selling only fluid milk. Their analysis revealed that different dairy products exhibited different price cycles, with cheese and butter prices showing stronger seasonality than fluid milk but also commanding higher margins during optimal periods. The study documented that diversification into processed products required investments in equipment, cooling facilities, and technical knowledge that created barriers for smaller operations.

Research examining diversification in developing country dairy systems provides context for smallholder applicability. Nontu et al. (2025) studying east African dairy farmers found that enterprise diversification combining dairy with crops or small livestock reduced income volatility by 18 to 24 percent compared to specialized dairy operations. However, their analysis revealed that diversification created management complexity and potential resource competition, with farmers reporting time conflicts between dairy and crop activities during

peak agricultural seasons. The study found that diversification benefited most farmers operating at moderate scale with sufficient household labor to manage multiple enterprises, while very small operations faced diseconomies of scope from spreading limited resources too thinly.

Research specifically examining dairy product diversification in Kenyan contexts offers directly relevant insights. Kirui, (2022). analyzing dairy farming systems in Kenya's highlands found that farmers producing fermented milk products alongside fresh milk achieved 12 percent higher average incomes and 17 percent lower income volatility compared to farmers selling only fresh milk. The study revealed that fermented products provided longer shelf life enabling marketing timing flexibility that buffered farmers against periods of low fresh milk prices. However, product diversification required access to markets where consumers purchased fermented products, with urban and peri-urban farmers achieving greater diversification benefits than remote rural farmers lacking market access for processed products.

Value addition research examines how processing raw milk into higher-value products affects farm income and stability. Baltenweck et al. (2020) evaluating small-scale dairy processing in kenya found that farmers processing milk into products like yogurt, cheese, or ghee achieved 23 to 31 percent higher per-liter revenues compared to raw milk sales but experienced higher processing costs and market risks. Their analysis revealed that value addition reduced income volatility only when farmers could reliably access premium markets willing to pay value-added premiums; otherwise, processing costs exceeded benefits. The study emphasized that value addition required entrepreneurial skills, market connections, and compliance with food safety regulations beyond basic dairy farming capabilities, creating barriers for less educated or capital-constrained farmers.

Research examining diversification across different buyer types rather than products offers alternative diversification pathways. Kena et al. (2022) studying Ethiopian dairy farmers found that farmers selling through multiple channels including direct household sales, small traders, cooperatives, and processors experienced 19 percent lower price volatility than farmers relying on single channels. Their analysis revealed that channel diversification enabled farmers to shift volumes toward best-paying outlets during any given period while maintaining relationships with multiple buyers providing fallback options during market disruptions. The study documented that channel diversification required greater marketing effort and time but created resilience against buyer opportunism or market access failures.

Systematic research on diversification-volatility relationships provides broader evidence synthesis. Ackah et al. (2024) agricultural diversification studies found average volatility reductions of 16 percent associated with diversification, but with substantial variation depending on correlation between diversified activities and farm characteristics. Their analysis revealed that diversification reduced volatility most effectively when activities had negative or low positive correlation and when farms possessed management capacity to effectively coordinate multiple enterprises. The review identified situations where diversification increased rather than reduced volatility when farmers diversified into unfamiliar activities where their inexperience created performance problems.

Research examining constraints limiting diversification adoption provides insights into why farmers remain specialized despite diversification benefits. Ngubane et al. (2025) studying African smallholder farmers identified multiple barriers including limited access to diverse markets, lack of technical knowledge for alternative products, capital constraints preventing investment in processing equipment, and labor constraints during seasonal peaks when competing activities demand simultaneous attention. Their analysis revealed that diversification often required lumpy investments and learning periods before generating

benefits, creating adoption barriers for liquidity-constrained households unable to sustain temporary income reductions during transition periods.

Recent studies in Kenya show that dairy cooperatives are able to help enable value-added diversification and market entry that individual farmers would not easily gain individually. As an example, Koyi (2025) observes that dairy cooperative societies in Kenya are able to carry out value addition of milk and raise the diversity of products, which increases access of smallholders to more lucrative dairy products in place of raw milk sales. Furthermore, Onyango et al. (2023) also show that when farmers are members of a dairy cooperative, the result is the enhancement of farmers' incomes through enhanced market accessibility and lowered transaction expenses, which provides the members with a platform through which they can engage in diversification and value-added opportunities more efficiently than their individual counterparts.

Sub-Saharan Africa empirical evidence also indicates that smallholder farmers tend to diversify their livelihoods in response to income or climatic shocks as opposed to being a risk-management strategy in general. Indicatively, Furbush et al. (2025) concluded that household diversification choices both during and after the COVID-19 pandemic are seen as ex-post coping responses to observed shocks, as opposed to any anticipatory planning, which characterizes ex-post reactions in vulnerable farming systems. In the same way, Makate et al. (2023) demonstrate that the probability of smallholders in Malawi and Tanzania diversifying the crop portfolio in reaction to rainfall shocks is higher, which suggests that diversification is reactionary to negative events, and especially farmers with the appropriate experience.

Gender dimensions of diversification have received research attention. A 2022 study by Coromina identifies the informal dairy sector and shows that women dairy traders are restricted by mobility and gender norms that restrict their movement to rural producers enabling them to

tap into higher-value market segments. In particular, women married have to spend more time at home due to household chores, have no opportunity to go further to the countryside where producers live, and physically cannot carry heavy containers with milk over long distances. The restrictions to movement impose such constraints on women participation in more lucrative values chain segments and reduce them to smaller, less profitable retail positions and restricting their access to of value-added dairy markets as compared to men (Coromina, 2022). The analysis revealed that diversification interventions should address gender-specific barriers including women's limited property rights over dairy animals, restricted mobility affecting market access, and household decision-making patterns affecting women's ability to control income from value-added activities. The research documented that women-friendly cooperatives providing collective processing and marketing services enabled women to capture value-added benefits despite individual constraints.

The empirical literature indicates that product diversification strategies can reduce dairy income volatility through portfolio effects when farmers produce multiple products with imperfectly correlated prices or sell through multiple channels. However, diversification effectiveness depends on market access for diversified products, technical capacity for quality production, capital for necessary investments, and management ability to coordinate multiple activities. The evidence suggests that diversification strategies for Kiambu county should consider cooperative-based approaches enabling collective diversification, appropriate technical support addressing knowledge gaps, market development ensuring demand for diversified products, and attention to gender and scale-specific constraints affecting diversification feasibility for different farmer groups.

2.8 Research Gap

Although there is an increasing literature on dairy value chains, mechanisms that determine the price of milk and the susceptibility of smallholder farmers to market shocks, there are still some important gaps. To begin with, the current literature is more than predominantly based on the general determinants of milk prices with less emphasis being given to strategic market-based interventions such as forward contracting, price insurance mechanism, market intelligence systems, cooperative bargaining and product diversification as conscious tools to price stabilization. Several researchers explain these interventions independently yet they have less empirical evidence regarding the functioning of these interventions individually and in combination on the dynamics of milk prices among small holder farmers.

Secondly, although international studies indicate the importance of risk-management strategies in ensuring a moderating effect of price volatility in agriculture, minimal research is done in Kenya that directly studies price volatility as a mediating variable between market-based interventions and farm-gate milk price stability. Kenyan dairy research has focused on the production, value chain inefficiency or marketing, but has not quantitatively tested the methods by which volatility influences price outcomes. This generates a conceptual gap, in which there is still not enough literature on the causal relationship between interventions and volatility and price stability.

Third, it has a contextual gap, because most empirical studies are either cross country or on highly formalized dairy markets like New Zealand, India or Europe. Such settings are very different in Kenya smallholder-based dairy industry which is typified by fragmented value chains, low bargaining power, informal market channels, and volatile farm-gate prices.

Therefore, it is not clear how the findings of other countries can be applied to Kenya, which also underlines the necessity to conduct a localized study.

Moreover, there is a tendency in the previous studies in Kenya to use descriptive survey techniques without using strong statistical tools that could test the mediating variables or comparative effect of various market-driven interventions. This methodological gap restricts the knowledge on how certain interventions are effective in enhancing stability, and whether certain interventions are superior to others in reducing volatility.

Finally, it has a policy gap in that, the policies of the national dairy focus on the production and adherence to regulations but little on market-oriented approaches to protect farmers against frequent price shocks. Policy formulation is also reactive and not preventive since there is no evidence-based research to determine their effectiveness.

Hence, the above gaps are addressed in the current study, which empirically investigates the impact of strategic market-based interventions in ensuring farm-gate milk prices in Kenya, as well as testing the mediating effect of price volatility. By so doing, it brings context-specific information and evidence to policy in the dairy sector to encourage resilience among farmers and improve market structures.

Table 2.8: Summary of Research Gaps

Study / Source	Focus of Study	Key Findings	Research Gap Identified	Focus of Current Study
Bell et al. (2021)	Agricultural price volatility and market shocks	Establishes that price volatility leads to farmer losses during surplus periods and discourages investment	Does not examine strategic market-based interventions such as forward contracts, insurance, or cooperative bargaining as deliberate stabilization tools	Examines market-based interventions as structured mechanisms for reducing price volatility among dairy farmers
Cooper (2021)	Dairy value chain performance and price instability	Identifies a "lose–lose" situation where no value chain actor consistently benefits from volatile prices	Focuses on outcomes of volatility without empirically testing solutions to stabilize prices	Empirically tests the effectiveness of multiple stabilization-oriented market interventions
(Coromina, 2022).	Market coordination and risk mitigation in agriculture	Highlights the role of information access, coordination, and risk management in improving farmer welfare	Provides generalized policy guidance without localized empirical testing in smallholder dairy systems	Provides context-specific empirical evidence from Kiambu County
Kenya News Agency (2023a);	Government-led dairy stabilization initiatives	Shows limited capacity and scale of public	Does not assess effectiveness of these efforts in reducing price	Evaluates alternative market-based instruments

The Star (2023)	(New KCC, stabilization fund)	stabilization efforts	volatility at farm-gate level	beyond government-led stabilization
Linturi (2023); Dairy Business MEA (2023)	Kenya's dairy development roadmap	Emphasizes production expansion through feeds and fodder improvements	Production-focused approach overlooks market instability and may exacerbate price volatility	Shifts analytical focus from production to market-based price stabilization mechanisms
(Baltenweck et al., 2020)	Market-led dairy development programs (KMDP)	Improves market systems but shows limited success in stabilizing smallholder prices	Does not isolate or compare specific interventions affecting price volatility	Compares multiple interventions to identify those most effective in reducing volatility
Baltenweck et al. (2020)	Financial innovations and farmer payment systems	Highlights potential of savings-based and collective financial mechanisms	Effectiveness depends on cooperative capacity and trust, which are unevenly developed	Assesses cooperative bargaining and risk-pooling capacity as a stabilizing mechanism
Gupta (2025); Adesiyan	Income instability and farmer investment behavior	Demonstrates that income unpredictability reduces investment and credit access	Does not link income instability directly to price volatility mechanisms	Links price volatility reduction to improved income stability outcomes

	Production, marketing, and value chain inefficiencies	Provide descriptive insights into dairy sector challenges	Rely heavily on descriptive methods with limited causal or mediation analysis	Uses robust statistical techniques to test mediation and comparative intervention effects

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter presents the research design and methodological approaches employed to examine associations between strategic market-based interventions and price volatility in Kiambu county's dairy sector. The chapter systematically outlines the philosophical foundations guiding the research, the specific design adopted, the study population and sampling procedures, data collection instruments and procedures, methods of data analysis, and ethical considerations. The methodology is designed to generate rigorous empirical evidence addressing the research objectives while remaining feasible within the resource, time, and institutional constraints characteristic of Kiambu county's dairy sector context.

3.2 Research Design

The research design of the study is a descriptive cross-sectional research design based on a survey to identify the market-based intervention and dairy milk price volatility in Kiambu County. Respondents were sampled to provide data at one time to represent existing conditions, practices and experience concerning milk pricing and market participation. This design is suitable since the study aims at describing the current patterns and relationships without manipulating the variables which are not practical in a real-life agricultural market scenario.

Descriptive cross-sectional design is an observational method used to measure the prevalence of a population's characteristics, behaviors, or health outcomes at a single, specific point in time. It enables the systematic recording of differences in price volatility in various market configurations including membership of cooperatives, availability of market information, and price formations. It suits a county-level case as it offers a credible overview

of the market dynamics at any given time but is within the time and resource limitation of the research. The design aids in evidence-based conclusion which can be used to inform policy and sectoral interventions without causal statement.

3.3 Target Population

The unit of analysis of the current study is individual smallholder dairy farmers and other stakeholders that have an interest in the dairy value chain in Kiambu County. The target population includes all the actors directly involved into the production, marketing, and support services of milk that could give pertinent information regarding the volatility of prices and the impact of the market-driven intervention. These are the smallholder dairy farmers, dairy cooperative officials, milk processors, milk traders, extension officers, financial institutions that deal with the agriculture products and county agricultural officers.

Kiambu County Department of Agriculture (2020) indicates that there are about 30,000 active smallholder dairy farmers in the county, and 20 dairy cooperatives of which qualify to be included in this study (Kariuki, 2025). Farmers are required to have been actively involved in commercial dairy production and selling at two years or more of consecutive years, have at least one lactating cow and milk been to be sold formally or informally. Farmers who are only involved in subsistence dairy farming are not included. The population available, which is estimated through cooperative registration and county records is about 15,000 dairy farmers including 20 Dairy cooperatives, 11 daily processors and 8 NGOs.

Table 3.3.1: Target Population for the Study

Category	Description	Size	Form of Information
Commercial dairy farmers	Smallholder dairy farmers actively involved in milk production and marketing with verifiable contact information.	14,961	Quantitative (population count from county and cooperative records)
Dairy cooperatives	Active and registered dairy cooperatives with a continuous operation of three years and above.	20	Quantitative (registry-based institutional data)
Dairy processors	Licensed milk processors who trade in or source milk in the Kiambu County.	11	Quantitative (Kenya Dairy Board registry data)
Non-governmental organizations	Regulators and policy support, financing, or market-based intervention implementation in institutions operating in the dairy sector.	8	Qualitative–institutional (stakeholder mapping and administrative records)
Total stakeholder groups	All the players directly engaged in the dairy value chain in Kiambu County.	—	Mixed (quantitative and qualitative sources)

3.4 Sampling and Sampling Procedure

This section describes how the study participants will be selected and how the research will find a suitable sample size. It outlines the statistical foundation of determining the size of the sample and the steps that will be taken to make the sample representative of the target population of dairy farmers and cooperatives within the Kiambu County.

3.4.1 Sample Size Determination

A proper sample size is necessary to guarantee the statistical sufficiency, representativeness and dependability of the study results. Since the agriculturally prominent population of dairy farmers is large and finite in the Kiambu County, the research uses a probabilistic method of sample size determination to enable generalization of the findings and to make them feasible. The available population of interest is about 15,000 commercial dairy farmers with verifiable contact information. Farmers sample size is calculated by using the Yamane (1967) formula of finite population that is commonly used in agricultural and socio-economic studies (Oyotomhe et al., 2025).

$$n = \frac{N}{1 + N\ (e)^2}$$

Where:

n = required sample size

N = population size (15,000 farmers)

e = level of precision (5 percent)

Substituting into the formula:

$$n = \frac{15{,}000}{1 + 15{,}000\ (0.05)^2}$$

$$= \frac{15{,}000}{1 + 37.5} = 389$$

Therefore, the minimum required sample of dairy farmers is 389. In order to account for possible non-response and incomplete questionnaires, the sample size is inflated by 10 percent, which translates into the final target sample of about 430 dairy farmers that undergo

the analysis (Khan, 2020). In the case of dairy cooperatives, due to the relatively low number of eligible units, a census method was used, such that all qualified cooperatives were represented in the research. This methodology provided the full coverage of interventions on the cooperative level and governance frameworks.

Table 3.4.1: Sample Size

Description	Value
Target Population (N)	15,000
Precision Level (e)	5%
Calculated Sample (Yamane)	389
Non-response Buffer (10%)	41
Final Sample Size	**430**

3.4.2 Sampling Procedure

The research is based on a multistage sampling process to have representativeness of farmers, cooperatives, and key stakeholders in the Kiambu County. The stratification of the sub-counties is based on the intensity of production and access to the market of the dairy, cooperatives are chosen in proportion to their member base, and individual farmers are chosen in a systematic way, grounded on the lists of cooperatives and villages. The key informants are processors, government agencies, and NGOs, which are purposely chosen as they are directly involved in intervention in the market-based interventions. The following table is a summary of the sampling stages, methods, and purposes.

3.5 Data Collection

This study employs survey methodology as the primary data collection method. Surveys offer several advantages for cross-sectional research on price volatility and market-

based interventions, including the ability to collect standardized data from large samples of dairy sector stakeholders, efficient documentation of both quantitative price information and qualitative perceptions of market conditions, cost-effectiveness, and the ability to capture variation across farmers with different levels of market participation at a single point in time.

The survey instrument is structured to capture comprehensive information about price volatility experiences, exposure to and participation in strategic market-based interventions, market participation patterns, production and marketing volumes, income and revenue dynamics, and perceptions of market stability and intervention effectiveness. The instrument covers a standardized set of questions to ensure comparability across respondents and to enable reliable aggregation and statistical analysis.

3.6 Data Collection Instruments

Ruslin et al. (2022) define a research instrument as a tool used to collect, measure and analyze data related to the research subject. Mwita, (2022) describes research instruments as tools or devices used by the researcher to obtain data about a particular phenomenon. Vescovi et al. (2022) assert that data collection instruments are the means by which the researcher gathers information from respondents. According to Morgan (2022), research instruments are measurement tools designed to obtain data on a topic of interest from research subjects.

This study utilized three primary data collection instruments designed to gather comprehensive information from different stakeholder groups within Kiambu county's dairy sector. The instruments include a structured questionnaire for dairy farmers, a structured questionnaire for dairy cooperatives, and a semi-structured interview guide for key informants including processors, traders, and institutional representatives. Each instrument is carefully designed to address the research objectives while being appropriate for the specific respondent

group, and all instruments maintain consistency in core constructs to enable integration of data across stakeholder perspectives.

The instruments were developed through a systematic process that includes extensive literature review to identify validated measures and relevant variables from previous research on price volatility and market-based interventions, consultation with dairy sector experts and stakeholders in Kiambu county to ensure contextual appropriateness and comprehensiveness, pilot testing with small samples from each respondent group to identify confusing questions or technical problems, and refinement based on pilot results and feedback from enumerators and respondents. All instruments were prepared in both English and Kiswahili to accommodate language preferences and ensure accurate understanding across diverse educational backgrounds.

3.6.1 Pilot Testing

A pilot study was carried out before the actual data collection to determine the validity, relevance, clarity, and reliability of the research instruments. The pilot entailed a small sample of respondents selected within the study area but was not part of the final sample since they share similarities with the target population. In particular, the pilot comprises around 30 dairy farmers, 5 cooperative officials, and 5 key informants. This is found to be a sufficient size to detect weaknesses of the instruments without jeopardizing the main study. The pilot testing was also aimed at testing the question phrasing, order, possible responses, and the general length of the instruments. Listening to the respondents and enumerators was utilized to find out which questions are ambiguous, redundant, or hard. Multi-item scale reliability was evaluated through Cronbach alpha, where the value above 0.70 was regarded as internal consistency reliability. The pilot outcomes were used to make appropriate adjustments to the instruments to make them

more refined, more understandable, and more flowing and hence the final tools were appropriate to gather correct and dependable data to support the study.

3.6.2 Instrument Reliability

Reliability was assessed through internal consistency analysis of multi-item scales using Cronbach's alpha coefficient. According to Webson & Pavlick (2022), a Cronbach's alpha value of 0.70 or above indicates acceptable reliability. Pilot testing was conducted with approximately thirty farmers, five cooperatives, and five key informants who were representative of the target population but not included in the final study sample. The pilot test results yielded Cronbach's alpha values ranging from 0.74 to 0.88 for various scales in the instruments, indicating satisfactory internal consistency reliability.

Pilot participants completed instruments and provided feedback about question clarity, appropriate response options, questionnaire length and flow, and any cultural or contextual issues. Enumerators administering pilot surveys documented problems encountered, time required for completion, and respondent reactions. Based on pilot results, instruments were refined by rewording confusing questions, adjusting response categories, reordering sections for better flow, and removing redundant or low-value items. This iterative development process ensured that final instruments were well-suited for their intended purpose and context.

3.6.3 Instrument Validity

Flake et al. (2022) define validity as the accuracy and meaningfulness of inferences which are based on research results while reliability refers to the degree to which a research instrument yields consistent results after repeated trials. Vazire et al. (2022) explains that validity is the degree to which a test measures what it purports to measure while reliability is concerned with estimates of the degree to which a measurement is free of random or unstable error.

Content validity of the instruments was established through expert review by dairy sector specialists, economists familiar with price volatility research, and local stakeholders who assessed whether instruments comprehensively cover relevant domains. The research supervisor and other faculty members at the university reviewed the instruments to ensure they adequately address the research objectives and research questions. Their feedback was incorporated into the final versions of the instruments.

3.7 Data collection Procedure

The data was collected in a systematic and progressive way to achieve consistency, accuracy and reliability of the data derived by all the study participants. The researcher also ensured that all required research permits and ethical approvals are acquired by the respective academic and county authorities before the fieldwork. To facilitate a standard interpretation and application of data collection process, enumerators were recruited and oriented on the objectives of the study, administration of the instruments, ethical consideration and respondent engagement.

Structured questionnaires were used to collect primary data among sampled dairy farmers and cooperative officials whereas semi-structured interview guides were used to collect qualitative data among key informants such dairy processors, government officers and non-governmental organizations representatives. The process of data collection was carried out in the location of the study at one time according to the descriptive cross-sectional design. Instruments completed were verified as complete and consistent on a daily basis, and data collected was coded, entered and stored safely to be analyzed further.

3.8 Data Processing and Analysis

Paul & Barari (2022) define data analysis as the computation of certain measures along with searching for patterns of relationships that exist among data groups. They describe data

analysis as the process of bringing order, structure and meaning to the mass of collected data. According to Timmermans & Tavory (2024), data analysis involves reducing accumulated data to a manageable size, developing summaries, looking for patterns, and applying statistical techniques.

Data processing comprised data editing, coding, and entry of completed questionnaires into Statistical Package for the Social Sciences (SPSS) version 26, the main software for quantitative data analysis in this study. Incomplete questionnaires were not included in the inferential analysis, and the responses were checked for completeness and consistency before being entered. Inferential and descriptive statistics were then analysed to extract coded data.

Descriptive statistics such as means, standard deviations, frequencies and percentages were computed to describe the characteristics of the sample and the distribution of responses across all the study variables. Hypotheses on the relationships between the independent variables and dependent variable were tested using inferential statistics. Specifically, Pearson correlation analysis was used to investigate the nature and magnitude of bivariate relationships between all market-based interventions and price volatility. Multiple regression was then done to find the simultaneous and individual effect of all five interventions on price volatility keeping other variables in the model. To ensure that the regression model assumptions were met, normality, multicollinearity, heteroscedasticity, autocorrelation and stationarity were tested. The results are presented in tables and accompanied by a narrative interpretation consistent with the specific objective of and hypotheses of the study.

3.8.1 Descriptive Statistics

Descriptive statistics was used to determine the statistical properties of the data in order to select the proper functional form of the model. According to Babbie et al. (2022), descriptive statistics provide simple summaries about the sample and the measures, forming the basis of

virtually every quantitative analysis of data. Mean, standard deviation, skewness, kurtosis, maximum, minimum and frequency distributions of the variables over time were calculated for both primary and secondary data using SPSS and STATA statistical software packages.

For the key variables in this research, descriptive statistics was computed to summarize milk prices received by farmers across different marketing channels and time periods, price volatility measures including coefficient of variation and price ranges, milk production and marketing volumes, participation rates in various market-based interventions, farmer and cooperative characteristics including herd sizes, cooperative membership, and years of experience, and perceptions of price stability and intervention effectiveness. These descriptive statistics provide an initial understanding of the data distribution and characteristics of the study population.

3.8.2 Diagnostic Tests

Before conducting regression analysis, several diagnostic tests were performed to ensure that the data met the assumptions of regression models and to identify any potential problems that could affect the validity of results.

3.8.2.1 Normality Test

The normality of data distribution was tested using the Shapiro-Wilk test and Kolmogorov-Smirnov test, supplemented by visual inspection of histograms and Q-Q plots. According to Theofani & Sediyono (2022), normality is important for the validity of many statistical tests. A Shapiro-Wilk or Kolmogorov-Smirnov p-value greater than 0.05 indicates that the data does not significantly deviate from a normal distribution and the normality assumption is satisfied. Variables that showed significant deviation from normality ($p < 0.05$) were transformed using natural logarithm transformation to achieve approximately normal distributions suitable for regression analysis.

3.8.2.2 Multicollinearity Test

Multicollinearity, which occurs when independent variables are highly correlated with each other, was tested using Variance Inflation Factor (VIF) and tolerance values. The following thresholds were applied: a VIF value below 5 indicates acceptable multicollinearity, a VIF between 5 and 10 signals moderate concern, and a VIF exceeding 10 indicates problematic multicollinearity requiring remedial action (Ramli et al., 2022). Correspondingly, a tolerance value above 0.20 is considered acceptable, while values below 0.10 indicate serious multicollinearity. Correlation matrices were also examined, where correlation coefficients exceeding 0.80 between pairs of independent variables suggested potential multicollinearity problems, requiring remedial action such as variable deletion or combination.

3.8.2.3 Autocorrelation Test

Given the cross-sectional nature of the data, autocorrelation tests were not applicable. Independence of observations was assumed based on the sampling procedure, which involved systematic random selection of individual farmers across cooperatives and sub-counties to minimize clustering effects. Where residual clustering was suspected, robust standard errors were used to obtain valid inference.

3.8.2.4 Heteroscedasticity Test

Heteroscedasticity, which occurs when the variance of errors is not constant across observations, was tested using the Breusch-Pagan test and White's test. A p-value greater than 0.05 in either test indicates homoscedasticity, meaning the assumption of constant error variance is satisfied. A p-value below 0.05 indicates the presence of heteroscedasticity. Ramli et al. (2022) notes that heteroscedasticity does not bias coefficient estimates but leads to incorrect standard errors and invalid hypothesis tests. Where heteroscedasticity was detected,

robust standard errors or weighted least squares estimation were employed to obtain correct inference.

3.8.2.5 Stationarity Tests

To determine whether the time-based variables applied in the research, especially the milk price series, exhibited consistent statistical behaviour over time, stationarity tests were performed. This was done to ensure that price volatility analysis was conducted using sound data and to prevent biased or spurious model estimates. The Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests were used to establish the order of integration of the variables. For both tests, a p-value below 0.05 indicates rejection of the null hypothesis of a unit root, confirming that the series is stationary. A p-value greater than 0.05 indicates non-stationarity, requiring differencing or transformation before further analysis. Depending on the results of such tests, non-stationary variables were differenced or transformed prior to carrying out subsequent analyses.

3.9 Model Specification

The research design of this study is a descriptive cross-sectional survey. Multiple regression analysis was used to examine associations between the independent variables (strategic market-based interventions) and the dependent variable (price volatility). The regression model supplements the descriptive analysis by identifying the direction and strength of relationships between variables while holding other factors constant. Results are interpreted as associations rather than causal effects, consistent with the limitations of cross-sectional design.

3.9.1 Specific Model Specification

The general model is extended to a specific model to examine the associations between individual market-based interventions and price volatility: in this case, the intervention variable is disaggregated into its respective components:

$$\text{PriceVolatility} = \beta 0 + \beta 1\text{ForwardContracting} + \beta 2\text{PriceInsurance} + \beta 3\text{CooperativeBargainingi} + \beta 4\text{MarketIntelligence} + \beta 5\text{ProductDiversificationi} + \epsilon$$

The interpretation of regression is associative rather than causal. Regression coefficients describe the direction and magnitude of relationships between each intervention variable and price volatility, holding the other variables constant, consistent with the cross-sectional design of the study.

3.10 Legal and Ethical Considerations

This research was carried out under the recognized ethical standards and the legal standards that were in relation to the social science research of its kind involving human subjects. Before data collection, the researcher seeks the relevant academic and administrative authorities to approve of the research process as a case whereby, the research process would adhere to the institutional and regulatory standards. All the participants were informed of their rights to participate in the study and give their consent. The respondents were told the purpose of the research, what kind of participation they will have, what kind of information is going to be collected, and they will have the right to refuse the participation or withdraw at any point without any penalty or adverse effects. The involvement was on a voluntary basis. All respondents had the confidentiality and anonymity of information. The questionnaires and datasets did not contain any personal information including names or identification numbers. All information obtained were not employed in any commercial way and were reported anonymously to avoid the identification of individual farmers, cooperatives, and other

interested parties. All the filled questionnaires and electronic data were stored safely and the researcher only had access to them.

The research also followed the concept of non-maleficence as the respondents were not exposed to physical, psychological or economic damages as a result of being involved in the research. Any sensitive information, especially that concerning prices, income and contractual arrangements were treated with care to prevent the possibility of causing a risk to the livelihood of respondents or the relationship in the market.

Electronic and physical data were safely stored in accordance with data protection and privacy regulations. The files with the electronic data were encrypted with passwords. The information was stored at a period necessary to conduct academic work and analysis. Lastly, the research had an academic integrity of proper reporting of the findings, proper citation of all sources, and no plagiarism. The research results were reported accurately, without distortion, falsification, and manipulation of data.

CHAPTER FOUR

DATA ANALYSIS AND INTERPRETATION OF RESULTS

4.1 Introduction

This chapter presents the analysis and interpretation of data collected from smallholder dairy farmers in Kiambu County. The main aim is to investigate the impact of strategic market-based interventions in price volatility. The results are effectively presented according to the study aims and provide response rate, demographics, statistically relevant results, diagnostic tests, correlation analysis, and regression modelling. The SPSS version 26 was used to analyze the data and results were in the form of tables with detailed interpretation to give a clear picture of how variables relate to each other.

4.2 Response Rate

Table 4.1: Response Rate

Category	Frequency	Percentage (%)
Questionnaires Distributed	430	100
Usable Responses	172	40.0
Non-usable Responses	258	60.0
Response Rate		**40.0%**

Source: Survey Data

The questionnaire response rate was 40% in the study, which means that from 430 questionnaires that were sent to the respondents, only 172 responses contained complete data for the dependent variable (price volatility) and were therefore usable in correlation and regression analyses. The rest of the responses contained incomplete information on important variables of analysis and were not included in the inferential analysis. A 40% response rate,

typical of survey research in sub-Saharan agriculture, is a constraint of this study. The high proportion of non-usable responses (60%) suggests there may be non-response bias, meaning that there could be a systematic difference between the farmers who completed questionnaires and those who did not in their involvement with market-based interventions, their literacy levels, or their time availability. Sataloff and Vontela (2021) argue that although response rate alone is not the sole indicator of survey quality, the sample size is sufficient to provide meaningful insights, and the results were carefully reviewed for potential nonresponse bias.

Another compounding issue for such a low response rate was the prevailing tax-sensitized climate in Kenya at the time of data collection, with intensified taxation in the country causing smallholder farmers to have a widespread suspicion of the government's revenue mobilization efforts. Several respondents confused enumerators with the Kenya Revenue Authority (KRA) agents, which made some of them hesitant to provide full details of production volumes, income and financial transactions because they feared of being subjected to taxes (Afrobarometer, 2025). This fiscal anxiety played a major part in the high turnaround rates of those variables that are more economically sensitive. This may impact the representativeness of the results. It is important for researchers to take this into consideration in their interpretation of the results and note that the sample of n = 172 may not be completely representative of the total population of smallholder dairy farmers in Kiambu County. Follow-up methods, enumerator-assisted administration, and mobile tools, should be used in data collection of future studies to enhance the response rate and minimize attrition.

4.3 Demographic of Respondents

In this section, the essential demographic and background features of the respondents are outlined, which will help to interpret the results of the study. The geographic location of

respondents is of much interest especially since regional variations can affect the dairy farming practices, market accessibility, and price volatility exposure.

4.3.1 Distribution by Sub-County

Table 4.3: Distribution of Respondents by Sub-County

Sub-County	Frequency	Percentage (%)
Gatundu North	32	7.4
Gatundu South	3	0.7
Githunguri	53	12.3
Juja	44	10.2
Kabete	41	9.5
Kiambaa	50	11.6
Kiambu	1	0.2
Kikuyu	52	12.1
Lari	10	2.3
Limuru	52	12.1
Ruiru	46	10.7
Thika	46	10.7
Total	**430**	**100.0**

Source: Survey Data

The fact that the respondents were distributed among sub-counties implies that the research had wide geographic coverage in Kiambu County. The sub-counties that had the highest representation were Githunguri, Kikuyu, and Limuru, and these are also in line with their reputation in dairy production. This implies that the research was able to capture

information in regions where there is high activity of dairy farming, thus upgrading the applicability of the results.

Moreover, the comparatively even representation of the majority of the sub-counties means that the data are representative of different farming settings, market access conditions, and institutional support systems. This disparity is especially crucial to consider price volatility because various regions can be characterized by different degrees of market integration, infrastructure development, and access to cooperative services. As a result, the results represent an overall image of the dairy industry, and not be biased towards a particular area.

Table 4.3: Demographic Characteristics of Respondents

Characteristic	Frequency	%
Gender		
Male	280	65.1
Female	150	34.9
Total	**430**	**100.0**
Age Category		
Below 30	45	10.5
30–40	117	27.3
41–50	157	36.6
Above 50	111	25.6
Total	**430**	**100.0**
Education Level		
No Formal Education	30	7.0
Primary	95	22.1

Secondary	185	43.0
Tertiary/Higher	120	27.9
Total	**430**	**100.0**
Farming Experience		
Less than 5 yrs	55	12.8
5–10 yrs	138	32.0
11–20 yrs	170	39.5
Above 20 yrs	67	15.7
Total	**430**	**100.0**

Source: Survey Data

Table 4.3 presents the demographic profile of the 172 respondents. The majority of the farmers were male (65.1%), with the largest age group being 41–50 years (36.6%). Most respondents had attained secondary education (43.0%), and the dominant farming experience category was 11–20 years (39.5%), indicating a relatively experienced farming community in the study area. Note that the frequencies and percentages reported in Tables 4.2 and 4.3 are computed from the full distributed sample (N = 430), whereas all inferential analyses (correlation and regression) are based on the 172 usable responses. This distinction should be borne in mind when interpreting mean comparisons: the descriptive characteristics of the full sample may not precisely reflect those of the analytical subsample, potentially introducing a disparity between the demographic profile described and the population on which statistical findings are based.

4.4 Descriptive Statistics for Study Variables

This section gives the descriptive statistical analysis of the key study variables involved in the analysis. To give a general idea of the central tendencies and variability in responses, it

summarizes the perceptions of respondents in terms of mean and standard deviation values. Results are presented based on the key constructs of the research starting with forward contracting arrangements. It should be noted that the internal consistency (reliability) of each multi-item scale was not reported in this study. Future versions should include Cronbach's alpha coefficients for each construct to confirm that items reliably measure their intended latent variable. Generally, Cronbach's alpha values of ≥ .70 are considered acceptable for social science research (Nunnally, 1978). The absence of reliability statistics is an acknowledged limitation that may affect confidence in the construct validity of the Likert-scale measures used.

4.4.1 Forward Contracting Arrangements

Table 4.4: Descriptive Statistics for Forward Contracting

Statement	Mean	Std. Dev
The contract price is stable	4.60	0.80
The buyer honours payment and price terms	4.40	0.85
Contracting has improved my income predictability	4.50	0.82

Source: Survey Data

The findings show that forward contracts are highly embraced by smallholder dairy farmers, which is demonstrated by the high mean value of 4.50. This implies that the majority of the respondents feel that they enter into contractual agreements in a bid to stabilize the prices and to minimize the risks of experiencing market volatility.

The standard deviation is relatively low at 0.82, which implies that there is not a high dispersion of observations in the responses, the opinions and practices of farmers towards forward contracting are quite similar within the sample. This uniformity indicates the forward contracting is not only widely used but also similarly comprehended by farmers.

These item-level results indicate very high mean scores of between 4.40 and 4.60 producing a composite mean of 4.50, thus reflecting a strong agreement between the respondents in terms of the application and efficacy of the forward contracting. The maximum mean is found in the statement that contract prices are stable 4.60, thus indicating that a strong perception of forward contracts as a price stabilization tool is held by farmers. Likewise, the average 4.50 of income predictability affirms that contractual agreements increase planning and financial certainty. The marginally smaller mean of buyer compliance 4.40 suggests that although the contracts are generally respected, some discrepancies in enforcement can occur. Although respondents reported high levels of adoption of forward contracting arrangements, the regression results indicate that this intervention does not significantly explain variations in price volatility (B = -.083, p = .488).

4.4.2 Price Insurance Mechanisms

Table 4.5: Descriptive Statistics for Price Insurance

Statement	Mean	Std. Dev
Insurance premiums are affordable	4.10	0.92
Insurance protects me from milk price drops	4.40	0.86
I would join a well-designed price insurance scheme	4.40	0.86

Source: Survey Data

A mean of 4.10 and a standard deviation of 0.92 shows that there is a general consensus that the affordability is acceptable, but the deviation is relatively higher, which means that the perceptions of affordability are relatively different among respondents. This disparity indicates that there are differences in the level of income and access to financial resources, that is, affordability is not equally felt across all farmers.

The mean and standard deviation of 4.40 and 0.86 respectively indicate a high consensus on the view that insurance is effective in terms of protection against the decline of prices. This implies that the farmers usually see insurance as an effective risk management tool to help soften income shocks. This moderate variability means that although majority of the farmers hold this opinion, a minor percentage might be limited in terms of exposure or knowledge in regards to insurance benefits.

An average of 4.40 and a standard deviation of 0.86 depicts that there is a great desire among farmers to engage in well-organized insurance programs. This implies positive acceptance in formal risk transfer mechanisms. Nonetheless, the moderate dispersion indicates that the willingness is not fully homogeneous and could be due to the existence of variation in the levels of trust, awareness and previous experience with financial products. The composite mean for price insurance mechanisms was 4.30, computed as the average of the three item means ((4.10 + 4.40 + 4.40) ÷ 3 = 4.30), indicating a moderately high level of adoption and positive perception of insurance-based risk management among respondents. Although respondents reported high levels of adoption of price insurance mechanisms, the regression results indicate that this intervention does not significantly explain variations in price volatility.

4.4.3 Market Intelligence Systems

Table 4.6: Descriptive Statistics for Market Intelligence Systems

Statement	Mean	Std. Dev
I have access to timely milk price information	4.50	0.78
I compare prices before selling milk	4.30	0.82
Market information helps me negotiate better prices	4.40	0.80

Source: Survey Data

The mean of 4.50 and standard deviation of 0.78 show a high level of agreement that farmers can access timely market information. The variability is not that high, which means that there is a high degree of consistency in answers; it could be implied that the access to information systems is not regarded as a luxury and is equally experienced by the sample.

The standard deviation of 0.82 and a mean of 4.30 shows that there is a general consensus that farmers compare prices prior to selling their produce. Nevertheless, the dispersion is a little higher, which indicates that the practice is widespread but not uniformly used, which may be explained by the dissimilarity in the market structure, time limitations, or availability of rival buyers.

The correlations that market information increases bargaining outcomes are well supported with a mean of 4.40 and a standard deviation of 0.80. This means that farmers are finding information to be a valuable instrument in enhancing negotiating strength and gaining enhanced prices. The variability is also relatively low, which also indicates a consistent perception of this among respondents. The composite mean for market intelligence systems was 4.40, computed as the average of the three item means ((4.50 + 4.30 + 4.40) ÷ 3 = 4.40), indicating a high level of perceived usefulness and access to market information among the sampled farmers. Although respondents reported high levels of engagement with market intelligence systems, the regression results indicate that this intervention does not significantly explain variations in price volatility when controlling for other variables.

4.4.4 Cooperative Bargaining Capacity

Table 4.7: Descriptive Statistics for Cooperative Bargaining Capacity

Statement	Mean	Std. Dev
The cooperative negotiates better prices for members	4.30	0.90
Payments from the cooperative are reliable	4.10	0.95
Cooperative membership stabilizes my milk income	4.20	0.88

Source: Survey Data

The standard deviation of 0.90 and a mean of 4.30 show that farmers tend to agree that cooperatives can enhance the results of price negotiation. Nonetheless, the moderate-high distribution implies the presence of variability in the effectiveness of cooperation that is probably caused by the differences in management efficiency, leadership models, and regional performance.

The standard deviation of 0.95 and mean of 4.10 are indicative of overall consensus in the payment reliability, yet the standard deviation is relatively high, which suggests variation in payment experiences. This implies that though one cooperative may operate effectively, another might have delays or inefficiencies in its operations that would lead to a lack of trust in the cooperative by its members.

The mean of 4.20 and a standard deviation of 0.88 indicate that cooperative membership is seen to play a role in income stability. The fact that the dispersion is moderate means that this advantage is not uniformly distributed meaning that the strength and performance of cooperatives are not equal everywhere. The composite mean for cooperative bargaining capacity was 4.20, computed as the average of the three item means ((4.30 + 4.10 + 4.20) ÷ 3 = 4.20), indicating a high level of agreement among respondents regarding the perceived value of cooperative structures in supporting price negotiation and income stability. Although

respondents reported high levels of cooperative engagement, the regression results indicate that cooperative bargaining capacity does not significantly explain variations in price volatility.

4.4.5 Product Diversification

The results for product diversification are outlined on table 4.8

Table 4.8: Descriptive Statistics for Product Diversification

Statement	Mean	Std. Dev
Diversification has increased my dairy income	4.40	0.83
Income from diversified dairy products is more stable	4.20	0.87

Source: Survey Data

The mean of 4.40 with a standard deviation of 0.83 shows that there is a high level of agreement that diversification boosts the level of income. This implies that farmers well understand the diversification as an excellent method of maximizing income by diversifying their income. The moderate variability means that the degree to which the income is to be improved varies among the farmers depending on their level of diversification. Mean 4.20 with a standard deviation of 0.87 indicates that there is an agreement that diversification leads to income stability. This means that farmers consider diversification as a tool of decreasing the variability of income over time. Nonetheless, the variation implies that not every farmer has the same degree of stability, and it is probably caused by the differences in the production capacity and market access. The composite mean for product diversification was 4.30, computed as the average of the two item means ((4.40 + 4.20) ÷ 2 = 4.30), indicating a high level of agreement among respondents that diversified dairy production contributes positively to income levels and stability. Although respondents reported high levels of diversification activity, the regression results indicate that product diversification does not significantly explain variations in price volatility.

4.4.6 Price Volatility

Table 4.9: Descriptive Statistics for Price Volatility

Statement	Mean	Std. Dev
Milk prices are stable throughout the year	3.50	1.05
Price fluctuations affect my household budget	4.10	0.98
My dairy income is predictable from month to month	3.80	1.03

Source: Survey Data

The 3.50 mean and standard deviation of 1.05 suggest that there is relatively low agreement on price stability, indicating that farmers commonly believe that milk prices are volatile across the year. The high dispersion indicates that there are large differences in experience that is, some farmers will have a moderate stability whereas others will have high instability.

The mean is 4.10 with standard deviation of 0.98 indicating a high consistency in the view that price variability hurts the household budget. This shows that household financial planning is directly affected and clearly influenced by price volatility. The relatively high variability implies that the extent of this impact varies among households.

The mean of 3.80 with a standard deviation of 1.03 indicates a moderate consensus on predictability of income. This implies that although a number of farmers can predict the level of income they will have, most farmers continue to face uncertainties. The large dispersion also shows that there are large differences in predictability in the sample, which are probably explained by the availability of markets and risk management policies. It is worth noting a notable disparity between the descriptive means of the independent variables and those of the dependent variable. The five intervention constructs all yielded high composite means in the range of 4.20 to 4.50 on a five-point scale, suggesting that respondents strongly endorsed their

engagement with market-based interventions. In contrast, the price volatility items yielded lower and more dispersed means (range: 3.50–4.10), indicating moderate-to-high perceived volatility. This divergence is analytically important: respondents simultaneously report high adoption of stabilizing interventions and ongoing experience of price volatility, which may indicate that (a) the interventions are not translating into experienced price stability at the farm level, (b) respondents perceive the interventions favourably but their actual effectiveness in reducing volatility is limited, or (c) the ceiling effects characteristic of Likert scales in self-report surveys may have compressed variance in the intervention variables, reducing their statistical power to predict variation in the outcome. This inconsistency should be explored further in the discussion chapter.

4.5 Diagnostic Tests

This section presents the diagnostic tests conducted to verify whether the assumptions of regression analysis were satisfied. These tests include normality, multicollinearity, heteroscedasticity, and linearity. Ensuring that these assumptions are met enhances the validity and reliability of the regression results.

4.5.1 Normality Test

Table 4.10: Tests of Normality

Variable	Test	Statistic	df	Sig.
Price Volatility	Kolmogorov-Smirnov	0.266	172	0.000
Price Volatility	Shapiro-Wilk	0.876	172	0.000

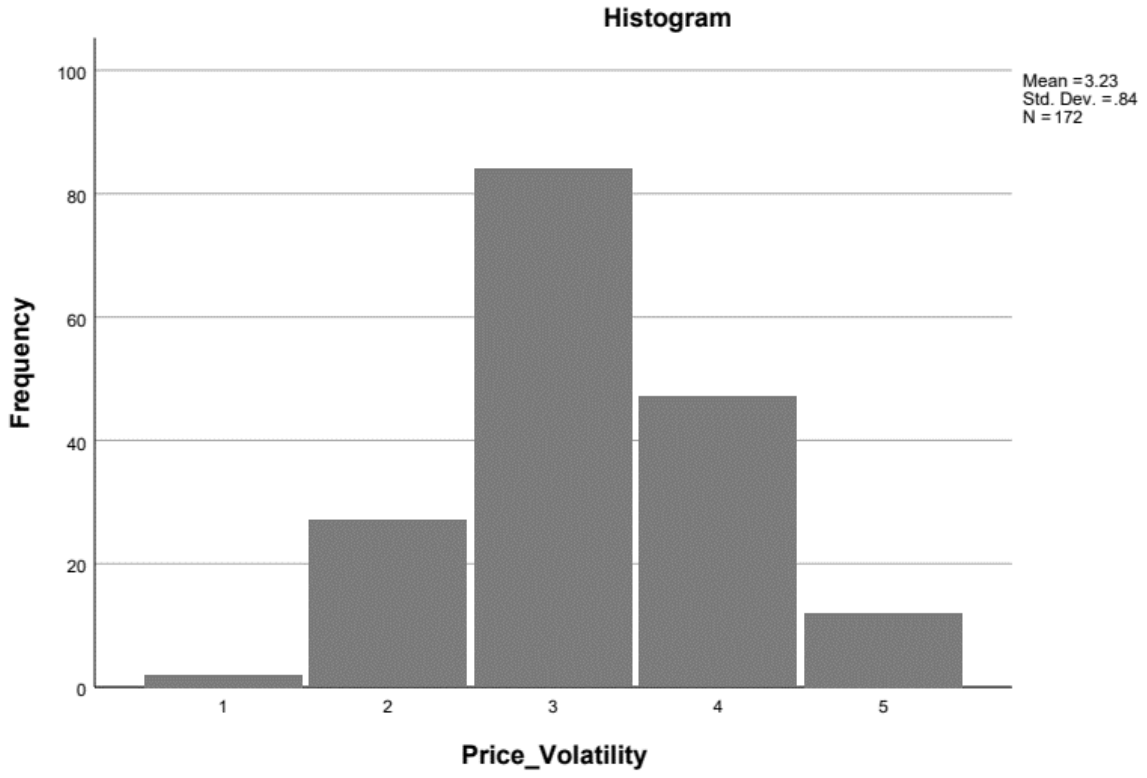
Source: Survey Data

The outcomes of the normality tests show that the dependent variable (price volatility) does not have a normal distribution. The Kolmogorov-Smirnov test as well as the Shapiro-Wilk

test has a significance value of 0.000, which is below the significance level of 0.05. This causes a rejection of the null hypothesis, which is that the data are normally distributed.

Nevertheless, even though this statistical measure is the sign of non-normality, the histogram can give further information about the pattern of distribution.

Figure 4.1: Histogram of Price Volatility



The histogram indicates that the price volatility distribution is about a bell-shaped distribution, with the majority of the values concentrated around the mean. Even though there are minor deviations of ideal normality, the distribution does not seem heavily skewed or kurtotic.

Normality tests, such as Shapiro-Wilk, are very sensitive in large samples, such as in this study, and tend to pick up small deviations as statistically significant. The Central Limit Theorem states that, given a large sample size (n > 30), the sampling distribution approaches

normality, no matter what the underlying data distribution is. Thus, the minor breach of normality is not regarded as significant enough to dismiss the regression analysis, and the data can be regarded as appropriate to conduct additional parametric tests.

4.5.2 Multicollinearity Test

Table 4.11: Multicollinearity Test (VIF Values)

Variable	Tolerance	VIF
Forward Contracting	0.682	1.466
Price Insurance	0.641	1.560
Market Intelligence Systems	0.598	1.672
Cooperative Bargaining Capacity	0.623	1.605
Product Diversification	0.657	1.522

Source: Survey Data

Multicollinearity is the phenomenon of having a high correlation between independent variables and this could lead to distortion of regression estimates. Variance Inflation Factor (VIF) and tolerance values were used to determine this. The findings indicate that, the VIFs are less than 10 and the tolerance values are greater than 0.1 that multicollinearity is not an issue in this research. The VIF values in the range of 1.466-1.672 indicate a moderate level of correlation between the predictors, which is okay in regression analysis. This confirms that every independent variable is adding some unique information to the model and that the regression coefficients can be read without distorting them due to multicollinearity.

4.6 Correlation Analysis

In this section, the Pearson correlation coefficients are given to analyze the strength and direction of relationships between the variables under study before the regression analysis.

Table 4.12: Pearson Correlation Matrix

Variables	FC	PI	MIS	CBC	PD	PV
FC	1					
PI	.312**	1				
MIS	.285**	.341**	1			
CBC	.267**	.298**	.322**	1		
PD	.251**	.276**	.304**	.318**	1	
PV	-.140	-.056	-.161*	-.130	-.105	1
p	.068	.469	.036	.091	.172	—

FC = Forward Contracting, PI = Price Insurance, MIS = Market Intelligence Systems, CBC = Cooperative Bargaining Capacity, PD = Product Diversification, PV = Price Volatility

To analyze the quality and the direction of the bivariate relationships of strategic market-based interventions and the price volatility among smallholder dairy farmers, Pearson correlation analysis was performed. The findings reveal that forward contracting was negatively related to price volatility (r = -.140, p =.068) and maybe higher utilization of forward contracting is associated with less price volatility, but this association was not significant. Price volatility also showed a weak negative and insignificant relationship with price insurance (r = -.056, p =.469), which showed no statistically reliable bivariate relationship. In the same way, cooperative bargaining capacity had a weak negative though not significant association with price volatility (r = -.130, p =.091) suggesting that farmers who engage in cooperative bargaining could have slightly lower volatility, but the difference was not significant.

There was a low but statistically significant negative association between market intelligence systems and price volatility (r = -.161, p =.036). This indicates that better market information access is related to the volatility of price at the bivariate level. The price volatility was weakly negatively correlated with product diversification (r = -.105, p =.172), but it was not statistically significant. Generally, the correlation outcomes indicate that most strategic interventions have negative relationships with the price volatility with the exception of market intelligence systems which showed statistically significant relationship between the two variables. Correlation analysis however does not take into consideration the overlapping effects of the predictors hence a multiple regression analysis was performed so as to identify the independent predictive effect of individual interventions.

4.7 Regression Analysis

Regression analysis was done to establish the joint and independent effects of the independent variables on price volatility.

4.7.1 Model Summary

Table 4.13: Model Summary

Model	R	R^2	Adjusted R^2	Std. Error of the Estimate
1	0.176	0.031	0.002	0.542

Source: Survey Data

The summary of regression model shows that there is a weak association between the joint strategic market-based interventions and price volatility (R = .176). The coefficient of determination (R 2 =.031) indicates that the five independent variables together only accounted 3.1% of the variation in price volatility among smallholder dairy farmers.

The adjusted R^2 value of .002 further indicates that, after accounting for the number of predictors in the model, the explanatory power of the regression equation is extremely weak. This indicates that the chosen strategic market-based interventions can only account for a very small percentage of the variation in the volatility of prices. These results suggest that the impact of factors external to the model could have a stronger influence on price volatility in smallholder dairy farmers.

4.7.2 ANOVA

Table 4.14: ANOVA

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	1.597	5	0.319	1.056	0.387
Residual	49.869	165	0.302		
Total	51.466	170			

Source: Survey Data

The results of the ANOVA show that the regression model was not significant, $F(5,165) = 1.056$, $p = .387$. Considering the p-value is greater than the standard significance level of 0.05, it is impossible to reject the null hypothesis that the model is not explanatory. This means that the joint strategic market-based interventions incorporated in the model are not a significant predictor of the price volatility among sampled smallholder dairy farmers. The overall regression model, therefore, fails to give enough evidence to conclude that the interventions selected have a collective effect on price volatility in the area of study.

4.7.3 Regression Coefficients

Table 4.15: Regression Coefficients

Variable	B	Std. Error	t-value	Sig.
Constant	2.145	0.312	6.874	0.000
Forward Contracting	-0.083	0.119	-0.696	0.488
Price Insurance	-0.062	0.101	-0.619	0.536
Market Intelligence Systems	-0.125	0.119	-1.049	0.297
Cooperative Bargaining Capacity	-0.028	0.109	-0.255	0.799
Product Diversification	-0.002	0.112	-0.012	0.990

Source: Survey Data

The regression coefficients were tested to understand the independent effects of each strategic market-based intervention to price volatility with any other two predictors held constant. Forward contracting had a negative coefficient (B = -.083), indicating the inverse correlation with price volatility, but it was not significant (p =.488). This implies that forward contracting was not a significant predictor of price volatility in the model.

Price insurance had a negative coefficient (B = -.062, p =.536), which means that it does not have any statistically significant impact on price volatility. The negative coefficient (B = -.028, p = .799) of cooperative bargaining capacity was non-significant which means that this factor has no significant predictive value. Market intelligence systems captured the negative coefficient (B = -.125), but the relationship was not statistically significant when the other variables were controlled (p = .297). This result is well worthy of explicit discussion because market intelligence demonstrated an explicit bivariate correlation with price volatility (r = -.161, p = .036). The apparent impact of market intelligence was lost in the multivariate analysis, indicating that this effect may be operating in conjunction with other interventions,

such as cooperative membership, which is particularly important when considering several factors simultaneously. The bivariate correlation may also be due to the combined effect of the co-occurring interventions, as farmers who also access market intelligence are more likely to be part of a cooperative or to forward contract. These results illustrate the importance of multivariate analysis to separate overlapping predictors and the need to be careful not to make causal inferences from bivariate correlations.

The negative coefficient of product diversification (B = -.002, p = .990) was close to zero, which means that the relationship is not statistically significant with price volatility. In general, the price volatility was not significantly predicted by the regression model using any of the strategic market-based interventions.

4.7.4 Model Limitations

The regression model has very low explanatory power ($R^2 = 0.031$), which means that only 3.1 % of the variance in price volatility can be explained using the five independent variables selected. In addition, the overall model is not statistically significant ($F(5, 165) = 1.056$, $p = .387 > 0.05$), which verifies that the predictors do not collectively explain the price volatility at a level that is statistically acceptable. No individual regression coefficient reached statistical significance, meaning that none of the interventions including; forward contracting, price insurance, market intelligence systems, cooperative bargaining capacity, or product diversification shows a statistically significant independent relationship with price volatility when the other variables are held constant.

The findings do not indicate that the interventions are futile, but rather that the farm-level adoption of market-based strategies, as perceived by farmers, may not be enough to bring about statistically significant reductions in price volatility. This suggests that other variables (which are not captured in the model) such as the structural market environment, seasonal

supply variations, processing capacity bottlenecks, policy regimes and macro-economic conditions may be more important in explaining dairy price volatility in Kiambu County. Larger models should also be developed that include such structural and contextual factors to enhance the explanatory power and explain the determinants of price volatility in smallholder dairy systems in the future.

4.7.5 Interpretation of Non-Significant Findings

The result of the non-significant regression model ($R^2 = .031$, $F(5,165) = 1.056$, $p = .387$) is not to be dismissed but requires careful interpretation given that it represents a substantively meaningful finding in its own right. Below three key explanations are offered.

First, the structural interventions on the farm may not be adequate to counteract price volatility at the market level. In smallholder dairy systems, the price volatility is driven mostly by macro-structural factors such as seasonal variability in supply, the pricing power of processors, government dairy marketing policies, and macro-economic conditions which exist outside of the farm gate. Changes in individual farmer adoption of forward contracting, price insurance, or market intelligence systems can increase household-level income predictability, but are unlikely to lead to changes in market-level price signals that affect volatility. This interpretation is in line with the theory of the commodity market, which separates risk management from the level of the producer from the level of the market for determining prices. The null finding thus represents a logically consistent result: the behavior of individual farms is not a determinant of the price outcomes in the market.

Secondly, the sample size of $n = 172$ may have been too small to yield statistically significant differences for small effect sizes. None of the r values were large enough to be associated with one another, and a power analysis indicates that a much larger sample would be needed to detect such effects at $\alpha = .05$, with adequate power ($\beta \geq .80$). The sample size is

further restricted by the 40% response rate for 430 questionnaires distributed and the potential for a Type II error, that is, that a true but small effect went undetected. Modest relationships among farm-level interventions and price volatility might be better detected by future studies using purposive sampling methods or longitudinal designs.

Third, the independent variables and dependent variable price volatility were both measured through perceptual Likert-scale items, which can have dampened the statistical relationships compared to those found with objective data on prices. While the self-reported perceptions of price stability by respondents (Table 4.9) may not necessarily correspond exactly to the market price fluctuation actually observed in the processor or cooperative payment history, the data indicate that some movement occurred in the past year. Subjective measures can increase or decrease the true relationship between variables because they can create shared method variance. The regression results could be different if the price volatility data had been objective rather than subjective, as in the case of the coefficient of variation in farm-gate prices over the course of 12 months. This is an important measurement limitation that should be taken up in future studies using triangulation with administrative price records.

4.8 Hypothesis Testing Summary

Table 4.16: Hypothesis Testing Results

Hypothesis	Statement	Result
H1	Forward contracting reduces price volatility	Not Supported
H2	Price insurance reduces price volatility	Not Supported
H3	Market intelligence systems reduce price volatility	Not Supported
H4	Cooperative bargaining capacity reduces price volatility	Not Supported
H5	Product diversification reduces price volatility	Not Supported

Source: Survey Data

The hypothesis testing results indicate that none of the proposed hypotheses were supported by the regression analysis. Whereas, some of interventions showed weak negative correlation with price volatility, none of the interventions was found to have any significant effect in the multivariate regression model. This indicates that the chosen strategic market-based interventions cannot independently describe price volatility amongst smallholder dairy farmers in the Kiambu County. The results suggest that the actual causes of price volatility in dairy could be broader market, structural, seasonal or institutional factors which are not reflected in the current model, and which are potentially stronger than the interventions investigated in this paper

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter presents a detailed synthesis of the key findings derived from the data analysis and interpretation presented in the previous chapter, and it draws conclusions in line with the study objectives. It also describes practical, policy, and institutional suggestions based on the empirical findings, the limitations that were faced in the course of the research, and suggestions of future research. The main aim of this research was to investigate the impact of strategic market-based interventions on price volatility in smallholder dairy farmers in the Kiambu County. In particular, the research concentrated on forward contracting, price insurance, market intelligence systems, cooperative bargaining capacity, and the diversification of products as possible strategies to the reduction of price fluctuations. This chapter thus incorporates both statistical and theoretical and practical information to help come up with a complete picture of the effectiveness of such interventions in the dairy sector.

5.2 Summary of Findings

The response rate for the 430 questionnaires was 40.0% with a total of 172 responses received. The descriptive results showed that the mean for each independent variable was high, implying that most of the smallholder dairy farmers are strategic users of market-based interventions. This means farmers are not just aware of these strategies, but are implementing them to help deal with the risks that occur in the dairy market when prices change. The study results indicated that market-based interventions are widely used (high composite means), but the regression results indicated that they do not significantly affect the variations of price volatility ($R^2 = 0.031$, $F(5,165) = 1.056$, $p = .387$).

To examine the relationship between forward contracting and price volatility, the findings indicated a weak negative relationship which did not exist statistically. In line with this the second objective based on price insurance showed no statistically significant correlation with price volatility, although it showed a weak negative relation. The third goal that investigated the market intelligence systems had a statistically significant negative correlation at the correlation level, but the effect was not significant in the regression analysis. The fifth goal is a product diversification goal and did not statistically significantly affect price volatility, while the fourth goal related to cooperative bargaining had a weak and non-significant negative correlation.

Overall, the regression analysis revealed that the overall interaction of all the strategic market-based interventions was statistically insignificant and weak in explaining the variation in the price volatility, which accounted for only 3.1 percent of the total variation in price volatility. These results imply that the chosen interventions are not significantly predictive of price fluctuations when used concurrently, so other external variables may have a more leading role in price changes in the dairy industry.

5.3 Discussion of Findings by Variable

The findings from the present study provide useful information on the price volatility characteristics of the dairy industry and the limitations of market-based intervention at farm level as a means of market stabilization. The descriptive results showed that farmers use various strategies including forward contracting, insurance, and diversification, but these strategies were not found to be associated with the price volatility in the regression study. This indicates that there is a gap between the strategic uptake and the market response in terms of price.

Theoretically, these non-significant results have significant implications. The results do not imply that market-based interventions aren't relevant, but question the notion that farm-

level market interventions necessarily lead to measurable price stability at the market level. The collective action theory and market information theory that was used in this study might need to be adapted in situations where the market is poorly developed, the cooperative governance is weak, and the policy is poorly enforced. The results indicate that the theories' prediction relies on the creation of structural conditions which are not found in the smallholder dairy industry in Kiambu County. This is a theoretical contribution, as the study establishes the boundary conditions within which it can be expected that farm-level strategic interventions will be able to dampen price volatility, while adding to the existing literature on how to analyze agricultural market interventions in developing economies.

5.3.1 Forward Contracting Arrangements and Price Volatility

The regression analysis did not show any relationship between forward contracting and price volatility to be statistically significant (B = -.083, p = .488). The results of this finding do not support the hypothesis that forward contracting has a negative association with price volatility in the setting studied. The formal contractual arrangements are likely to be underdeveloped or poorly implemented in the smallholder dairy system in Kiambu County, and may have only a minimal impact on the market, a structural explanation is plausible. However, the lack of a statistically significant association also could be due to limited market coverage – that is, only a portion of farmers might be part of formal contracts – and the overall impact of the contracts on market-level price volatility would be minimal. This aligns with evidence from around the world that the effectiveness of forward contracting depends strongly on the quality of the contracts, enforcement and the number of participants.

5.3.2 Price Insurance Mechanisms and Price Volatility

There was no statistically significant relationship between price insurance mechanisms and price volatility (B = -.062 p = .536). Though there is a positive composite mean score

(4.30), suggesting positive attitude towards insurance, the positive attitude towards insurance is not reflected by the relationship of insurance and price stability outcomes in the regression model, and can be detected in the model by price stability outcomes. The pattern indicates that existing insurance schemes offered to Kiambu County smallholders may not be specifically geared towards the dairy industry's price risks or the scale of adoption may be too small to have a market impact. This is in line with the empirical evidence in the smallholders in particular, where a variety of factors can limit access to insurance, such as cost, low trust, complex products, and a lack of knowledge about claims.

5.3.3 Market Intelligence Systems and Price Volatility

At the bivariate level, the market intelligence systems had a statistically significant negative correlation with the price volatility ($r = -.161$, $p = .036$), indicating that increased access to market information is correlated with reduced price volatility at the bivariate level. This relationship was however not statistically significant in the multivariate regression model ($B = -.125$, $p = .297$), meaning that when other interventions are accounted for, the relationship does not exist on its own. This trend reflects the idea that access to information is useful, but it's not enough to solve more fundamental structural market inefficiencies. While having access to price information could facilitate the individual farmer's selling decisions, it does not address factors affecting price volatility on the market level that include supply-side, infrastructure, and institutional constraints. The multivariate result thus should not be interpreted as information systems being irrelevant as it proves that market intelligence must be part of the wider market reform process to prove its price stabilizing role.

5.3.4: Cooperative Bargaining Capacity, Product Diversification and Price Volatility

Cooperative bargaining and product diversification were not statistically significantly associated with price volatility in the regression model ($B = -.028$, $p = .799$; $B = -.002$, $p =$

.990, respectively). For cooperative bargaining, the lack of a significant relationship could be the result of structural barriers within the cooperative sector that limit the capacity of cooperatives to generate measurable price stability from their collective effort, such as poor governance, uneven market integration, and free-rider issues. At the descriptive level, product diversification is related to income stability (composite mean = 4.3), but at the regression level, it shows no significant relationship with price volatility. This matches the theory that diversification is mostly a household's income-smoothing tool and not a direct driver of milk price developments at the market.

The aggregate of these results collectively points to a more structural explanation: the dairy smallholder farmer sector in Kiambu County is characterized by factors that lie outside the scope of strategic interventions that can be implemented by individual farmers, such as seasonality, limited processing capacity, infrastructural constraints, and macroeconomic dynamics. Although individual level strategies are popular and favorable, they were not found to be statistically significant when included in a multivariate price volatility model. However, a more holistic strategy combining systemic market reforms, policy measures and institutional capacity-building with farm-level interventions may be needed for this sector to deliver measurable price stability.

One possible explanation for these findings is that the majority of the price variation in the dairy sector can be attributed to structural and systemic factors which are not directly related to individual farmers. Some of these factors can be seasonal milk production, consumer demand, lack of efficiency in the supply chain, inadequate processing facilities, and macroeconomic factors. A set of individual strategies can assist farmers to cope with household income fluctuations, but such strategies are not likely to be correlated with a measurable decrease in overall market price volatility without supporting structural changes.

A lack of association between forward contracting and price volatility may be a sign of limited or poor formal contractual organization in the study area. Similarly, no significant relationship was found for price insurance, which could mean that current products are inappropriate for smallholders or that scale of adoption is not large enough for market level effects to be detected. The findings also indicate that there is no statistically significant relationship between the cooperative bargaining capacity and price volatility, suggesting structural constraints such as uneven governance, uneven market power and cooperative management effectiveness among sub-counties. Although there is theoretical potential for cooperatives to bolster collective bargaining, the empirical evidence of this link depends on the quality of the cooperatives, and the extent to which they are integrated into markets.

The overall results of the market intelligence systems revealed a negative and statistically significant correlation with the price volatility at the bivariate level; however, this association was not found in the multivariate regression model, which indicated that more detailed structural market inequalities do not depend solely on information access. In the same way, the diversification of products at the household level is not related with the price volatility at the market level in a statistically significant manner. All these results suggest that price volatility is a complex phenomenon and relates to a large number of factors, none of them being addressed by a single strategy; therefore, a more comprehensive approach is needed that encompasses all the factors which influence price volatility.

5.4 Conclusions

The study finds that market-based interventions are common among smallholder dairy farmers in Kiambu County, but have no statistically significant impact on price volatility. The overall model was not statistically significant ($p = .387$) and the regression explained only 3.1% of the variation in price volatility ($R^2 = 0.031$). This implies that the level of intervention and the state of the dairy markets are not sufficient to guarantee a stable price in the dairy industry

and that other external and/or structural factors not captured in the model may be responsible for the price volatility.

Second, the research shows that there are also more fundamentally structural, institutional and market-related events that can vary prices, but which are not captured in the model. Such factors can comprise seasonal production cycles, market inefficiencies, infrastructural constraints and gap in the policies all of which lead to changes in dairy prices.

Third, the study shows that some of the interventions (market intelligence systems), have some potential in price outcomes, but, when used alone they do not seem to be so influential when used together with the other variables. This implies that single interventions can hardly bring any significant changes in price stability.

Last but not least, the paper points to the need for a more systemic "whole of market" strategy to address price volatility that combines farmer-level measures and institutional reform and policy and market development measures.

5.5 Recommendations

This section presents policy, practical, and institutional recommendations based on the study results on dairy market price volatility and the performance of risk management strategies among the smallholder farmers in Kiambu County.

5.5.1 Policy Recommendations

The regression results showed that none of the five market-based interventions were significant in explaining price volatility and the model could account for only 3.1% of the variation. This low explanation power suggests that the structure of markets is a more important driver of price changes in the dairy sector than other factors. Therefore, it is important for county governments to introduce dairy price monitoring units that provide dairy farmers with farm-gate dairy price bulletins through SMS, which is a low-cost intervention that has the

potential to improve the effectiveness of market intelligence. In general, policy makers should focus on improving market governance at a system level, not just at the farmer level. This involves the formulation and execution of price stabilisation policies including minimum price guarantees or the control of a dairy price to limit price fluctuations. Furthermore, the formal and enforceable contractual arrangements in the dairy sector should be strengthened, to make forward contracting systems valid, effective and beneficial to smallholder farmers.

The policy makers need to also focus on coming up with inclusive and accessible agricultural insurance programs which are directly tailored to deal with price risks of smallholder farmers. This can include subsidizing the premiums, creating more awareness and collaborating with the players in the private sector in coming up with more effective insurance products. Moreover, market infrastructure (storage facilities, processing and transport facilities) should be invested in to improve the market efficiency and volatility.

5.5.2 Practical Recommendations

Improvement of the effectiveness of the already existing strategies at the farmer level requires the improvement of the knowledge, skills and resources of the farmer. Farmers are to be urged to join properly controlled and open cooperatives which are more likely to increase their collective bargaining strength and access the market better. They need to establish training and capacity-building programs that will assist farmers to learn to comprehend and apply market-based interventions.

There should also be an attempt to enhance the access to reliable and timely market information via digital platforms and extension services. Farmer would be better equipped to analyse and respond to the market information and make better decisions on production and marketing. Although diversification must remain as an income stability strategy, it must be accompanied with more comprehensive market reforms to deal with price volatility.

5.5.3 Institutional Recommendations

Government agencies, non-governmental organizations and development partners as institutional stakeholders should aim at enhancing the dairy value chain to enhance coordination and efficiency. This involves encouraging enhanced connections between farmers, processors and markets, and enhancing price transmission mechanisms.

In addition, the government and accountability within the cooperative societies should be enhanced to ensure that they can provide what cooperative members are interested in. Farmers can also be empowered further through strengthening of their institutional support systems such as extension services and financial advisory services to help them cope with the market risks.

5.6 Study Limitations.

There were a number of limitations in this study that could have affected the results. Among the key weaknesses was that the effective sample size was reduced by the missing data, limiting the amount of observations to be used as the regression model, and potentially, compromising the statistical power of the study. Also, the utilization of self-reported data predisposes the risk of biasing in responses because it is not always possible to get accurate or objective information.

It was also limited in its scope, as it only analyzed the selected interventions based on the market approach, and did not look into other factors that might have influenced the study, such as policy influences, environmental conditions and market dynamics in general. Thus, the implications are that the results should be treated with a certain level of skepticism. Importantly, a reliance on perceptual volatility indicators, based on farmer self-reports rather than objective price data, could have dampened the observed associations between interventions and prices. The results are therefore interpreted as showing that the interventions as perceived by farmers are not enough to stabilize prices under the current structural conditions

and not because market-based interventions are ineffective. This is because future studies using objective price panel data would be more well suited to test these relationships.

5.7 Recommendations for future work.

Future studies could focus on identifying other factors which affect price volatility in the dairy industry, such as macroeconomic variables, policy measures and the dynamics along the supply chain. Longitudinal studies to investigate the changes in prices with time are also necessary to have a better understanding of seasonal and cyclic trends.

Comparative approaches across regions could also be employed in future research in which it would be assessed whether the results can be replicated in other contexts. Furthermore, to gain a better understanding of the existence of smallholder farmers and the practical challenges that they face with price volatility, qualitative research methods may be used.

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APPENDICES

Appendix I: Questionnaire

QUESTIONNAIRE FOR SMALLHOLDER DAIRY FARMERS

Title of Study: Strategic Market-Based Interventions and Price Volatility among Smallholder Dairy Farmers in Kiambu County

Instructions: All responses will be treated confidentially. Do not write your name.

SECTION A: RESPONDENT AND FARM CHARACTERISTICS

1. Sub-County: ☐ Githunguri ☐ Kiambaa ☐ Kikuyu ☐ Limuru ☐ Lari ☐ Other _____
2. Respondent role: ☐ Household Head ☐ Spouse ☐ Other _____
3. Age (years): ____
4. Gender: ☐ Male ☐ Female
5. Highest education level: ☐ None ☐ Primary ☐ Secondary ☐ Tertiary
6. Years in dairy farming: ____
7. Number of dairy cows: ____
8. Average milk production/day (litres): Low season ___ / High season ___
9. Main selling channel: ☐ Cooperative ☐ Processor ☐ Trader/Broker ☐ Direct Consumers ☐ Other ____

SECTION B: FORWARD CONTRACTING

On a scale of 1- to 5, where (1=Strongly Disagree … 5=Strongly Agree): please indicate your response on Contract Price Stability

QUESTION CODE	STATEMENT	SCALE (1–5)
Q10	The contract price is stable.	1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐
Q11	The buyer honours payment and price terms.	1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐
Q12	Contracting has improved my income predictability.	1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

SECTION C: PRICE INSURANCE

On a scale of 1- to 5, where (1=Strongly Disagree … 5=Strongly Agree): please indicate your response on Contract Price Insurance

QUESTION CODE	STATEMENT	SCALE (1–5)
Q13	Insurance premiums are affordable.	1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐
Q14	Insurance protects me from milk price drops.	1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐
Q15	I would join a well-designed price insurance scheme.	1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

SECTION D: MARKET INTELLIGENCE SYSTEMS

On a scale of 1- to 5, where (1=Strongly Disagree … 5=Strongly Agree): please indicate your response on Market Information Access and Use

QUESTION CODE	STATEMENT	SCALE (1–5)
Q16	I have access to timely milk price information.	1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐
Q17	I compare prices before selling milk.	1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐
Q18	Market information helps me negotiate better prices.	1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

SECTION E: COOPERATIVE BARGAINING CAPACITY

On a scale of 1- to 5, where (1=Strongly Disagree … 5=Strongly Agree): please indicate your response on Cooperative Negotiation and Payment Reliability

Indicator: Cooperative Negotiation and Payment Reliability

QUESTION CODE	STATEMENT	SCALE (1–5)

Q19	The cooperative negotiates better prices for members.	1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐
Q20	Payments from the cooperative are reliable.	1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐
Q21	Cooperative membership stabilizes my milk income.	1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

SECTION F: PRODUCT DIVERSIFICATION

On a scale of 1- to 5, where (1=Strongly Disagree … 5=Strongly Agree): please indicate your response on Product Diversification

QUESTION CODE	STATEMENT	SCALE (1–5)
Q22	Diversification has increased my dairy income.	1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐
Q23	Income from diversified dairy products is more stable.	1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

SECTION G: PRICE VOLATILITY

On a scale of 1- to 5, where (1=Strongly Disagree … 5=Strongly Agree): please indicate your response on Product Diversification

QUESTION CODE	STATEMENT	SCALE (1–5)
Q24	Milk prices are stable throughout the year.	1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐
Q25	Price fluctuations affect my household budget.	1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐
Q26	My dairy income is predictable from month to month.	1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

SECTION H: OPEN-ENDED QUESTIONS

Q27. What is the biggest challenge you face regarding milk prices?

.....

Q28. In your opinion, what should be done to improve milk price stability in Kiambu County?

.....

Appendix II: University Authorization Letter



P.O.Box: 53067 – 00200
Nairobi, Kenya.
Tel: 020 252 7170/1 – 5
Email: vc@anu.ac.ke
www.anu.ac.ke

Africa Nazarene University School of usiness

Ref: ANU/SB/MBA/110063369/2026

Date: 19th February 2026 Mr. Aluku Eugene Barasa Reg. No: 110063369

MBA in (Strategic Management)

RE: RESEARCH AUTHORIZATION FOR: ALUKU EUGENE BARASA

Dear Sir/Madam:

Mr. Aluku Eugene Barasa is a dedicated postgraduate student currently pursuing a Master of Business Administration (MBA) at Africa Nazarene University. As part of the requirements for his degree, he is undertaking a research study titled "***Strategic Market-Based Interventions and Price Volatility in the Dairy Sector; A Case of Kiambu County, Kenya***"

We kindly request your support in facilitating his research activities. Any assistance or cooperation extended to him will be highly appreciated and will significantly contribute to the successful completion of his academic work. Your support will play a vital role in advancing his academic and professional development.

Yours faithfully,

Dr. Harley Mutisya, PhD,
OGW
https://www.anu.ac.ke/
Personal Contact:
0722758125

Appendix III: Nacosti research license

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NATIONAL COMMISSION FOR
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    iv. Result in exploitation of intellectual property rights of communities in Kenya
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14. The Commission shall have powers to acquire from any person the right in, or to, any scientific innovation, invention or patent of strategic importance to the country.
15. Relevant Institutional Scientific and Ethical Review Committee shall monitor and evaluate the research periodically, and make a report of its findings to the Commission for necessary action.

National Commission for Science, Technology and Innovation(NACOSTI),

Off Waiyaki Way, Upper Kabete,

P. O. Box 30623 - 00100 Nairobi, KENYA Telephone: 020 4007000, 0713788787, 0735404245

E-mail: dg@nacosti.go.ke Website: www.nacosti.go.ke

Appendix IV: Map of Kiambu County

